Next Generation Automobiles
in Miyagi

http://www.miyagicar.com/

Strategic Regional Innovation Support Program by MEXT(For recovery from Tohoku Disaster) Next-Generation Automobiles / Miyagi Area

Published November, 2015

Strategic Regional Innovation Support Program by MEXT
(For recovery from Tohoku Disaster)
Next-Generation Automobiles / Miyagi Area

Global/Local Innovations for Next Generation Automobiles

Program, abstracts, and presenting materials for

- International Conference "Global/Local Innovations for Next Generation Automobiles" on October 27-29, 2015
- Joint Session of Twelfth International Conference on Fluid Dynamics (ICFD2015)
  OS19: "Global/Local Innovations for Next Generation Automobiles" on October 28, 2015

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Tohoku Economic Federation
Tohoku University
Miyagi Prefecture
The 77 Bank
Intelligent Cosmos Research Institute

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Tohoku Economic Federation
Tohoku University
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To All People around the World,

We thank you very much for your enormous support for our recovery and reconstruction in the areas devastated by the 2011 Tohoku Earthquake and Tsunami. Although we still experience many difficult days, going through this hardship has allowed us to discover new ways to strengthen bonds that invigorate our attitude toward reconstruction and revival.

In this situation, the automotive industry has largely been considered a major center of economic opportunity because of its economic impact. All over the Tohoku region but especially in Miyagi prefecture, the expectation for the automotive industry is enormous. Emblematic of this expectation is the recent startup of the Toyota Motor East Corporation.

Our project the "Strategic Regional Innovation Support Program" supported by MEXT (Ministry of Education, Culture, Sports, Science and Technology) kicked off in July 2012 in order to realize the reconstruction and revival of Tohoku, through the development of new products and system by the collaborative efforts of industry, academia and government. This collaboration is primarily based on the strong and diverse R&D at Tohoku University, a leader in domestic and international education.

As a research-oriented university, Tohoku University has been involved in a number of collaborative efforts with big business but less so with smaller, local businesses. As one might assume, the importance of developing local businesses is of the highest order. Since June 2012, we have held a wide variety of events: Research information session for local business people, over fifty lectures for manpower training, visiting more than forty laboratories for local business people, our researchers were invited to tour local companies, and poster presentations by all laboratories which joined in this project. These events broke down the borders separating the university from local businesses and as a result a number of new collaborations have begun to bloom.

We also understand that there are many leaders who are trying a variety of challenges to realize both global and local innovations in next generation automobiles. We are very happy to organize an international symposium on global/local innovations for next generation automobiles by inviting such worldwide leaders and design a variety of ways to realize global/local innovations in next generation automobiles. We have to emphasize that many local companies greatly contribute to this symposium in addition to leading laboratories in Tohoku University. We sincerely hope that this symposium provides opportunities to deepen our friendship and promote reconstruction and revival of Tohoku Area through a variety of challenges for the innovations in next generation automobiles.

Katsuto Nakatsuka, Director

Akira Miyamoto, Chairman of Research Promotion Committee

Contact

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Research Promotion Committee

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Please visit our official website for details of the project;
www.miyagicar.com

If you have any inquiry, please contact the laboratories and companies directly. And please don't hesitate to contact the Research Promotion Committee to refer which of them may help you.

International Conference "Global/Local Innovations for Next Generation Automobiles"

Organizers: A. Miyamoto (Tohoku University), P. Kapsa (Ecole Centrale de Lyon), M.C. Williams (AECOM, USA) and K. Nakatsuka (Intelligent Cosmos Research Institute)

Joint Session of Eleventh International Conference on Fluid Dynamics (ICFD2015)
OS19: "Global/Local Innovations for Next Generation Automobiles"

Date: Tuesday, 27th - Thursday, 29th October, 2015
Conference Site: Sendai International Center, Sendai, Japan
Website: http://www.miyagicar.com/
http://www.ifs.tohoku.ac.jp/icfd2015/

Tuesday, October 27

12:00-12:50 Lunch Meeting / Sakura 1

13:00-13:10 **Opening**
Akira Miyamoto, Philipe Kapsa, Mark C. Williams, and Katsuto Nakatsuka

15:00-15:10 Break

16:50-17:00 Break

Wednesday, October 28

10:30-10:40 Break

ICFD Joint Session OS19

12:10-12:50 Lunch Meeting / Sakura 1

13:00-14:45 **Short Oral Presentations of Poster**

14:45-14:55 Break

Thursday, October 29

Global and Local Innovations for Next Generation of Vehicles

Masayoshi TOMIZUKA
Professor, Department of Mechanical Engineering, UC Berkeley, USA

Global and Local Innovations for Next Generation of Vehicles

Masayoshi Tomizuka
Cheyl and John Neerhout, Jr. Distinguished Professor
Department of Mechanical Engineering
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Tohoku University
October 27, 2015

Presentation Outline

- **Trends in Automated Vehicles (AV)**
  - Background and Definitions
  - Current Status
- **Research Activities at UC Berkeley**
  - Selective Projects at UC Berkeley
- **Look Ahead**
  - Expectations for the Decade Ahead
  - Challenges
- **Summary Remarks**

History of Vehicle Automation

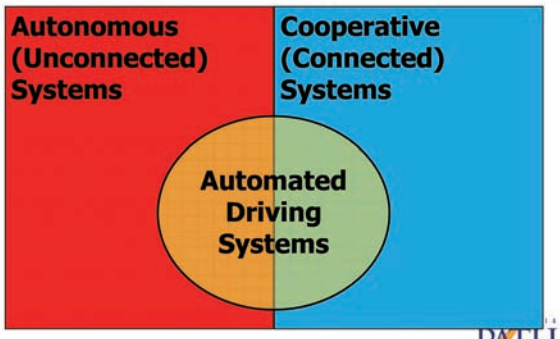
- **1930s – GM Futurama Exhibition**
- **1960s – 1980s**
  - Various R&D in US, Japan, and Europe
- **1990s**
  - US National Automated Highway Consortium
  - Continuing R&D in EU and Japan
- **2000s**
  - US DARPA Grand Challenges
  - Relatively more intensive R&D globally
- **2010s**
  - Google "Driver-less Cars"
  - Significant Automaker announcements

Goals that Could be Served by Vehicle Automation

- **Immediate Effects**
  - Improving user safety and minimizing driving hazards
  - Providing driving comfort and convenience
  - Freeing up time and attention demanded by driving
  - Enhancing mobility options for disadvantaged users
  - Improving fuel or energy efficiency
  - Reducing transportation cost by car for individuals
- **Longer-Term and System-Wide Effects:**
  - Reducing traffic congestion in general
  - Reducing or redistributing vehicle user costs
  - Reducing energy use and pollutant emissions
  - Making efficient use of existing road infrastructure
  - Reducing cost of future infrastructure and equipment

Automated Platoon (1997 NAHSC Demonstrations)

Autonomous and Cooperative Vehicles



SAE J3016 - Levels of Automation
Taxonomy and Definitions for to On-Road Motor Vehicle Automated Driving Systems

SAE Level	Name	Narrative Definition	Execution of Steering/ Acceleration/ Deceleration	Monitoring of Driving Environment	Fallback Performance of Dynamic Driving Task	System Capability (Driving Modes)
Human driver monitors the driving environment						
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	Driver Assistance	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes
2	Partial Automation	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	System	Human driver	Human driver	Some driving modes
Automated driving system ("system") monitors the driving environment						
3	Conditional Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the *dynamic driving task* with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	System	Human driver	Some driving modes
4	High Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	System	Some driving modes
5	Full Automation	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	All driving modes

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Examples at Each Automation Level

Level	Example Systems	Driver Roles
1 Driver Assistance	Adaptive Cruise Control OR Lane Keeping Assistance	Must perform other non-automated functions and monitor driving environment
2 Partial Automation	Adaptive Cruise Control AND Lane Keeping Assistance Traffic Jam Assist	Must monitor driving environment (system try to engage driver)
3 Conditional Automation	Traffic Jam Pilot Automated Parking	May read a book, text, or web surf, but be prepared to intervene when needed
4 High Automation	Highway driving pilot Closed campus driverless shuttle Driverless valet parking in garage	May sleep, and system can revert to minimum risk condition if needed
5 Full Automation	Automated taxi Car-share repositioning system	No driver needed

PATH VAA Project (Level 1)
Automated Bus in Eugene Oregon

LTD, Eugene Oregon
- 2.5 miles of single/double dedicated ROW
- One 60ft New Flyer BRT bus
- Functions:
  - Lane guidance for on dedicated BRT lane
  - Precision docking



Nissan Infiniti (Level 2)
Lane Keeping + ACC

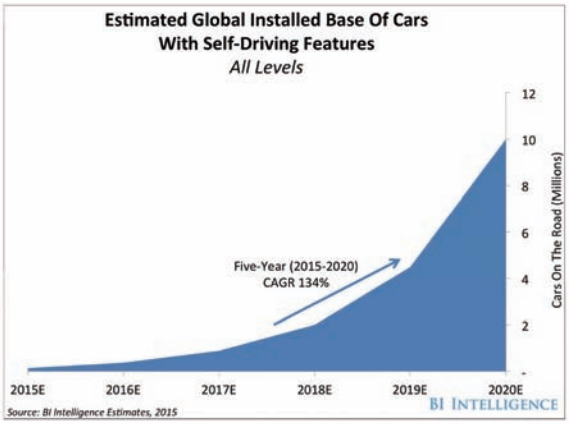
- Youtube Video (Note that driver goes to backseat at end of video, a misuse case for Level 2)

https://www.youtube.com/watch?v=zY_zgEmKV1k

Current Status - OEMs

Organization	Confirmed and Predicted Product Introduction	Predictions of Readiness for Autonomous Vehicles
Audi/VW	2016 – traffic jam assist 2014 – automated parking	Available by 2020
BMW	2014 – traffic jam assist 2014 – automated parking	Available by 2020
Bosch	2014 – traffic jam assist available for OEMs	Available by 2020
Continental		Available by 2020
Ford	2015 – fully assisted parking	
General Motors	2017 – Super cruise	Available by 2020
Google		Available by 2018
Honda	Valet parking by 2020 or earlier	
Mercedes-Benz	2014 – traffic jam assist	Available by 2020
Mobile Eye		2016 – technology ready for OEMs
Nissan	2015 – highly autonomous	Available by 2020
Tesla	2016 – highly autonomous	
Toyota	Mid 2010s – highly autonomous	
Volvo	2015 – traffic jam assist 2015 – automated parking	Zero fatality by 2020

Estimated Market Introduction



Current Status and Trends

Emerging Forces

- Significant Advancements in sensing and computing technologies
- Considerable developments by high-tech industries and automakers
- Greater publicity and awareness
- Legislations following the steps

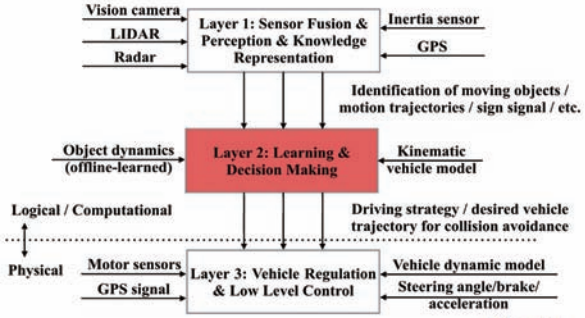
Current Trends

- Intensive research in all regions globally
- Heavy investments by auto industry
- Commercial products highly feasible within next 3-5 years

Selective Research Projects at UC Berkeley

ROAD System for Automated Driving

- Changliu Liu and Masayoshi Tomizuka

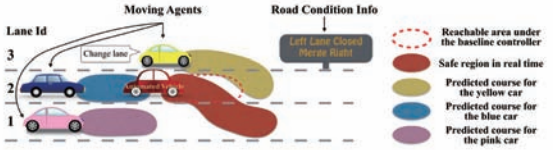


ROAD System for Automated Driving

- Changliu Liu, Masayoshi Tomizuka -

Efficiency: Navigate to the destination in minimum time

Safety: Interact with surrounding vehicles properly



- **Predict the future course for each surrounding vehicle (learning and prediction);**
- **Find a trajectory in the safe region (decision making).**

Autonomous Driving in Urban Environment
Wei Zhan, C-Y Chan, and M. Tomizuka

French "Drive for You" Foundationrench "Drive

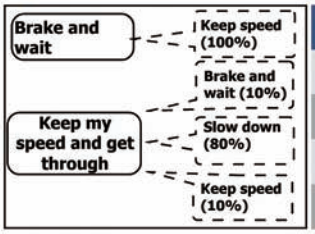
- **Foundation headquartered at Mines ParisTech**
- **Industrial Sponsors**
  - Valeo, Peugeot, Safran
- **Academic Partners**
  - Mines ParisTech, France
  - EPFL, Switzerland
  - Shanghai Jaio-Tung University, China
  - PATH, UC Berkeley, USA
- **Innovation Lab**
  - Mines ParisTech + INRIA + IFSTTAR

Driving Behaviors and Interaction

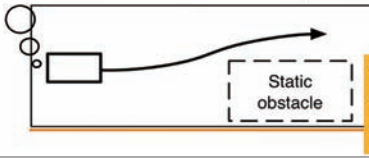
- Wei Zhan, C-Y Chan, M. Tomizuka -

- **Objectives in driving**
  - Time efficiency, comfort, courtesy
- **Constraints in driving**
  - Safety, traffic rules, obstacles, vehicle dynamics
- **Reciprocal methodology**
  - Problem formulation: Social interaction
  - Probability distribution – subject vehicle vs. others
  - Safety: to achieve the fairly best case which will probably happen, and guarantee to survive in worst cases although they will probably not happen
  - Neither purely cooperative nor adversarial

Driving Behaviors and Interaction
- Wei Zhan, C-Y Chan, M. Tomizuka -



	safety	time-efficiency	courtesy	comfort	total utility
Brake and wait	safe	2	10	8	20
Keep speed (100%)	safe	10	7	10	
Brake and wait (10%)	safe	10	8	10	26.3
Slow down (80%)	safe only with emergency braking	2	8	2	
Keep speed (10%)					



- Objectives: **Time efficiency, comfort, courtesy**
- Constraints: **Safety, traffic rules, obstacles, dynamics**
- Methodology: **Social interaction**

Cooperative Systems

"Connected Vehicles" Research at PATH

PATH RFS Test Facilities

Included within this Richmond Field Station (RFS) facility is

- A test track that has been used extensively for dynamic vehicle experiments in controlled environment.
- The test track is covered by a variety of sensors and instruments, which can generate high accuracy positioning data for vehicles moving along the track.
- An Intelligent Intersection is equipped with DSRC and WiFi network links that enable the use of wireless communication links for potential testing of vehicle-to-infrastructure applications.

El Camino Real Connected Vehicles Testbed

Included within the El Camino Real are

- A 2-mile, 11-intersection stretch of El Camino Real SR-82 arterial in Palo Alto, California
- Equipped with the updated hardware and software that are compatible with IEEE 1609 and SAE J2735 and with other USDOT test beds such as one in Michigan.
- Linked security server of USDOT managed by Leidos (formerly SAIC) so that communication security protocols can be exercised.
- Signal Phase and Timing (SPaT) information
- Dedicated intersection computer to augment local computing capability
- IPv6 connectivity to backhaul
- Intersection maps as MAP broadcasts
- Use of DSRC, Wi-Fi, Bluetooth, Cellular

PATH V2X Activities

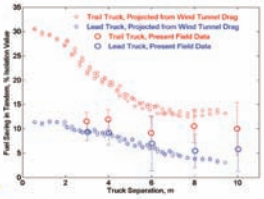
- **First to deploy RSE (roadside equipment) on public Roads, Emeryville, CA, 2004**
- **First to publicly demonstrate VII (Vehicle-Infrastructure Integration) Concepts of Operations at ITS World Congress in San Francisco, 2005**
- **Build and operate VII California Test Bed, and conducts collaborative work with automakers**
- **Vehicle-Infrastructure Technology Affiliated Laboratory (VITAL) Consortium**
  - Non-competitive joint research by members
  - Focus on use of communication technologies for safety, mobility, environment applications
  - Members include Industrial Technology Research Institute (ITRI), Taiwan and SANDEX, Japan

Cooperative Adaptive Cruise Control
(Research at PATH in Collaboration with Nissan)

- **CACC extends from Adaptive Cruise Control (ACC) with the addition of V-V communication (DSRC); 2006-2015**
- **5.9 GHz DSRC, Denso WRM, 10 Hz Communication**
- **Potential increase in roadway efficiency without compromising safety**
- **Pilot collaboration research with Nissan on driver experience**
  - ACC time gaps of 1.1 to 2.2 seconds
  - CACC time gaps of 0.6 to 1.1 seconds
- **2013 FHWA EARP project focus areas: traffic stream analysis, driver selection of time gaps and driving behaviors**

Automated Truck Platooning
- with V2V communication -

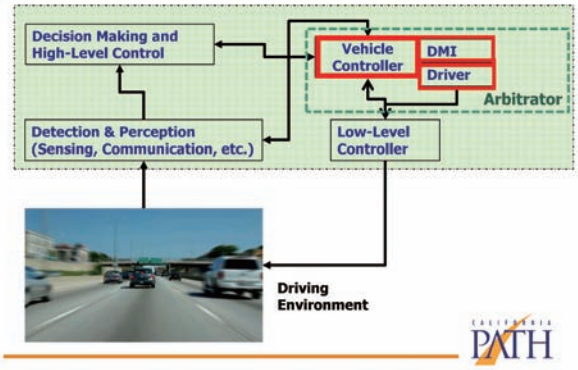
- Similar to Japan Energy ITS project (2011-2014)
- Developed and tested 2- and 3- truck platoons under automatic spacing control at gaps from 3 m to 10 m
- Estimated Fuel savings of 10 -15% measured



Challenges

- What must be overcome?
  - Technical
  - Safety concerns
  - User Expectation
  - Market Acceptance
  - Legal

AV with Driver in the Loop
- System Architecture and Data Flow



Challenges in Driver-Vehicle Interaction

- DVI and HMI issues
  - Situation Awareness
    - Effective alert under reduced workloads
  - Carryover Effects
    - Automation influence on driver mental status
  - Decision and Control Arbitration
    - Machine-Human task sharing and switching
    - allocation of machine and human intelligence
- Critical for highly automated systems especially for Levels 3-4

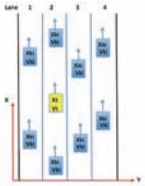
Challenges for AV/DVI Design

Information → Decision → Control

- (System) Control Requirements
  - Display content and alert mechanism
  - Appropriate (or available) options
- Drivers
  - To be alerted (awakened) from non-driving tasks
  - To be capable of taking (appropriate) actions
- Challenges for highly automated systems
  - Driver monitoring required
  - Understanding of driver intention
  - Arbitration of driver and system, if necessary

Exemplar Vehicle-Driver Interaction Situations

Information → Decision → Control

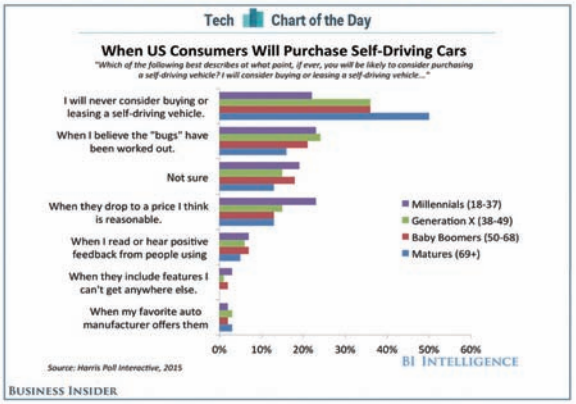


- Assuming a Level 3 system, and while in the process of lane changing,
  - Under what conditions, can the system accept drivers' intervention (e.g. hard braking and large steering action)?
- Assuming this is a Level 4 system, and while crossing an intersection,
  - Avoid tempting driver to intervene in complex situations?

Social and Legal Issues

- **Some Laws and Vehicles Codes Need to be Changed**

Will People Buy It?
- Market Acceptance and User Expectation -



How Safe is AV Safe Enough?

Safety Records of Human Drivers

- According to the Accident Statistics of Germany, the injury accident rate on the autobahns is 0.08 per million vehicle-kilometers.
  - In other words, on average **12 million vehicle-kilometers** are driven between the occurrences of injury accidents.
- **12 million vehicle-km per injury incident**
  = 30,000 km/per year X 50 years X 8 vehicles

- The fatal accident rate on the autobahns is 1.9 per billion vehicle-kilometers.
- For most states in US, the numbers are between 1.0 and 3.0.

- **Current vehicles driven by humans have very strong safety records, and autonomous vehicles have to be implemented at a very high performance level to be comparable.**

Look Ahead in the Coming Decade

- **Highly functional automation will be available (such as valet parking and freeway driving assist)**
- **Carmakers will offer Level 2 and maybe Level 3 systems**
- **Deployment of Level 4 will be local (such as Google "pods")**
- **Social and technical challenges remain for completely driverless cars to be widely deployed**

A Paradigm Shift

- **Cars will "do things" for us when we are on the move.**
  - **We used to tell them what to do**
  - **Now they are more likely to tell us what to do**

- **The Google and Uber of the world are already causing a paradigm shift in the car culture.**
  - **Do you really need to own a car?**
  - **Liberty of going places for the disadvantaged and unlicensed**

As good as it Gets!
- Connected Automation -

- **Nissan Motors Commercial (Youtube video)**
  https://www.youtube.com/watch?v=nrNfKbk8_Og

Control of Vehicle with a Large Sideslip Angle

Kazuhiro Kosuge

Professor, Bioengineering and Robotics Graduate School of Engineering, Tohoku University, Japan

Control of Vehicle with a Large Sideslip Angle

Kazuhiro Kosuge and Hiroshi Nakano
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Graduate School of Engineering
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JAPAN

DREEMS
Dependable-and-Robust-in-Extreme-Environment-vehicle Maneuver System

Sideslip Motion During Automotive Race

Skilled drivers utilize sideslip motion to drive a car fast [2] in automotive races such as rally races.

e.g., Drift

Drifting rally car [3]

If we could control a vehicle with a large sideslip angle, fast and safe driving, like a rally driver could be realized.

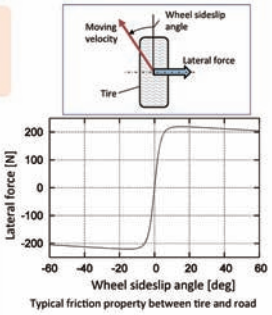
[2] M. Croft-White, "Measurement and analysis of rally car dynamics at high attitude angles," Ph.D. dissertation, Cranfield Univ., Cranfield, UK, May 2006.
[3] TRD rally challenge http://trdrallychallenge.jp/

Nonlinear Tire Friction Property

During a large sideslip motion, nonlinearity of tire-road friction property could not be negligible.

Nonlinear tire model

- Depends on environment-related properties
  - road surface condition
  - temperature



Typical friction property between tire and road

Goal of Project DREEMS

To develop a control system for a vehicle with a large sideslip angle using a steer angle of front wheels and driving forces of four independently-driven wheels.

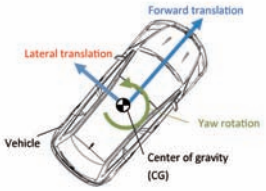
- A motion control system is designed based on a planar vehicle dynamics.
- The resultant control system does not require the nonlinear tire model.
- A steady-state cornering experiment is executed to illustrate the effectiveness of the proposed scheme.

Vehicle Model

Assuming that roll and pitch rotations are negligible, we consider to control the following three motions;

- Forward translational motion
- Lateral translational motion
- Yaw rotation,

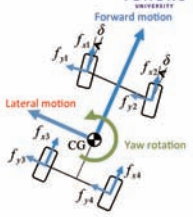
by using driving forces of four wheels and the steer angle of front wheels as control inputs.



Vehicle moving on horizontal plane

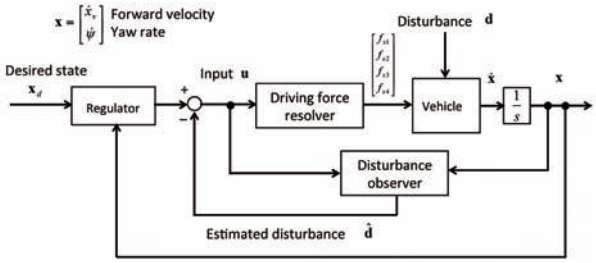
Controller Design

- Forward translational motion
  - Driving forces could be considered dominant force.
    - ➡ Controlled using Driving forces
- Lateral translational motion
  - Lateral forces could be considered dominant force.
    - ➡ Controlled using Lateral forces
- Yaw rotation
  - Motion are affected by driving forces and lateral forces.
    - ➡ Controlled using Driving forces



- Redundancy
- Easy to observe
- Generated actively

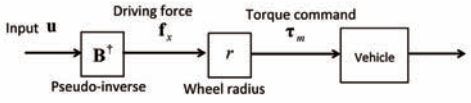
Controller for Forward Translational Motion & Yaw Rotation



Block diagram of the control system for forward translational motion and yaw rotation

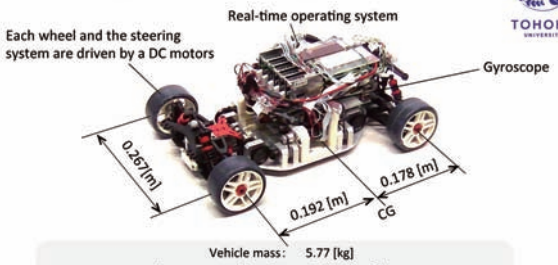
Controller for Forward Translational Motion & Yaw Rotation

- We utilize the pseudo-inverse method for deriving the driving forces.



Block diagram of part of driving force resolver

Experimental System



Vehicle mass:	5.77 [kg]
Yaw moment of inertia:	0.1043 [kgm²]
Wheel diameter:	0.097 [m]
Wheel polar moment of inertia:	0.156x10⁻³ [kgm²]
Control frequency:	1 [kHz]
Controller gain:	$[k_{iv} \quad k_{iv} \quad k_{ip}]^T = [10 \quad 30 \quad 10]^T$
Cornering stiffness :	$C_1 + C_2 =$ 40 [N/rad]

Experimental System

- Forward velocity
- Lateral velocity (Sideslip angle)

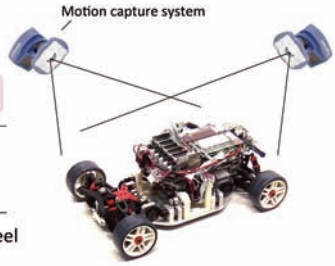
⇨ Motion capture system

- Yaw rate

⇨ Gyroscope

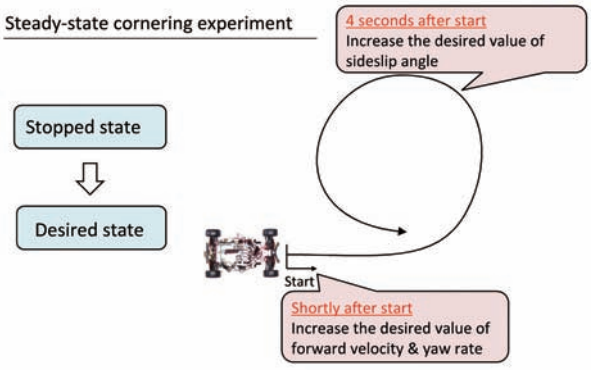
- Angular velocity of each wheel
- Steer angle

⇨ Rotary encoder



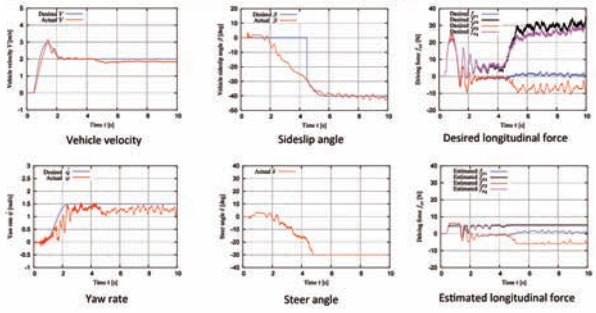
Experiments

Steady-state cornering experiment



Experimental Results

Controller 2 Sideslip angle β = -40deg



Conclusion

- We proposed a motion control system of an electric vehicle with a large sideslip angle using driving forces of four independently-driven wheels and the steer angle of front wheels.
- Proposed control system is separated into two controllers.
  - Forward translational motion & yaw rotation controller using redundant driving force inputs.
  - Lateral translational motion controller using steer angle as an input.
- Steady-state cornering experiment is executed.
- The experimental result shows that the proposed method can control the large sideslip motion of the vehicle.

12

Integrated sensors and actuators

Jörg Frömel

Associate Professor, WPI-AIMR, Tohoku University/ Fraunhofer ENAS, Japan/Germany

Integrated Sensors and Actuators

J. Froemel, M. Schueller, A. Hackert
L. Kroll, T. Otto, T. Geßner
Fraunhofer ENAS

Outline

1. Internet of Things
   - Definition
   - What do we need to enable the Internet of Things?
     - Technologies
     - Social needs
2. General Trends in Automotive
3. Cluster of Excellence MERGE
4. Smart Systems Integration

Internet of Things – a new dimension

Until now the Internet was blind
...
the Internet only connects people at anytime and anywhere,
but the environment of these people could not be connected

With **the Internet of Things** a new dimension could be connected:

ANYTHING

Source: Journal Internet of Things

Definition of IoT by EPoSS

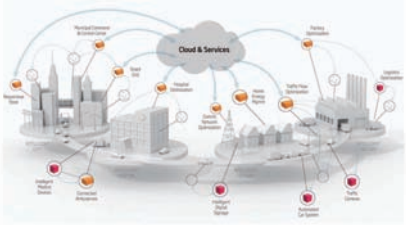
„Things having identities and virtual personalities operating in smart spaces using intelligent interfaces to connect and communicate within social, environmental and user context"

The Internet of Things is

"a world-wide network of interconnected objects uniquely addressable, based on standard communication protocols"

Internet of Things Definition according to Yole Développement

"Internet of Things devices is the aggregation of all sensing modules which are linked to the Cloud – either directly or through a gateway – and with which data is processed and valorized in any manner."



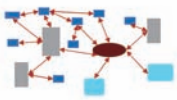
Sensors & Technologies for IoT, Yole Developpement 2014

Internet of Things – enabling Technologies

- Low power consuming devices (Electronics and sensors)
- Sensing devices: MEMS/NEMS
- NFC (Near Field Communication)
- RFID (Radio Frequency Identification)
- Smart Systems Integration
- New materials like polymers
- New technologies
- New radio standards for bandwidth and frequencies
- Consistent transmission protocols
  (or integration of different communication standards and protocols)
- Alternative energy sources, energy harvesting and low-power chipsets

Internet of Things – enabling Social Needs

- Create laws and control by an impartial governance authority (e.g. UN or an industrial consortium)
- Protection of privacy
- Regulation of the liability
- Protection of minorities
- Voluntary use of the smart things
- Creation of sensitive areas without networking
- Creation of the IoT by the general public (e.g. public forums, round tables)
- Education
  - At the school: to learn the critical use of the IoT
  - At the university: to analyze the effects of the IoT on the society



First Generation
- Sensing and actuation
- Signal conditioning and processing
- Wireless/wired communication
- Hybrid and monolithic integration, system on board, chip on board

Second Generation
- Multifunctional sensing, actuation and inference
- Predictive and adaptive
- Networking function
- Partially autonomous
- Partially 3D-integration

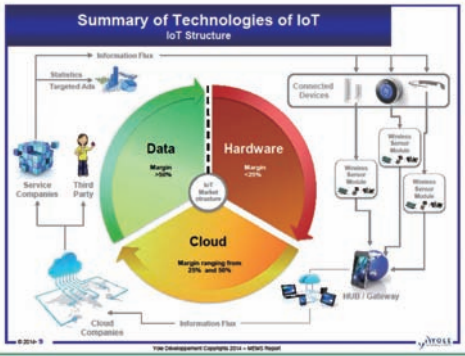
Third Generation
- Self-calibrating and self healing sensors and actuators
- Artifical intelligence
- Self-organized networks
- Energy autonomous
- Complete 3D-integration

1990 .... 2005 2020

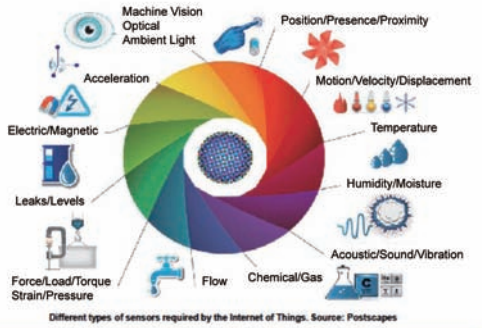
Outline

1. Internet of Things
   - Definition
   - What do we need to enable the Internet of Things?
     - Technologies
     - Social needs
2. General Trends in Automotive
3. Cluster of Excellence MERGE
4. Smart Systems Integration

IoT Structure



Need for diversified sensors



Different types of sensors required by the Internet of Things. Source: Postscapes

Yole Développement Copyrights 2014 – MEMS Report

IoT - General Trends in Automotive

- Navigation systems
- On board diagnostic systems
- Automatic parking assistant
- GPS based car lock down
- Automatic emergency communication
- Autonomous driving car
  - large number of sensors
  - historical data
  - resilient computing
- Traffic information exchange
- Route planning as swarm
- Traffic sign car intercommunication

Many issues are basically already solved (from hardware point of view), software is also not far behind.

So what is the point we are not there yet?

IoT - General Trends in Automotive

Issues

What happens in case:

- Wireless communication breaks down?
- The latest software upgrade of your computer is crashing?
- Your car catches a virus?
- A hacker has fun by making your car a full stop on the highway?
- An engineer leaks the code to make a car transmit the signature of emergency car?

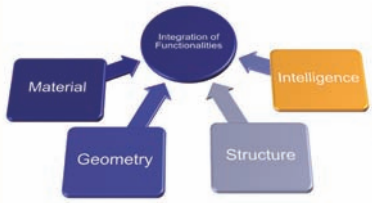
Such kind of challenges must be taken care of!
That is now more important than development of hardware!

Outline

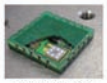
- Introduction
  - Integration of Functionalities
  - Smart Systems Integration
- Cluster of Excellence MERGE
- Smart Systems Integration
  - Incentive
  - Integration of fluidic actuators
  - Nanoparticle basied sensors
  - Metamaterialials
  - Integration of Silicon based sensors

Smart Structures

- Integration of Functionalities:
  Accommodate many functions in one part or preform
- Integration of Intelligence:
  Smart Systems Integration

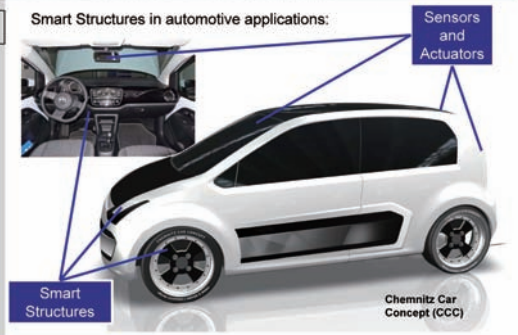



Embedded MEMS sensor module


MEMS in interposer structure

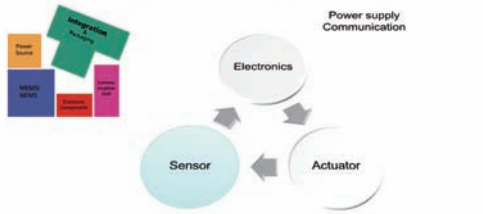
Smart Structures

Smart Structures in automotive applications:



Smart Systems Integration

- Smart System Integration is more than just „Sensor-Integration":



SHM, Stress and Strain
Vibration, Deformation
Humidity / Temperature

Optical: Illumination, Display
Thermal: active Deicing, Heating / Cooling
Mechanical: Active damping, Sonic transducers, Morphing

Smart Systems Integration

- Smart System Integration is more than just „Sensor-Integration":

How to manufacture this in a mass producible way?

MERGE
Cluster of Excellence

Cluster of Excellence MERGE

CLUSTER OF EXCELLENCE • Merge Technologies for Multifunctional Lightweight Structures

Einführung
Exzellenzcluster MERGE
Smart Systems Integration

Merge Technologies for Multifunctional Lightweight Structures (EXC 1075)

- 01.11.2012-31.10.2017
- 34 Mio. EUR
- 100 researchers

TECHNISCHE UNIVERSITÄT CHEMNITZ

www.tu-chemnitz.de/MERGE

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In-line process

IRD A

IRD A/B — Fibre-foil-tape unit

IRD D — Sensor integration

IRD A/D — Fold winding

IRD A — Contin. orbital wrapping

IRD D

In-situ process

IRD B

IRD C

ILCx

Master Unit with Plug & Produce Modules

Preform Wind Energy Rotor Blade (WERB)

Chemnitz Car Concept (CCC)

System Demonstrators

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Introduction
Cluster of Excellence MERGE
Smart Systems Integration

IRD A — Semi-finished products and preform technologies — Prof. Wielage, Dr. Nestler

IRD B — Metal-intensive technologies — PD Dr. Drossel, Prof. Neugebauer

IRD C — Textile-/ plastics based technologies — Prof. Kroll

IRD D — Micro- and nanosystems intergration — Prof. Geßner

IRD E Interface technologies, Prof. Lampke

IRD F Modeling, integrative simulation and optimisation, Prof. Ihlemann

NETWORKING AREA

› Generetic technology and system demonstrators, recycling
› Theories, models simulation and optimisations methods

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Introduction
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Smart Systems Integration

Smart System Integration

Integration of Sensors and actuators EXAMPLES

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Overview

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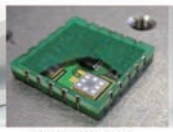
Introduction
Cluster of Excellence MERGE
Smart Systems Integration

- Incentive of Smart Systems Integration in composite structures:
  - Integration of sensors and actuators in hybrid structures
  - Integration of electronics, power supply and communication
  - Increase of the performance and functional density
  - Development of innovative technologies for integration
  - Development of new sensor and communication concepts for functionalized structures

Fully integrated actuators for AFC



MEMS in interposer structure

Embedded MEMS sensor module

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Integrated fluidic actuator engineering

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Introduction
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Smart Systems Integration

Central objective:

- Integration of actuator structure and transducers Combination of functional layers and materials
- Integration in lightweight structures

Actuator sections, SJA on the basis of MuCell® Technology

Use Case:

- Actuators for the active flow control for the reduction of flow resistance of cars

Integration in roof spoiler/ aerofoil sections: no modification of the structure is necessary.

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Integrated fluidic actuator engineering

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Introduction

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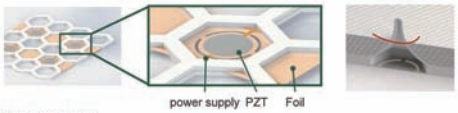
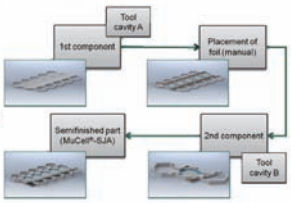
Smart Systems Integration



- Manufacturing
  - injection moulding of the first cavity
  - Insertion of transducers incl. contacting
  - injection moulding of the second cavity
  - Opening of the structure



Nano particle based sensors

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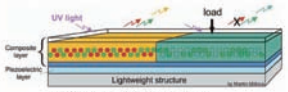
Smart Systems Integration

Central objective:

- Pressure-sensitive film for sensors
- Color change under external force
- Integration in lightweight structure



Sensor layer and illustration of the function

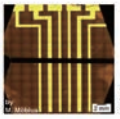
Quantum Dots

Use Case :

- Display of force effect (crash, damage) on vehicle parts

Chemnitz Car Concept (CCC)

www.tu-chemnitz.de/MERGE/



Microscope image of a test structure
Source: Martin Möbius

Nano particle based sensors

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Introduction

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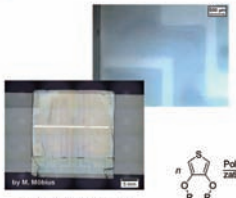
Smart Systems Integration

Production:

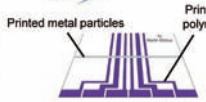
- Printing of metal and polymer layers
- Direct on devices or back injection
- Usage of new Particles and materials

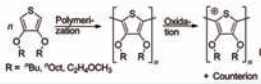
Sheet fed inkjet printer DMP2831 *(FujiFilm Dimatix)*

Dimatix FUJIFILM



Layer stack with printed electrodes





by E.A. Poppitz

+ Counterion

Metamaterials

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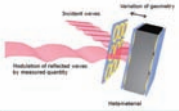
Smart Systems Integration

Central objective:

- Patch Antenna for energy & information transfer at 24/60 GHz
- Metamaterial for improved antenna effect and immediate sensor functionality
- Integration through printing technology



Use Case:

- Wireless display at rear-view mirror

complete(!) wireless display at rear-view mirror

Metamaterials

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Introduction

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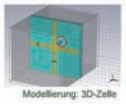
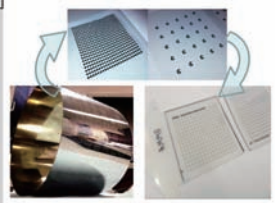
Smart Systems Integration

Manufacturing:

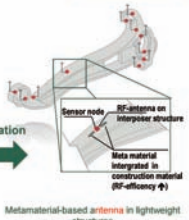
- Computer-aided design and simulation
- Production of cells on PET-foil with conductive ink
- Back injection moulding of printed structures



Modellierung: 3D-Zelle



Integration



Metamaterial-based antenna in lightweight structures

Integration of Silicon-based sensors

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Introduction

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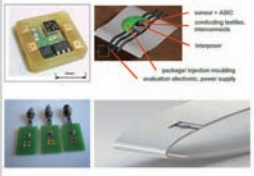
Smart Systems Integration

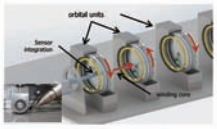
Central objective:

- Miniaturized modules for material integrated sensors
- Integration of si-sensors
- Suitable for R2R-manufacture

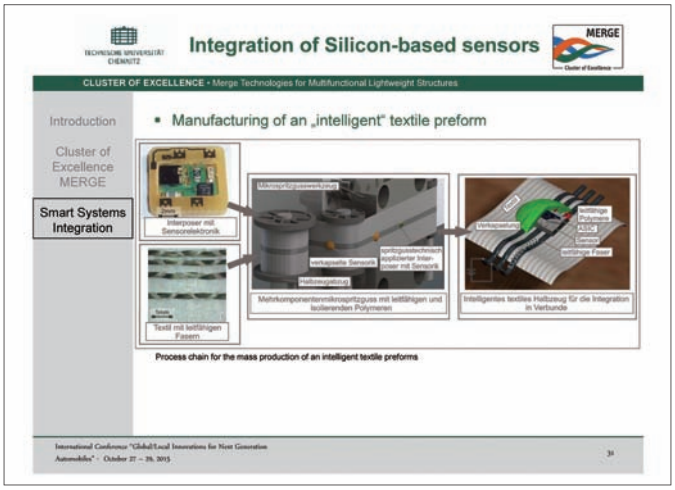


Examples of use:

- Sensors for wind turbine rotors



- Sensors at interior


Integration of Silicon-based sensors
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Smart Systems Integration
Manufacturing of an „intelligent" textile preform
Interposer mit Sensorelektronik
Textil mit leitfähigen Fasern
Mehrkomponentenmikrospritzguss mit leitfähigen und isolierenden Polymeren
Intelligentes textiles Halbzeug für die Integration in Verbunde
Process chain for the mass production of an intelligent textile preforms
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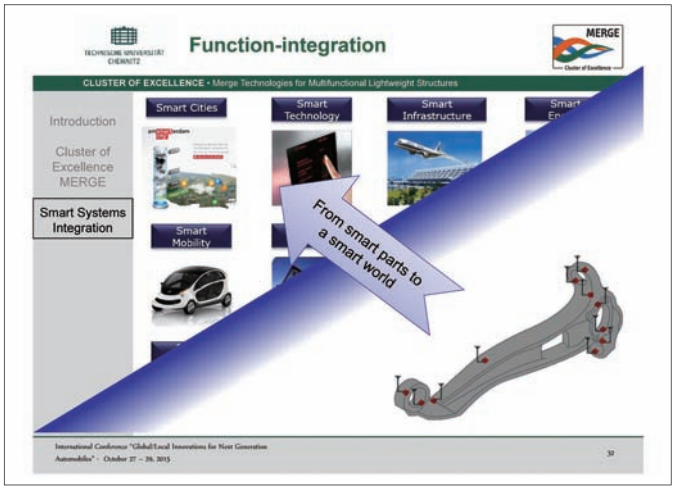
Function-integration
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Smart Systems Integration
Smart Cities
Smart Technology
Smart Infrastructure
Smart Mobility
From smart parts to a smart world
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Thank you for your attention!
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Thanks to the contributors to this presentation:
Dr. Steffen Kurth, Dr. Jörg Martin, Dr. Jörg Schaufuss, Dr. Jürgen Tröltzsch,
Mathias Lipowski, Silvana Eggers, Martin Möbius, Toni Großmann, Alexander Hackert
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Electrochemical Technologies for the Transportation and Energy Industry of the Future

Matthias Scherge

Director, IWM MicroTribology Center, Fraunhofer, Germany

Running-in phenomena in combustion engines

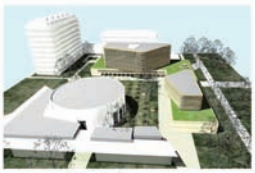
Matthias Scherge

MIKROTRIBOLOGIE CENTRUM - Numbers

-8 groups, 80 employees, 20 doctoral students, 4 professors
-annual turn over 5 Mio. €
-investments between 2008 bis 2015: 20 Mio. €

-good cooperation with KIT and Universität Freiburg
-many national and international collaborations

RNT Test Cells



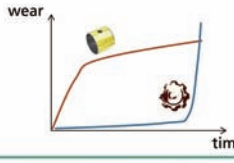
Analytics

Structure

Focus: Systems with Ultra Low Wear Rates

Typical average wear rates of engine components as determined by radionuclide technique [4]

Engine component	Wear rate
Piston ring	5–15 nm/h
Small coated bearing	Measures 5 nm/h
Large coated bearing	2–10 nm/h
Tappet	10 nm/h
Cam	5–10 nm/h

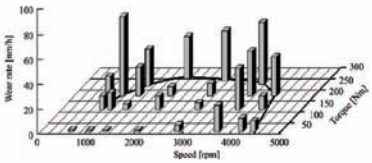


Tribological Levers to Reduce CO_2-Emission and Fuel Consumption

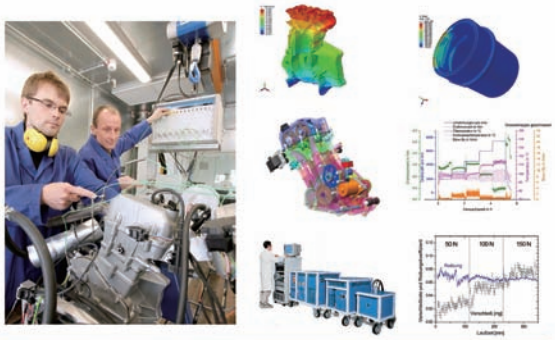
lever	effect
running-in	-direct energetic conditioning of the system
oil and additivation	-direct (additives) and indirect (viscosity) influence on the system
finishing	-partial presumption of the running-in -support of hydrodynamics

Wear measurement based on the RadioNuclide Technique (RNT)

Removal of engine parts (e.g. piston ring or bearing) → Radioactive labeling and re-assembling → Continuous wear measurement



Single Engine Test Cell with RNT

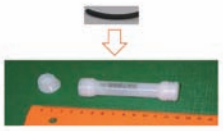


Labeling

thermal neutrons

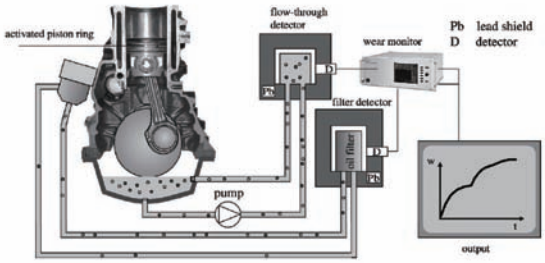
reaction K (a,b) K+

Cr → Cr51

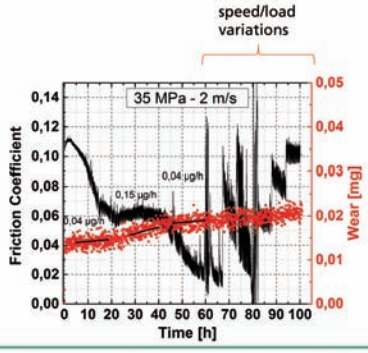


pneumatic delivery

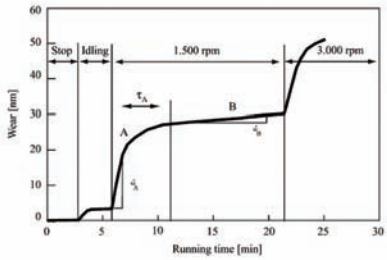
Test Setup



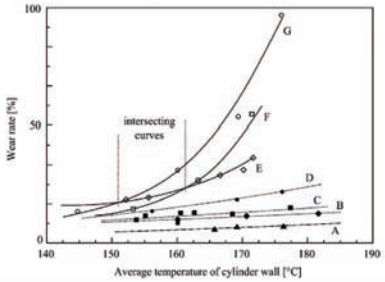
Precise and Online Friction and Wear Testing



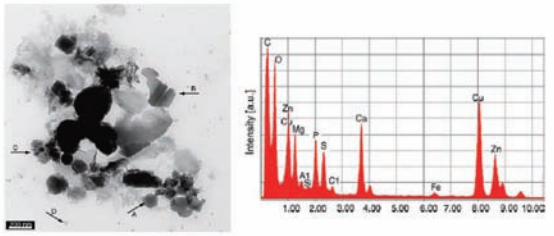
Analysis of Running-in Wear



Oil Testing by RNT

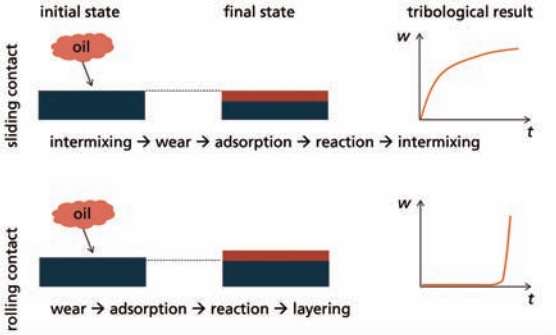


Analysis of Engine Wear Particles

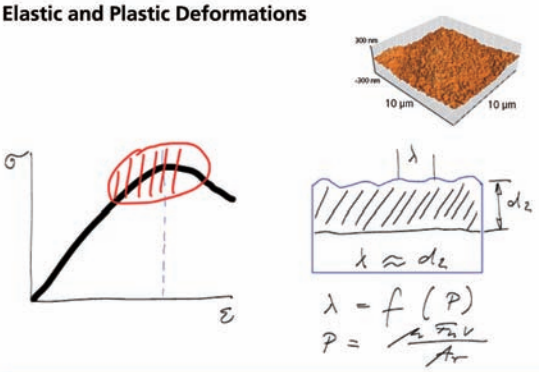


Source: Characterization of wear debris of systems operated under low wear-rate conditions, Scherge et al., WEAR 260(2006)458-461.

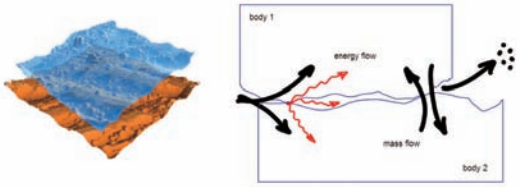
Oil – Surface Interaction



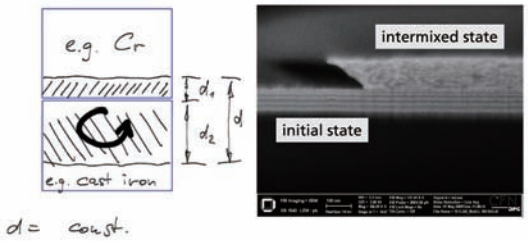
Elastic and Plastic Deformations



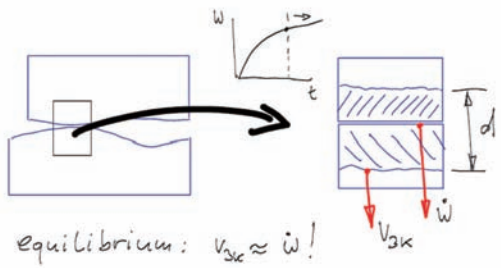
Interacting Bodies with Lubrication



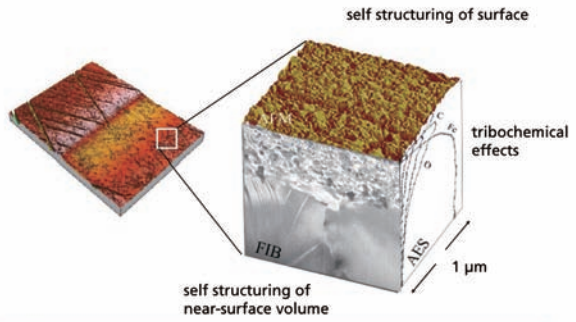
Intermixing



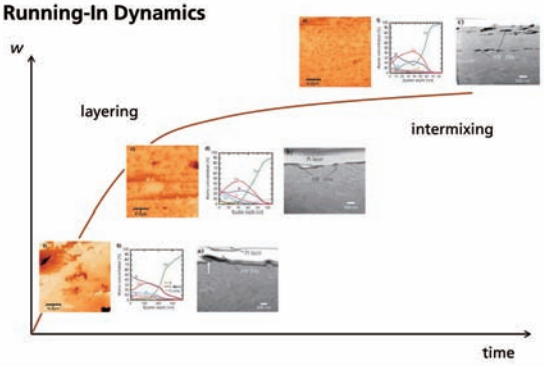
Tribosystem in Equilibrium



Material Changes during Running-in

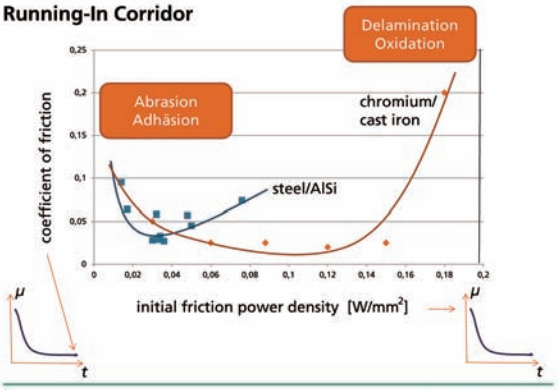


Running-In Dynamics



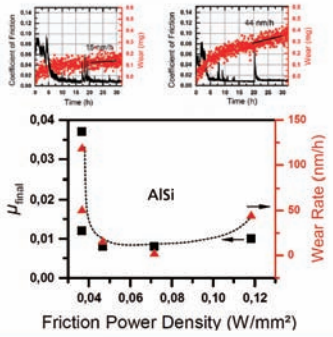
Dienwiebel, Pöhlmann, TRIB. LETT. 27(2007)

Running-In Corridor



M. Scherge, D. Linsler
Wear Corridor, accepted by WEAR

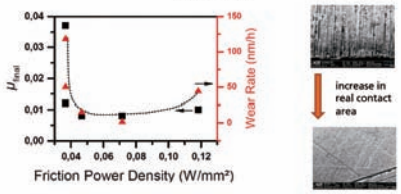
Running-In Corridor – Friction and Wear



M. Scherge, D. Linsler
Wear Corridor, accepted by WEAR

Running-In Recipies

friction power density too high
→ friction modifier
→ increase in real area of contact
→ increase of oil viscosity
→ coatings



friction power density too low
→ additivation
→ decrease in real area of contact
→ decrease of oil viscosity

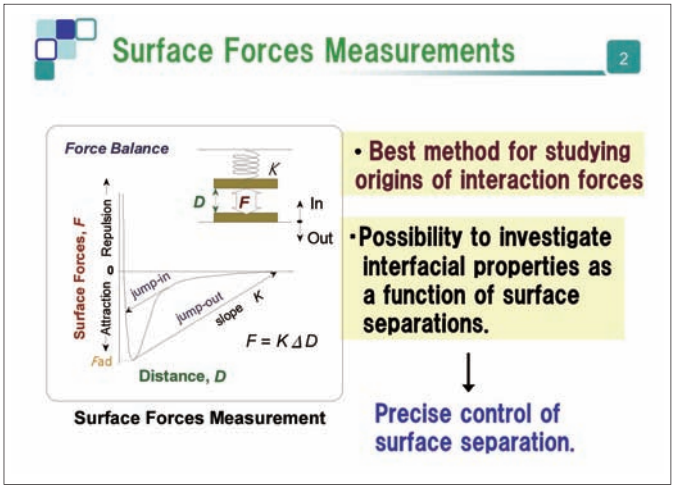
Summary

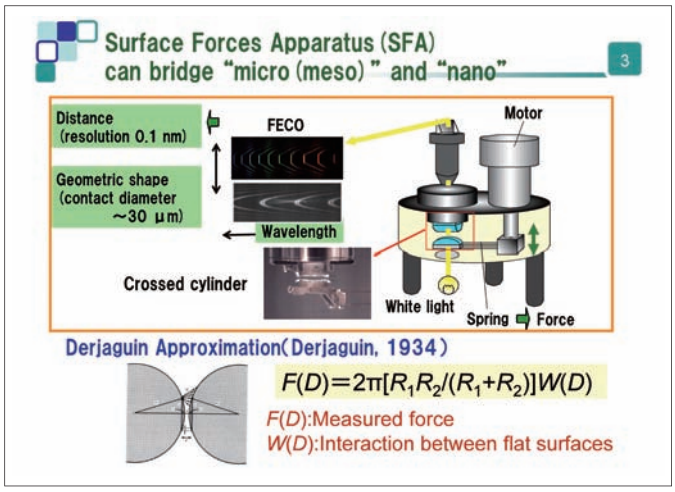
-the running-in is one of the least understood phenomena of a tribological system
-running-in is controlled by the initial energy consumption of the system
-continuous friction AND wear measurement is the only way to understand the mechanisms
-the tests have to accompanied by high-resolution surface science
-running-in can be influenced by suface finish, oil viscosity and additivation

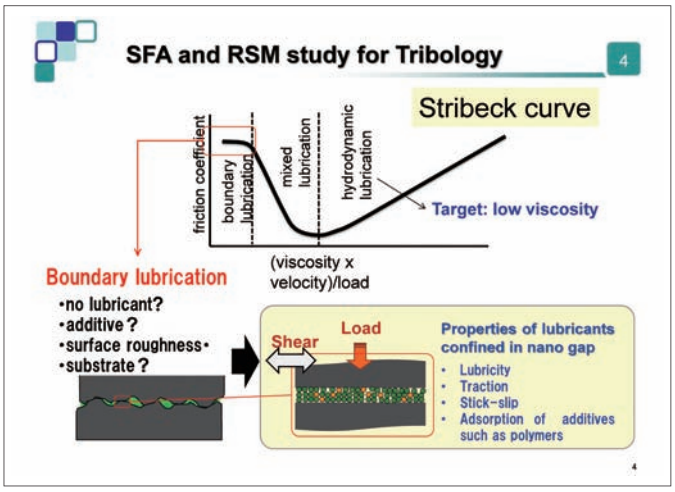
Nano-scopic Approach for Green Tribology

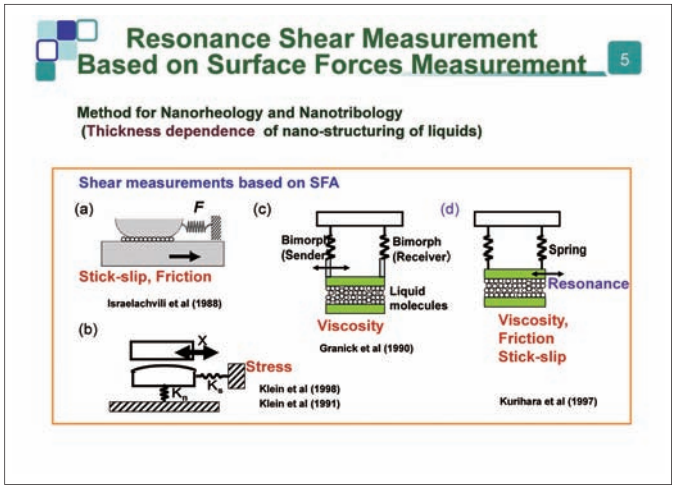
Kazue Kurihara

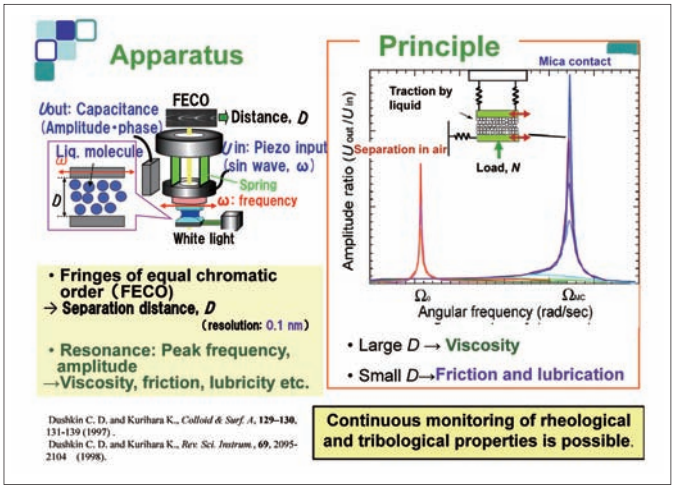
Professor, Institute of Multidisciplinary Research for Advanced Materials (IMRAM), Tohoku University, Japan





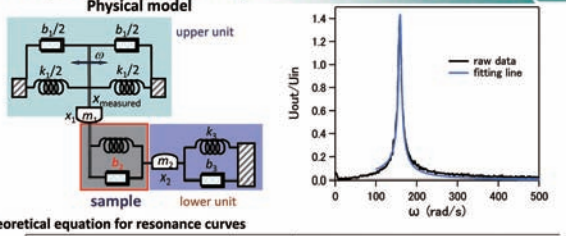






Physical model analysis of resonance curves

Physical model



Theoretical equation for resonance curves

$$\frac{U_{out}}{U_{in}} = \frac{C}{\alpha}\sqrt{\frac{(k_2+k_3-m_2\omega^2)^2+\omega^2(b_2+b_3)^2}{\left\{(k_1/\alpha+k_2-m_1\omega^2)(k_2+k_3)-\omega^2(b_1+b_2)(b_2+b_3)-k_2^2+b_2^2\omega^2\right\}^2+\omega^2\left\{(k_1/\alpha+k_2-m_1\omega^2)(b_2+b_3)+(k_2+k_3-m_2\omega^2)(b_1+b_2)-2k_2b_2\right\}^2}}$$

b_1, b_2, b_3:damping parameter, k_1, k_2, k_3 :spring constant, m_1, m_2 :effective mass, ω :angular frequency, X: displacement, α :$X_{measured}/X_1$, C:apparatus constant, U_{out}/U_{in} :Resonance amplitude

b_2 and viscosity(η_{eff}) for sample liquid can be determined

*) M. Mizukami and K. Kurihara, *Rev. Sci. Instrum.*, **79**, 113705 (2008).

Practical lubricants

8

「low viscosity lubricants」: one of major targets

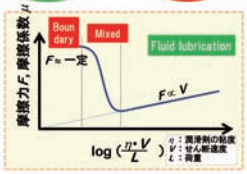
High energy efficiency

Low fluid resistance ⇒decreased μ

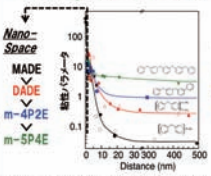
Poblem: yakitsuki/seizure

at boundary lubrication

Increased μ & wear



Phenyl-ether lubricants



Effective viscosity parameter vs separation distance.

A mechanism for "Yakitsuki (Seizure)"

For decreasing the viscosity

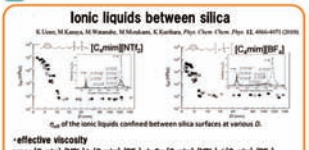
➡ Effective additive
Lubricant molecular design

J.Watanabe, M.Mizukami, K.Kurihara, *Trybol. Lett.* 56 (2014) pp. 501-508

Elucidation of lubrication at the molecular level

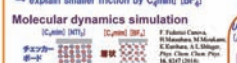
9

Ionic liquids between silica



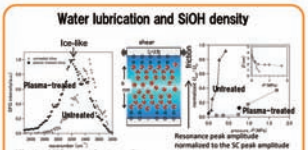
·effective viscosity
nano: $[C_4mim][NTf_2] > [C_4mim][BF_4]$, bulk: $[C_4mim][NTf_2] < [C_4mim][BF_4]$
→ explain smaller friction by $C_4mim][BF_4]$

Molecular dynamics simulation

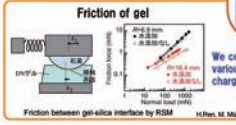


Friction: Large, Small

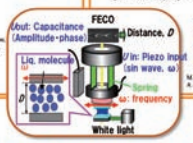
Water lubrication and SiOH density



Friction of gel



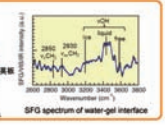
Friction between gel-silica interface by RSM H.Ren, M. Mizukami, T. Tanabe, H. Furukawa, K. Kurihara, Soft Matter, 11, 6192(2015).



We could quantitatively evaluate various contributions (deformation, charge etc.) to friction.

Plasma-treated silica (higher Si-OH density) showed higher lubricity and stability against pressure which might due to ice-like structure of water.

M. Kasuya, M. Hino, H. Yamada, M. Mizukami, H. Mori, S. Kajita, T. Ohmori, A. Suzuki, Kanae Kurihara, *J. Phys. Chem. C* 117, 13540-13546 (2013).



Characterization of Interfaces by SFA and RSM

10

Characterization of confined liquids

X-ray diffraction from thin liquid films

Thickness: 500 nm (previous) → several nm (this work)

·structural relaxation

·Confined effect on E-induced orientation

Interfacial water

At various phys. chem. conditions

Silanol density Water cont.

Tribology

Lubrication in the presence of additives

SFG spectroscopy

RSM and macro-properties

Dispersion rheology

silica
Li-ion in ionic liquid
Li-ion battery

RSM

Temp. control

IR heater
Room temp. ~100℃, ±0.1℃

Large-scale simulation with molecular model

To understand confinement effect

Novel SFA's

Electrochemical SFA

Evaluation of electrodes: Effective potential and ion adsorption

Twin-path SFA

Fluorescence SFA

PH and viscosity of confined liquids

Nano-scopic characterization of tribological phenomena can provide new insights in the phenomena, leading to develop new lubricant materials based on more rational design for Green Tribology.

Manitoba Battery Electric Transit Bus Fleet Development & Demonstration

Ray Hoemsen

Director, Applied Research and Commercialization, Red River College, Canada

RED RIVER COLLEGE | APPLIED RESEARCH & COMMERCIALIZATION

Manitoba Battery Electric Transit Bus Fleet Development & Demonstration

Ray Hoemsen, FEC, P. Eng.
Director, Applied Research & Commercialization
Red River College | Winnipeg, Manitoba CANADA

Tohoku University | Sendai JAPAN

October 27, 2015

CANADA

Next Generation Automobiles in Miyagi

Red River College © 2015

Manitoba CANADA

- 49th to 60th parallel
- 548,000 km²
- ~1.3M people
- Ocean access (summer)
  - Net After-Tax Cost of Corporate R&D: 45¢ to 47¢ per $1 of R&D
- Winnipeg (capital) weather
  - Extreme humid continental climate
  - 306 days with measureable sunshine
  - 521.1 mm precipitation annually
  - 132 days of snow cover – 110.6 cm average snowfall
  - -47.8ºC (1879) to 42.2ºC (1937) = 90ºC difference
  - Windchill (temperature + wind) record = -57.1 (1996)
  - Humidex record (temperature + humidity) = 48 (2007)

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Red River College

- Manitoba's largest institute of applied learning
- Over 200 full- & part-time academic programs
  - Personal Development to Trades to Degrees
- More than 30,000 enrolments across eight campuses
- Annual operating budget ~$180M
- ***Applied Research & Innovation: Fuelling Manitoba's economic growth & community development***
  - Annual research support ~$6M
  - Ranked as a TOP 10 Canadian Research College
- Flexible Intellectual Property Policy
  - Institutional ownership (for clarity)
  - Commercial rights routinely assigned to private-sector sponsors
  - Rights retained for future research & education

Red River College © 2015

Vehicle Technology & Energy "Cluster"

- Focus on Off- and On-Highway Vehicle Technology
- Integrated approach
  - Applied research, education & training
  - Reflective of community needs
  - Partnerships are an essential component
    - Industry, government & academic
    - Ability to leverage cash and in-kind contributions
- Builds on existing College expertise and facilities
  - School of Transportation Aviation and Manufacturing
  - Research Centres, Research Chairs and Research Professionals
  - Technology Access Centre for Aerospace & Manufacturing
- Focused applied research program
  - Vehicle Development & Vehicle Performance

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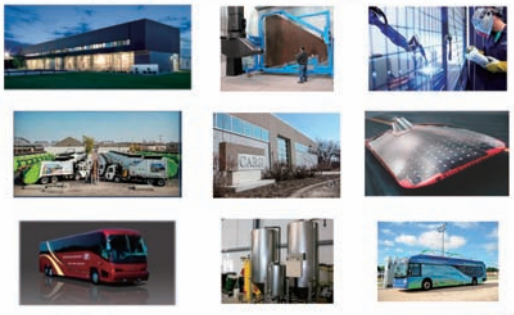
Vehicle Technology Infrastructure & Projects

Extreme (cold) & renewable energy focused



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Electric Vehicle Technology & Education Centre

- Mission:
  - Support electric vehicle innovation in/by Manitoba's transportation sector
  - Enhance electric vehicle education at RRC & in the region
  - Increase public awareness of electric vehicle technology
- Provincial financial support ($645,000) based upon RRC's track record of applied research & demonstrations in advanced transportation & energy
- Leads College engagement in the battery electric transit bus project

EVTEC

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Battery Electric Transit (BET) Bus

- Public-Private Partnership – International Consortia
- 2011 to 2014: $3 million, three-year project
  - Project development at NFI Winnipeg, Manitoba Hydro & RRC
- Goals
  - Develop a prototype advanced battery electric transit bus
  - Utilize MHI & NFI technologies
  - Demonstrate the bus & associated charging technologies
    - Test operational capabilities under Manitoba's extreme climatic conditions
    - Use demonstration as a showcase for other potential markets in N.A.
- 2012: Expanded scope (with SDTC & consortium partners)
  - $10M five bus fleet multi-year trial in fare service with Winnipeg Transit

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RRC Role: BET Bus Prototype & SDTC Phases

- Financial project management & administration
- Assembly & monitoring of lithium ion batteries
- Charging infrastructure involvement (Manitoba Hydro-led)
- Phase 3
  - Operation (drivers), troubleshooting & minor maintenance
  - Service manual input (for EV operation)
  - Monitoring & evaluation of field tests
- Public report drafting (of original consortium project)
- SDTC Phase
  - Redesign, testing & prototyping of MHI battery packs for integration into two NFI Xcelsior XE40 production coaches
  - Monitoring of MHI battery packs
  - Operational support

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BET Bus Prototype Specifications

- NFI Xcelsior platform tested to standard industrial durability & life criteria (6X Altoona Durability Test)
- Energy-efficient electric permanent magnet traction motor
- MHI air-cooled lithium ion battery packs – 120 kWh (8 x 15 kWh)
- Bio-diesel heater for cold climates
- Similar weight to comparable diesel-electric hybrids
- Desired battery life – six to eight years

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BET Charging Infrastructure

- Dual module charger
  - 300 to 500 kW
  - Utility friendly, outdoor enclosure for curb-side installation
  - Enhanced safety & wireless communication
  - Integrated fault & isolation detection
- Overhead rapid charging dock
  - Automated rooftop interface (pantograph) – no operator intervention
  - Easy drive-through ingress/egress for rapid charging
- Now at YWG to enable fare service with Winnipeg Transit
  - Route 20 (**Watt** Street)
- Target of 6 minute charge/hour = no net charge depletion
  - 300 kW charger, 20 kph average speed & 1.45 kWh per km

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RESULTS: BET Bus Prototype (Original – Unit #1)

- MHI 120 kWh Li-on packs integrated in NFI Xcelsior coach
- Prototype completed June 2012, two-year field test/demo
  - Manitoba Hydro suburban-downtown shuttle - 15 kms round trip
  - ~20,981 kms (September 2015)
  - 300 kW charger = 20 minutes to full recharge
- Energy consumption (average of test & industry experience)
  - 2 kWh/mile – no air conditioning
  - 3 kWh/mile – with full air conditioning
  - 4 kWh/mile (estimated) – electric coach heating
    - Bio-diesel or diesel heater recommended
      - Less GHGs & 80-85% thermal efficiency
  - Overall average: 145 kWh /100 km

- blogs.rrc.ca/ar/2014/05/manitobas-new-electric-bus-and-charging-system-revolutionizing-clean-energy-public-transportation-systems

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RESULTS: BET Bus Production Units (SDTC)

- SDTC Bus Production Units #2 to #5 (September 2015)
  - SDTC – MHI #1 (180 kWh) – 22,517 kms
  - SDTC – MHI #2 (180 kWh) – 17,599 kms
  - SDTC - XALT Energy #1 (200 kWh) – 9,755 kms
  - SDTC - XALT Energy #2 (200 kWh) – 27,102 kms

- Demonstrations and applications
  - Winnipeg Transit fare (revenue) service – operating reliably
  - Transit Property demonstrations across North America
  - "Altoona Test" per FTA – industry-leading results
- First NFI commercial sales (two) to Chicago Transit Authority
  - 28,852 kms and 27,887 kms (as of 2015 09 08)

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SDTC BET Bus Milestones

- Production units (four) operational in 2014
- Reliability simulation – on route, schedule maintained, shadow service (no passengers)
- Battery duty cycle evaluation (Sept 2014 to March 2015)
  - 1.45 kWh/km (2.3 kWh/mile) energy consumption
  - 57.5 kWh of energy required to recharge (after 40 km route)
  - 29% of battery pack capacity
- Altoona Test very successful, no failures related to:
  - Axles
  - Batteries
  - Electric air compressor
  - Electric drive
  - Electric HVAC
  - Electric steering

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Altoona Test Results (June 2014 to July 2015)

- Federal Transit Administration (FTA) Test Program
  - Testing in Service-Life Category 12 Years/500,000 Miles
- "SDTC" XE40 prototype
  - New Flyer Xcelsior bus platform
  - Siemens ELFA drive motor
  - XALT Energy batteries - 200 kWh
  - 76-person capacity
- Industry-leading results
  - Reliability
  - Fuel efficiency
  - Interior noise
  - Gross Vehicle Weight Rating

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Altoona Test Results (June 2014 to July 2015)

- Failures = 21
  - Competitors: "A" @ 33 | "B" @ 49
- Unscheduled Repairs = 74.0 hours
  - Competitors: "A" @ 258.5 hours | "B" @ 278.5 hours
- Energy consumption overall average = 1.84 kWh/mi
  - Diesel equivalent fuel economy = 20.50 mpg
- Vehicle range average = 87.01 miles
- 0 to 35 mph interior noise average = 68.6 dBA
  - Competitors: "A" @ 70.4 dBA | "B" @ 75.2 dBA
- Highest passenger-carrying capacity of any electric bus in N.A.
- Federal Zero-Emission Bus Voucher Incentive Program registered, including California
- altoonabustest.psu.edu/buses/458

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Takeaways

- "Clean Tech" offers socially rewarding & technically interesting opportunities for innovation
- Personal & corporate relationships are the foundation for project success
- Clear roles are necessary, especially in consortia
- Many partners & enablers have contributed over the last decade to project success - partnerships work
- Battery electric transit buses perform reliably & efficiently in Manitoba's extreme climate, especially cold
- Altoona Test shows that "Made-in-Manitoba" electric vehicle technology is an industry leader

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Enablers & Partners

- **Enablers – since 2003**
  - Canada Foundation for Innovation
  - Department of Foreign Affairs and International Trade
  - Knowledge Infrastructure Program
  - Manitoba Vehicle Technology Centre
  - National Research Council Industrial Research Assistance Program
  - Natural Sciences & Engineering Research Council (CCIP, IE, ARTI, TAC & ARD-2)
  - Province of Manitoba (COPSE, ETT & IEM)
  - Sustainable Development Technology Canada
  - Western Economic Diversification
- **Partners – since 2011**
  - New Flyer Industries
  - Manitoba Hydro
  - Mitsubishi Heavy Industries (Japan)
  - Province of Manitoba (Energy Division)
  - Red River College
  - Winnipeg Transit

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- Pennsylvania Transportation Institute. 2015. Federal Transit Bus Test. Report Number: LT-BT-R14005.
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Questions?

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Winnipeg, MB

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Blog: blogs.rrc.ca/ar
Twitter: @RRCResearch

AR&C Team: January 2014

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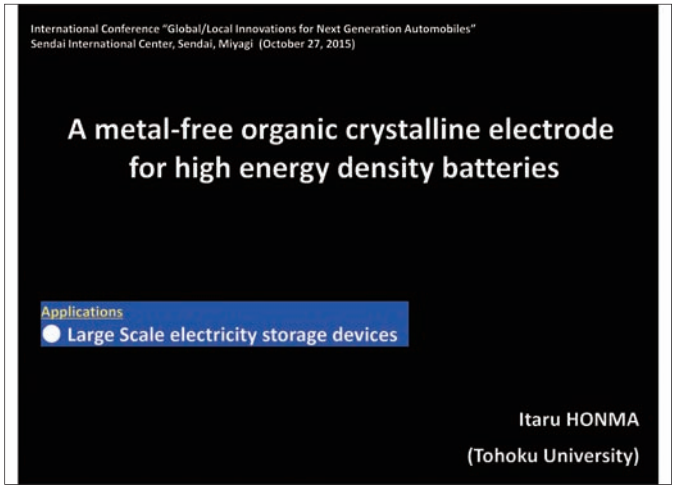
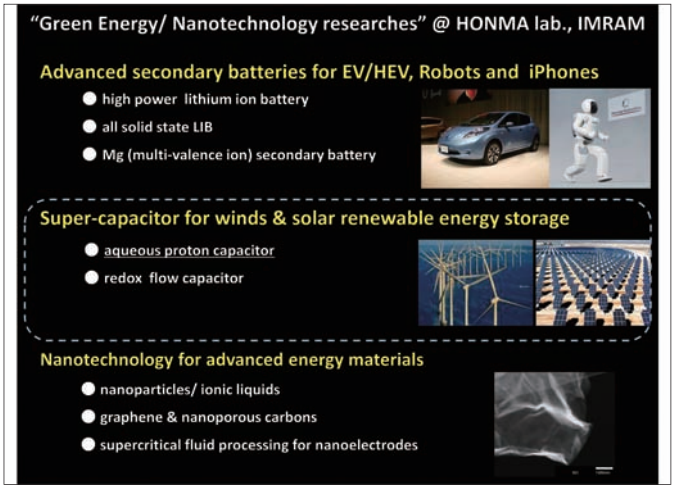
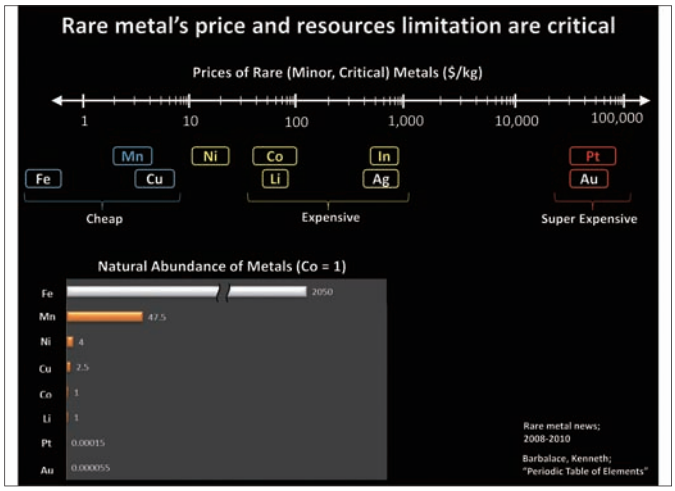
A metal-free organic crystalline electrode for high energy density batteries

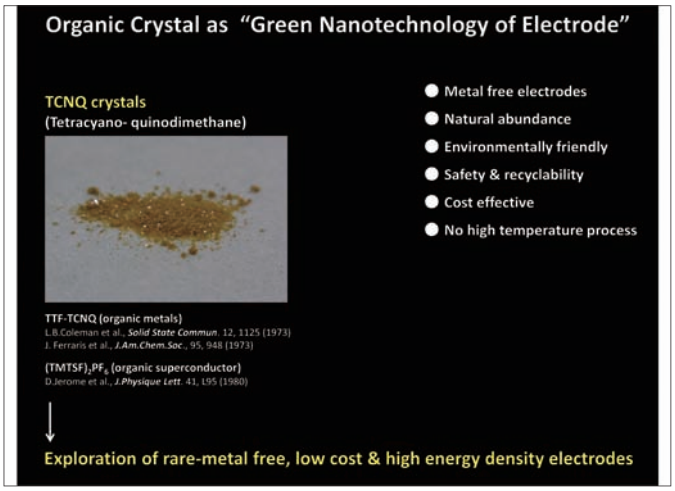
Itaru Honma

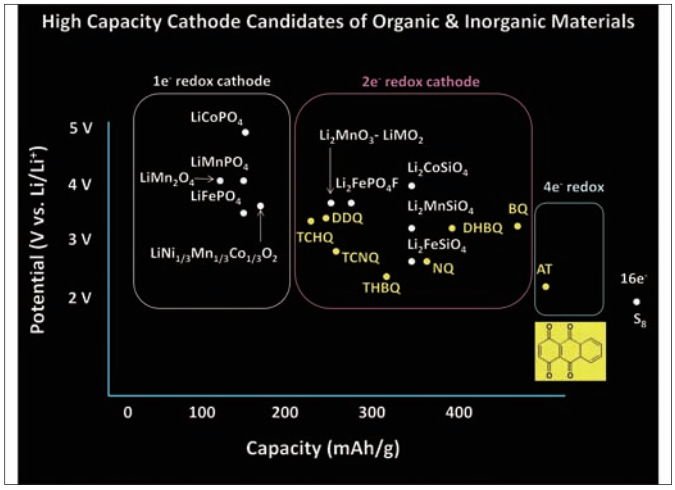
Professor, Institute of Multidisciplinary Research for Advanced Materials (IMRAM), Tohoku University, Japan









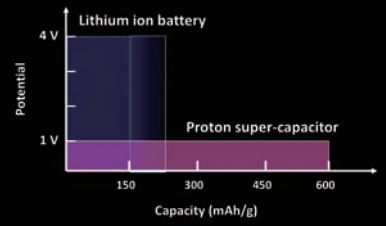


More safe, low cost, high energy density battery ?

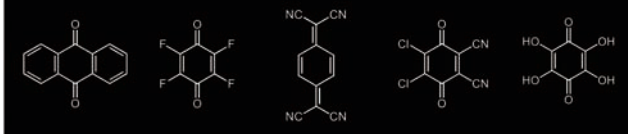
Aqueous electrolyte in spite of organic

H^+ in stead of Li^+

Absolutely metal-free battery
(employing only 5 elements of H, C, O, Cl, S)



Large Redox Capacity of Organic Molecular Crystals
(Quinone)



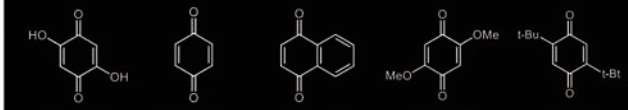
257 mAh/g
AQ
Anthraquinone

295 mAh/g
TFBQ
Tetrafluoro-benzoquinone

262 mAh/g
TCNQ
Tetracyano-quinodimethane

237 mAh/g
DDQ
Dichlorodicyano benzoquinone

310 mAh/g
THBQ
Tetrahydroxy-benzoquinone



383 mAh/g
DHBQ
Dihydroxy-benzoquinone

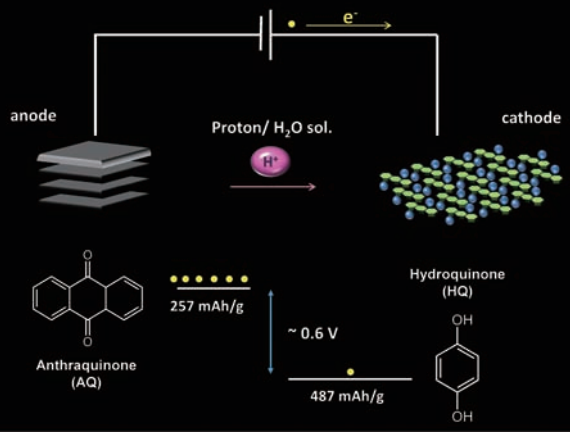
496mAh/g
BQ
Benzoquinone

339mAh/g
NQ
Naphthoquinone

319mAh/g
DMBQ
Dimethoxy-benzoquinone

243mAh/g
DtBu-BQ
Di-t-Butyl-benzoquinone

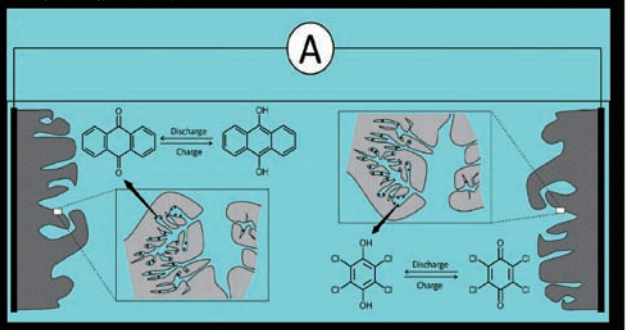
Proton shuttle redox-capacitor



Organic nanocrystals in Nanoporous carbon electrodes

AQ (27wt.%)/Maxsorb /PTFE

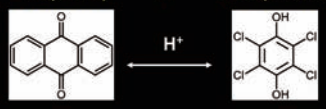
TCHQ (27wt.%)/Maxsorb /PTFE

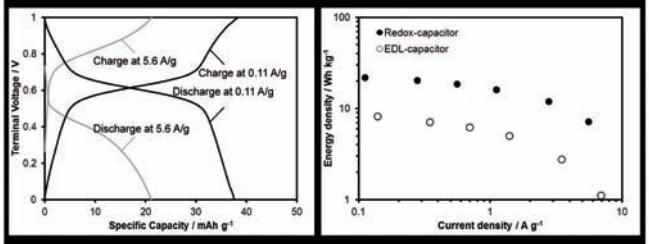


Organic nanocrystals are supported within 1-10nm sized Nanopores of carbon electrodes to suppress dissolution into the electrolyte solution

Rate capability of proton shuttle redox-capacitor

AQ(anode) – TCHQ(cathode)





Energy density and power density is larger than that of EDLC capacitor

Device potential of proton super-capacitor
(Proton shuttle redox-capacitor)

Battery device	Energy density	price	Cycle life	safety
EDLC	< 5 Wh kg^{-1}	◎	> 10000	◎
proton super-capacitor	10-20 Wh kg^{-1}	◎	> 1000	◎
Pb-acid	20-30 Wh kg^{-1}	○	< 1000	◎
Lithium ion capacitor	10-30 Wh kg^{-1}	△	> 10000	△
Lithium ion battery (LIB)	100-150 Wh kg^{-1}	△	~ 1000	△

The proton super-capacitor device in this work (only 5 elements of H, C, O, Cl, S are employed) is low cost, long cycle life and safety, however, has as same energy density as that of Pb-acid

➡ Applications to stationary electricity storage for the smart grid, renewable energy (solar & wind power)

Advanced Automotive Three Way Catalysts via Solvothermal Reactions

Tsugio Sato

Professor, Institute of Multidisciplinary Research for Advanced Materials, Tohoku University, Japan

Advanced Automotive Three Way Catalysts via Solvothermal Reactions

Tsugio Sato, Shu Yin
Institute of Multidisciplinary Research for Advanced Materials,
Tohoku University, Sendai 980-8577, Japan

CONTENTS

- **Ceria-based mixed oxides for automobile exhaust gas cleanup**
- **Tin oxide-based mixed oxides for automobile exhaust gas cleanup**

1

Improvement of OSC of CeO_2 by doping with metal ion

$CeO_2 \rightleftharpoons Ce^{4+}_{1-x} Ce^{3+}_{x} O_{2-x/2} \square_{x/2} + x/4\ O_2$

The ideal $r(M^{n+})/r(O^{2-})$ ionic size ratio of MO_8 = 0.732
In the case of fluorite structure ceria: $r(Ce^{4+})/r(O^{2-})$ = 0.703

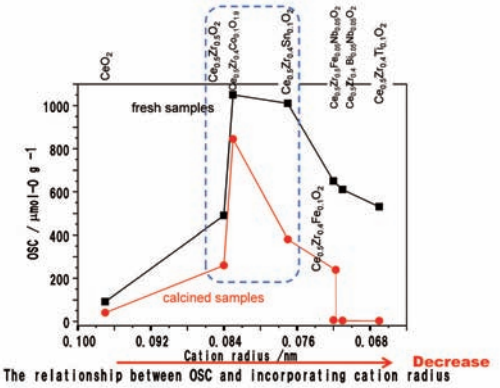
Ce^{4+} is not large enough to stabilize the fluorite structure

Improve the OSC by doping with metal ion smaller than Ce^{4+}

Crystal structure of CeO_2

8 cordination ion size (nm)		of various metal ions	
Ce^{4+}	0.097	Ti^{4+}	0.067
Zr^{4+}	0.084	Sn^{4+}	0.077
Ca^{2+}	0.112	Nb^{5+}	0.071
Fe^{3+}	0.072	Bi^{3+}	0.071
Al^{3+}	0.059		

2



Cation radius (nm): Ce^{4+} (0.097) > Zr^{4+} (0.084) > Co^{2+} (0.083) > Sn^{4+} (0.077) > Fe^{3+} (0.072) ≧ Nb^{5+} (0.071) = Bi^{3+} (0.071) > Ti^{4+} (0.067)

3

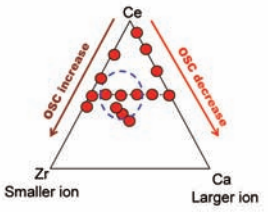
CeO_2-ZrO_2-CaO

$(NH_4)_2Ce(NO_3)_6$: 15 mmol
$ZrO(NO_3)_2$: x mol
$Ca(NO_3)_2$: y mol
H_2O: 60 ml
Conc. NH_3 aq.: 1.5 ml

↓ Heating at 220°C, 24h

↓ Washing Water & ethanol)

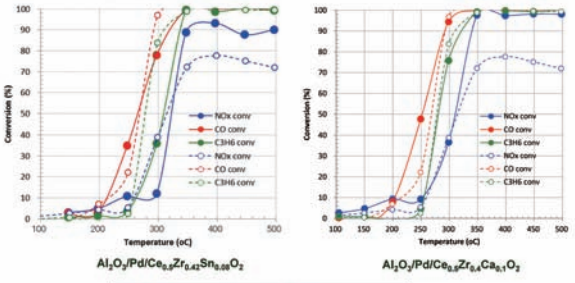
8 coordination ionic radii (nm)
Ce^{4+} : 0.097
Zr^{4+} : 0.084
Sn^{4+} : 0.077
Ca^{2+} : 0.112
Mn^{2+} : 0.093



4

Three-way catalytic property

Weight	60mg (including Pd/Al_2O_3)
Mixed gas	250 ml/min, NO (500ppm), CO (5000ppm), C_3H_6 (400ppm), H_2 (1000ppm), O_2 (5000ppm), CO_2 (14%), H_2O (7%), weak lean



Full line: Samples prepared in our work
Dotted line: $Al_2O_3/Pd/CeO_2$ of a standard sample

5

Conclusions for the ceria-based mixed oxides for the automobile exhaust gas cleanup

- **The OSC of CeO_2 could be improved by co-doping of Zr^{4+} with Sn^{4+} and/or Ca^{2+}.**
- **γ-$Al_2O_3/Pd/Ce_{0.5}Zr_{0.4}Ca_{0.1}O_2$ exhibited the excellent three way catalytic performance superior to γ-$Al_2O_3/Pd/Ce_{0.5}Zr_{0.4}Sn_{0.1}O_2$ and γ-$Al_2O_3/Pd/Ce_{0.5}Zr_{0.5}O_2$**

6

- Tin oxide-based mixed oxides for the automobile exhaust gas cleanup

1. Morphologies control of SnO_2

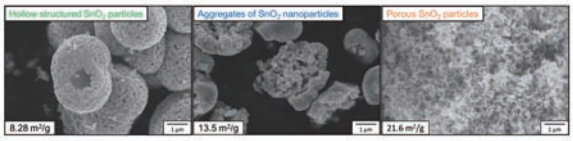
Preparation of various morphologies of SnO_2 particles to evaluate the OSC.

2. Alkali earth metal ion doping with SnO_2

Effect of alkali earth metal ion doping on the thermal stability and OSC of SnO_2.

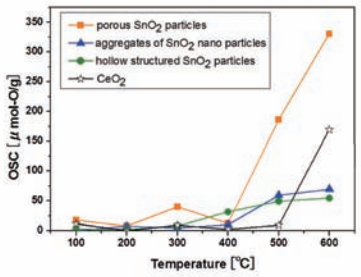
7

Specific surface areas of the various morphologies of SnO_2



- Specific surface area:
  Porous SnO_2 (21.6 m^2/g) >
  Aggregates of SnO_2 (13.5 m^2/g) >
  Hollow structured SnO_2 (8.28 m^2/g)

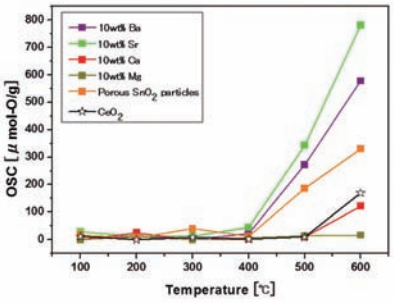
8



OSC of the annealed SnO_2 samples and CeO_2.

- **SnO_2 showed the OSC superior to CeO_2 below 500°C.**
- **The OSC of the SnO_2 samples changed depending on the specific surface area in the order porous SnO_2 particles > aggregated SnO_2 nanoparticles > hollow structured SnO_2 particles.**
- **The porous SnO_2 particles showed the OSC superior to CeO_2 even at 600°C**

9



OSC of the doped SnO_2 samples and CeO_2

- **As expected, the OSC of porous SnO_2 particles could be greatly improved by doping with alkali earth metal ions such as Sr^{2+} and Ba^{2+}, but degraded by doping with Ca^{2+} and Mg^{2+}.**

10

Representative Three Way Catalytic Performance

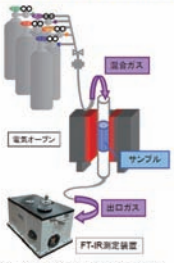
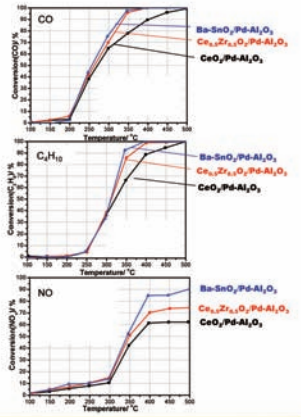


Fig. CO – NO - $n\text{-}C_4H_{10}$ ガス浄化活性測定装置

ガス流量	1L/min
ガス組成	O_2 : 3000ppm
	CO : 3000ppm
	NO : 500ppm
	$n\text{-}C_4H_{10}$: 700ppm
	N_2 : balance



Development of Advanced Automotive's Catalysts 11

Conclusions for the tin oxide-based mixed oxides for the automobile exhaust gas cleanup

- **Porous SnO_2 particles possessing the OSC superior to CeO_2 could be prepared by solvothermal reaction, where the large specific surface area seemed to be useful to improve the OSC property.**
- **The OSC of SnO_2 was greatly improved by doping with alkali earth metal ions such as Sr^{2+} and Ba^{2+}.**
- **Ba-SnO_2/Pd/γ-Al_2O_3 exhibited the excellent three way catalytic performance superior to CeO_2/Pd/γ-Al_2O_3 and $Ce_{0.5}Zr_{0.5}O_2$/Pd/γ-Al_2O_3**

12

Non-destructive testing of CFRP using eddy current technique

Toshiyuki Takagi

Professor, System Energy Maintenance Laboratory, Institute of Fluid Science, Tohoku University, Japan

Twelfth International Conference on Fluid Dynamics (ICFD2015)
OS19: Global / Local Innovations for Next Generation Automobiles
October 28, 2015
Sendai, Japan

Non-destructive testing of CFRP using eddy current technique

Toshiyuki TAKAGI*, Hiroyuki KOSUKEGAWA, Ryoichi URAYAMA and Tetsuya UCHIMOTO

Institute of Fluid Science, Tohoku University

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http://www.ifs.tohoku.ac.jp/asel/

No. 2

Contents

No. 3

Backgrounds - Properties of CFRP -

CFRP(Carbon fiber reinforced plastic) has attracted attention as a structural material to replace steel and aluminum.

Excellent mechanical properties
- **Light weight**
- **Specific strength**
- **Specific Elastic modulus**
- **Corrosion resistance**

BMW, i3

Carbon Fiber + **Resin**

Electric conductive — Dielectric plastic

Anisotropic electromagnetic characteristics

No. 4

Backgrounds - Non-destructive testing -

Generally, **UT** (Ultrasonic Testing) is used to detect defects of CFRP.

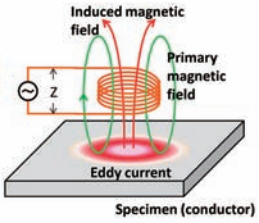
Undetectable

Flaws in the vicinity of the surface
Orientation of carbon fiber in CFRP

If detectable in inline, yield rate and production cost is improved

ECT(Eddy current testing)

Rapid detection capability
- Flaws in the vicinity of the surface
- Orientation of carbon fiber in CFRP



In the previous studies of ECT for CFRP

Using a TR probe and high frequency (more than 10MHz)
Detection signal may includes large noise and is unstable.

No. 5

Objectives

To inspect fiber orientation in CFRP by means of ECT

In this study

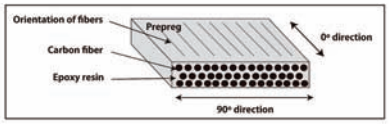
To obtain a more stable detection signal

Using mutual induction-differential type probe
Using low frequency (2MHz or less) with less noise

No. 6

Preparation of CFRP specimens

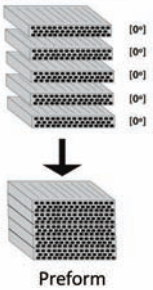
The CFRP specimens are fabricated by curing epoxy resin of a preform by autoclave process.



Unidirectionally oriented prepreg
(TR380G250S, Mitsubishi Rayon Co., Ltd.)
Thickness : 0.26mm

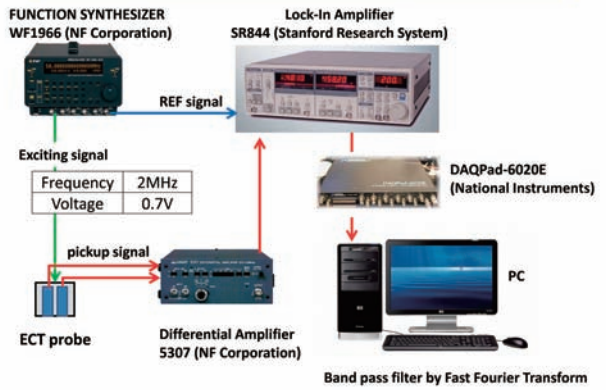
Autoclave process condition
Curing temperature : 130℃
Compression : 0.5 Mpa, 60 min.

Lamination layer



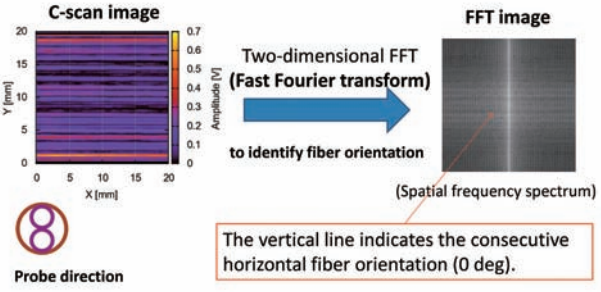
Measurement system of ECT

No. 7



Results - Unidirectional CFRP -

No. 8



Unidirection fiber orientation was identified.

Summary

No. 9

We showed the detectability of carbon fiber orientation of UD laminated CFRP by ECT

We used mutual induction-differential type probe and low frequency 2MHz to obtain stable signal

It is possible to obtain the information of carbon fiber orientation in CFRP with stable detection signal by ECT

The Seminars for CFRP Studies

No. 10

http://www.ifs.tohoku.ac.jp/cfrp/

Founded in October 2014

Consortium of universities, corporations and public research organizations in Tohoku region of Japan, aiming for promotion of the developments with CFRP in Tohoku

Lecture meeting

Technical investigation

JSPS Core-to-Core Program

International research core on smart layered materials and structures for energy saving

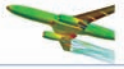
http://www.ifs.tohoku.ac.jp/c2c/

Energy Loss by Friction

Energy Loss and economic loss by contact surfaces amount 2% of gross domestic product

Energy Loss by Turbulence

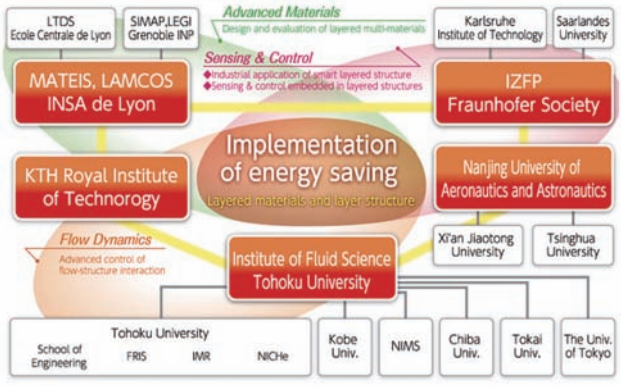
Boundary layer control of airplane wings may reduce skin friction by 90%, total drag by 40%



Control of interface between flow and structure to make break-through in energy-saving

To establish novel energy-saving technology by smart layered materials and structures based on flow dynamics

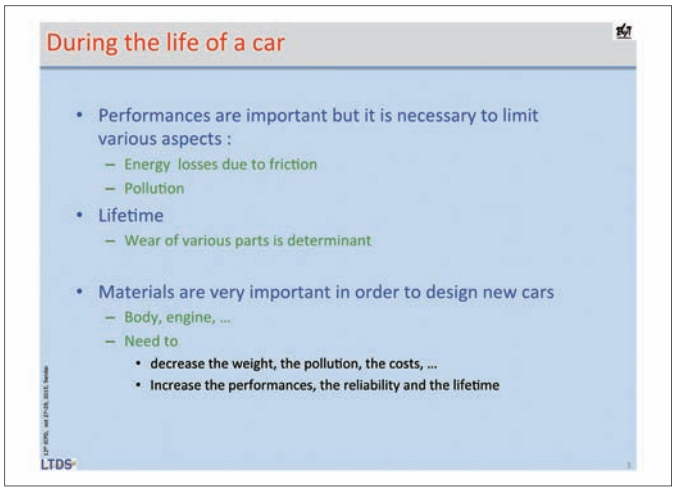
International research core on smart layered materials and structures for energy saving

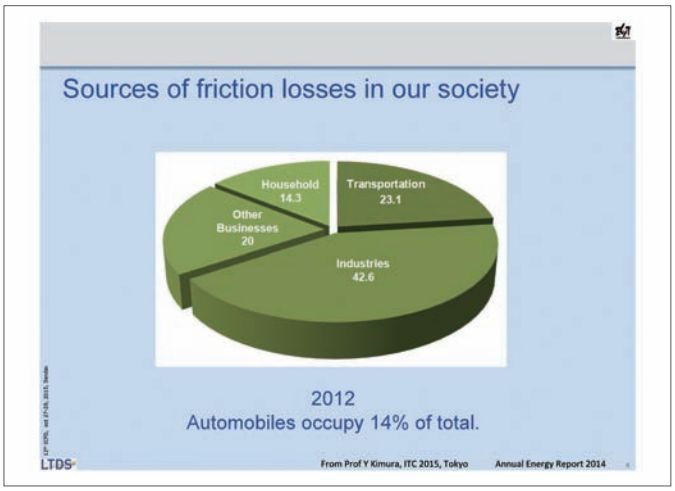


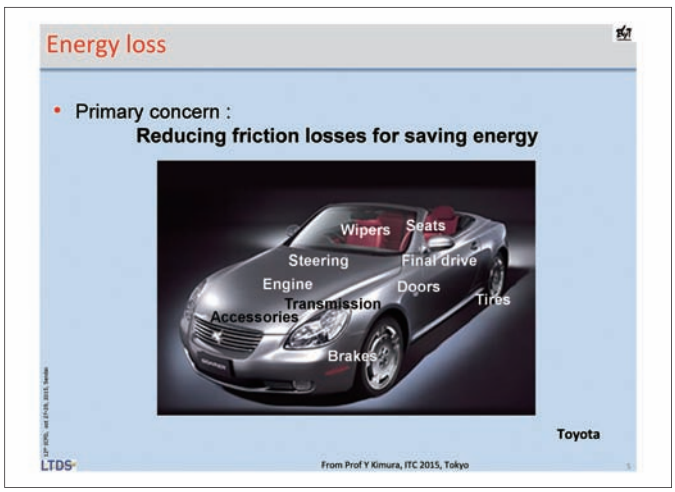
Material testing for valve seat of diesel engine

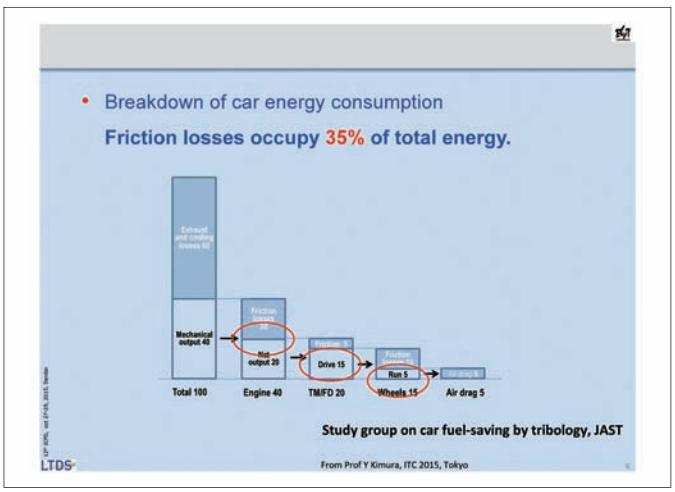
Philippe KAPSA

CNRS Research Director STMS/LTDS, École Centrale de Lyon, France

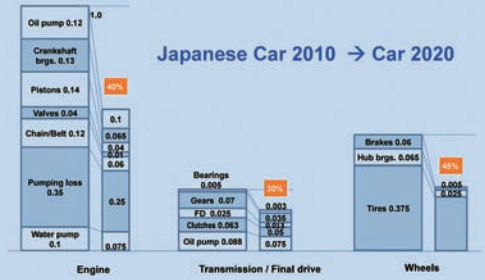








- Estimated reduction of friction losses in each components



Study group on car fuel-saving by tribology, JAST

From Prof Y Kimura, ITC 2015, Tokyo

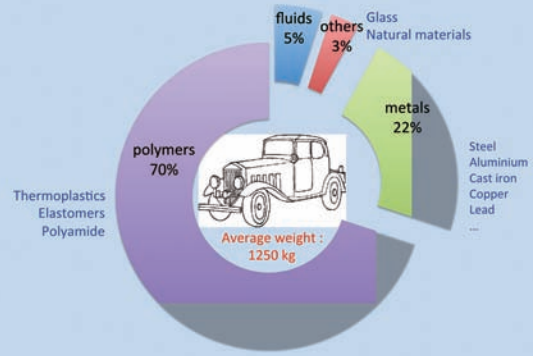
LTDS

- Progress for "friction and wear" aspects are possible by modifying :
  - The design of engines and mechanical parts
  - The lubricant (viscosity, additives, ...)
  - The materials (bulk, coatings, composites, ...)
- Lifetime is mainly related to wear.
  High tribological performance materials can increase the lifetime...

→ need to develop new materials, new process, ...

LTDS

Materials for automobile



LTDS

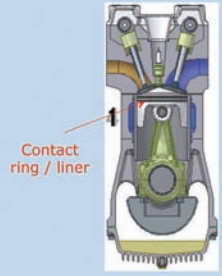
Metals for engines

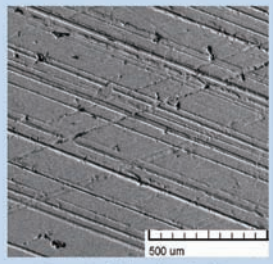
- Metals for engine parts are more and more loaded
  - Mechanical stresses, temperature, chemical aspects
- Selection of high performance metals and coatings (surface treatments) are of primary interest
- Important need to have representative tests...
  - Field tests
  - Bench test
  - Laboratory tests

LTDS

Example of ring / liner contact

- A very important mechanism for the performances and the lifetime



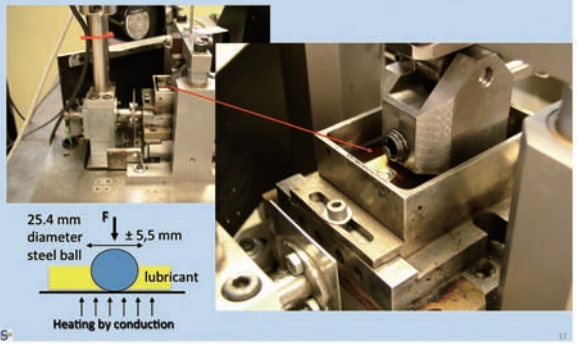


Topography of the liner obtained by honing

→ Bench tests are useful to study this contact but the cost is important

LTDS

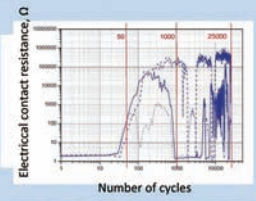
- Materials, lubricants are very often tested using a Pin on Disc (PoD) tribometer with an alternative motion.

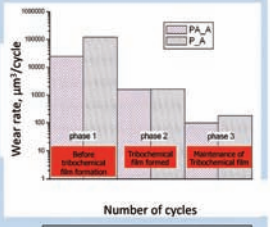


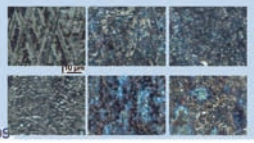
LTDS

- Pin on disc test can help in lubricant, materials selection

The lubricant efficiency is related to the formation of a tribochemical film on sliding surfaces leading to a reduction of the wear rate







Study of ring / liner contact for diesel engine :
Sphere on liner contact
Oil lubricated
Reciprocating motion
150°C

[PhD thesis, J. Keller, LTDS, 2006]

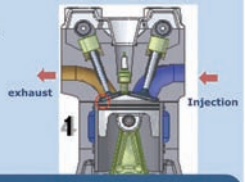
LTDS

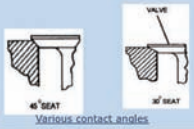
Valve on seat contact for diesel engine

The seat material is subject to severe conditions:

- **High temperature** (Ambiant → ≈ 750°C)
- **Double contact conditions :**
  - Impact : at the closure.
  - Sliding : due to vibration or misalignments.
- **Various angles** can be used to optimize the gas flows.
- **Sliding Contact conditions**
  - → Dry
  - → Presence of oil or combustion products

Combustion cycles
1. Injection
2. Compression
3. Explosion
4. exhaust





Various contact angles

complex damage

Few studies in the litterature

LTDS

What test can we use ?

- Classical pin on disc test appeared to be intersting but not sufficient to reproduce completely the real system

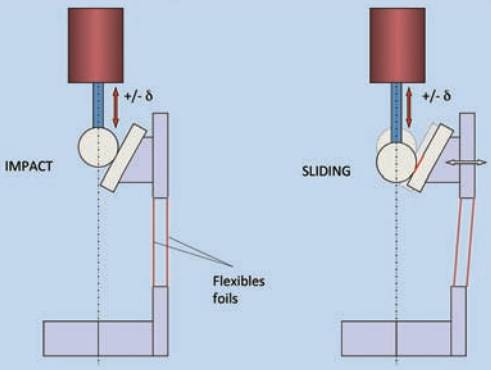
→ Development of simple specific systems

Technical requirements for the test system

- Materials, samples
  - Representative materials...
    - Steel / coating (All alloy substrate)
- Type of contact
  - Flat on flat, Cylinder on flat, Ball on flat
- kinematic
  - Shocks —> Frequency, energy, shock velocity, ... to be defined
  - And sliding
- Contact pressure / force
  - Normal force ?
    - PSA information : F impact = 700 N; Sheffield studies F combustion = 13 kN
  - Constant, variable ?
- Temperature
  - Ambiant —> 400 °C
- Atmosphere
  - Combustion gaz ? NO in a first approach
- Measurements
  - Forces, displacements, temperatures
  - Observations of surfaces
  - Wear

LTDS

Impact / sliding tribometer developed at LTDS

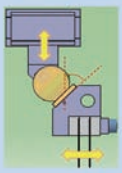


LTDS

52100 steel ball

α=30; 45; 60; 90°

Sintered steel flat



Advantages:
- Simple configuration,
- A constant impact energy,
- Possibility of temperature,
- Impact angle adjustable.

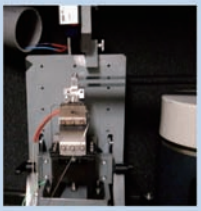
Measurements during tests
- Ball position
- Impact force
- Electrical contact resistance

Measurements after test
- Profilometry,
- Wear scar observations.

LTDS

IMPACT-SLIDING test

??? → what is the exact motion ?



Test, 4 mJ à 16 Hz.

Tools :
- High speed video camera
- Electrical contact resistance
- Finite elements modelling.

Observation with high speed video camera 4 mJ à 16 Hz.

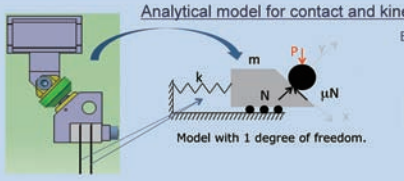
LTDS

Analytical model for contact and kinematics (A. Ramalho)

Equation of motion:

$$F_1 = \frac{P}{2}(\cos 45 - \mu)$$

$$m\ddot{x} + kx = F_1 \sin \omega t$$

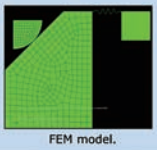


Impact / sliding tester

FEM quasi static contact

- Kinematics for 45° impact
- Friction

→ Dynamic phenomena are negligible.

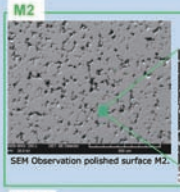


FEM model.

LTDS

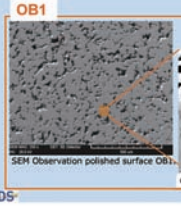
Experiments with 2 steels: M2 and OB1

M2



- Surface porosity: 22%, → Density: 8.16 g/cm³
- Carbide size: **10** µm.
- Carbides: -M_6C -MC
- Hardness HV: 504

OB1

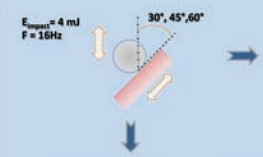


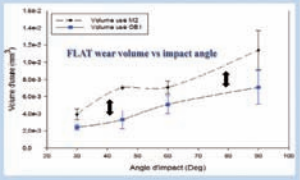
- Surface porosity: 28%, → Density: 7.75 g/cm³
- Carbide size **5** µm.
- Carbides -$M_{23}C_6$ -M_7C_3
- Hardness HV: 733

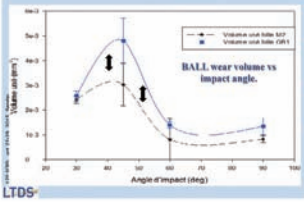
LTDS

Test results: dry conditions

Impact / sliding tests





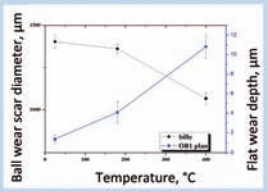


- FLAT wear volume increases with impact angle
- OB1 presents the lowest wear.
- Antagonist material of OB1 presnets the highest wear.
- Maximal wear volume is observed for 45°.

LTDS

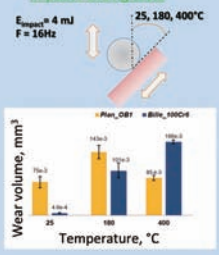
Test results: dry conditions, effect of temperature

Wear for reciprocating PoD at various temperatures



- Wear volume of ball decreases with temperature
- Wear volume for OB1 flat increases with temperature

Impact / sliding tests



- Wear volume of ball is maximum at **400°C**.
- Wear volume of OB1 flat is ùmaximum at **180°C**.

The contact loading modifies the oxidation process and the wear

LTDS

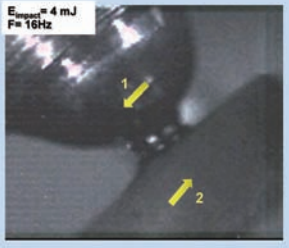
Test results: lubricated conditions

Reciprocating PoD test in lubricated conditions:

- The friction coefficient decreases when a lubricant is present

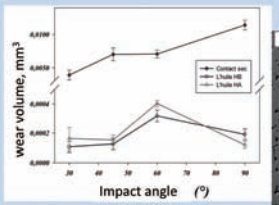
Impact / sliding test with lubricant

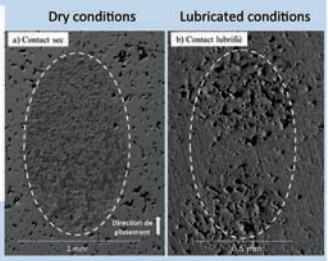
- The lubricant remains in the contact
- A metal / metal contact is detected by ECR measurements. Longer than without lubricant
- Impact force is decreased by the lubricant
- Impact force decreases with lubricant viscosity



Observation with high speed camera.
Lubricated contact, 45°

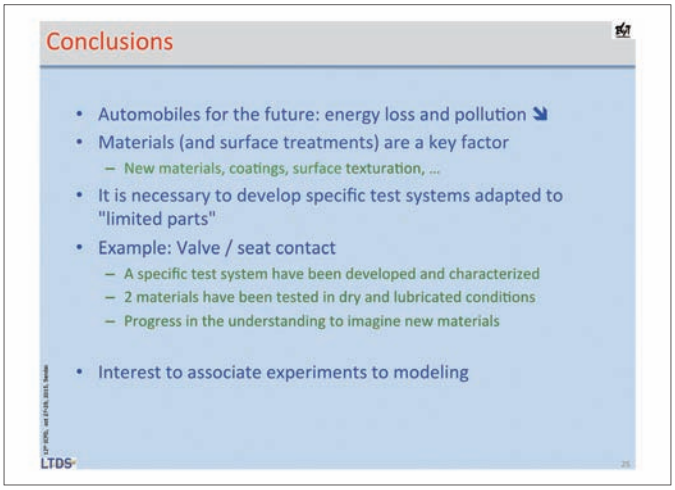
LTDS





- Reduction of adhesion.
- Observed for all angles
- Damage for lubricated case are initiated at the pores

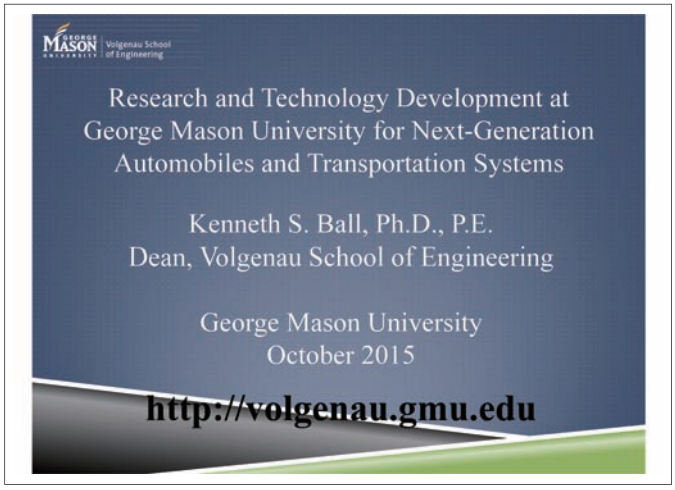
LTDS

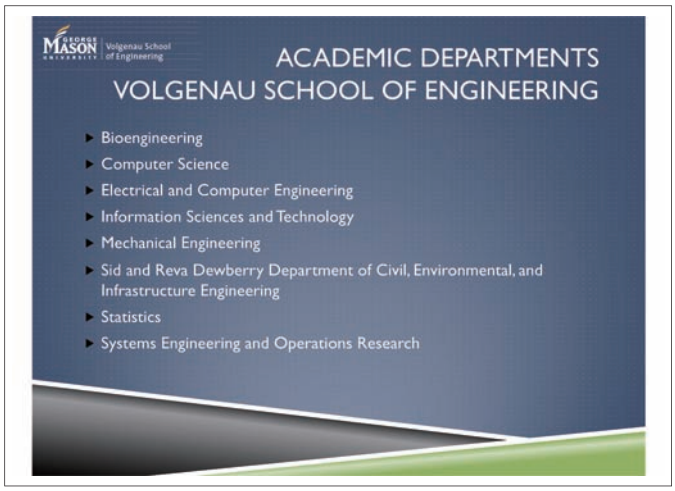

Conclusions
• Automobiles for the future: energy loss and pollution ↘
• Materials (and surface treatments) are a key factor
– New materials, coatings, surface texturation, ...
• It is necessary to develop specific test systems adapted to "limited parts"
• Example: Valve / seat contact
– A specific test system have been developed and characterized
– 2 materials have been tested in dry and lubricated conditions
– Progress in the understanding to imagine new materials
• Interest to associate experiments to modeling
LTDS

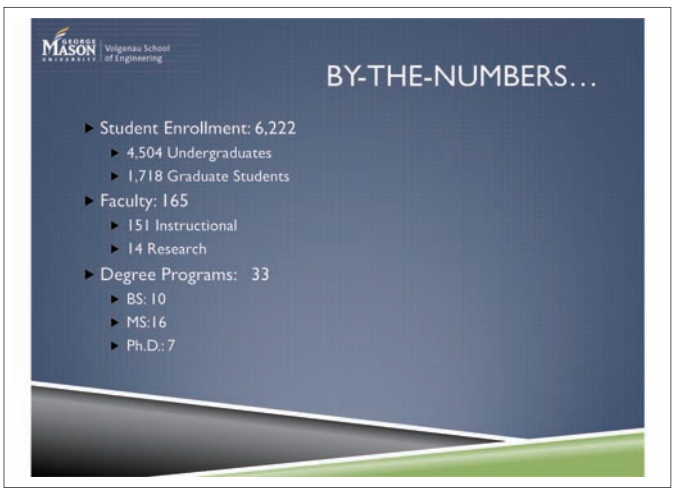
Research and Technology Development at George Mason University for Next-Generation Automobiles and Transportation Systems

Kenneth Steven Ball

Dean, the Volgenau School of Engineering, George Mason University, USA







RELEVANT AREAS OF EXPERTISE

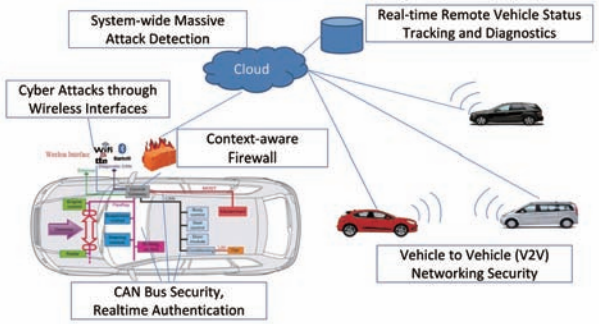
- Autonomous Systems and Controls
- Robotics and Unmanned Vehicles
- Sensors and Multi-Sensor Fusion
- Trusted Communications and Connected Vehicles
- Cybersecurity and Cyber-Physical Systems
- Safety and Reliability; Resilient Systems
- Signal and Array Processing; Data Analytics
- Artificial Intelligence
- Testing and Evaluation
- Logistics

Cybersecurity of Connected and Automated Cars

Kai Zeng, Ph.D.
Professor of Electrical and Computer Engineeing and Cybersecurity Engineering

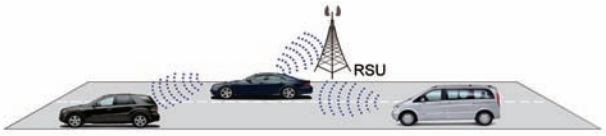
Amir Alipour-Fanid
Ph.D. Student

Security and Privacy of Connected and Automated Cars

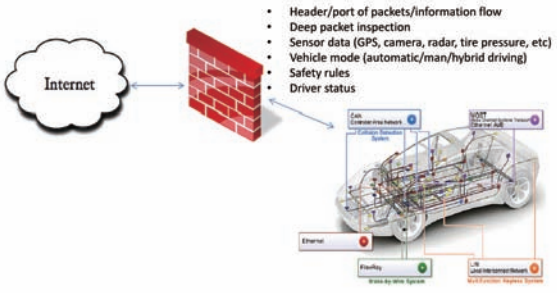


Physical Layer Challenge-Response Authentication

- Application: Used for V2I and V2V authentication
- Mobility: Favor fading channel and dynamic environment
- Security:
  - Immune to replay attack
  - Information-theoretical secure (i.e., security strength is not determined/affected by computing power, but guaranteed by physical laws)
- Scalability:
  - No need to increase key length when attacker's computing power is improved
  - Extensible to multi-user and multi-hop networks



Context-Aware Firewall for Connected and Automated Cars

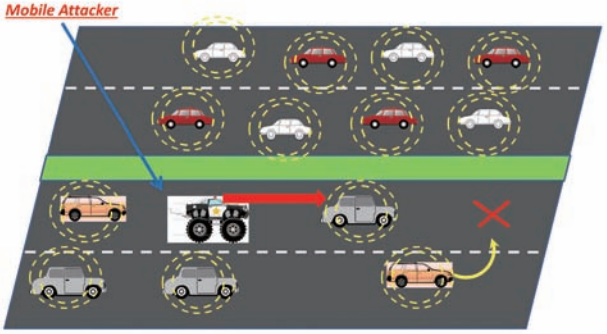


GPS Spoofing Attack Detection for Connected and Automated Cars

- **Global Positioning System security**
- GPS spoofing involves two steps: taking over the legitimate GPS satellite signal and then transmitting the spoofing signal.
- **Application: V2V (cooperative safety application)**
- **Detection**
- **Countermeasure**

Practical view:
Safety application ==➔ Exact Position has a vital role ➔ GPS defines the location
➔ DSRC (Dedicated Short Range Communication) send position info. to other vehicles

Mobile Attacker



1- V2V (for safety) information exchange: Position, Speed, Heading, Brake Status

2- DSRC technology: communication between vehicles is reliable up to a range of around 300 m

3- Safety Applications
Emergency Electronic Brake Lights (EEBL),
Forward Collision Warning (FCW),
Blind Spot Warning (BSW)
Lane Change Warning (LCW)
Do Not Pass Warning (DNPW)
Intersection Movement Assist (IMA)

4- VSC-A relative positioning requirements
Which-Road : relative accuracy level is 5 m
Which-Lane : relative accuracy level is 1.5 m

5- GPS relative positioning methods:
Single Point (SP) and Real-Time Kinematic (RTK) :
Single Point : sharing positioning data elements such as latitude, longitude, elevation
Real-Time Kinematic (RTK) : sharing GPS raw data in Radio Technical Commission for Maritime Services (RTCM) v3.0 format, used in the RTK relative positioning method.

Duminda Wijesekera, Ph.D.
Professor of Computer Science

- Trusted Cognitive Radios for Smart Cars
- Trusted Broadcasts for Smart Vehicles
- Secure V2V Communications
- Data dissemination in V2I infrastructures
- Emergency Handling in Smart Highways
- Commercial Mobile Alert System (CMAS)

Trusted Cars and Roads

- Primary Objective: Multiple radios in the CAN network (Controller Area Network) to have secure communications within the (Car) network
- Secondary Objective: Communications between smart cars and smart highway infrastructure to be secure.
- Method: Use a trusted and cognitive radio (communication module) to transmit short-range radio signals.

Trusted Broadcasts for Smart Highways

- Smart Highways Broadcast information for smart cars to use for
  - Safety warning including emergency handling
  - Weather conditions,
  - Asking room for emergency vehicles
  - Traffic lights
- All these will light up inside the dash with voice a – so called in-cab signaling
  - will talk to the break manager if the human driver does not respond
  - Will talk to autopilot

Evolutionary Computation and Evolving Agents

Kenneth De Jong, Ph.D.
Computer Science Department

Collision Avoidance and Navigation

Goal:

Get single agent to reliably perform complex navigation tasks. Extend to multiple cooperating agents.

Approach:

Evolve behaviors offline via simulation

Download & test on real robot

GEORGE MASON UNIVERSITY | Volgenau School of Engineering

RAJESH GANESAN, PH.D.
PROFESSOR, SEOR

- Analytical Modeling and Computational Research for Next Gen Automobiles
  - Big Data Analytics (Data-Information-Knowledge)
- Dynamic optimization using artificial intelligence of vehicle operational parameters for
  - Effective cruise control
  - Minimized emissions
  - Maximized fuel/battery/fuel-cell economy
- Simulation and Optimization of system, process, and product design parameters
  - Multi-objective optimization
  - Trade-off analysis of conflating parameters
- Engineering process control and statistical real-time monitoring of advanced manufacturing processes
- Algorithm development for vehicle computers

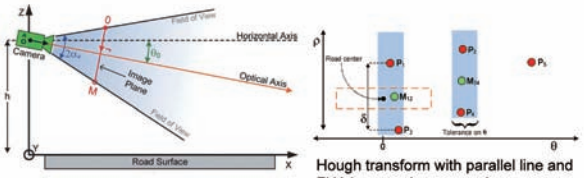
Automatic Steering and Lane Tracking

Monson Hayes, Ph.D.
Chair and Professor
Department of Electrical and Computer Engineering (ECE)

Gerald Cook, Ph.D.
Earle C. Williams Professor of ECE

Lane Tracking for Driver Safety

- A multi-stage system involving inverse perspective mapping, matched filters using lane marking standards, Hough transforms, RANSAC, Kalman filtering, among others.
- Single and dual camera (forward and backward looking) systems.
- Performance evaluation using ground truth data.



Hough transform with parallel line and FHA lane marker constraints.

Feature Selection and Evolution Modeling for Tire Wear Analysis

Ideas for Collaboration

Jill K. Nelson and Kathleen E. Wage

Department of Electrical and Computer Engineering

Statistical Signal Processing Lab

Director: Jill K. Nelson, Associate Professor of ECE
Ph.D. in Electrical Engineering, University of Illinois at Urbana-Champaign, 2005

Focus areas:
- Localization and tracking
- Blind source separation
- Signal processing for communications
- Signal processing for music

Funded projects:
- *Tree Search Approaches to Multiple Target Tracking*
  Funded by the Office of Naval Research, 2009-2011
- *Linking Interest and Conceptual Knowledge in Electrical Engineering*
  Funded by the National Science Foundation, 2008-2010
- *Encouraging Innovative Pedagogy through Long-Term Faculty Development Teams*
  Funded by the National Science Foundation, 2010-2012

Students: 3 PhD, 3 MS, and 1 undergraduate

Ocean Acoustic Signal Processing Group

Focus: multidisciplinary problems that require a synthesis of signal & array processing, acoustics, and oceanography

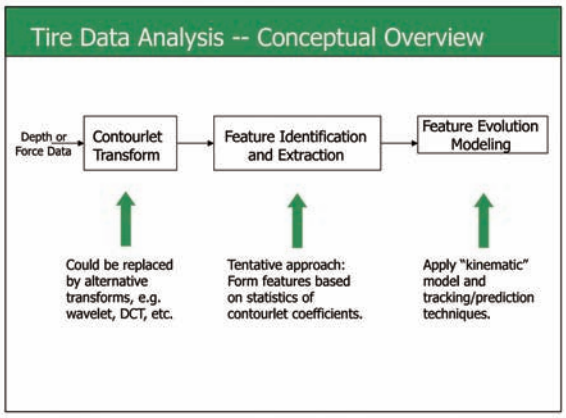
Director: Kathleen E. Wage, Associate Professor of ECE
PhD, MIT/Woods Hole Oceanographic Institution

Current students: 3 PhD and 1 MS

External funding: Office of Naval Research (ONR)
- *Stochastic Eigenanalysis for Adaptive Array Processing* (2009-11)
- *Mode Processing & Tomography for the Philippine Sea* (2009-11)
- Selected previous awards:
  - *Signals & Systems Concept Inventory*, National Science Foundation (2005-10)
  - *ONR Young Investigator Award* (2005-08)
  - *Robust Matched Field Processing*, Lockheed Martin (2001-02)

Group website: http://ece.gmu.edu/~kwage/research/oasp

Tire Data Analysis -- Conceptual Overview

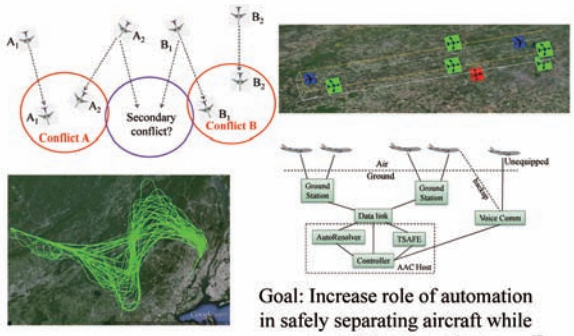


John Shortle, Ph.D.
Professor, Systems Engineering & Operations Research

Related Expertise

- Aviation safety
- Automated separation
- Reliability
- Rare-event simulation

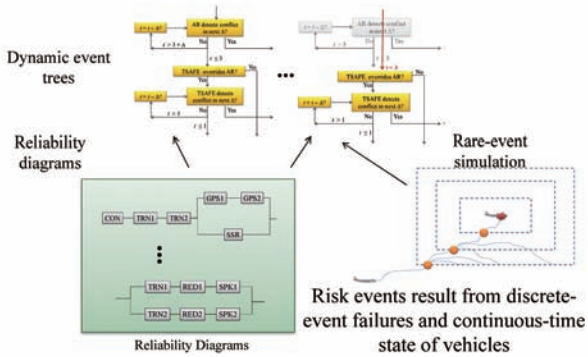
Automated Separation Assurance



Goal: Increase role of automation in safely separating aircraft while maximizing throughput

27

Safety Evaluation and Rare Events



Risk events result from discrete-event failures and continuous-time state of vehicles

Next-Generation Automobile Research
Lance Sherry, Ph.D. Director, CATSR

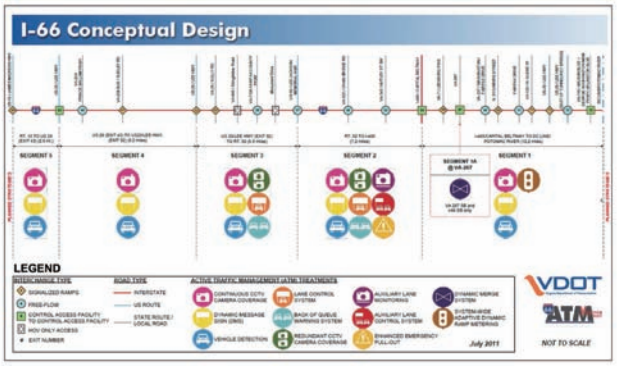
- **Design:**
  1. Collision-Risk analysis
     - CATSR/GMU pioneered new method for collision risk analysis using *Dynamic* Event Trees and Rare Event Simulation
     - Now widely used in aviation
  2. Human Factors Design (provisional patent)
     - CATSR/GMU developed Monte Carlo simulation of Human-Computer Interaction (HCI)
     - Used for design and certification of airline flight deck procedures
  3. Design of (Semi-) Autonomous Systems
     - Combinatorial state-space approach to autonomous system design
     - Explicitly designs interventions for hazards
  4. Paranoid Driver Associate (invention disclosure submitted)
     - Joins off -vehicle data (e.g. maintenance logs, recalls, ...) with on-vehicle data to identify probabilistic alerting for drivers
- **Operation:**
  1. Real-time Big Data Analytics of Vehicle Trajectory and Guidance/Control Mode data for:
     - Vehicle
       - efficiency (e.g. fuel burn, accelerations/decelerations)
       - emissions inventory analysis
       - Real-time risk factors
       - Performance Anomaly detection
       - Control Mode Anomaly detection
     - Transportation
       - flow analysis
       - real-time risk factor identification

Volgenau School of Engineering
Systems Engineering & Operations Research *Center for Air Transportation Systems Research*

Connected Vehicle Testbed in Northern Virginia
Shanjiang Zhu, Ph.D., Asst. Prof. CEIE

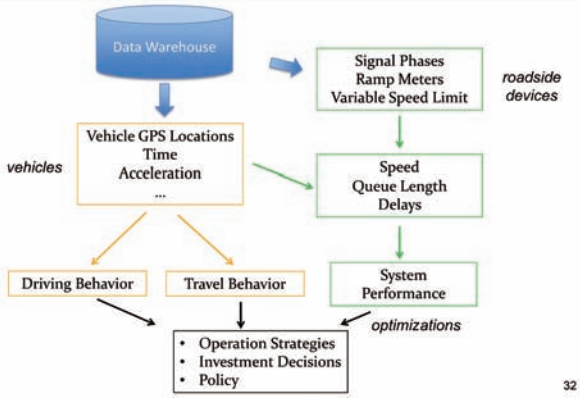
30

Active Traffic Management along I-66



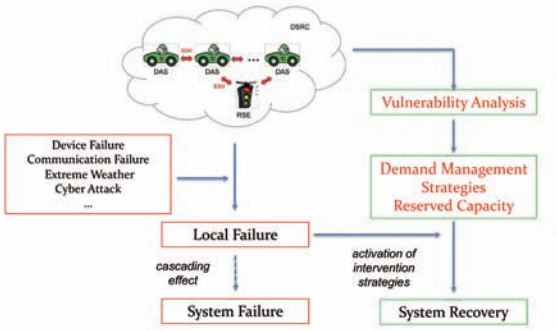
31

Travel Behavior Study and System Performance Evaluation



32

Resilience Strategies



33

Distributed Traffic Light Coordination

Prof. Sean Luke
Department of Computer Science

- **No** centralization
- **No** communication among traffic lights
- Highly **efficient** in terms of total system throughput
- Highly **fair** in treatment of vehicles
- Good handling of **emergency events**
- Good handling of **sudden high traffic events** (everyone leaving a rock concert at the same time)
- **Green waves** should appear naturally
- **Simple**

Connected Vehicle Research at Mason

Mohan Venigalla, Ph.D., Assoc. Prof. CEIE

- Hardware
  - sensor technologies, hardware units
- Communication
  - protocols, security, data collection and transfer
- Data processing, analysis and solutions
  - dynamic routing, traffic management, driver behavior

GEORGE MASON UNIVERSITY | Volgenau School of Engineering

Kenneth S. Ball, Ph.D., P.E.

If interested in discussing research or academic partnerships or collaborations, please contact me at:

ball@gmu.edu

http://volgenau.gmu.edu

THANK YOU FOR YOUR ATTENTION

Electrochemical Technologies for the Transportation and Energy Industry of the Future

Mark C. Williams

Program Manager, AECOM, USA

Electrochemical Technologies for the Transportation and Energy Industry of the Future

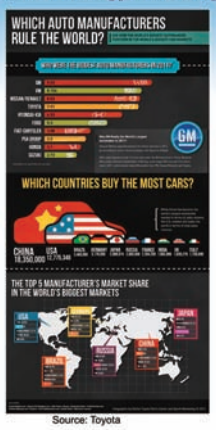
Dr. Mark C. Williams
Program Manager
AECOM
Visiting Professor, Tohoku University

Transportation and Energy - Walking Hand in Hand

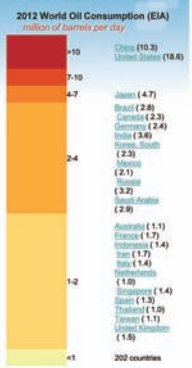
50 million are sold annually – Japan may be the world's largest producer

China and US are the enormous markets

When will this trend change? If US and China consume 40% of the world's depleting oil reserves, what will the rest of the world use?



Source: Toyota



Types of Primary Energy

- Primary Energy (Stored and Real time)
  - Oil
  - Coal
  - Natural Gas
  - Biomass
  - Nuclear
  - Solar
  - Wind
  - Hydro
  - Geothermal

The Future

- Oil, Coal and nuclear are finite stored energy
- These will be going away in the future
- These leaves solar, natural gas, biomass, wind, geothermal and hydro

Energy Conversion Technologies for Electrified Transport

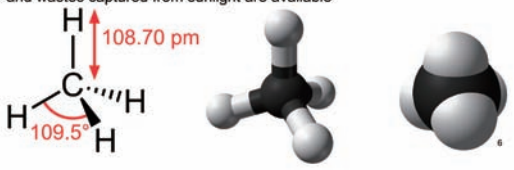
- Natural gas fuel cells represent conversion of chemical to electrical (c →e);
- Batteries and electrolysers/fuel cells, electrical to chemical to electrical (e → c →e);
- Hydrogen, chemical to chemical to electrical (c → c →e);
- Solar, light to electrical (λ→e); and
- Solar synthesis, light to chemical to electrical (λ → c →e).

Natural Gas

We will always have natural gas (methane) on this planet

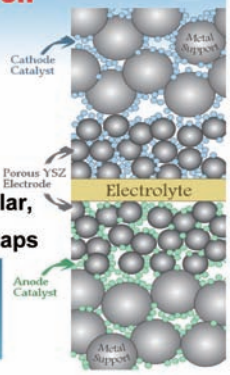
We benefit from the chemical energy extracted from sunlight on this planet
- Coal, petroleum and natural gas are stored chemical energy from the past

As long as there is life and sunlight, we will always have natural gas on this planet in the future
- Methane from human (ADG) and plant and animal and plant residues and wastes captured from sunlight are available



Natural Gas Fuel Cells for Transportation

- Natural gas fuel cells
  - Direct methane
  - Internal reforming
- Complete re-look
- Metal-supported planar or tubular, intermediate temperature, perhaps SOFC-type
  - Durability
  - Efficiency



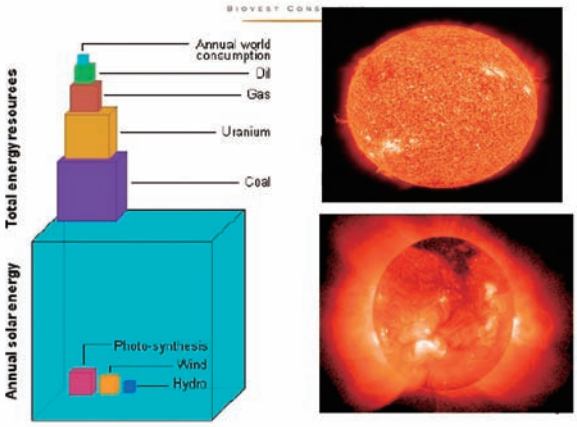
Hydrogen

- Hydrogen fuel cell vehicles will require a hydrogen infrastructure.
- Natural gas is currently the principle method to generate hydrogen. Production from renewable energy – wind, solar, geothermal and biomass is also possible for the future.
- The use of hydrogen for vehicles may require the development of two infrastructures – one for natural gas and one for hydrogen.
- In future H2 and fuel production could be directly synthesized from water, CO2 and light. H2 and liquid fuels could be indirectly synthesized from water, NG and energy (light, thermal).

Batteries

- Battery/storage chemicals are a key possibility for the future. Electricity is needed to charge these chemicals.
- The chemical energy is then converted back to electrical energy. So it is in reality a way to store electrical energy.
- Electrolysers convert electrical energy and/or thermal energy into chemical energy. An electrolyser combined with a fuel cell is actually a rechargeable battery.

Grid of Future



Priority Research for Electrified Transportation

- Light (solar performance and cost)
- Natural gas on-board storage
- Electrolyers/fuel cells
- Batteries (performance and cost)
- H2 fuel cells for transportation for long distance
- Natural gas fuel cells for transportation
- H2 and fuel production directly from water, CO2 and light
- H2 and liquid fuels indirectly from water, NG and energy (light, thermal)

Future Role of Safety Testing Technology in Vehicle Design and Development and Highway Safety

Cing-Dao (Steve) Kan
Professor, Director, Center for Collision Safety and Analysis, George Mason University, USA

Future Role of Safety Testing Technology in Vehicle Design and Development and Highway Safety

Professor Cing-Dao Kan

Wednesday, October 28, 2015

GEORGE MASON UNIVERSITY — Center for Collision Safety and Analysis CCSA

1

Overview

- Full scale vehicle crash testing
- Organizational aspects
- Sled testing
- Component testing
- Interior & pedestrian safety testing
- Anthropomorphic test devices (“dummies")
- Testing and simulation

2

Crash test - history

- 1934: First barrier crash test by GM
- 1959: First crash test at Mercedes Benz
- 1979: NHTSA begins crash testing
- 1997: Euro NCAP’s first results released
- 2006: China NCAP

3

Crashworthiness then and now

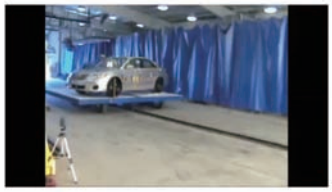
- Fatalities in Germany 1950-2010:

- 1950’s: ~ 6 deaths per 100 million miles traveled in US
- 2009: ~ 1 death per 100 million miles traveled in US

4

Side Impact – e.g. Oblique Pole Test

- “Flying Floor”
- Pre-test preparations
- “Impact point pin”
- “Retaining bands”
- Camera positioning
- Sensor technique
- 50% male and 5% female front occupants



5

Quasi-static roof strength tests

- FMVSS 216 (2 sides, 5 inch)
- IIHS test (1 side, 10inch)

6

Frontal – IIHS Small Overlap Impact

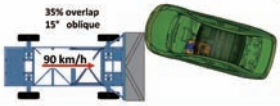
- 25 % overlap
- 40mph
- since 2012

Additional test configurations

- Internal tests
- Real world safety
- Sensor tests
- Rear seat occupant
- Compatibility tests
- Future ratings
- Future regulation

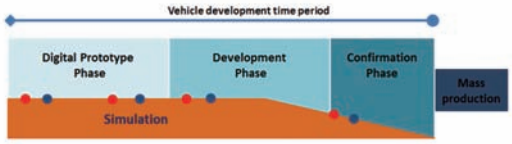
Future test – Oblique Impact

- Configuration not final
- Activities in Europe and US
- New barrier
- New load paths, kinematics
- New dummy



THOR

Vehicle development process



- Typically 3-4 years
- Can be shorter for derivatives
- Little or no testing in digital prototype phase

Vehicle functions

- Noise & Vibration Analysis
- Fatigue & Endurance strength
- Aerodynamics Analysis
- Fuel Consumption Analysis
- Vehicle Dynamics
- Active Safety
- ...
- Passive Safety

OEM - internal interactions

Testing
(full scale, sled, subsystem, component)

Simulation
(vehicle structure, occupant, pedestrian)

Accident Research
(Onsite Investigations, Database Analyses)

Design/Project
(project management, styling packaging, cost, weight..)

Challenges for testing

- Increasing number of vehicle platforms and derivatives
- Increasing number of requirements
- Stringent development plans
- Parallel setup and performance of tests
- Set priorities which test is necessary (which other tests are being covered, which can be skipped)
- Highly qualified personnel of different expertise: …
- Well organized processes (parts, setup, sensor, post-processing, pictures, filming …)

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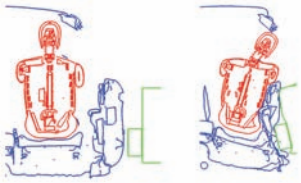
Necessity of sled testing

- Very realistic & efficient for load cases with little intrusion
- Complex load cases (e.g. side pole) require more validation & upfront sled setup
- Multiple use of sled with prototype/ predecessor interior
- Simulation (more realistic vehicle & intrusion behavior) and sled test (realistic restraint system hardware characteristics) complement each other
- Many tests with fast adaption (airbag folding ..) possible
- Very important (due to reduced & late full scale testing)

14

Sled test boundary conditions

- Vehicle pulse from testing (early prototype or predecessor)
- From simulation
- Intrusion profile
- Timing
- Tilting angle

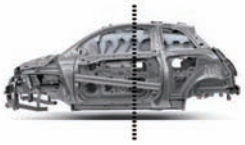


t=0ms t=20, 40 ..ms

15

Sled test devices

- Frontal impact sled
- Sled with pitching
- Side barrier sled on sled
- Side pole test:
  1) full vehicle body in white structure on sled
  2) sled with predefined hinges, pre-deformed structure (developed using simulation)



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Rear impact - Whiplash

- BioRID
- EuroNCAP
- IIHS

- Precise seating procedure
- Cooperation with seat manufacturer

17

Advanced sled testing system

- Multiple intrusion profiles/pulses
- Capture complex intrusions
- Principle testing
- Evaluate injury mechanisms

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Restraint components then & now

- 1958: Volvo invents 3-point seat belt
- 1971: Airbag patented by Mercedes
- 1980: Airbag in production (S-Class)
- Today: xx airbags & optimized restraints

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Pedestrian safety & Interior impact

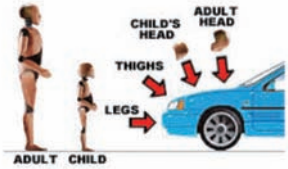
- FMVSS 201u: upper interior head impact protection requirement since 1995 (US)

- Pedestrian protection requirements (Euro NCAP)

20

Pedestrian safety (Euro NCAP)

- Head impact
- Leg impact
- Adult
- Child
- Interdisciplinary teams (testing, simulation, packaging, styling)



21

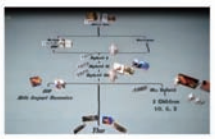
Pedestrian safety - Countermeasures

- Active systems
- Passive systems
- Affects styling
- Affects Packaging

22

Dummy historical

- 1947 - .. John P Stapp
- 1949: Sierra Sam
- 1966: VIP
- 1971: Hybrid I
- 1973: Hybrid II
- 1977: Hybrid III
- 1987: Hybrid III 5%
- ???: THOR?



23

Examples of current & future dummies

- SID2s: 5th percentile female

- BioRID: rear impact, whiplash

- WorldSID 50% (EuroNCAP 2015)
- WorldSID 5% under development

- Child dummies Q6 & Q10 used by EuroNCAP (2015)

- THOR 50th & 5th percentile

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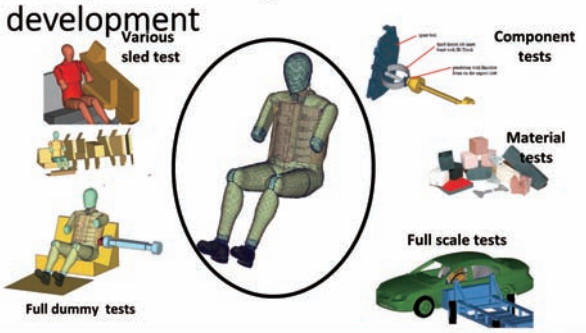
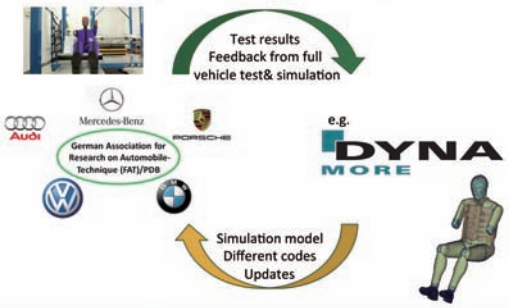
Example – Dummy model development



25

FAT Dummy development process



26

Dummy positioning

- Seat position
- H-Point Manikin
- Defined distances
- xyz-coordinates

27

"Climate room"

- Ensure right temperature
- Injury criteria can be temperature dependent
- Some criteria more sensitive than others

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Available Dummy Models

- Frontal dummies
- Side impact dummies
- Rear impact dummies
- Child dummies
- Different sizes
- Variations (US – Europe)

29

Future frontal dummy?

- THOR: Test device for Human Occupant Restraint
- Better biofidelity than Hybrid III
- 4 point thoracic injury evaluation
- Instrumented legs and face
- 5th percentile: under development
- Activities and plans to be used in Europe & US
- Development for 50th percentile is advanced

30

Simulation then and now

- **Simulation "yesterday":**
- Coarse meshes, structure only
- Separate rigid body models
- No component models from suppliers
- "Nice to have", development relied on testing

- **Simulation today:**
- Detailed models (~ 6 million finite elements for fully integrated model)
- "Not without" Major contribution in development

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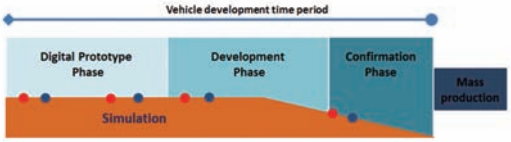
Simulation & testing organizational

- Testing & simulation work hand in hand
- Development engineers familiar with both areas
- Testing engineers can judge simulation results
- CAE-engineers are integrated in testing tasks
- Some areas "merged test & simulation", e.g. FMVSS201, Pedestrian safety, occupant safety
- Full scale vehicle & occupant simulation at OEM
- Sled test & simulation at OEM and system supplier
- Component test & simulation (airbags, trim ..) at supplier

32

Vehicle development process



- Typically 3-4 years
- Can be shorter for derivatives
- Little or no testing in digital prototype phase
- Early phase more simulation dominated, later phase more test dominated

33

Future test & simulation

- **Test & Simulation work "hand in hand"**
- **Complementary use of test & simulation results**
- **Test of standard load case, Simulation of variations**
- **Passing of certain regulations through virtual testing (simulation)**
- **Simulation will not replace testing but gives additional answers**

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Will we still need all this in the future?

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Thank you for your attention!

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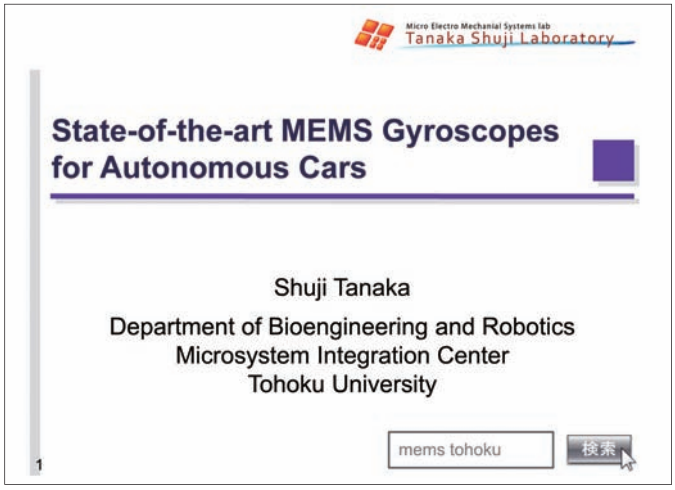
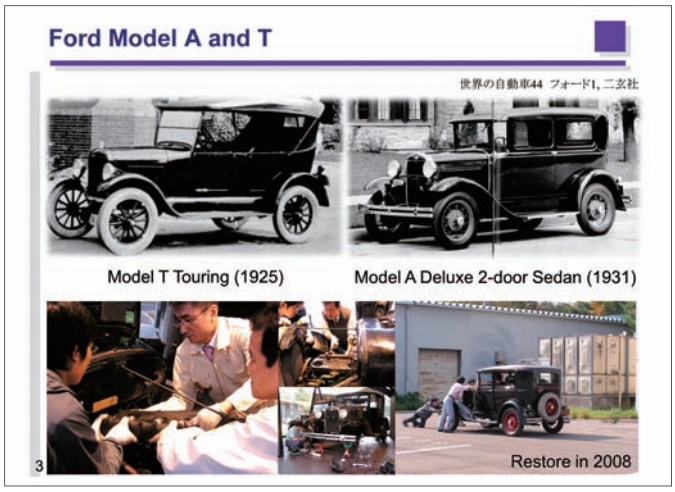
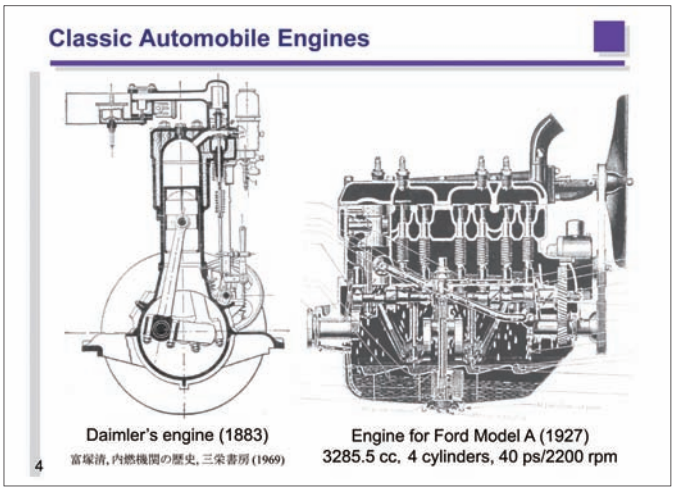
State-of-the-art MEMS Gyroscopes for Autonomous Cars

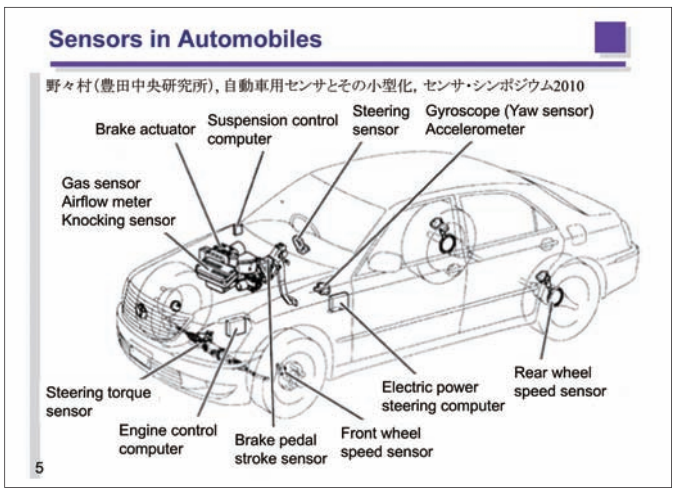
Shuji Tanaka

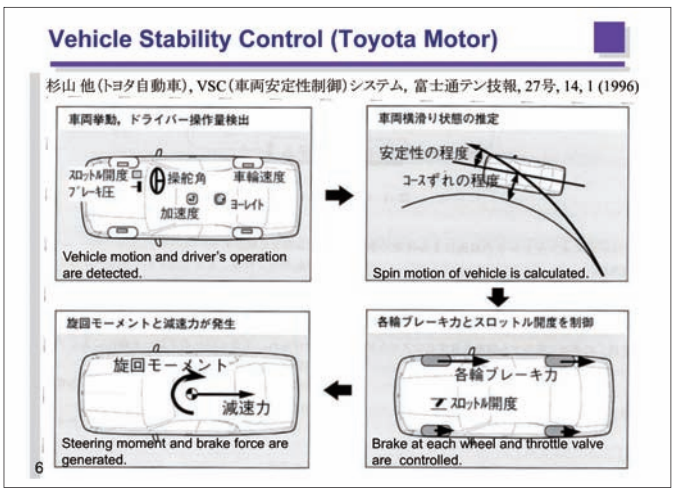
Professor, Bioengineering and Robotics Graduate School of Engineering, Tohoku University, Japan





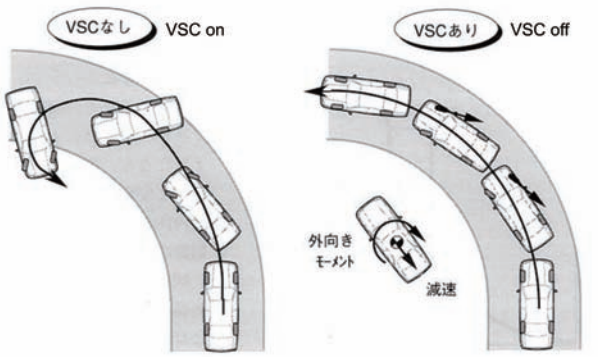






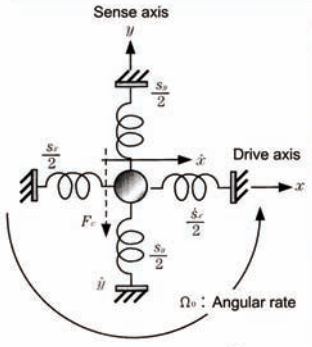
Vehicle Stability Control (Toyota Motor)

杉山 他(トヨタ自動車), VSC(車両安定性制御)システム, 富士通テン技報, 27号, 14, 1 (1996)

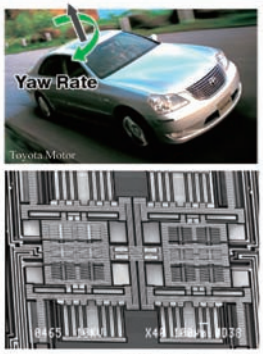


7

MEMS Vibratory Gyroscope



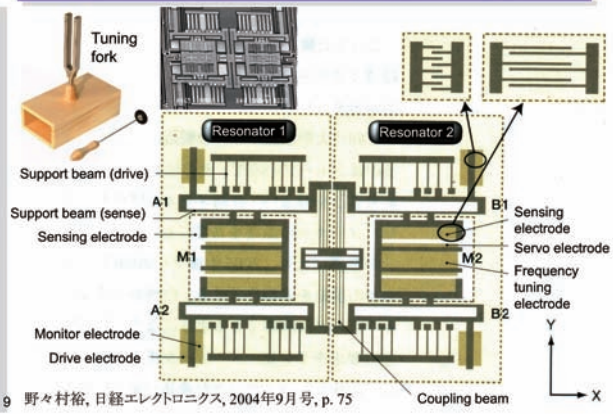
Colioris force $F_{cy} = 2m\Omega\dot{x}$



Gyroscope for vehicle stability control
(Toyota Motor, Tohoku Univ.)

8 多摩川精機, ジャイロ活用技術入門, 工業調査会 (2002)

MEMS Vibratory Gyroscope (Toyota Motor)

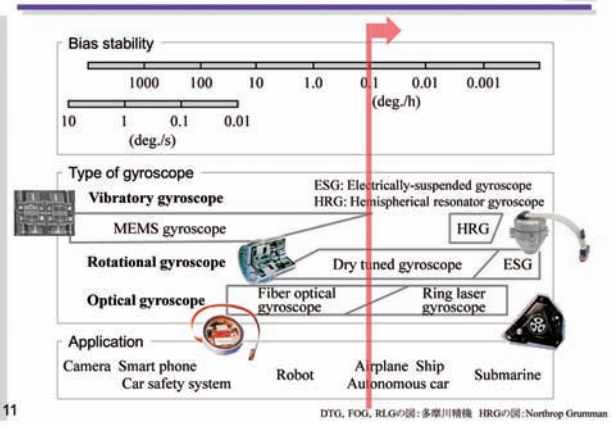


9 野々村裕, 日経エレクトロニクス, 2004年9月号, p. 75

Future Applications of MEMS Gyroscopes

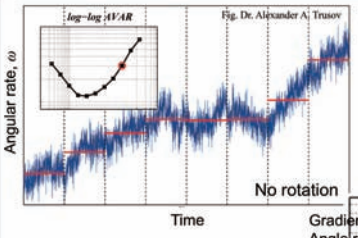
10

Performance of Gyroscopes



11

Bias Stability of Gyroscope



White noise and random walk of angular rate

Gradient of $\tau^{1/2}$
Angular rate random walk
(White noise accumulation)

Log-Log AVAR

Gradient of $\tau^{-1/2}$
Angle random walk
(Johnson noise)

Bias instability
(Flicker noise,
1/f noise)

$\sigma^2(\tau)$

τ

Allan variance (AVAR)

$$\sigma^2(\tau) = \frac{1}{2}\left\langle(\omega_{k+m} - \omega_k)^2\right\rangle$$

$$\sigma^2(\tau) = \frac{1}{2\tau^2(N-2m)}\sum_{k=1}^{N-2m}(\theta_{k+2m} - 2\theta_{k+m} + \theta_k)^2$$

Change of ω is averaged over different time constants τ

12

Difficulties of MEMS Gyroscope

Any small imperfections result in error.

- Imperfect orthogonality of drive and sense axes
- Mechanical and electrical coupling between drive and sense axes
- Unideal amplifier

etc.

Deep reactive ion etching

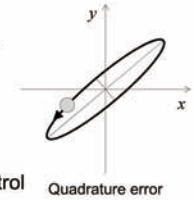
"Compromises" are made to avoid difficulties.

- Intentional mismatch in resonance frequency between drive and sense axes (Mode mismatch)
- Low quality factor

→ Limit in performance

→ Mode matching and high quality factor

→ Much better structure and advanced control



Quadrature error

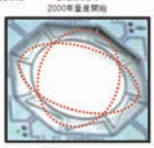
13

High-Performance MEMS Gyroscope (SSS)

資料: Silicon Sensing Systems

SGH01

2000年量産開始



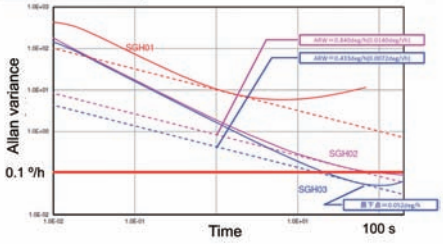
Segway

Mode-matched, force-rebalanced gyroscope

SGH03

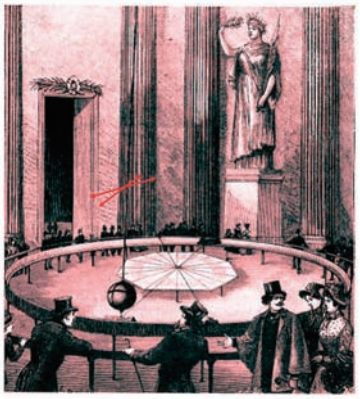
Magnet

Production by Sumitomo Precision and Design by UTC Aerospace Systems (UK)



14

Foucault Pendulum



Wikipedia

In 1851, French physicist Jean Bernard Léon Foucault (1819-1868) demonstrated the revolution of the earth using a pendulum of 67 m and 27 kg suspended in Panthéon de Paris.

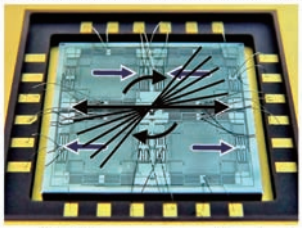
The vibration plane rotates, although only gravity works on the mass.

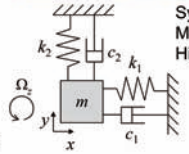
Foucault pendulum is a rate-integrated gyroscope (whole angle mode gyroscope).

15

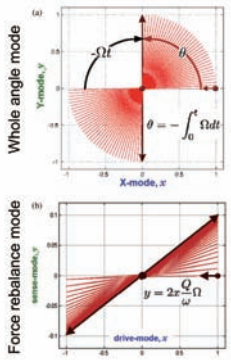
Whole Angle Mode Gyroscope (UC Irvine)

I.P. Prikhodko *et al.*, Sensors and Actuators A, 177 (2012) pp. 67–78





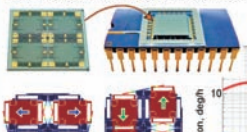
Symmetric structure
Mode matching
High Q factor



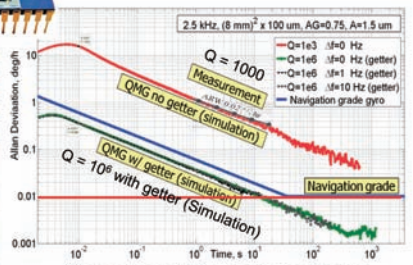
16

High-Performance MEMS Gyroscope

Northrop Grumman, UC Irvine (Prof. Shkel), Hilton Head Island Workshop 2014



Force rebalance mode and whole angle mode can be switched.



Allan variance for force rebalance mode

- Scale factor stability is 3 ppm in whole angel mode.
- FR-mode is less affected by frequency mismatch.

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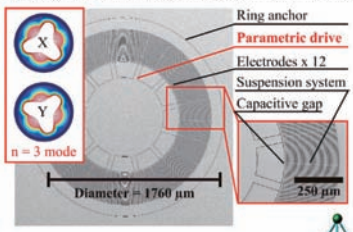
Whole Angle Mode Gyroscope

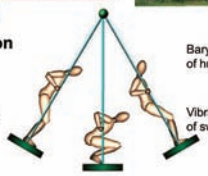
D. Senkal1, … T.W. Kenny2, A.M. Shkel1, 1UC Irvine, 2Stanford Univ., IEEE MEMS 2015



How to sustain free vibration without perturbation?

→ Parametric amplification

Spring constant is modulated at doubled frequency of resonance frequency.



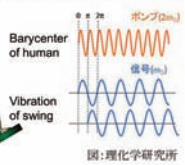
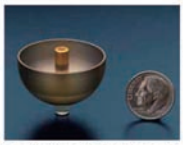


図:理化学研究所

18

Hemispherical Resonator Gyroscope

High-end gyroscope for aerospace applications (Northrop Grumman)



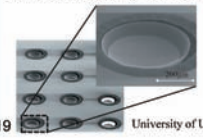
Hemispherical resonator made of fused silica ($Q = 25 \times 10^6$)

Bias stability 0.005 °/h

Bias stability 0.0005 °/h

Price ~1M US$?

Miniaturization by MEMS technology (DARPA project)



University of Utah

University of Michigan

Georgia Institute of Technology

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Summary

- A high-performance gyroscope of affordable price is a key component for autonomous cars.
- A bias stability of 0.1 °/h or better is required.
- This level of bias stability is realized by fiber optic gyroscopes, but the price is two or three orders of magnitude higher than expected.
- The required bias stability is two orders of better than that of the present MEMS gyroscopes for consumer applications.
- Drastic improvement in the performance of MEMS gyroscopes is theoretically possible but practically challenging.

【Requirements】

- Perfectly-symmetric two-axis orthogonal resonators with ultrahigh quality factor
- Advanced control system to compensate any imperfection and low-noise analog frontend

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MEMS Facilities in Aobayama Campus

Micro/Nano-Machining Research and Education Center (MNC)

Microsystem Integration Center

S. Tanaka Laboratory Cleanroom

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MEMS R&D Centers

- From proof-of-concept on small pieces to prototype development on 4 or 6 inch wafers
- Prototyped devices in Microsystem Integration Center can be basically utilized for business, i.e. as commercial samples and provisional products.
- For mass-production in small-to-medium volume, developed technology can be smoothly transferred to our partner foundry, MEMS Core in Sendai, Japan.

S. Tanaka Lab's cleanroom — Small piece

Micro/Nano-Machining Research & Education Center — 4 inch wafer

Microsystem Integration Center (μSIC) — 6 inch wafer

22

Micro Electro Mechanial Systems lab
Tanaka Shuji Laboratory

Tohoku University, Department of Bioengineering and Robotics

S. Tanaka Laboratory

Chair of Advanced Bio-Nano Devices

教 授	特任教授	准教授（μSIC）	特任准教授	准教授（AIMR）	助 教	助教（μSIC）
田中 秀治	門田 道雄	室山 真徳	吉田 慎哉	フロメル ヨーク	塚本 貴城	平野 栄樹
S. Tanaka	M. Kadota	M. Muroyama	S. Yoshida	Jörg Frömel	T. Tsukamoto	H. Hirano

Please visit S. Tanaka Laboratory website at http://www.mems.mech.tohoku.ac.jp/index_e.html

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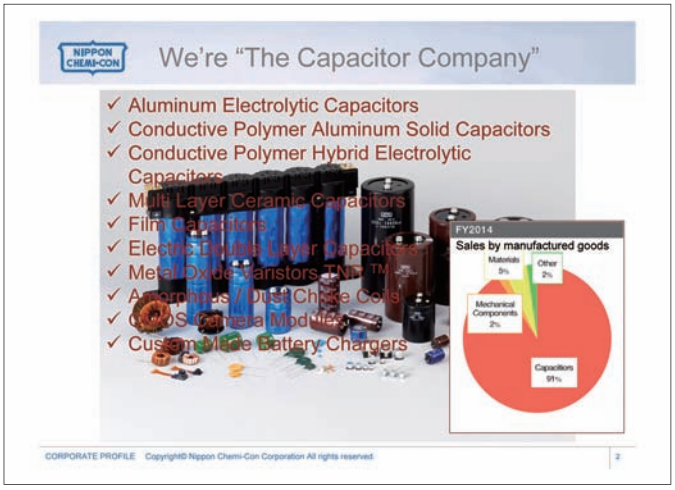
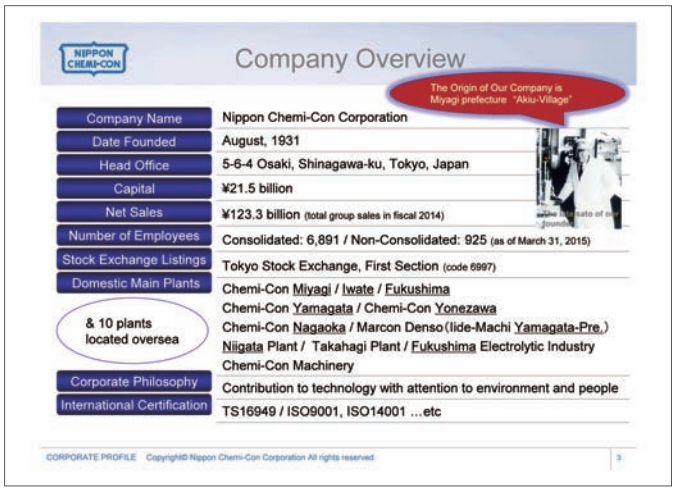
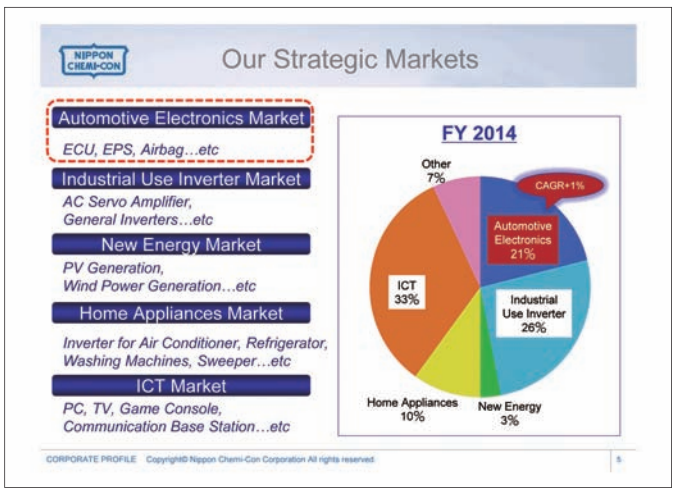
Our Performance for Automotive Electronics Market

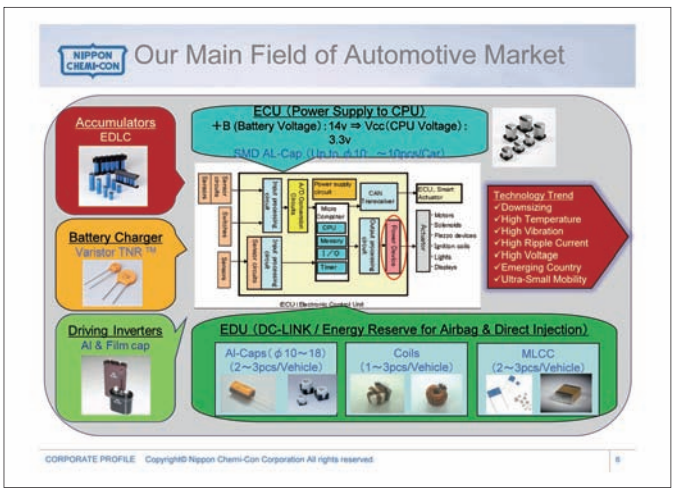
NIPPON CHEMI-CON CORPORATION

Japan









Focused Products: EDLC

New Comer!
Mazda MX5 Miata
(Roadstar)

12-25V

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Why did MAZDA use EDLC?

EDLC is a very Heavy Duty Accumulator!

	Capacitor		Lithium-ion batteries		Nickel-metal Hydride batteries		Lead-acid storage batteries	
Type	Electric Double Layer		HEV application		HEV application		Vent type	
Energy density (Wh/kg)	×	5~10	○	100~200	○	50~80	○	30~40
Voltage (V)	△	2.5	○	3~3.7	△	1.2	△	2
Maximum Output (W/kg)	○	10,000>	○	4,000	△	1,000~2,000	×	200
Resistance (mΩ)	○	1	△	2.5	△	3	△	5
Operating temperature(℃)	○	-30~70	△	-30~60	△	-30~60	○	-30~80
Cycle life (soc 0 ⇔100% @25℃)	○	1,000,000>	△	3,000>	△	1,000 >	×	300>
Safety	○	–	△	–	○	–	○	–
Environmental load	○	–	×	Li,Co,Ni,Mn	×	Ni	×	Pb

From Mazda's 2012 No30 Technology Report
(Courtesy of Mazda Motor Corporation. Copying and/or distributing this slide is prohibited.)

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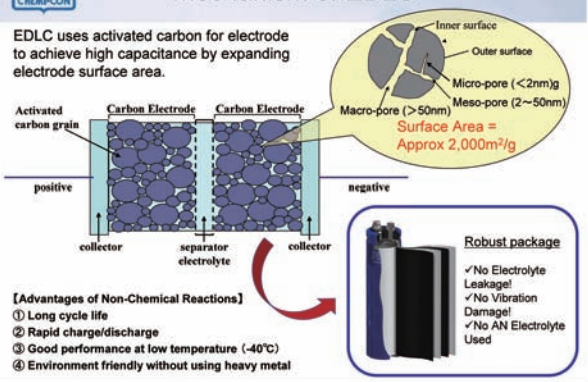
Mechanism of EDLC

EDLC uses activated carbon for electrode to achieve high capacitance by expanding electrode surface area.



【Advantages of Non-Chemical Reactions】
① Long cycle life
② Rapid charge/discharge
③ Good performance at low temperature (-40℃)
④ Environment friendly without using heavy metal

Robust package
✓No Electrolyte Leakage!
✓No Vibration Damage!
✓No AN Electrolyte Used

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Adoptation Example of EDLC

Energy Emission Reduction (electricity, gasoline)
- ①Peak power assist
- ②Effective use of regenerated energy

New Energy: Wind Power, Solar, Fuel Batteries
- ③Stabilization of wind power
- ④Improvement of solar power charge
- ⑤Electricity assist for fuel batteries

Safety and Security
- ⑥Measure for voltage drop
- ⑦Safety measure for disasters

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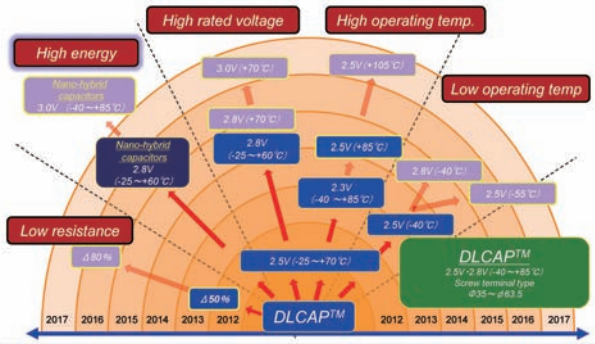
5 Points of Technical Development



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"Contribution to technology with attention to environment and people"

As a global supplier of aluminum electrolytic capacitors, Nippon Chemi-Con will continue to make comprehensive efforts to develop and utilize innovative new technologies.

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TEL: 03-5436-7711
FAX: 03-5436-7831
URL: http://www.chemi-con.co.jp/

Thank you for your kind attention.

Multi-Fuel Engine Project

Kazuhiko Kami

President & Representative Director, Hana Engineering Japan K.K., Japan

"Global/Local Innovations for Next Generation Automobiles"
Invited Lecture Oct. 28, 2015

Multi-Fuel Engine Project

Kazuhiko KAMI
President & Representative Director
Hana Engineering Japan K.K.

"Multi-Fuel Engine Project"

-Conducted since 2013 under "Next Generation Automobiles –Miyagi Area," a regional innovation program of Industry-Academia Collaboration funded by MEXT

-Primary members include following labs. of Tohoku Univ. and regional companies:

Miyamoto Lab.,
Kuriyagawa Lab.,
Yoshikawa Lab.,
Hana Engineering Japan K.K. (Sendai),
My Car Plaza Corp. (Hanamaki, Iwate), and
Kyoyu K.K. (Sendai)

Leader of Shale Gas Revolution

Ideal next generation engine exceeding DDF (Diesel Dual Fuel) engine and Gas mono combustion engine

That is:
Multi-Fuel Engine

Novel technology bringing dramatic improvement in fuel efficiency and high environmental performance while maintaining high power torque of diesel engine

*PCT Appl. filed on Feb. 10, 2015

What is Next Generation Automobile?

- The World is interested in super capacitor EV or FCV for next generation motorcars.
- However, motor driven FCV is not suited for buses and tracks.
- Only diesel engine can provide drive source for mid-size buses and tracks that need large torque.
- However, diesel engine has low environmental performance and produces lots of harmful exhaust materials.
- Upon Shale Gas Revolution started in the U.S., we think of Multi-Fuel Engine that brings high environmental performance and is suited for mid- and large size buses and tracks, and we move to production.

Problem with Diesel Engine

It has changed from visible PM to "invisible" PM.

- Diesel engine of previous generation
  PM (Particulate Matter): Regulation became severe. Ex.) Eight Regional Government Ordinance obligates automobiles entering the regions to equip with PM reduction system.
- Current diesel (advanced) engine – Common Rail System
  Refinement of fuel by common rail system lead to increase of nano PM by several ten thousand times. PM merely became invisible.

In Europe, according to announcement, increase in deaths relate to increase in nano PM due to common rail system.

Nano PM invade into not only circulatory organ such as heart, brain, and nerve system but also sexual organ

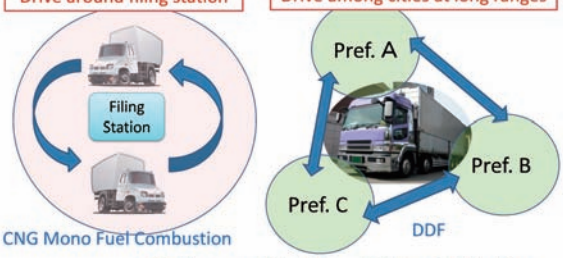
Fundamental step to suppress PM

Engine for automobile, ship and generator, using natural gas does not produce PM

Technology to lower environmental pollution: CNG mono fuel combustion and CNG-DDF

Drive around filing station

Drive among cities at long ranges



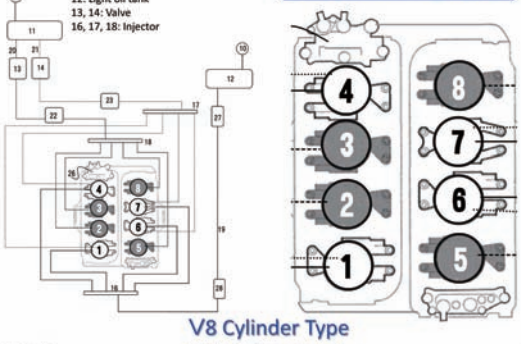
CNG : Compressed Natural Gas LNG : Liquefied Natural Gas

If LNG supply system established, drive ranges of both types expanded.

Copyright Hana Engineering Japan K.K.

2, 3, 5, 8: Gas mono fuel combustion cylinder
1, 4, 6, 7: DDF combustion cylinder
11: Natural gas tank
12: Light oil tank
13, 14: Valve
16, 17, 18: Injector

Schematics of MF Engine



V8 Cylinder Type

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Operation of 4 Cylinder MF Engine (By animation)

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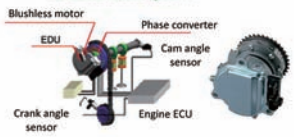
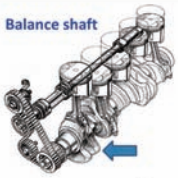
Cylinder head, variable valve system, balance shaft, input/output clutch, etc. need to be newly developed

Variable valve system

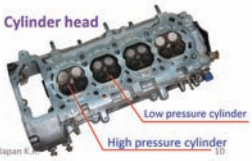


Balance shaft



Input/output clutch (torque converter)

Cylinder head



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Summary

Muti-Fuel Engine:

- Has high environmental performance comparable to super capacitor EV system or fuel cell system for motorcars;
- Can suppress nano PM that undermine human beings' health and lives;
- Is a landmark engine that may cause revolution of fuel suited for harmony with shale gas revolution; and
- Is a next generation engine that the world has been waiting for and not just for Japan.

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Thank you for your attention.

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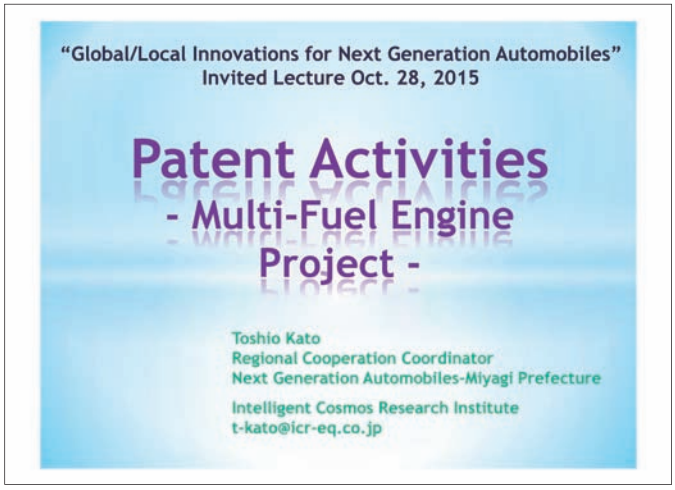
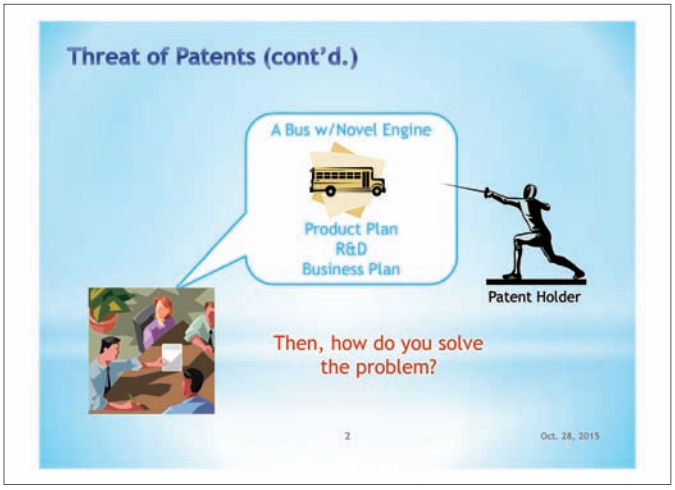
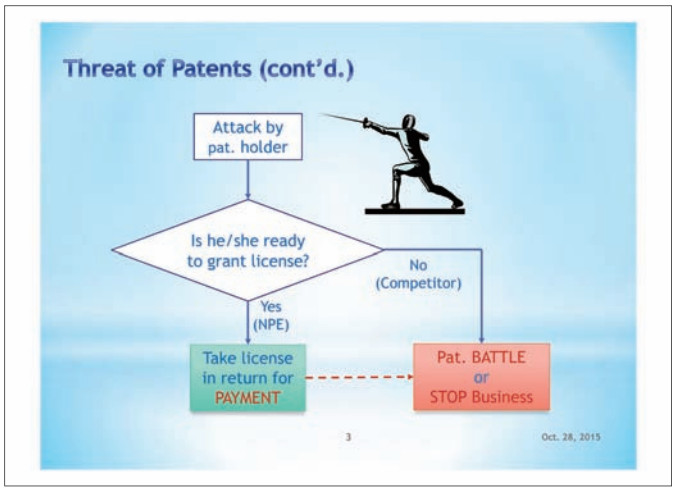
Patent Activities - Multi-Fuel Engine Project -

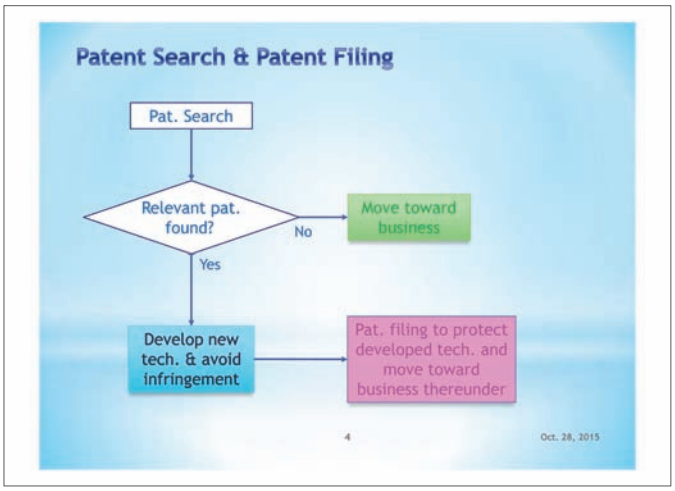
Toshio Kato

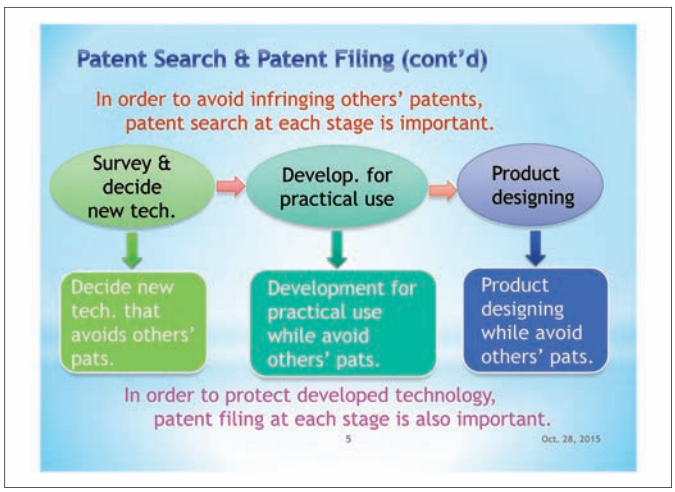
Regional Cooperation Coordinator, Intelligent Cosmos Research Institute K.K., Japan

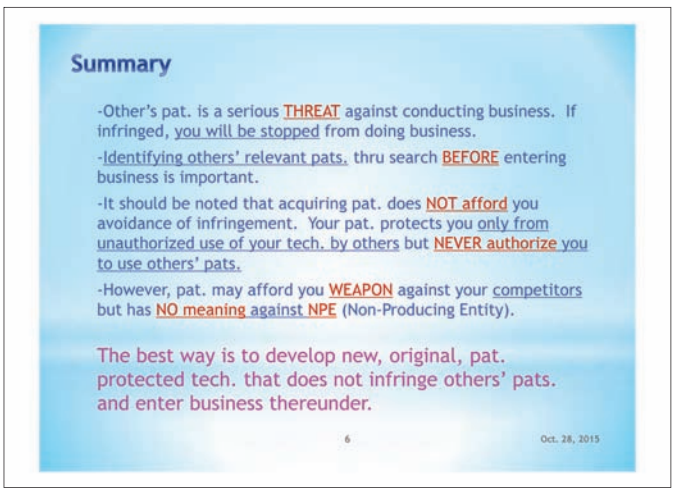












Progress of MF Engine Project:

-Beginning of 2013, Project started

-In 1st half

1st idea ("Twin engines")

-In June, 1st patent search for novelty through pat. law firm

Prior art found

-In 2nd half

Next idea ("DDF-CNG combined engine")

7 Oct. 28, 2015

Progress of MF Engine Project (cont'd.):

-In August, 2013, 2nd patent search for DDF, CNG, & DDF-CNG combined engines

Lots of prior pats. for DDF or CNG engines but less for DDF-CNG combined engine

-Beginning of 2014, idea of current MF engine fixed

-In Feb., JP national pat. appl. filed

-In 2014, development for practical use (experiment of DDF engine)

-In Feb., 2015, PCT pat. appl. filed

-In August, PCT has been published (laid open)

8 Oct. 28, 2015

One of Project Outcome at present:

Patent application filed and now published as WO2015122418 (laid open)

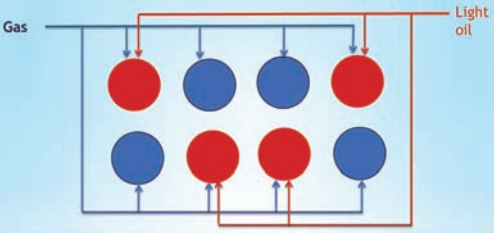
"Multi-fuel engine and control method thereof"

Applicants: Hana Engineering Japan K.K. (Sendai), My Car Plaza Corp. (Hanamaki, Iwate), and Kyoyu K.K. (Sendai)

Inventors: K. Kami (Hana Engineering Japan), R. Obara (My Car Plaza), A. Miyamoto (Prof., Tohoku Univ.), and T. Kuriyagawa (Prof., Tohoku Univ.)

9 Oct. 28, 2015

(Abstracted from Pat. Appl.)



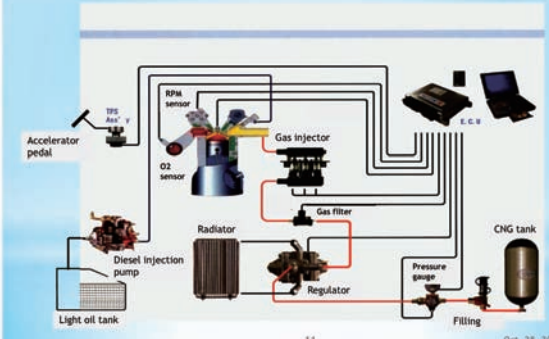
Engine cylinders

Ignited by spark. Used up to 1,000rpm or all rotation range.

Ignited by pressure heat. Used beyond 1,000rpm.

10 Oct. 28, 2015

Current Experimental Mid-size Bus Engine - DDF



11 Oct. 28, 2015

Next stage:

- Realize "MF Engine," that is DDF + CNG
- Survey commercial needs/areas (domestic and overseas)
- Clarify business model (such as remodeling)
- Secure patent rights based on WO2015122418 in primary countries/territories
- Search into 3rd parties' relevant patents

We will welcome joint partners to our Project!

12 Oct. 28, 2015

Intelligent Cars:
Disrupting Everyday Life in the Automobile Industry

Erik P.M. Vermeulen

Professor, Tilburg Law & Economics Center, Tilburg University, the Netherlands

Intelligent Cars:
Disrupting Everyday Life in the Automobile Industry

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Abstract

The car of the future will have a number of technological features that, although built on currently existing technologies, will result in something that is qualitatively different from the car of today. This paper begins by describing these features, namely full autonomy, connectivity, sustainability, software control and modular architecture. As such, the rise of the "intelligent car" will transform the automobile industry and both the experience and meaning of cars and "driving". Understanding the design challenge posed by the rise of the intelligent car - that is to say, the necessity of re-imagining the user experience of the car and mobility in a digital age - represents a profound challenge for incumbent companies seeking to stay relevant in the automotive eco-system of the future. In particular, business enterprises will need to develop organisational structures, processes and practices that facilitate the kind of design thinking necessary to maximise the opportunities afforded by the intelligent car. The paper suggests that there are various strategies that existing players can utilise to protect against the risks created by these changes. These strategies are derived from other sectors of the economy that have been forced to adapt to disruptive technological innovation. To this end, we identify a number of "principles" that can provide orientation in this project. A willingness and capacity to make a sustained commitment to such principles is going to be crucial to the long-term survival of both new and traditional players. Significantly, these principles involve a break with much of the contemporary discourse on best practice in the regulation of companies.

I. "But is it a Car . . . ?"

Let's begin with a story about the near future experience of the automobile:

> *"This morning, as I got ready to leave for work, I used the app on my smartphone to order a car. Today, I needed to drop off my children at football practice on the way to the office, so I ordered the four seat model. Since I usually commute alone I had to make a change to the pre-scheduled one-seater that normally collects me. At the designated time, a driverless car pulled up outside the house and a push notification on my watch alerted me that it had arrived. The car door was opened by the retinal sensor. Once we were all seated, I used the voice recognition system to confirm the various destinations and the car automatically set off. We took the most efficient route as determined by the on-board navigation system in coordination with the city's intelligent transport matrix. Our arrival times were accurately predicted in advance and the experience was safe and pleasant. The new electric cars are quieter and cleaner than the cars of my childhood. Moreover, driverless cars have all but eradicated accidents and there are less cars on the roads as a result of the managed traffic flows. In the absence of problems, my only task is to sit back and enjoy the ride. This suits me, as I never actually learnt how to drive. My children used the journey time to watch a TV show on the main in-car monitor. I sent a couple of e-mails and prepared for my first meeting of the day. Since I needed to work late, I booked another car to collect my children after practice. At the same time, I arranged for a car to pick up my parents for a barbecue tomorrow afternoon. It will be nice to see them, although I wish my father wouldn't go on to the children about how "a driverless car isn't really a car" and how much more "fun" it used to be when he was able to drive for himself. Somehow, I find his attitude irritating . . . "*

The car of the future - for convenience, we will refer to it as the intelligent car - is no longer the stuff of science fiction, but represents the near future reality for both the automobile industry and consumers of automobiles. There seems to be surprisingly little disagreement about where the industry is heading. Disagreements tend to focus on the likely time-scale for the roll-out of the technology and the nature of the transition period whilst intelligent cars co-exist with current "driver-driven" models.

And even if most of the above story doesn't come to pass, this particular vision of the future is taken sufficiently seriously right now within the industry to orient the thinking, decisions and actions of key players. As such, understanding the nature and implications of these developments, as well as formulating an effective response to them, represents

an important challenge both for incumbents within the automative industry, as well as newcomers looking to move in on this lucrative global market.

More generally, the automobile industry represents an important case study on corporate governance in an age of disruptive technological innovation. What do companies need to do in terms of their internal governance mechanisms in order to maximise their opportunities for succeeding in the context of these technological changes? And what are the implications of these new business models for policy makers and regulators?

The intelligent car will be a wonder of technology; that much is obvious. But in what sense is the imaginary car of the future still a car? The Ford T and subsequent generations of mass consumption automobile utilised the internal combustion engine and modern production techniques to deliver a unique experience of self-directed power freedom, and control. It was this experience that established the hold of the car over the modern cultural imagination. And - as with the smartphone more recently - this consumer experience has sold well everywhere; the global appeal of car ownership is evidenced by the economic success of automobile manufacturers in markets as diverse as China, India and beyond. Perhaps more than any other twentieth century consumer product, the car stands as a symbol of the potent combination of freedom, technology and mass consumption that has defined economic modernity.

And yet, a striking feature of the intelligent car of the future - at least as portrayed in the story above - is that the technology, experience and meaning of "driving" such a vehicle seems far removed from the technology, experience and meaning of driving today. The combined sense of personal autonomy and controlled power seems to have all but disappeared from the machine-controlled, digital living space that characterises the intelligent car. Rather than liberating us, the car of the future seems to lock us more tightly into the routines and control structures of everyday life.

In what follows, we want to suggest that the task of re-imagining the user experience of "driving" and the social meaning of the automobile is going to present one of the most important challenges for all players in the emerging new automotive eco-system. Offering an attractive new vision will be a crucial element in any new business model. We will suggest that this challenge is best thought of as a design challenge. Of course, developing, managing and integrating powerful new technologies will be vital in bringing the intelligent car to market. But ultimately, it will be the capacity of manufacturers to offer a meaningful personal experience of the intelligent car and its place in everyday life that will be crucial in determining which companies succeed and which don't.

Our hunch is that those companies that embrace the design challenge of integrating new car technology into a coherent value proposition that adds meaning to the quality of life of consumers will be best placed to succeed. As such, the challenge facing any business enterprise looking to operate successfully in the automotive eco-system of tomorrow will be to develop a business model and organisational structures, processes and practices that facilitate the kind of design thinking necessary to maximise the opportunities afforded by the intelligent car.

The last part of the paper will offer some suggestions as to how this might be achieved. We identify a number of principles that can orient such a project. A willingness and capacity to make a sustained commitment to such principles is going to be crucial to the long-term survival of both new and traditional players. Significantly, these principles involve a break from much of the contemporary discussion on best practice in the regulation of companies. Much of the extant discussion has become overly cautious and negative as a result of the focus on agency costs, investor protection and regulatory compliance. In this respect, what we advocate is a re-thinking of the contemporary debate on internal governance structures within companies in which greater emphasis is put on identifying organizational forms and practices that facilitate creative design thinking and an on-going process of disruptive innovation that will allow a business to remain relevant in the face of a radical technological transformation.

II. The New Technology of the Intelligent Car

The intelligent car will have a number of technical features that, although built on currently existing technologies, will result in something that is qualitatively different from the cars of today. Since these technologies are central to the disruption of the automobile industry, it is worth briefly reviewing them. These features can be introduced under five headings:

A. Fully Autonomous

The intelligent car will act autonomously; that is to say, it will make decisions independently of the driver, according to pre-programmed algorithms and machine learning systems installed by the manufacturer. For the moment, these decision making systems are limited to providing assistance in specific risk situations; for example, adaptive cruise control (the car alters its speed on the highway based on how fast the car in front is traveling); collision avoidance (the car uses radar sensors to tell if it is getting too close to the vehicle in front and issues a warning if it is); and blind spot notification (the car uses radar to inform the driver if another vehicle has entered into the blind spot and if an

attempt is made to change lanes while another vehicle is there, the system will emit a warning to stay in the current lane). All of these technologies share a common feature; they give temporary control to the car and not the driver. As such, the development of vehicle autonomy has already moved through several various phases; from information, warning, and assistance through to situational control. In this way, the trajectory towards full autonomy has already began to take shape.

In the near future, however, driverless cars that continuously control all facets of driving will become the norm. The role of the human "driver" will gradually diminish until finally the only task left to be performed will be the monitoring of on-board systems and problem management. Google's well-publicised project to develop a driverless car is perhaps the most high profile example and, as of mid-2015, Google-powered driverless vehicles had collectively logged over one million miles of fully autonomous driving. The Google Car combines GPS and Google Maps with various types of hardware sensors that perceive the local environment. The artificial intelligence systems collate this information and decide how fast to accelerate, when to slow down or stop, and when to steer the wheel. Self learning programs ensure that situation appropriate decisions are taken and permit the setting of different driver "personalities".

Most major automobile manufacturers are now working on autonomous vehicles of this kind. More recently, there have been rumours that Apple plans to develop a driverless car. Although differences in the implementing technology remain, the trend towards fully autonomous vehicles seems irreversible. Google and other automakers hope to bring fully self-driving cars to market by 2020.

B. Connected (V2V, V2I & the Internet of Things)

The intelligent car will be "connected" and able to monitor, in real time, its own operations and the road conditions, as well as communicate with other electronic devices and vehicles, as well as an intelligent transport infrastructure.[7] As such, the intelligent car will occupy an important place in the "Internet of Things", the expanding network of devices that connect everyday life into a global digital infrastructure.

Cars will seamlessly connect to other electronic devices. Google Android Auto already allows mobile devices running the Android operating system to be operated in vehicles through the head unit of the dashboard. This service performs several functions offering the driver control over GPS mapping and navigation, music, SMS, telephony, and web search. Hands-free operation and voice commands are included for safe driving. Apple's CarPlay offers similar functionality. The extension of the Android and Apple ecosystems

into the car will facilitate the merging of navigation, information, communication and entertainment functions.

Vehicle-to-Vehicle (V2V) connections will enable vehicles to send data directly between cars. For example, if a car senses ice on an area of road, it will alert other cars in the vicinity. Vehicle-to-Infrastructure (V2I) connections will allow cars to send and receive data from traffic lights, road signs and even from the road itself.

Perhaps most significantly, embedded connectivity of this kind will facilitate the operation of intelligent transport systems that are able to analyse traffic flows in real-time, adjusting traffic signals and junction priorities, and communicating with "drivers". Automated traffic control will permit driverless cars to go along certain routes at designated speeds creating an automotive social network that maximises efficiencies in traffic flows. This automotive network will, in turn, be integrated into an intelligent transport system, comprising intelligently controlled trains, buses, trams and bicycles, as a key component of the "smart" cities of the future.

C. Sustainable (Greener, Safer, Cheaper)

The intelligent car will be "greener", safer and cheaper than currently existing models.

New materials and energy sources will ensure that cars are more environmentally friendly. A combination of regulatory pressures regarding emission standards, technology advances, and consumer preferences mean that the end of the internal-combustion engine is simply a matter of time and producers will adopt some form of electrified vehicle. Various factors will determine whether range-extended electric vehicles, battery electric vehicles, or fuel-cell electric vehicles become the dominant technology of the future. The emergence of new sources of car power will create new opportunities for manufacturers. For example, some automakers are already investigating the possibilities of alternative fuels or investing in wind farms to generate power for electric vehicles.

Cars will be safer; the combination of computer controlled autonomy and connectivity will significantly reduce the 1.25 million deaths and countless (50 million+) injuries that take place on the world's roads each year. The driverless car of the future will be more reliable than humans, at least in the performance of routine driving tasks, since they will have more extensive perception, more reliable reactions, and they will not be affected by the various distractions that affect human drivers (e.g. noisy passengers, texting, sleepiness, or health emergencies). Since 90% of crashes are caused by human error, the scope for reductions is enormous. Factoring in the resources expended in dealing with car accidents -

ambulance services, police, medical care etc. - the potential savings from the these safety gains are estimated at more than US$500 million.

Regarding cost, the more energy efficient means of powering cars will contribute to a significant reduction in running costs. Freed from the need to prioritise safety considerations such as roll cages, bumpers and air bags, car producers can greatly simplify the production of cars, which in turn will become lighter and less expensive to purchase and run. Automobiles will last longer as collisions are minimised and new production techniques facilitate the creation of parts on demand. Moreover, the risk of auto-theft will be greatly reduced as security features, notably engine immobiliser systems, become more sophisticated.

In a myriad of ways, the intelligent car will contribute to the increased well being of drivers, as well as the sustainability of the natural and social environment.

D. Software Controlled

The value in car production will increasingly shift from the hardware to software. Cars are already complex products with most vehicle-controlled components being computer controlled. Even low-end cars now have more than 30-50 embedded electronic control units that communicate over multiple controller area networks. The number of lines of software code running these systems, at least when compared to other products, is already high. A modern high-end car, for example, features around 100 million lines of code, and this number is planned to grow to 200-300 millions in the near future as the drive to autonomy and connectivity continues. The average high-end car of today has at least seven times more code than a modern commercial jet, Windows Vista or an F-22. With enhanced autonomy and connectivity, the importance of computer software is only set to increase.

An important distinction in this context - at least in terms of the likely future structure of the automotive eco-system - is that between the car "operating system", which will control and monitor every function of the car from the autonomous functionality to the entertainment system, and the software "content" that will enhance the enjoyment, functionality and productivity of the passengers. In this respect, the new automotive eco-system looks set to evolve in a similar direction to personal computers, tablets and smart phones. A clear division of labour will exist between operating system providers (the Windows, Apple, Google equivalent) and the specialised software developers focusing on the many different aspects of the in-car experience (entertainment, productivity, information).

E. Modular Architecture

The intelligent car will be transformed from a "box-on-wheels" to a highly complex, integrated system of multiple hardware and software technologies. Intelligent cars will - even more than today - be the product of modular design and specialised production. The supply and assemblage of the hardware - i.e. the engine, body, lighting, sensors, seats, interfaces etc. - seems set to become even more specialised.

Car companies responsible for the ultimate production of the hardware will become assemblers tasked with the increasingly complex task of integrating the multiple and diverse hardware and software systems. In the automotive eco-system of tomorrow this task is closest to the task performed by car producers and hardware suppliers of today. To pursue the computer industry comparison of the last section, the hardware providers are analogous to the producers of computer hardware, such as Dell, Toshiba, HP etc.

All of the above predictions may not come to pass. But some - possibly most - will. As mentioned above, there seems to be a broad consensus on the direction of technological developments. Moreover, it seems obvious that these changes will transform the car and profoundly disrupt the automobile industry. The time-scale may be the source of some uncertainty, but there is agreement that these changes will gradually trickle down from luxury vehicles to mass-market cars, just as earlier technologies such as anti-lock brakes or power steering did before. The most difficult time is likely to be the transition period, while both autonomous and non-autonomous cars co-exist on the same roads.

Nevertheless, in spite of the uncertainties, we seem to be entering a period of transformation that threatens to undermine the pre-eminence of existing carmakers, just as smartphones displaced Nokia or digital cameras displaced Kodak from their once dominant position in the mobile phone and analogue camera markets. Already, high-tech newcomers with pre-existing expertise in integrated software design, such as Google and Tesla, have entered the car business, and - with other tech giants (e.g. Apple) contemplating a similar move - this trend looks set to continue.

III. Disruptive Innovation & the Design Challenge of the Intelligent Car

The intelligent car will dramatically reshape not only the landscape of the automobile industry, but also the way we interact with vehicles and, indeed, the future design of our cities. In order to appreciate the implications of the disruption caused by near future

developments in the car industry, it is important to have a clear understanding of what is being disrupted by the rise of the intelligent car. Answering this question invites us to think about the complex, multi-dimensional character of technological innovation and its effects.

A. What is Disrupted by Disruptive Innovation?

Clayton Christenson in his classical account defined disruptive innovation in the following way: "An innovation that transforms an existing market or creates a new market, typically by trading off raw performance in the name of simplicity, convenience, accessibility, or affordability." Christenson understood the force of disruption as progressively changing the industrial landscape and transforming business. Disruptors create growth by redefining performance that either brings a simple, cheap solution to the low end of an established market, or enables "non-consumers" to solve pressing problems.

In this way, innovative technologies disrupt at multiple levels. From the business perspective, new technology disrupts existing ways of doing business and the configuration of stakeholders and their respective interests that exists within a particular sector at a given time. We will return to the business model aspect of disruption later in the paper, as well as governance structures and practices within companies today.

From the perspective of government, innovative technologies disrupt existing regulatory schemes and create new policy issues. We don't want to talk about this aspect of the issue in this paper, but the intelligent car clearly raises multiple regulatory questions of this kind. Just to take a simple example, but important example: current rules in most jurisdictions do not allow self-driving cars on the roads. The 1968 Vienna Convention on Road Traffic, to which 72 countries are party, stipulates that a human being always has to be at the controls. There are many other issues. The intelligent car will generate an enormous amount of data for alternative usage, which is likely to present challenges pertaining to data security, privacy concerns, and data analytics and aggregation. In a tort context, questions will need to be resolved as to who is at fault in the event of an accident involving driverless cars. Moreover, autonomous cars will need to communicate both among themselves and infrastructure to be most efficient in their operation. To facilitate this, the government will need to safeguard telecommunication frequencies and protect against security threats, most obviously the possibility of car hacking. Finally, government will need to enhance the safety of intelligent vehicles by reorganising the transport infrastructure in a way that is more appropriate to them. Such changes might include updating road markings and signs, installing V2I communication infrastructure "in" roads, creating special lanes for autonomous vehicles to use when experiencing technical failures, and creating "no human driving" zones etc.

Even a brief list of possible regulatory concerns highlights the range and complexity of disruption for governments. In this paper, however, we would like to focus on another aspect of disruption, namely the impact on consumers and what this might mean for producers. Innovative technology disrupts the routines and practices - the flow - of everyday life of end users of technology either by offering a previously unavailable experience or a novel variation on a pre-existing experience. When Apple created the iPhone, for example, it offered a new mobile phone/mobile internet/mobile content experience. What is being disrupted by innovative technology is a particular user experience and the attendant social meanings of that experience in the broader narrative arc of a person's everyday life.

The point that we would like to emphasise is that new technologies create opportunities for designing new or at least "updated" consumer experience. If we accept a definition of design as the delivery of a new and meaningful user experience, then design thinking can be thought of as anything that contributes to achieving this goal. In the context of new technology, therefore, this means designing, marketing and then selling products that aspire to deliver a meaningful user experience *through* technology.

With this framework for thinking about what is disrupted by disruptive technology, we can return to our discussion of the automobile history and the challenge posed by the intelligent car.

B. The Meaning of the Car in Everyday Life

In order to understand what exactly is being disrupted by the rise of intelligent car, it is instructive to consider the origins of the modern automobile industry. Karl Benz was granted a patent for his internal combustion engine in 1879, and started producing automobiles in around 1885. In the United States, Ransom E. Olds started operating an assembly line for the production of automobiles in 1901. But neither Benz's engine nor Olds' new production techniques were successful in disrupting the horse and carriage industry. The disruption came later, in 1908, when Henry Ford started mass production of the Model T.

The Model T was not primarily an achievement of new technology, but of design. Of course, it possessed the right combination of technological features necessary to offer a better experience than driving a horse driven carriage, it was simple enough to operate and it was affordable enough for the middle class to buy. But more than that it sold a new kind experience that was immediately understandable and appealing. In particular, what the Ford T offered was an experience of freedom and control for consumers. The allure of being able to go where we want, whenever we want is a powerful one. The experience of

driving - its physicality and associated feelings of independence - has always been crucial to the mass consumer appeal of the car and the sustained growth of the automobile industry.

The sense of freedom and new possibilities it afforded became central in establishing the special place of the car in the everyday life of ordinary citizens over the course of the twentieth century. Even a cursory look at contemporary car advertisements or the popularity of TV programmes such as the BBC's *Top Gear* reveal that much of the appeal of the car derives from this strong connection with a narrative of liberation, adventure and individual empowerment. The mythology of cars and the freedom of the open road has been central to the identity of modern societies. Modern cities have been shaped around the road network and vast suburbs far from urban centres have been built. All of this has been made possible by the automobile. The history of the car highlights the centrality of the user experience and of engaging customers in an experience that they value.

Of course, the everyday reality of driving for most people today is less and less about freedom and control. It is more an imagined than a real experience. Urbanisation and mass car ownership has created congested cities that mean driving has become, for the most part, a source of boredom, frustration and even anger. The average commuter now spends 250 hours a year behind the wheel of a vehicle and that time is increasingly seen as wasted time. And any feelings of freedom or escape can be seen as illusory. As such, mobility today is increasingly inefficient and expensive, and the imagined experience of driving is increasingly disconnected from the reality. Nevertheless, the mythology of the car as a site of self-directed freedom and control has been, and continues to be, enormously important for the continued growth of the car industry.

C. The Design Challenge of the Intelligent Car

A paradoxical effect of the intelligent car is that although it will be a technological marvel that solves many of the frustrations of contemporary mobility, it will undermine the meaning that driving and the car have had ever since the Ford T captured the public imagination in the early part of the twentieth century. The intelligent car offers a bland experience in which the very appeal of driving - the real or imagined sense of power, freedom and control - will be replaced by a joyless process of systems management. As such, driving will be reduced to an empty simulation of the experience of driving in which the car and intelligent transport system are "in control" and not the "driver". This, in turn, will transform the special meaning of the car in everyday as it becomes just another device in the Internet of Things.

In this way, the experience of the car and driving, as it has traditionally functioned, will be eroded by the rise of the intelligent car. The car will no longer be able to provide a sense of self-directed freedom and personal expression. Google's recent prototypes, for example, have no steering wheel, brake pedal, or accelerator. When a "driver" need only program or speak a destination, what becomes of the driving experience? In answering this question, a key challenge facing car-manufacturers - as well as any new entrants to the market - will be to re-think the role, function and place of the car and the experience of mobility in a networked age. Those manufacturers who are best able to offer a new and engaging experience of the intelligent car will be best placed to succeed.

This challenge of re-imagining the meaning of the car is a question of design more than it is one of technology. Design focuses on understanding an area of human experience and then developing a product or service that utilises technology to improve that area of experience and empower people in new and previously unimagined ways. This is what the Ford T did so successfully and this is what producers of the intelligent car will need to do. Technology will be central to the delivery of a new user experience, but it is the experience - again both real and imagined - that will be the key.

Consider companies like Apple and Google. The recent success of Apple, for instance, has not been the result of their ability to develop new technologies, even if technology is central to what they do. When Apple created the iPhone, for example, it designed a new mobile phone/mobile internet/mobile content experience - using a combination of off-the-shelf and custom designed parts. According to their public statements, Apple did not think of itself as delivering a new technology to consumers. Rather, it aspired to design a new experience, and then identified the technologies best placed to deliver that experience in the most elegant manner possible. Steve Jobs, in particular, was always very insistent on this point on the relationship between technology and meaningful experience:

> You've got to start with the customer experience and work backwards to the technology. You can't start with the technology and try to figure out where you're going to try to sell it. And I've made this mistake probably more than anybody else in this room. And I've got the scar tissue to prove it. And I know that it's the case.

Apple has repeatedly disrupted whole industries - computers, music, PDAs, mobile phones, software distribution, tablet computers. What is the lesson of Apple's success in delivering great products? However exciting or "clever" a particular piece of technology may be, if it fails to contribute to or connect with a new user experience capable of generating billions of dollars worth of sales, it should be shelved until such time that it can be incorporated into such a meaningful experience. It is only by obsessively focusing on

the task of designing innovative experiences that matter and not getting caught up in the technology that technology companies - actually, any companies - are able to survive and flourish.

A design-oriented account of innovation allows us to re-frame the challenge facing existing players in the automobile industry today. If the intelligent car no longer represents a space of power, freedom, and control, what kind of user experience is going to be associated with the car of future? How can mobility be re-imagined and re-packaged in a networked and digital age?

Thinking about the design challenge created by the emergence of the intelligent car also allows us to recognise the seriousness of the threat posed by the arrival of tech savvy new players, such as Google, Tesla and Apple into the automotive space. How can traditional players in the automobile industry compete with newcomers that have a proven track record in the type of design thinking that now becomes so important to the future of the car? What can automobile manufacturers do to enhance their design capacities and skills in order to remain competitive in an age of the intelligent car? We believe that answering these questions will be crucial to the long-term future of established players in the automobile industry.

D. The Value Proposition of the Intelligent Car

Who will succeed in the new automotive ecosystem that emerges when the intelligent car becomes a reality? The disruption caused by this new technology will compel established and new players to formulate original business models, and what will be crucial will be developing and selling a new value proposition. To adopt the the technologies and embrace fully self-driving vehicles, consumers will need to see real value for each new feature they buy. The ability to deliver an attractive value proposition that motivates a consumer to be willing to pay will therefore be critical. There are several overlapping visions in the existing discussion. Here they are presented separately, but manufactures will be obliged to engage with all of them. Each offers opportunities. Brief consideration of these three models of the future shows us the kind of innovative design thinking that will be required.

1. "High-End Disruptor"

In the early stages, the intelligent car will be sold as an exclusive, high-end product. Currently, this seems to be the Elon Musk - Tesla model, at least in the short to medium term. With its first generation models, Tesla won't be selling to low-end, price-sensitive customers (i.e. those who will continue to buy current vehicles) nor do they pursue non-consumers (i.e. those who don't currently drive cars at all). Rather, the selling point of the

Tesla will be a unique mix of technology, power and image. The Model S will produce the fastest 0-60 mph time of any four-door production automobile, but with an electric engine and "only one moving piece". Hence the marketing slogan: "Zero Emissions, Zero Compromises". As such, the Tesla business model is still selling a rather conventional vision of power, freedom and control.

In this regard, first generation intelligent cars will be sold as high-end disruptive innovations (i.e. the electric engine) that outperform existing products on traditional performance indicators (i.e. speed and image). They will sell for a premium price and will target the most discriminating buyers, only later entering low-end markets. The danger for incumbents is that they will be too slow to react to this change and that by the time the innovator enters the mainstream, it will be too late and the incumbents will be seriously threatened.

2. "Mobile Living Space"

Dieter Zetsche, Chairman of the Board of Management of Daimler AG and Head of Mercedes-Benz offers a more long-term vision of the value proposition of the car of the future: "Anyone who focuses solely on the technology has not yet grasped how autonomous driving will change our society. The car is growing beyond its role as a mere means of transport and will ultimately become a mobile living space." This view reflects a perception of the intelligent car as a new kind of private space that offers new opportunities for creating value. In a social environment where space is often at a premium and everything happens at an increasingly rapid pace, people have a desire for privacy and a space of their own to retreat to. On this vision, the real value of the intelligent car comes from selling the experience and content to the occupants.

Car interiors can then be redesigned to support activities other than the current model of driving and accident survival. Possibilities include a living room, bedroom, mobile office or a re-configurable space that can be adapted to the occupants' different needs. Fully autonomous driving means that time spent in the car can now be used for other activities opening up new revenue streams. In this way, the desirable qualities of intelligent cars will no longer be engine size and performance, but will gradually shift to various "in-car" factors, such as noise eradication, the smoothness of the suspension, the sophistication of the in-car computing systems and the ability to connect with other devices.

3. "On-Demand Mobility Service"

The intelligent car will contribute to a significant redefinition of vehicle ownership and expand opportunities for vehicle sharing. If vehicles can drive themselves, they can be ordered when they are needed. Thus, travellers would no longer need to own their own

vehicles and could instead purchase mobility services on demand. Technology and connectivity will pose the question of whether it's necessary to own an automobile. Car sharing is a prominent example: the consumer pays to use vehicles only as needed and foregoes the responsibilities - and benefits - of individual ownership. Car-sharing services, which allow people to make a reservation at the tap of a personal mobile device, are expected to grow significantly in the next few years, with dramatic increases in the number of users and in revenues. These developments also defy the very notion of a car as a personal, autonomous machine. The 18–34 demographic appear to place less importance on car ownership than previous generations. They are more open to sharing cars and to the rapidly growing number of "mobility services," such as BaBaCar, Uber and Lyft.

Intelligent cars will inevitably be linked to many kinds of new services, many of which cannot be anticipated today. For example, supermarkets may use them to deliver goods purchased on-line to your home. Meals other services to the elderly may become much more common, enabling the elderly to stay independent longer. Emergence services will be transformed by automated cars that can switch into an emergency mode and deliver anybody to the nearest hospital at high speeds.

4. "Open Operating Systems & Big Data"

A key theme of the intelligent car concept is the continuous exchange of information between the passengers, the car and the outside world. An alternative business model focuses on this data and how to exploit this data in order to customise the consumer value proposition. The market for big data is growing rapidly and major players in the data market may not want to manufacture vehicles, but they could see opportunities in designing vehicle operating systems. With more than a billion cars generating enormous amounts of data consumer behavior, traffic patterns, and topography, an operating system developer could generate significant value from the data they would collect. OS providers would partner with any of the world's vehicle manufacturers – and not just the traditional automotive manufacturers – to develop a platform for in-vehicle information and communication systems to provide drivers information about their vehicles and to connect to information and content from networked devices. Connected vehicle technology requires a large network of vehicles equipped with similar, or at least interoperable, communication systems.

E. Staying Relevant?

Incumbent players are rarely successful when an industry is radically disrupted.. As such, it seems clear that the capabilities, willingness, and foresight of incumbents will be severely tested by the arrival of the intelligent car. The main advantages enjoyed by the traditional

players will be their familiarity with the automobile, their control over the industry, and their high standards for testing and guaranteeing reliability. But these capacities alone may not be enough. Corporate history is littered with examples of companies that have died out because they ceased to be relevant and failed to be imaginative enough in responding to the arrival of new disruptive technologies. Recall Blackberry, Kodak, Sony (the Walkman) or Mosaic (Netscape), all of whom struggled to survive in the face of technological disruption. The companies best situated to navigate this new reality will be those that acknowledge the need to maintain relevancy via an on-going internal process of strategic transformation. Although this challenge raises many issues, in what follows we want to focus on the issue of internal governance reform.

IV. Governance-for-Innovation in the Automotive Eco-System of Tomorrow

The design challenge of the intelligent car creates a need for governance reform within the existing organisational structures of the incumbents. In this context, we are not thinking of corporate governance in the traditional sense of managing agency-costs, but the more pressing task of creating governance structures that facilitate value creation through innovative design thinking. This task has to start with an acknowledgement of the limits of existing organizational forms to successfully and continuously deliver innovation. The governance structures of companies that have lost their "start-up feel" need a serious makeover in order to survive. In particular, such companies need to implement governance practices and structures that make them better innovators. This involves recognising the importance of "flat hierarchies", "open communication" and "inclusiveness". The pace of innovation tends to be fastest in those companies that actively embrace looser organizational forms that are controlled by the innovators, rather than in companies with more hierarchical structures.

Based on practical experience and research conducted elsewhere, we have identified a number of principles and their related practices that have been utilised by the most successful and innovative firms. These principles are also relevant in context of a discussion of retaining relevancy in the automotive eco-system of the future. To that end, we offer an interpretation of the governance principles and related practices that we believe are going to be most effective in allowing a firm to succeed.

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A. The Principle of "Flat-Hierarchy"

As Lawrence Ellison has observed, tech moguls like Larry Page, Sergey Brin and Mark Zuckerberg run ostensibly public companies that are essentially "private fiefdoms". These charismatic leaders have structured corporate control in such a way that there is no way that investors or board members can unseat them. Charismatic leaders do this in order to ensure that regulatory requirements - e.g. the short-term quarterly results and the demand for dividends and share buybacks - don't take over and kill the relevancy of the company. Of course, from the regulatory perspective, such a structure can make such firms appear to be governance "renegades", something that in turn might have a chilling effect on prospective investors.

But this does not mean that these firms are absolute monarchies, like the fiefdoms of history. Quite the contrary; it is these firms that are associated with a "best- idea-wins" culture in which the seniority of the person making a proposal doesn't matter and in which open debate and collective decision making is fostered. Elon Musk, the CEO of TESLA Motors and the founder of SpaceX (a aerospace manufacturer and space transport services company), describes this sort of work environment as a "flat hierarchy". The most effective charismatic and visionary leaders recognise that the pace of innovation tends to be much faster in those companies with looser organizational forms and they use their innovation talent and control over the company to ensure that such a flat culture is allowed to flourish.

In this respect, the "flat hierarchy" and "best-idea-wins-culture" comes from the top-down. It represents a considered choice on the part of company leadership to break from the static hierarchies of traditional corporate governance.

In order to succeed, however, a flat hierarchy also depends on the active bottom-up participation of everyone inside the firm. Without the cooperation and input of talented employees this approach cannot succeed. An additional advantage of such an open working culture is that it provides greater opportunities for personal expression for those inside the company and ensures that the company remains relevant to them. The most talented employees in search of a meaningful career experience are not willing to passively accept the view of managers and will be increasingly inclined to move somewhere else if the firm does not afford opportunities to contribute or for personal growth. In this way, the flat hierarchy works to retain the relevancy of the firm for the best employees and other company insiders, as well as the consumers who benefit from the higher quality products or services that such a flat culture produces.

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Reid Hoffman, Ben Casnocha and Chris Yeh, discuss this issue in their book, *The Alliance*. They acknowledge that lifetime employment is no longer feasible or even desirable in a modern economy and that there is a need for a new model of employment relations. Such a model would not only aim to rebuild trust and loyalty between firms and employees, but would also create incentives for employees to become more entrepreneurial in the sense that we discussed above. Their answer is an "alliance-based relationship", which offers mutual benefits to the company and its employees. This alliance between the company's managers and its employees has various elements. The core elements include mechanisms that enable a company to hire employees for well-defined, but successive "tours of duty". The second element focuses on the creation of the employees' networks outside the organisation. The final pillar includes the creation of an "alumni network" which enables companies to maintain long-term relationships with their former employees. The employer-employee alliance can already be observed in a number startup communities, where the establishment of networks and connections is crucial to the success of both the company and the employees.

A less well-documented, but similar trend can be observed in the relationship between managers, directors and shareholders of a company. A new consensus amongst investors seems to be emerging, with the investors realising that when they frame the relationship between managers and shareholders in hierarchical terms, they trigger a short-term focus on quarterly results and share price within the company that usually leads to increased demands for dividends and stock buybacks. Accepting such demands can then make it extremely difficult for companies to recapture the focus on innovation and growth. Recognising this risk, however, investors are becoming more interested in the question of what it is that causes companies to thrive and stay ahead of their competitors. As they ask themselves how to imaginatively design their "portfolio" companies, they focus on the need to frame their relationship with managers as collaborative, rather than hierarchical.

B. The Principle of Open Communication

The second principle concerns communication strategies, particularly in the context of engagement with investors. A contrast between two types of firm may be helpful here. On the one hand, there are those companies that satisfy themselves with minimum compliance with the respective rules and regulations regarding interaction with investors. Such firms organise shareholder meetings, respect the shareholders' legal rights and provide investors with the mandatory quarterly and annual reports. Compliance-based communication with investors is characterised by a "check-the-box" attitude that usually results in bland, "boilerplate" statements about corporate governance and the company's past performance and opportunities for growth.

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On the other hand, are more innovative and disruptive companies that go beyond the mere dissemination of information obliged by the rules, but take a more integrated and innovative approach to the communication of the companies' prospects. In general, these companies publish their ownership and control structures in a clear, visually attractive and compelling way to provide investors with the confidence that they have been given sufficient information to make the best possible investment decision. These communications are often highly personalised with corporate leader clearly explaining in detail how they are going to propel "their" company towards value creation in the short, medium *and* long term. As a genuine partner, such an approach is also characterised by a willingness to admit to operational mistakes and challenges.

The French food services and facilities management firm, Sodexo, provides a good example of how this type of personalised, visual and clear, "integrated" report has been used. The firm is a "Governance Renegade" in the sense that the founder, Pierre Bellon, has used dual class shares to guarantee long-term control. Nevertheless, the company has presented its reports in an open and visually attractive way that goes way beyond the regulatory requirements. For instance, Bellon was very open in focusing on the succession issue, in particular the question of which one of his children would succeed him. The suggestion is that by openly confronting such a sensitive issue he was able to create trust and this trust ensured investors remained confident in the firm's prospects, in spite of the governance concerns that might (from the conventional perspective) otherwise deter them from making an investment.

Marc Suster and others have addressed the question of the limits of this kind of openness for private companies. His starting point is that providing management updates periodically for all investors is important, but in doing so you must assume that any information that is released to investors will be seen by others and that it is therefore important to hold back on your most sensitive information. Suster's concern is not that malevolent investors will misuse this information; such misuse would be revealed at some point damaging the investor's reputation. Rather, careless information dissemination by any company communicates poor judgment and risks reputational costs. Suster's proposed solution to this danger is a "state of the company" e-mail a couple of times a year, written on the assumption that it will get shown to others, but which nevertheless contains non-sensitive information on a wide range of issues that indicate the potential for positive future performance.

Moreover, open communication is not just about sharing information (the one-way dissemination of information *from* the company to other stakeholders, notably investors). It is also about building an on-going and constructive dialogue between executive

management and investors that will have a significant impact on the future performance of the company. There are multiple additional potential benefits for a company in adopting this kind of active and engaged communication strategy.

Firstly, the most important aspect of open engagement may be the connections created with other leading investors to explain and discuss growth strategies and invite input. These discussions assist company leaders in making better decisions and avoid tunnel vision by providing them with relevant information on the current state of the business environment in which they operate. Second, open engagement may facilitate the identification of new business opportunities or provide a better sense of their peers and competitors. Assuming that such peers and competitors are likely to be attracting a similar type of investor, then this knowledge can be extremely valuable. Finally, pro-active engagement helps founders-entrepreneurs in identifying "expertise gaps" on their board of directors and executive teams. It is in this collaborative context where investors may have the most impact on the spending plans of the CEOs of their "portfolio companies".

This last point is crucial. Open communication is concerned with information dissemination and exchange, and the potential benefits that accrue from the free flow of information. But this open flow of information can facilitate the identification of "gaps" in current corporate decision-making, and points to our third principle, namely the need for greater inclusiveness.

C. The Principle of Inclusiveness

The principle of inclusiveness, in this sense, covers a range of practices from those aimed at fostering a sense of belonging to maximising opportunities for substantive involvement in key decision making processes. There is obviously a significant degree of overlap with open communication in this regard. But whereas open communication is concerned with the flow of information within the corporate eco-system, inclusiveness is linked to various other aspects of participation, up to inclusion in key decision-making. The most innovative companies have acknowledged that they stand to benefit from a more inclusive attitude towards all stakeholders. In particular, inclusion creates a sense of participation and belonging that makes the whole corporate project more meaningful, both from the perspective of the employee and the firm.

Here we will focus on how inclusiveness might affect our thinking about the board. Currently, the dominant view is to see the board as the supervisor/monitors of the senior managers. In consequence, the board of directors tends to focus on the control of managerial misbehaviour and the monitoring of company past-performance and sustainability, rather than actively contributing to future performance.

Many companies now recognise that this role is no longer sufficient and that the model of board "independence" constitutes a missed opportunity. Instead, the more innovative firms include a diverse range of individuals who are then expected to work in collaboration with the firm's CEO and other senior managers to drive innovation. The directors help the firm stay relevant by the inclusion of diverse perspectives that are relevant to the company and a more collaborative model of the relationship with management ensures that these perspectives are incorporated into the decision making processes in a way that adds genuine value.

Consider Apple, for example. The company's late CEO, Steve Jobs, understood early on the important role of the board of directors for Apple's growth and innovation needs, but also in order to build relationships with its suppliers and customers. In order for the board of directors to retain a competitive advantage and help carry Apple forward (by focusing on relevance), its members needed to have a thorough understanding of the computer industry and the firm's products, and be actively involved in decision making.

Recall, that it was the board that removed Steve Jobs as Head of the Macintosh division in 1985. Following his return in 1997, Jobs, who was initially employed in an advisory role (along with being the CEO and Chairman of a computer animation company, Pixar), quickly regained control over the company's affairs. This became clear in the keynote address during the Macworld Expo in Boston on 6 August, 1997, where he explicitly avoided the announcement of new and innovative products, but revealed the appointment of four new, handpicked, board members. Jobs was convinced that changing the composition of the board of directors was a necessary first step to bring back focus, relevance, and interaction (with the outside world) to the company in its quest for disruptive innovation and creative products.

What is most relevant here is that Jobs knew that in order for the board of directors to become a competitive advantage and help carry Apple forward, its members needed to have experience in the computer industry and be passionate Apple users. Perhaps this is the reason why Mr. Woolard, Chairman and former CEO of Dupont, and Mr. Chang, a senior executive at Hughes Electronics, were "allowed" to stay for their leadership skills and knowledge of the Asian market respectively. Larry Ellison (software expertise and co-founder of Oracle), Jerry York (Former CFO with experience of reorganisations at both Chrysler and IBM), Bill Campbell (CEO of Intuit and former Vice-president of Sales and Marketing at Apple) were added to the Board of Directors. As expected, Jobs also joined the Board of Directors himself.

Again, Larry Ellison showed foresight about the new nature of the firm by explicitly stating (in 1997) that "Apple is the only lifestyle brand in the computer industry. It is the only company that people feel passionate about. My company Oracle - it is a huge company. IBM is a huge company, Microsoft is a huge company, but no one has incredible emotions associated with our companies. Only Apple is really a lifestyle brand". In the light of this piece, it is therefore not surprising that Apple has become the world's largest company by market capitalisation in 2012.

On the other hand, Arthur Levitt, the longest serving Chairman of the US SEC, who was a self-proclaimed fan of Apple and long time Mac user, was apparently denied a seat on the board after Jobs read a speech of Levitt's in which he emphasised the importance of a strong, *independent* board of directors. Jobs apparently phoned Levitt and told him that his ideas on the role of the board didn't fit with the culture of Apple, in that the board was not designed to act independently of the CEO, but in partnership with the CEO.

Critics of Apple's approach tend to make a point of emphasising that the board merely comprised the "friends of Steve", but this misses the point. A diverse board with a range of relevant expertise and an inclusive decision making process in which CEO and board work collaboratively offers a better prospect for fostering growth. In contrast, if the board is simply regarded as a device for the monitoring of senior management, there is a risk that the board will be filled with inappropriate people. In particular, there will be an over-representation of lawyers and accountants - i.e. those with a compliance-related expertise - and not individuals who can add genuine value to the core competencies of building a business.

One final point about inclusiveness: to accelerate innovation, established companies need to master collaborating and co-creating with external parties that have pre-existing capacities for design thinking. There is a pressing need for incumbents in the automotive to forge new connections with those sectors of the economy that are best situated to respond to the design challenge of the intelligent car, namely local start-up communities and the emerging global innovation eco-system. You will not get a new Toyota from a start-up, but Toyota will find that its core business is disrupted by start-ups. And new cars will emerge out of this process of disruption. It is in these sectors that visionary, entrepreneurial, and innovation-minded design solutions are most likely to emerge. They know what it takes in a networked age to find, develop and scale new products and solutions, and tapping into these capacities will be crucial to energise and inspire established players.

V. Conclusion

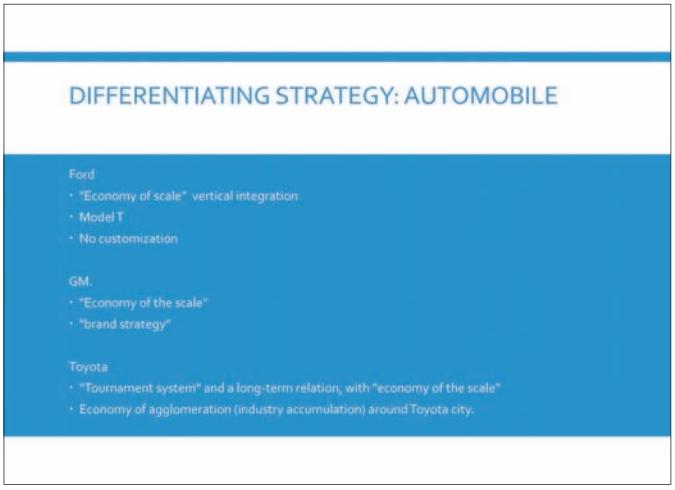
The car industry has been built on a business model that has not changed much since the time of Henry Ford. The industry is based on the production of vehicles that are powered by an internal combustion engine, driven by human beings and (for the most part) privately owned. All three of these features are likely to be disrupted over the course of the next few decades. There is a broad consensus that the new business model will involve electric cars that will drive themselves and there will be much more car-sharing. This vision of the future means that firms with expertise in electric power, networking, machine learning and autonomous technologies will be well situated to enter the automotive eco-system and challenge incumbents.

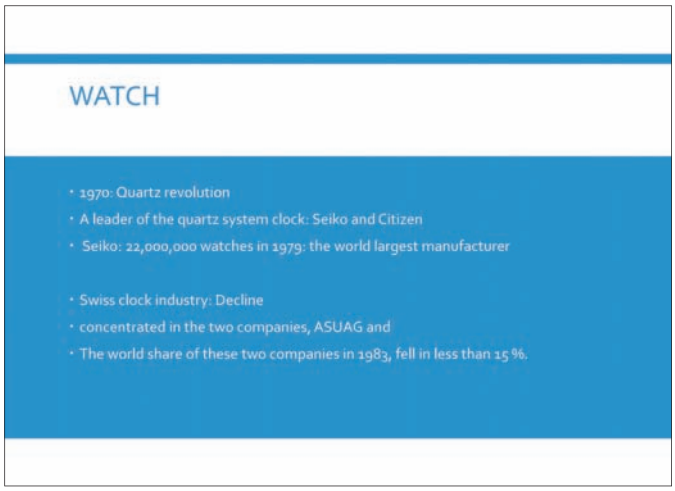
As such, the rise of the intelligent car seems likely to transform both the meaning of cars and "driving" in everyday life, and pose a profound challenge for the automobile industry. Certainly, that seems to be the consensus of those inside the industry. Understanding the design challenge created by the rise of the intelligent car - that is to say, re-imagining the user experience of the car and mobility in a digital age - represents a genuine challenge, particularly for established players. Nevertheless, there are strategies that existing players can utilise to protect themselves against these risks. In particular, a focus on disruptive internal governance reform and external collaboration with proven innovators. The paper identified some key strategies for achieving this, namely flat-hierarchies, open communication and inclusiveness. A willingness and capacity to make a sustained commitment to such strategies is going to be crucial to the long-term survival of the traditionally dominant players.

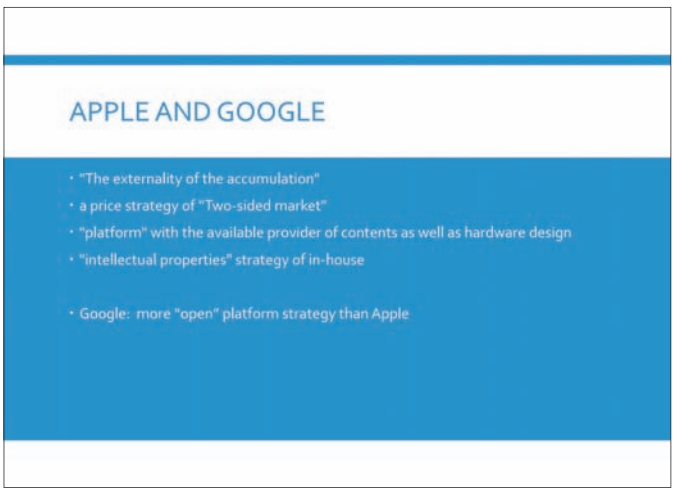
Platform by what?
- Hydrogen or TELEMATICS, or something totally new -

Masato Hisatake

Visiting Professor, New Industry Creation Hatchery Center, Tohoku University, Japan







PRICE MECHANISM OF TWO-SIDED MARKETS

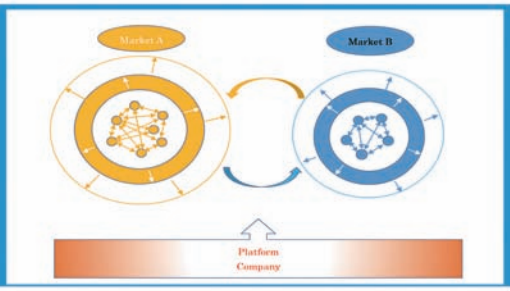
The network externality of the platform

- effect obtained from some goods depends on the number of those users.
- OS(PC)
- cellular phone
- Critical point (number of users) → demanded increases explosively.

direct network effect and indirect network effect

- two markets
- A: cellular phone and smart phone or advertsment
- B: application and contents
- Effect within a single market
- Effect from mutual positive cycle (feedback) between two markets

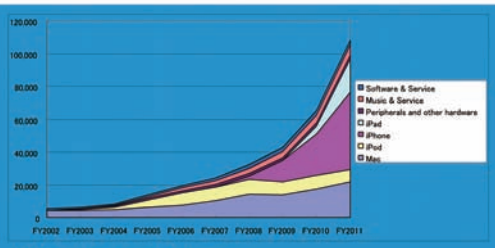
PLATFORM --> TWO SIDED MARKET



SUPPOSE: ELASTICITY OF DEMAND OF MARKET A IS LARGER THAN THAT OF MARKET B

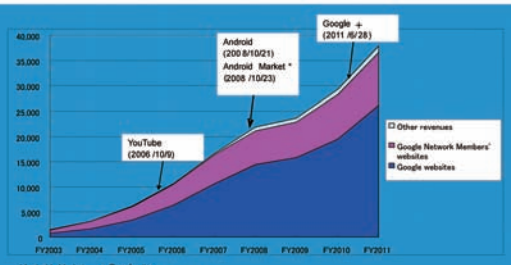
- Possible case:
- Law price for A → decrease of profit from market A << increase of profit form market B
- Platform which can become an industry standard: much larger (indirect) network effect

APPLE



(Data Source: SEC Filing Form 10-K)

GOOGLE



*Android Market --> Google Play

(Data Source: SEC Filing Form 10-K)

APPLE AND GOOGLE

Same strategy: platform business

- But, the big difference

Apple

- Platform: iTunes App Store
- Cash cow: in-house product such as iPhone and iPad

Google

- Platform: web search engine YouTube Android
- Cash cow: advertisement

SONY AT THAT TIME

- Seemed to have all resources which can make itself APPLE
- CD/MD, Music, Trinitron
- Became just a burden
- Governance?

- TOYOTA
- Another Sony?
- Engine, Hybrid system, Part suppliers, Distribution chain
- Governance?

THE ANXIETY

- Sony Digital dream kids
- stock price soaring <---> not clear strategy

- Toyota
- Hydrogen?

- Telematics
- Platform???

CHANCE: A GOOD, A LITTLE OR LITTLE

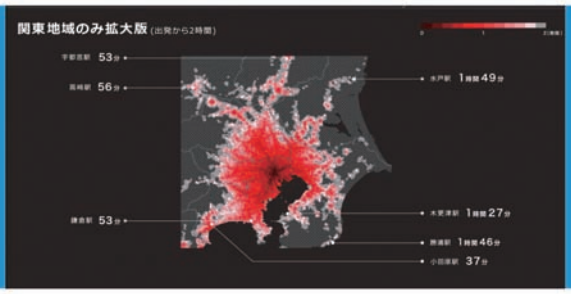
- Vigorous entrepreneur
- Individuals playing globally
- Collaboration with big companies
- Conversion to a new model

- Default for pharmaceutical industry, now IT, then Automobile

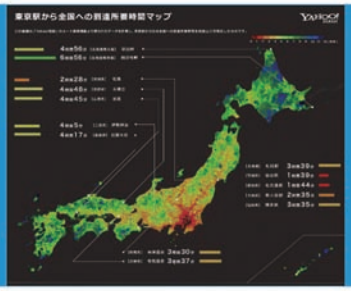
- CVC: serious one, independent, spin-off

BIG DATA SHOW US...

(SOURCE: HTTP://DOCS.YAHOO.CO.JP/INFO/BIGDATA/SPECIAL/2015/01/)



CONTINUED: JAPAN SENDAI (MATSUSHIMA)



GREATER TOKYO

- Tokyo will survive, because
- 30,000,000 people with very efficient transportation system (within 2 hours)
- Frequency
- Convenience
- Certainty

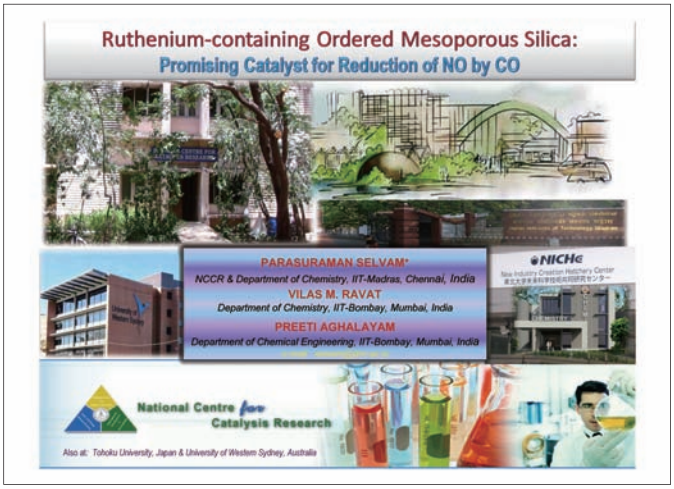
- Sendai should seriously consider its future as Greater Tokyo

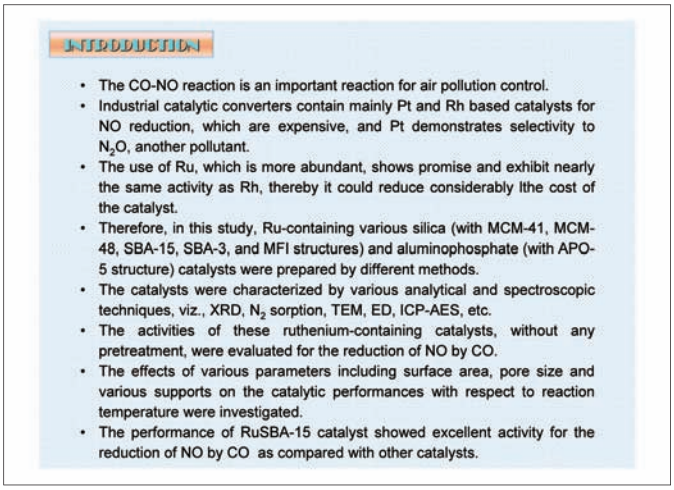
Ruthenium-containing Ordered Mesoporous Silica: Promising Catalyst for Reduction of NO by CO

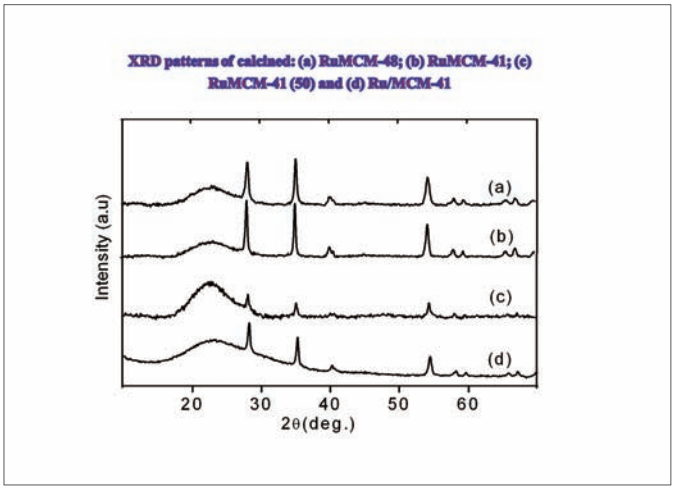
Parasuraman Selvam

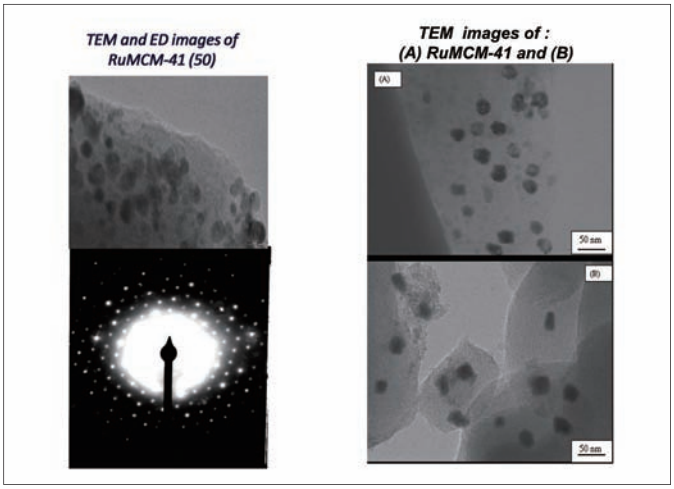
Professor, National Centre for Catalysis Research and Department of Chemistry

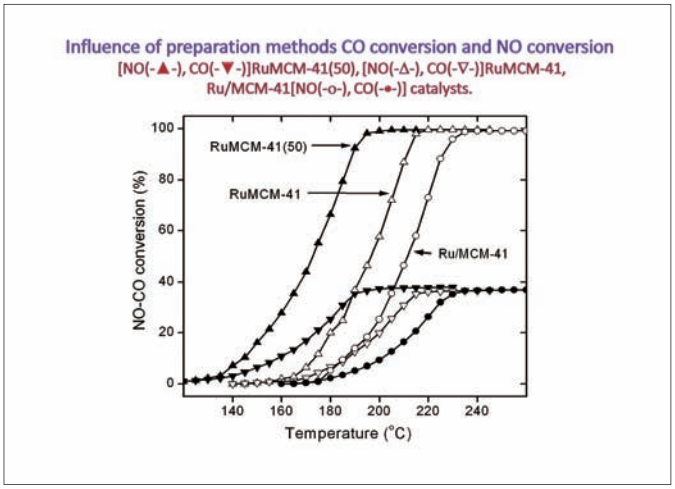
Indian Institute of Technology-Madras, India





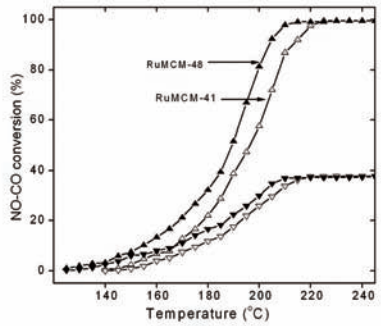




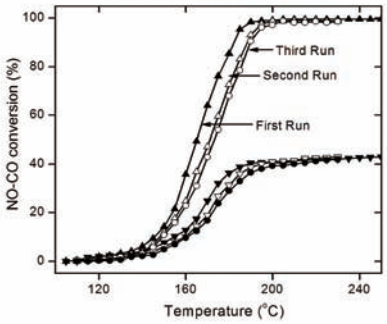


Effect of surface area and pore size on catalyst activity of NO reduction by CO :

[NO (-▲-), CO (-▼-)]RuMCM-48, [NO(-■-), CO(●)]RuMCM-41



Thermal stability of ruthenium species in RuMCM-41 (50) for the reduction of NO

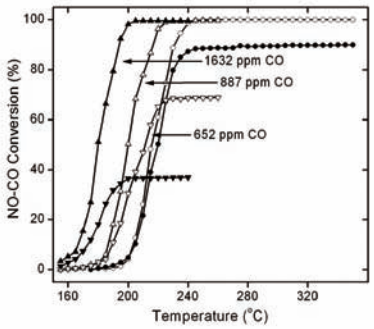


Effect of CO concentration on the reduction of NO over RuMCM-41(50)

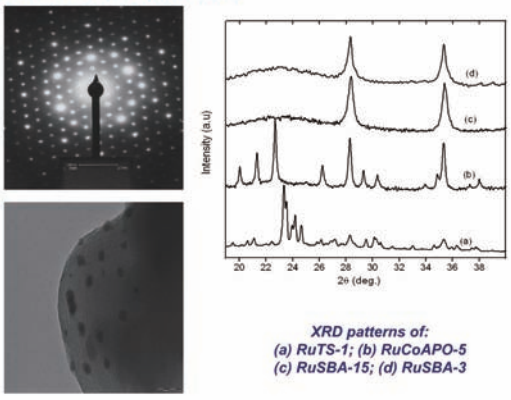
[850 ml/min (578 ppm NO (▲) + 1632 ppm CO (▼)],

[500 ml/min (581 ppm NO (Δ) + 870 ppm CO (∇)],

[400 ml/min (579 ppm NO (◄),+ 652 ppm CO (►)] catalyst.



TEM image and ED Pattern of RuSBA-15



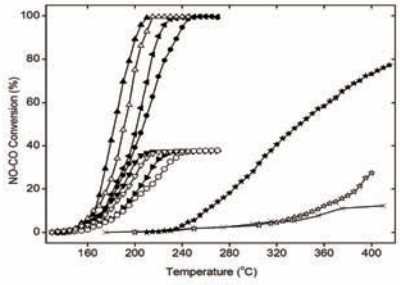
XRD patterns of:
(a) RuTS-1; (b) RuCoAPO-5
(c) RuSBA-15; (d) RuSBA-3

NO-CO conversion over various catalysts:

[NO(-▲-), CO(-▼-)] RuSBA-15, [NO(-Δ-), CO(-∇-)] RuSBA-3,

[NO(-◄-), CO(-►-)]RuTS-1, [NO(-●-), CO(-○-)]RuCoAPO-5,

[NO(-x-)] SBA-15, [NO(-★-)]CoAPO-5, [NO(-★-)] RuTS-1.



ACKNOWLEDGEMENT

DST / CSIR / BRNS / IOCL / SHELL / P & G / GRANULES

TU, DCU, ZIOC, UQ &

Thank You !

Transportation, hydrogen and fuel cell status in USA

Shannon Baxter

Executive Director, South Carolina Hydrogen and Fuel Cell Alliance, USA

SC HYDROGEN & FUEL CELL ALLIANCE www.SCHydrogen.org

Transportation, Hydrogen, and Fuel Cell Status in USA

Shannon Baxter, PhD

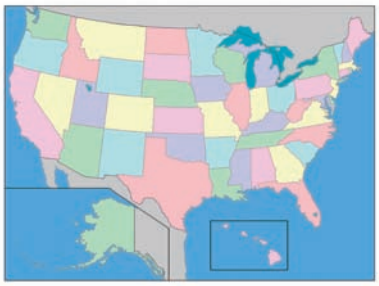
Executive Director

Global/Local Innovations for Next Generation Automobiles
October 27 - 29, 2015

Collaborating Coordinating Creating

SC HYDROGEN & FUEL CELL ALLIANCE www.SCHydrogen.org

Top Fuel Cell States



Collaborating Coordinating Creating

SC HYDROGEN & FUEL CELL ALLIANCE www.SCHydrogen.org

Which Comes First…The Vehicles or the Fuel?

Collaborating Coordinating Creating

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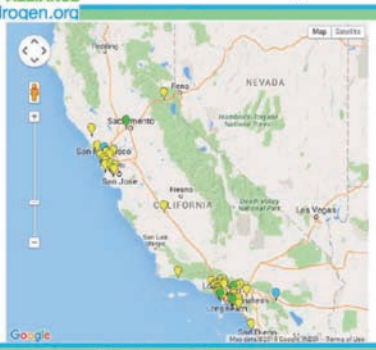
Infrastructure Update

California stations:
08 Open
47 In Development
03 Bus
58 **Total**



Collaborating Coordinating Creating

SC HYDROGEN & FUEL CELL ALLIANCE www.SCHydrogen.org

Station Status

- Demonstration
- Commercial

What is the difference and why does it matter?

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Sustainability and Mobility

- *GM*
- *Honda*
- *Hyundai*
- *Toyota*

What do these words currently mean in the USA?

Collaborating Coordinating Creating

SC HYDROGEN & FUEL CELL ALLIANCE
www.SCHydrogen.org

Next on the radar…

- *Heavy Duty*
- *Medium Duty*
- *Ports*

Collaborating Coordinating Creating

SC HYDROGEN & FUEL CELL ALLIANCE
www.SCHydrogen.org

U.S. States and policy makers are working together to create value for the fuel cell industry.

- *U.S. Government*
- *U.S. States*

U.S. states are often viewed as "laboratories of democracy" — U.S. Supreme Court Justice Louis Brandeis coined the phrase, referred to the idea that state and local governments can "test" new ideas.

Collaborating Coordinating Creating

SC HYDROGEN & FUEL CELL ALLIANCE
www.SCHydrogen.org

Let's Talk…to People

Everyone is a consumer…industry colleagues, engineers, infrastructure developers, our families, neighbors…with expectations based on their experiences. How do we talk to consumers about hydrogen and fuel cells?

SC HYDROGEN & FUEL CELL ALLIANCE
www.SCHydrogen.org

Thank you.
Domo arigatou gozaimasu

Shannon Baxter, PhD
Baxter@RackCorporation.com
(803) 705-8915

Collaborating Coordinating Creating

Green transportation
- Automotive integration options in sustainable infrastructures and industries -

Wolfgang G. Winkler
Professor, em. Director of Institute of Energy Systems and Fuel Cell Technology
Hamburg University of Applied Sciences, Germany

Prof. Dr. techn. Wolfgang Winkler, Retired Director of Institute for Energy Systems and Fuel Cell Technology

W. Winkler
Green transportation - automotive integration options in sustainable infrastructures and industries

Global/Local Innovations for Next Generation Automobiles
International Symposium 2015
October 27 – 29, 2015 in Sendai, Japan

- Technical requirements and background
- Integration in sustainable infrastructure
- Integration in sustainable industries
- Economic boundaries for sustainable development
- Conclusion and recommendations

- **Technical requirements and background**
- Integration in sustainable infrastructure
- Integration in sustainable industries
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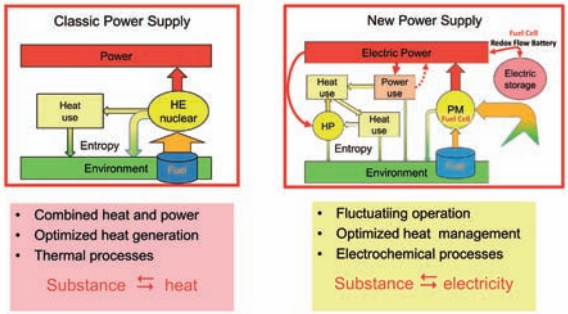
- Conclusion and recommendations

Changing role of industry



- Combined heat and power
- Optimized heat generation
- Thermal processes

Substance ⇆ heat

- Fluctuatiing operation
- Optimized heat management
- Electrochemical processes

Substance ⇆ electricity

- Technical requirements and background
- **Integration in sustainable infrastructure**
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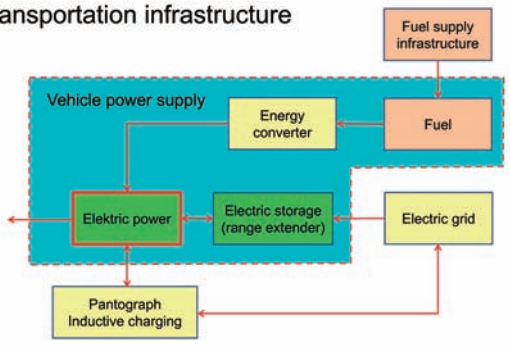
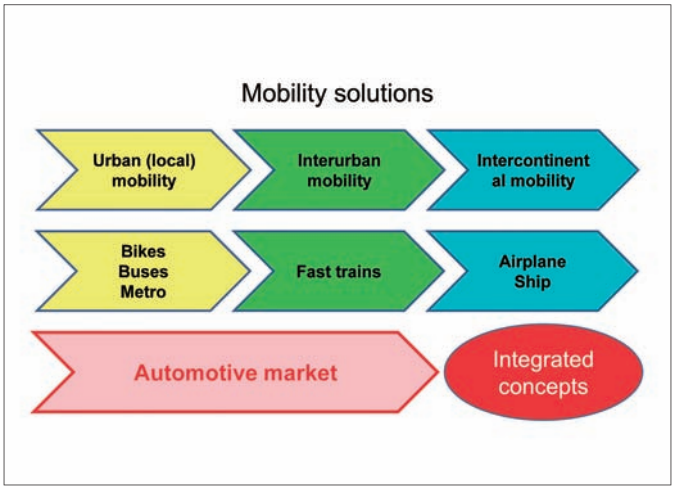
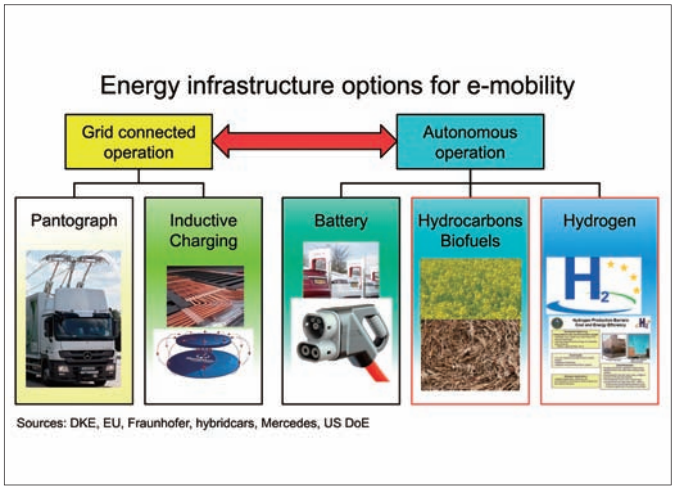
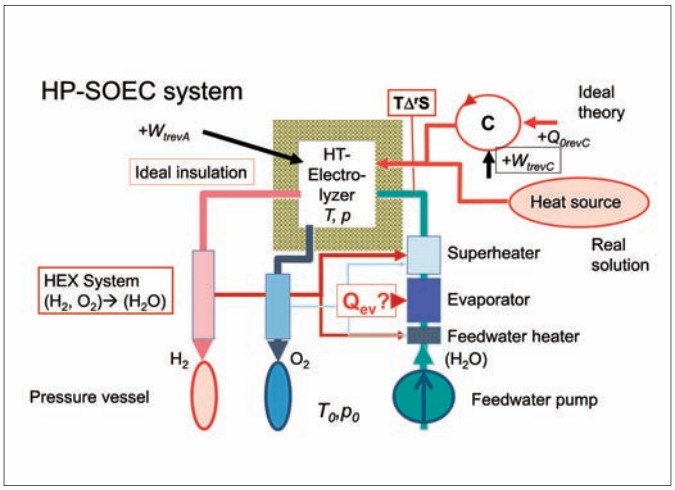
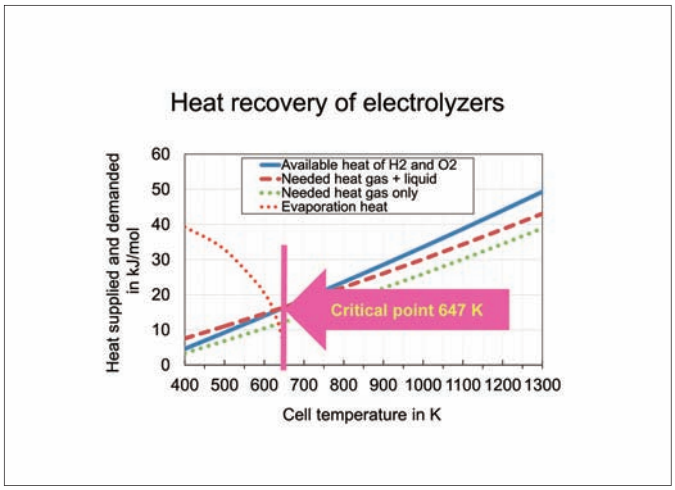
Transportation infrastructure

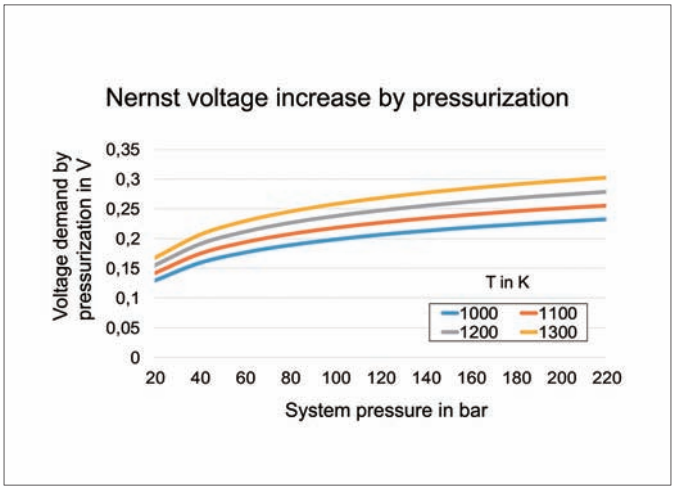


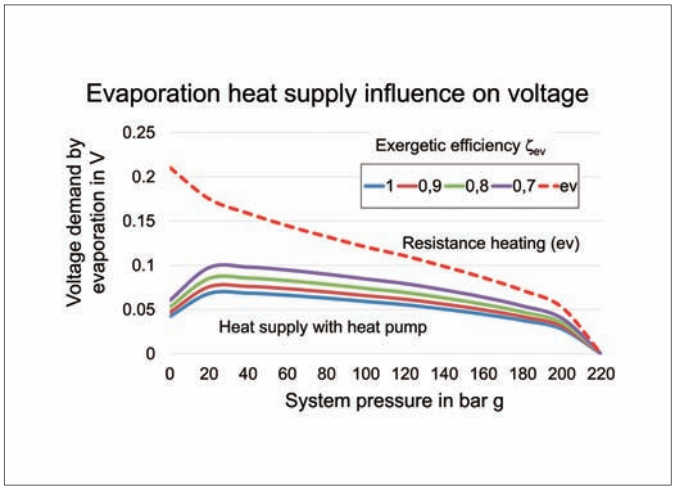

Mobility solutions
Urban (local) mobility
Interurban mobility
Intercontinental mobility
Bikes Buses Metro
Fast trains
Airplane Ship
Automotive market
Integrated concepts


Energy infrastructure options for e-mobility
Grid connected operation
Autonomous operation
Pantograph
Inductive Charging
Battery
Hydrocarbons Biofuels
Hydrogen
Sources: DKE, EU, Fraunhofer, hybridcars, Mercedes, US DoE


HP-SOEC system
Ideal theory
Ideal insulation
HT-Electro-lyzer T, p
Heat source
Real solution
Superheater
Evaporator
Feedwater heater
Feedwater pump
HEX System
Pressure vessel


Heat recovery of electrolyzers
Available heat of H2 and O2
Needed heat gas + liquid
Needed heat gas only
Evaporation heat
Critical point 647 K
Heat supplied and demanded in kJ/mol
Cell temperature in K


Nernst voltage increase by pressurization
Voltage demand by pressurization in V
T in K
1000
1100
1200
1300
System pressure in bar


Evaporation heat supply influence on voltage
Voltage demand by evaporation in V
Exergetic efficiency ζev
1
0,9
0,8
0,7
ev
Resistance heating (ev)
Heat supply with heat pump
System pressure in bar g

- Technical requirements and background
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- **Integration in sustainable industries**
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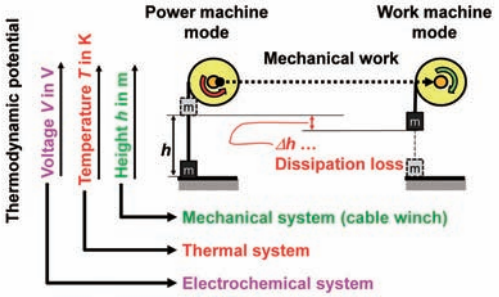
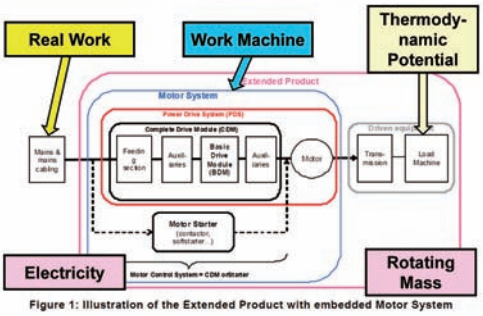
Regenerative machines



IEC ACEE and thermodynamic view of motor system



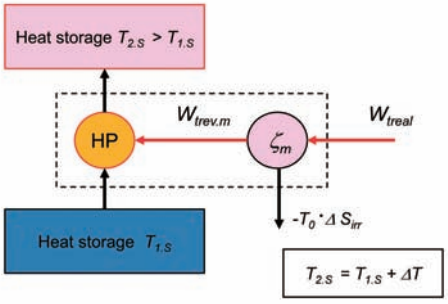
Source: IEC

Figure 1: Illustration of the Extended Product with embedded Motor System

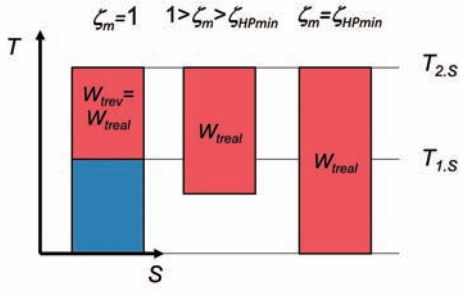
Reversible engineering solutions

Entropy Production by Temperature Differences	Heat Engines Heat Pumps
Generation of Mixing Entropy	Electrochemical Processes

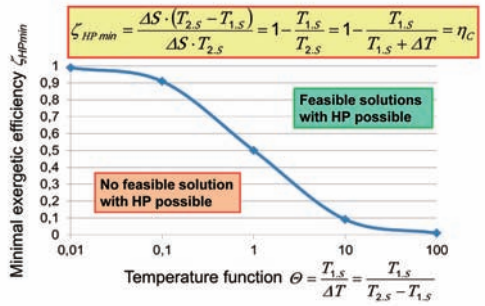
Real HP structure



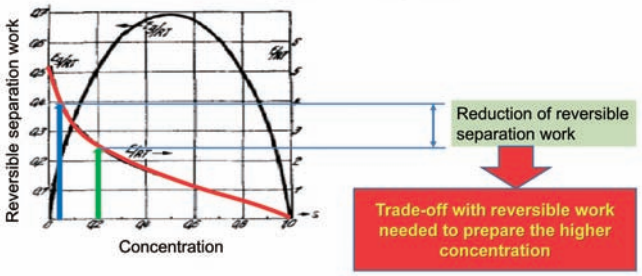
Exergetic efficiency and HP work



Feasibility chart of HP

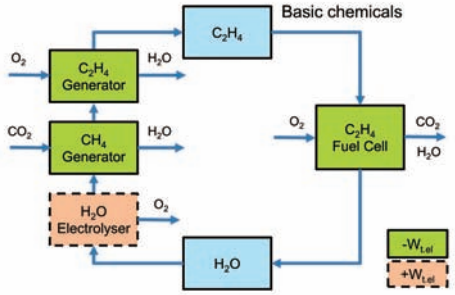


Background of Recycling

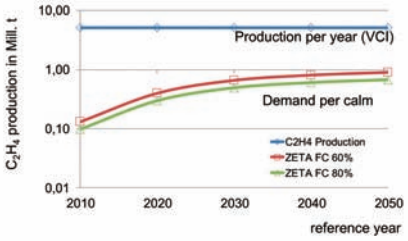


Source: F.G.: Houtermans. Über den Energieverbrauch bei der Isotopentrennung. Annalen. der Physik. 5. Folge. Band 40. 1941 p 493 - 508

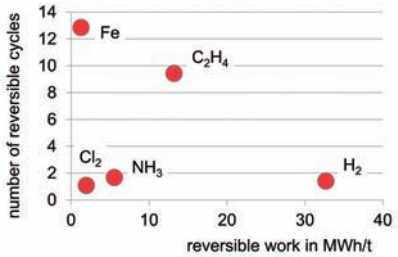
Industrial reverse process



C_2H_4 as storage for 10 days calm



Industrial storage options for covering calms



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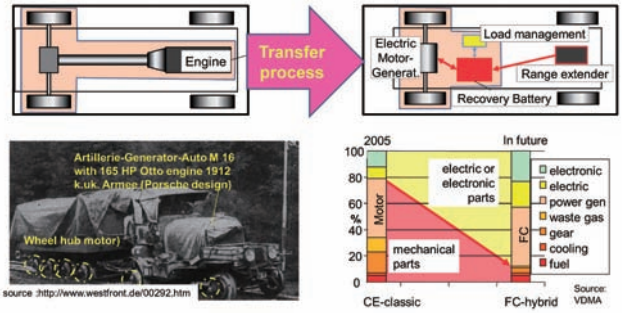
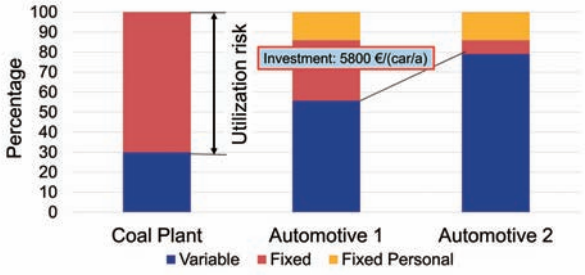
Transition to full electric systems



Average cost structure in industry



Sources: Audi, BMW, IFA, Manager Magazin

Energy saving options for trucks

Engine
- Variable valve actuation 1% - 2%
- Sequential turbo/downsizing → 5%
- Speed control (injection) → 5%
- Oil and water pump with variable speed 1% - 4%
- Controllable air compressor 3.5%
- Smart alternator, battery sensor electric accessory drive 2% - 10%
- Start/stop automatic 5% - 10%
- Dual fuel systems 10% - 20%
- Pneumatic booster: air hybrid → 4%
- Turbocompound (mechanical/electric) 4% - 7%
- Bottoming cycles/waste heat recovery (*e.g.* organic Rankine) 1.5% - 10%

Drive train
- Automated manual transmission 4% - 6%
- Full hybrid urban15% -30%
- Full hybrid long haul 4% - 10%
- Flywheel hybrid urban 15% - 22%
- Flywheel hybrid long haul 5% - 15%
- Hydraulic hybrid urban 12% - 25%
- Hydraulic hybrid long haul Avg 12%

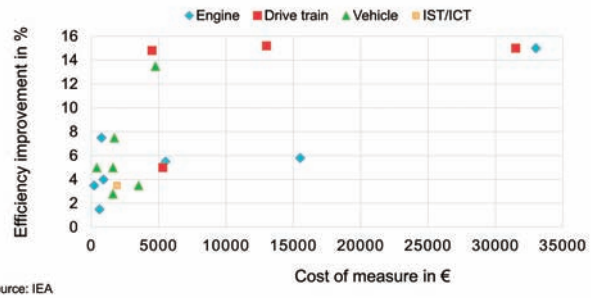
Vehicle
- Low rolling resistance tyres 5%
- Aerodynamic fairings 0.5% - 5%
- Aerodynamic trailer/boat tail 12% - 15%
- Single wide tyres 6% - 10%
- Light-weight materials 2% - 5%
- Active aerodynamics → 5%

IST/ITC
- Predictive cruise control 2% - 5%
- Driver support system 5% - 10%
- Acceleration control → 6%
- Vehicle platooning → 20%

. . . ?

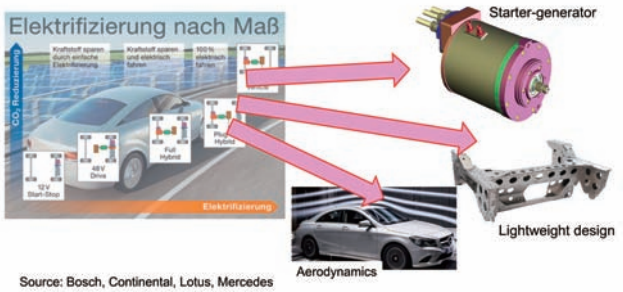
Source: IEA

Efficiency improvement-cost relation (trucks)



Source: IEA

Examples of the roadmap



Source: Bosch, Continental, Lotus, Mercedes

- Technical requirements and background
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Requirements

- Minimizing irreversible entropy is design rule
- General reversible structure is benchmark
- Energy recovery (system) & energy saving (component)
- Electrochemical-all electric process structure
- Lightweigt design, minimimizing of friction

Infrastructure

- Integration of automotive transport in general transportation
- Grid connected and autonomous operation can be combined to maximze flexibility
- Electrolyzers are key components in converting electricity in thermodynamic potential
- Pressurization of electrolyzers is an interesting option for HT electrolyzers

Industrial production

- Optimization of industrial production by reversible structures
- Recovery of electricity by motor/generators in industry
- Heat recovery with heat pumps in industrial processes
- Integration of industrial production in seasonal electricity storage
- Reversible separation work base for recycling strategies

Boundaries

- Industrial transition depends clearly on supply structure
- Evaluation of efficiency potential needs system approach
- Efficiency increase strategies show intelligent compromises between classical solutions to new concepts
- Prominent examples are starter-generator, leight weight design, and aerodynamics

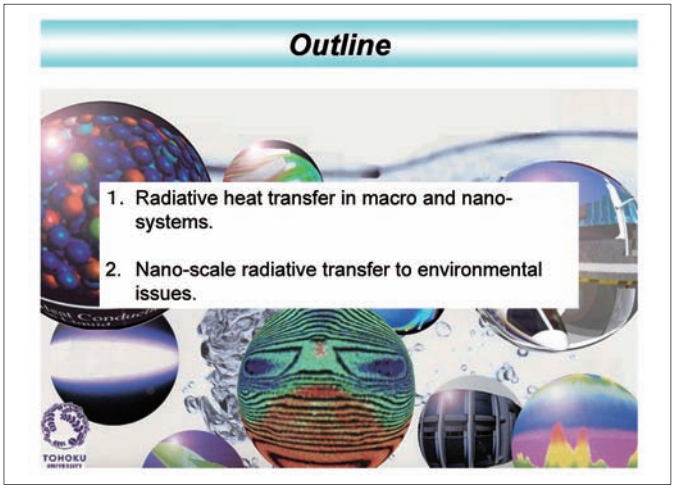
Acknowledgement

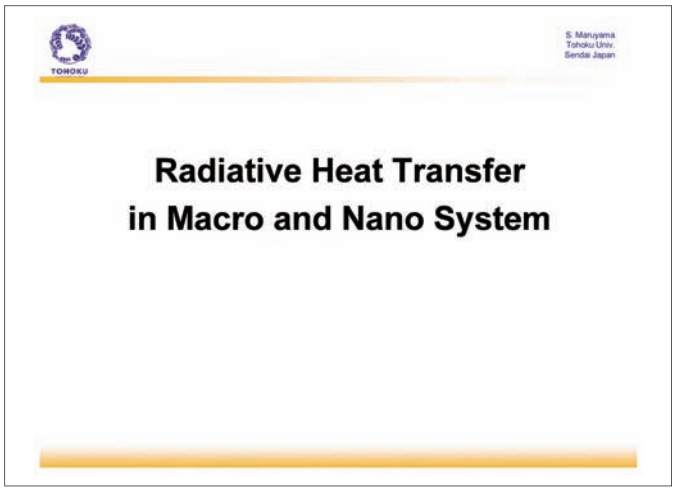
A part of the here presented work has been funded by the German Ministry of Economy (BMWi) in the DKE managed INS-Projekt SO-FIE N 510

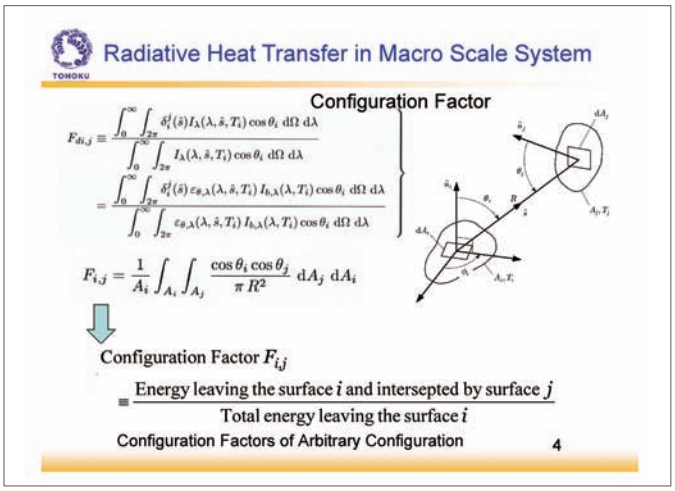
Radiative Transfer by Nano-Structure for Environmental Issues
- Development of Cool Black –

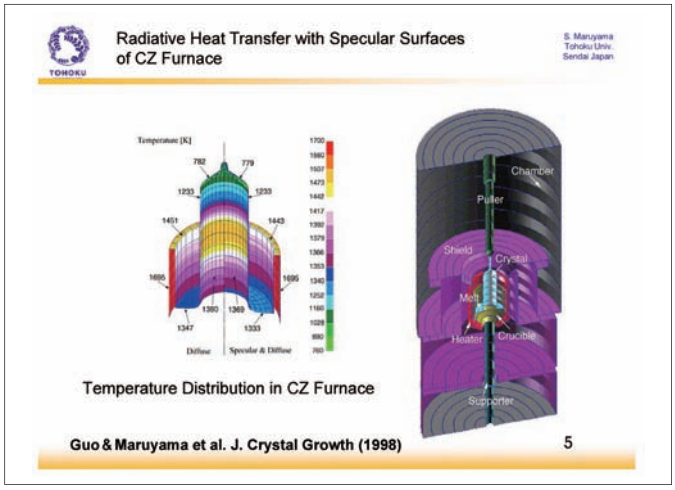
Shigenao Maruyama

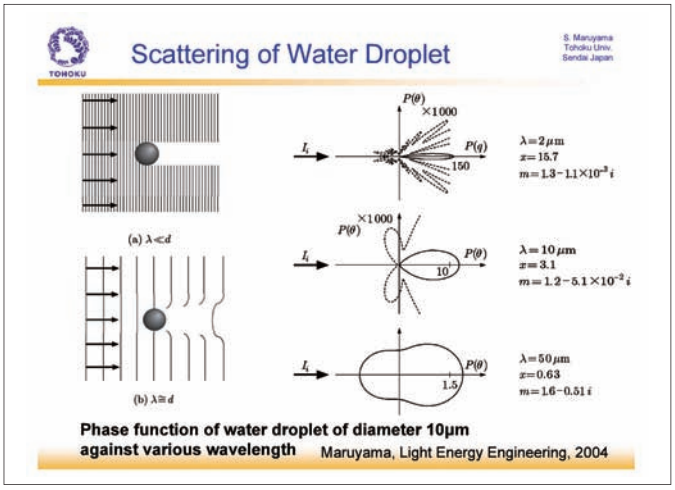
Professor, Heat Transfer Control Laboratory, Institute of Fluid Science, Tohoku University, Japan







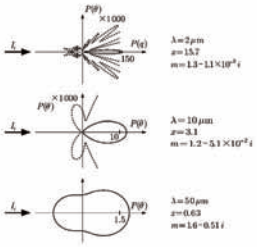




Light scattering by particles comparable size with the light wavelength

S. Maruyama Tohoku Univ. Sendai Japan

Mie Scattering



Light scattering of a water particle of diameter10μm irradiated by various wavelength lights

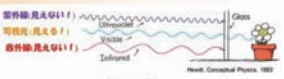
Maruyama, Light Energy Engineering, 2004

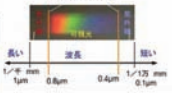
Visible and Invisible Lights

S. Maruyama Tohoku Univ. Sendai Japan

Visible or Invisible?

http://www.ifs.tohoku.ac.jp/ifs_movie/jpn/ifs_channel/movie_03_b.html

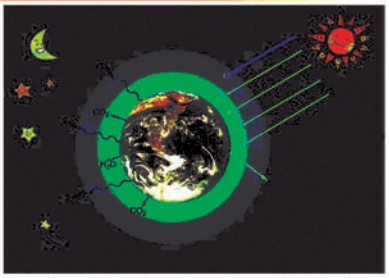




8

Global Warming and Radiative Heat Transfer

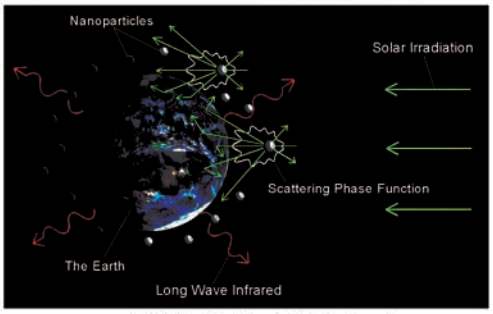
S. Maruyama Tohoku Univ. Sendai Japan



Global temperature is determined by the heat balance of the energy irradiated (wavelength =0.5 μm) by the sun and thermal emission (wavelength= 10 μm) form the earth.
The greenhouse gases are transparent against the sunlight, however, they absorb the long infrared from the earth. The gases increase the temperature of the earth.

Changing Energy Balance of the Earth

S. Maruyama Tohoku Univ. Sendai Japan



Sunlight scattered by particle in the atmosphere.

10

Heat Transfer Control by Dispersing Nano-particles

Cooling of the Earth by Nano-particles

S. Maruyama Tohoku Univ. Sendai Japan

Proposal

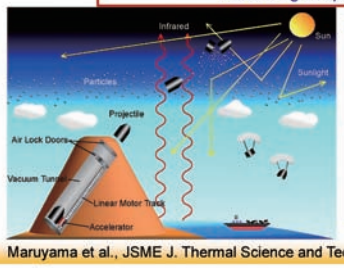
Optical Characteristics of Nano-particles

↓

Controlling Solar Irradiation by Dispersing Nano-Particles in Stratosphere

↓

Decreasing Temperature



- Material: Al_2O_3
- Altitude: 30 km
- Launching Site: 4000 m
- Acceleration: Linear Motor
- Projectile: 10 tons

Maruyama et al., JSME J. Thermal Science and Technology (2015)

11

Difference between Micro and Nano Systems

S. Maruyama Tohoku Univ. Sendai Japan

Macro and nano-systems can be defined in terms of radiative transfer

Macro-system:

The size of the system element is much larger than the wavelength of radiation.
The radiation can be treated as energy rays and geometrical optics can be applied.

Nano-system:

The size of the system element is similar or smaller than the wavelength of radiation.
Wave and quantum characteristics appear in the radiative transport.

12

Nano-scale Radiative Transfer to Solve Environmental Issues

13

Controlling Environment by Nano-technology

Phenomenon in nano scale

Spectral reflectance control

The amount and direction of scattering energy

Saving energy for air conditioning

Environmental problem

Phenomenon in macro scale

Urban heat island

Pigment particle observed by Scanning Electron Microscope (SEM)

Nanotechnology

Control of the phenomenon in nano scale has the big impact on the phenomenon in macro scale.

Collect thermal data on metropolitan Atlanta, Georgia Daytime air temperatures of only about 26.7 degrees Wikipedia

No.14

Energy Saving by Nano-particles

Advantage

Dark colors are used to paint the buildings or cars to improve aesthetic performance

Disadvantage

- ✓ High absorption against sunlight
- ✓ Increasing indoor temperature
- ✓ Increasing cooling load demand

Too much energy used

Environmental problem

Urban heat island

Global warming

Collect thermal data on metropolitan Atlanta, Georgia Daytime air temperatures of only about 26.7 degrees Wikipedia

Polar bear struggling to survive on the small ice left due to global warming

No.15

Energy saving by nano-particles

Contribution of UV/VIS/NIR lights in solar energy

Direct solar irradiation

Solar irradiance I, W/(m²·nm)

Wavelength λ, nm

Spectral solar irradiations

Typical black paint

Reflectance ρ, %

Reflectance of typical black paint

- 52% of near-infrared (NIR) light : 0.78–2.5μm
- 43% of visible (VIS) light : 0.38–0.78μm
- 5% of ultraviolet (UV) light : 0.30–0.38μm

Most effective to heat

It is possible to reduce sunlight absorption of exteriors by reflecting NIR energy.

Numerical analysis

The RTE is solved to find spectral reflectance of the coating system

Collimated and diffuse solar irradiation

Radiative Transfer Equation

$$\frac{dI_\lambda(x,\mu)}{ds} = \beta[-I_\lambda(x,\mu)+(1-\omega)I_{b,\lambda}(T)+\frac{\omega}{2}\int_{-1}^{1} I_\lambda(x,\mu')\Phi_\lambda(\mu')d\mu']$$

Reduced term by scattering and absorption | Emission term | Amplification term by scattering

Fresnel's equation

Independent scattering

Emission term
Theoretical design (VIS-NIR) : 0
Thermal analysis (VIS-IR) : Considered

Solar irradiation
Bird's model

Measured spectral reflectance

One-dimensional plane-parallel model

Radiation Element Method by Ray Emission Model (REM²)

S. Maruyama, Int. J. Heat Mass Tran. 41, (1998), 2847.

Comparison between measurement and analysis

No.18

VIS NIR

Reflectance ρ, %

Wavelength λ, μm

CuO d = 0.4 μm fv = 0.05
t = 10 μm Sub : White paper
Measurement
Calculation

Comparison between measured and calculated reflectivity of CuO coating on the white paper

The spectral behaviors of measured and calculated reflectance are almost same.

Evidence of our theoretical designing method

Gonome & Maruyama, et al., JQSRT, (2013)

Experiment

S. Maruyama
Tohoku Univ.
Sendai Japan

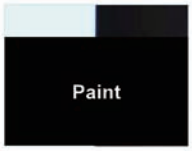
Specifications of the pigmented particles

Composition	Mean diameter of particles [μm]	Chemical company
CuO	0.050	Wako Pure Chemical Industries
CuO	0.89	Kojundo Chemical Laboratory
CuO	3.0	Wako Pure Chemical Industries

Preparing the coating

CuO powder

Mix with clear acrylic resin and paint



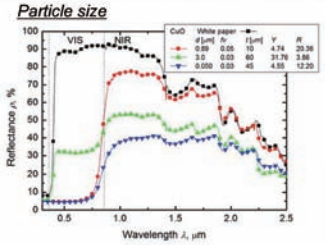
Standard black and white paper introduced by Japan Industrial Standards (JIS)

Gonome & Maruyama et al., JQSRT, 132, (2014).

Experiment

S. Maruyama
Tohoku Univ.
Sendai Japan

Particle size



Variation in the measured spectral reflectivity with particle diameter for CuO pigmented coating on white paper

Control of the particle size

Control of the spectral reflectance

Particle diameter *d* : 3.0 μm

Moderate VIS reflectance

Gray color

Hiding power of the big particle is low.

d : 0.89, 0.050 μm

Low VIS reflectance

Black color

NIR reflectance

d : 0.89 μm > *d* : 0.050 μm

Gonome & Maruyama et al., JQSRT, 132, (2014).

Conclusions

1. In radiative transfer, the size of the nano-system is similar or smaller than the wavelength of radiation, and wave and quantum characteristics appear.
2. Nao-scale radiative heat transfer may solve mega-scale environmental issues.

Radiative Transfer by Nano-Structure for Environmental Issues

Thank you for your attention

元気・前向き
Powerful Positive Tohoku University
東北大学

22

Supercritical CO_2 Technology - cleaning and catalyst impregnation -

Hiroshi Inomata

Professor, Research Center of Supercritical Fluid Technology Graduate School of Engineering,

Tohoku University, Japan

Supercritical CO_2 Technology

cleaning and catalyst impregnation

超臨界CO_2技術 -洗浄，触媒担持プロセス

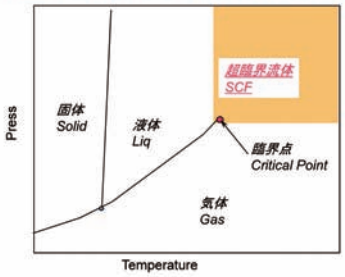
(Hiroshi INOMATA)

Research Center of SCF technology,
Graduate School of Engineering, Tohoku University

What is SCF ?

Non-condensable dense fluid above its critical temperature

Capable of controlling various properties widely
by tuning temperature and pressure conditions



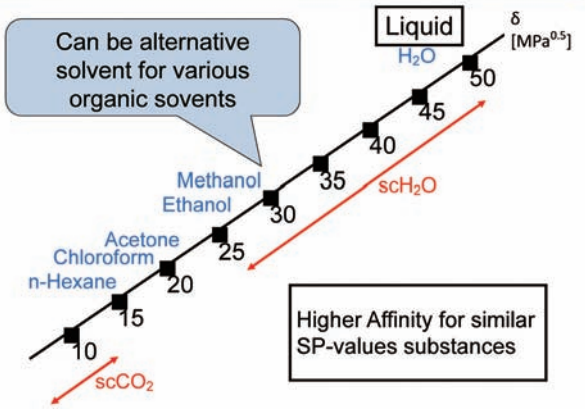
General features of supercritical fluids

○Non-condensable dense fluid
Can vary its density continuously from gas-like to liquid-like values.

○intermediate between gas - liquid

Property	Gas	SCF	Liquid
Density [kg/m^3]	0.6~2	300~900	700~1600
Viscosity [10^{-5} Pa・s]	1~3	1~9	200~300
Diffusivity [10^{-9} m^2/s]	1000~4000	20~700	0.2~2
Kinematic Viscosity [10^{-7}m^2/s]	100	1～10	10

Solubility Parameter – index of solvent property-



Applications

1. Cleaning of metal parts and clothes
2. Metal particle impregnation for catalyst preparation

No needs of DRYing process -

1. Pump-less circulating

⇔ Reciprocating Pump: generating particles

Rinsing System

→ Solvent recycle during circulation
Solvent renewing

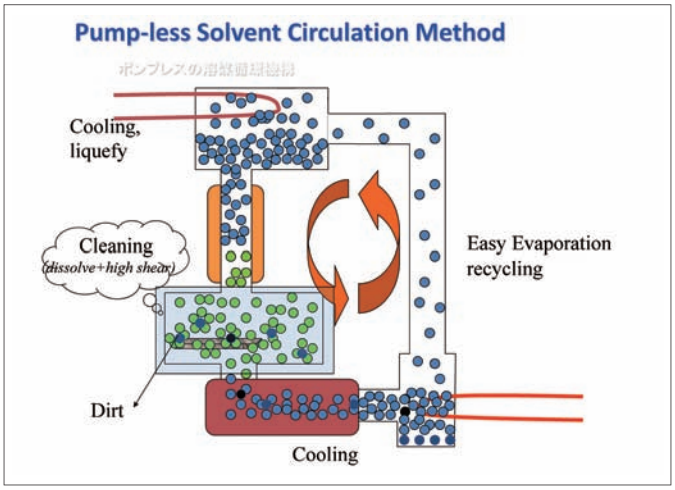
2. High penetrating and low surface tension → Porous supported catalysts

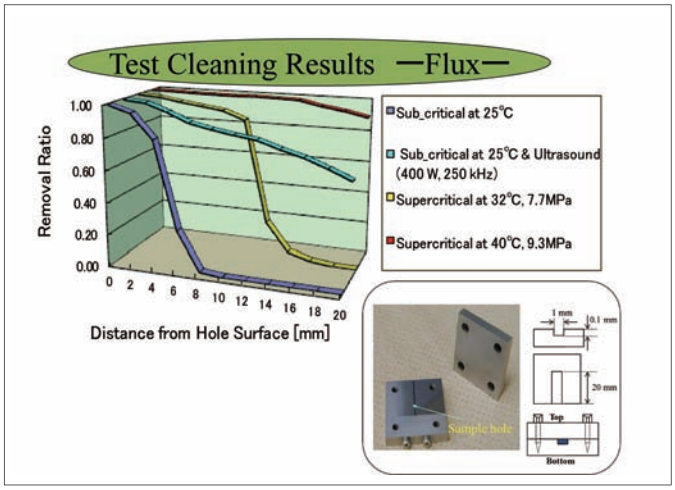
Benefits of CO_2 as a cleaning solvent

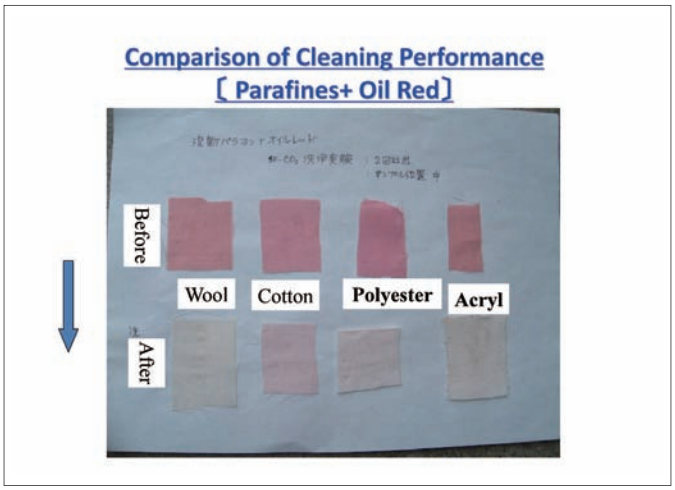
1) Environmental Friendly
2) Non-toxic, Stable
3) Inert (Less reactive)
4) Dissolve lipophilic
5) High diffusivity
+Low surface tension
6) Easy separation from dirt
7) Expect sterilization

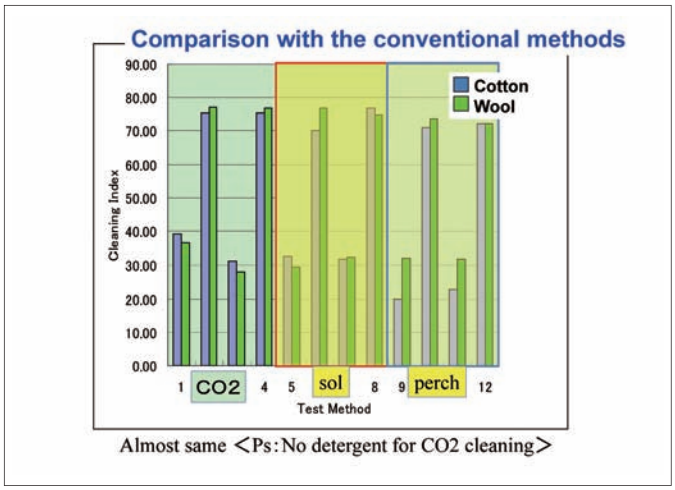
→

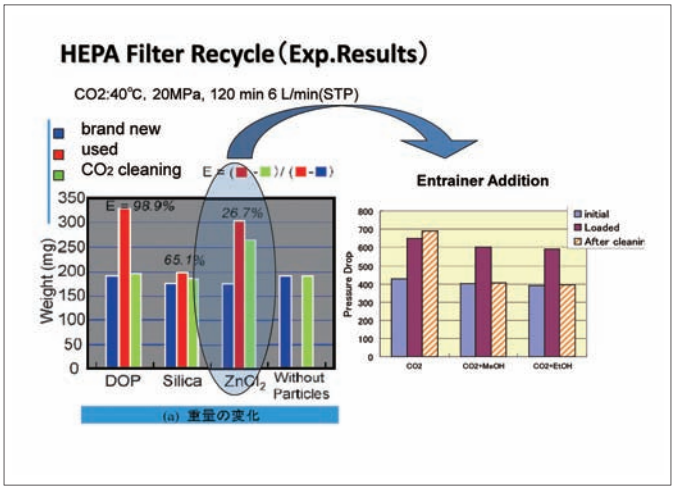
- precise machine - complicated (integrated) device
- water sensitive materials
- requiring long drying time
- solvent residual problem











Conclusions

- Cleaning is a promising field for supercritical CO_2 (sc-CO_2) technology because of its high diffusivity, low surface tension and no residual risk.
- High diffusivity and low surface tension are nice features for impregnation into porous meterials such as supported catalysts.
- Environmental friendly feature of sc-CO_2 is also suitable as a cleaning solvent.

Future Innovation of Foundation Brake for Adopting Regenerative Brake and Autopilot Capabilities

Hidetoshi Shimizu

General Manager, Link Japan, Japan

2015.10.27

Future Innovation of Foundation Brake for Adopting Regenerative Brake and Autopilot Capabilities

Link Japan

Hidetoshi Shimizu

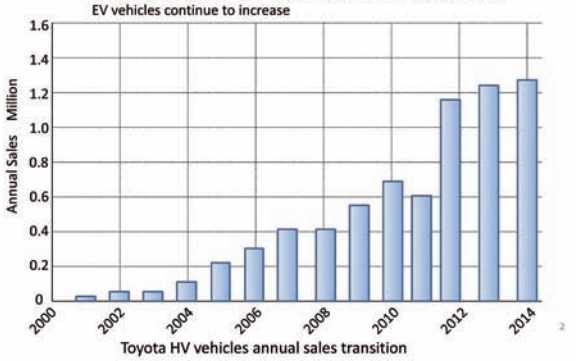
1

1. Background

a) Increase of regenerative brake systems

Offered by Cordia

Vehicles which provide regenerative brake systems such as HV and EV vehicles continue to increase



Toyota HV vehicles annual sales transition

2

b) What is 'braking'?

- Previous Brake

Brake = energy conversion + heat radiation

Kinetic Energy ($1/2mV^2$)
Potential Energy ($m \cdot g \cdot h$) → Friction Between Pads and Rotor → Heat Energy → Cooling → Heat dissipation to air

Heat energy increases as the weight and velocity of the vehicle increases

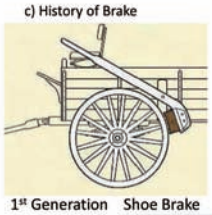
- Regenerative Brake

Kinetic Energy ($1/2mV^2$)
Potential Energy ($m \cdot g \cdot h$) → Regeneration → Electric Power → Driving vehicle

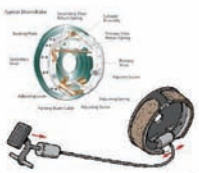
- Future brake system must be changed by this innovation, because the function for heat dissipation should be reduced in future brake systems

3

c) History of Brake



Offered by John Mack UTIL



1st Generation Shoe Brake

2nd Generation Drum brake

3rd Generation Disc Brake

What's next?

4

2. Impact of new trend

a) Impact of the regenerative brake system

- Brake by wire configuration is necessary for cooperative brake control with regenerative brake.
- Foundation brake load is drastically reduced by maximally utilized regenerative brake in normal use.
- Pad life is not a critical issue in this system, because pad life is related in normal brake use. Therefore, rotor heat capacity can be drastically reduced in this system.
- Reducing rotor heat capacity is required for keeping the friction surface fresh for smaller brake load in normal use to prevent NV issues.
- Adequate foundation brake power should be considered in battery full charge and emergency situation.
- Friction materials which offer high heat resistance are required if the front brake size is reduced.

b) Impact of Autopilot for foundation brake

- Brake by wire configuration is necessary for applying brake without driver's intension.
- Pad clearance can be decided without consideration of brake feel, if brake by wire is adopted. It may resolve brake drag and DTV problems.

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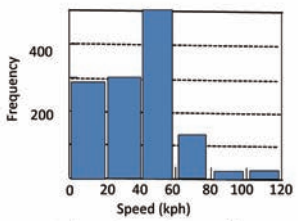
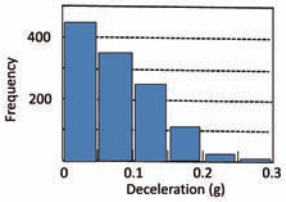
c) Usage of Foundation brake and regenerative brake



Brake apply speed at city traffic
Los Angeles (LA) City Traffic Test



Brake deceleration at city traffic
Los Angeles (LA) City Traffic Test

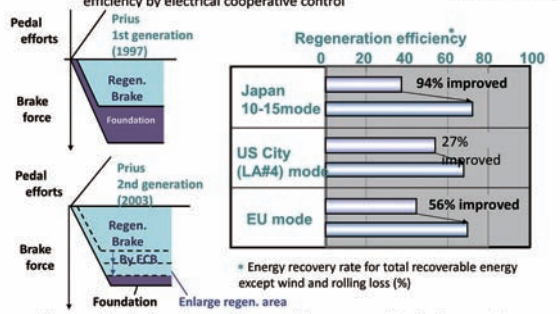
- Most brake applications occur at speeds less than 120kph in LA City Traffic testing.
- Most brake applications occur with decelerations less than 0.2g.

6

3. Improvements and the role of regenerative brake

a) Improvement of hybrid technology and regeneration efficiency by electrical cooperative control

Offered by Cordia



- Regenerative brake systems achieve great improvements, including covering a wider range of braking situations.
- If regenerative brake systems can cover most of the normal braking situations, it will generate a tremendous benefit for foundation brake configuration.

7

4. Role of regenerative brake and foundation brake in future brake system

a) Regenerative brake

<Role>

- All brake application in normal usage

<Tasks>

- Controllability in low speed and low deceleration range
- Braking force in low speed to zero speed range

b) Foundation brake

<Role>

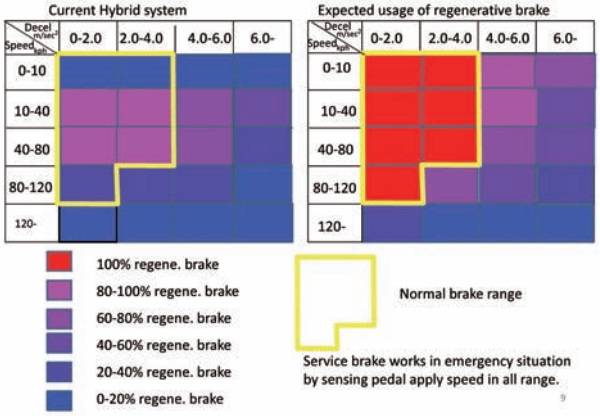
- High deceleration
- High speed (over 120kph)
- Battery full charge situation.
- Activated by sensing pedal speed in emergency case.

<Tasks>

- Response with gap between rotor and pad situation

8

c) Share of brake force between regenerative brake and foundation brake (Image)



Service brake works in emergency situation by sensing pedal apply speed in all range.

9

5. Concept of brake system adopting regenerative brake and Autopilot

a) System

	Required performance	Features	Tasks
Brake apply	• Good chemistry with regene. brake • Quick response	• Motor drive stroke simulator • ECU with backup	• Rapid computer processing • Improvement of brake feel
Corner Brake	• Small • Light weight • Enough brake Power in emergency situation • No DTV growth • No squeal	• Small EMB with appropriate power • Pad no contact with rotor • Larger effective Radius	• Rapid closing gap and brake apply • Appropriate power with smaller size • Usage of motor around zero speed
Rotor	• Small • Light weight • Larger effective dia. • No rust	• Perimeter disc rotor • Larger diameter, thin thickness, light weight • Stainless steel	• Layout for perimeter disc rotor • Wheel temperature in emergency situation • Stainless friction
Pad	• Small contact area • Heat endurance • Enough brake Power in emergency situation • High friction coefficient	• Sinter pad • No copper contain • Stable mu at high temperature range	• Consideration for high energy loading • Consideration for future environmental regulation

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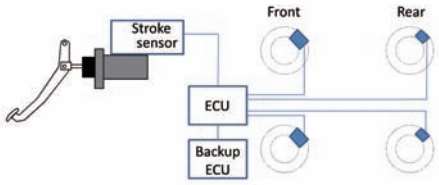
6. Brake component examples

a) Brake apply



- Fluid less brake system is good chemistry with brake by wire for regenerative brake and brake system for auto pilot
- Excellent response can be obtained by electric communication between stroke sensor and corner brake
- Excellent brake feel can be achieved by motor drive stroke sensor
- Backup ECU should be required for ensuring ECU failure

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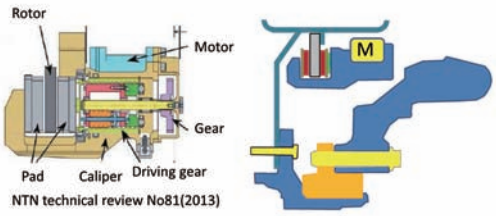
b) Corner brake



NTN technical review No81(2013)

- Smaller size caliper with small pad area
- Enough clearance between pad and rotor to realize non contact.
- EMB have advantage for controlling pad position to eliminate pad contact to rotor in brake off condition
- EMB have stable performance through wider ambient temperature range

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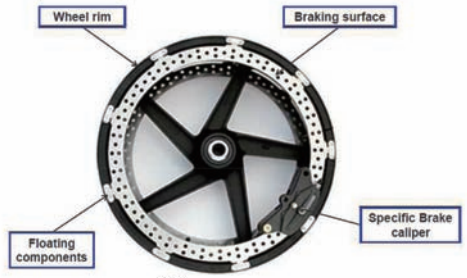
c) Rotor



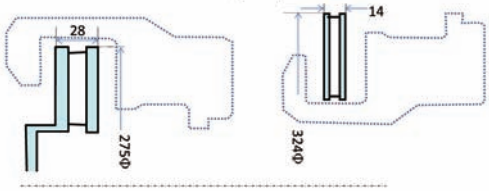
From http://thekneeslider.com/perimeter-disc-brake-rotors

- Larger effective radius can be ensured by perimeter disc.
- Stainless material to prevent rust without surface refreshment

13

Front brake temperature calculation example

- Vehicle specification GVW 2000kg, Fr distribution 0.72
- Brake load condition 100⇒0km/h 4.9m/s2 Interval 640m 20times



- Rotor Specification

	Conventional	Perimeter
Dimension	275x28V(9-10-9)	324x14V(4-6-4)
Surface area	1580cm²	1520cm²
Rubbing part weight	6.4kg	3.1Kg

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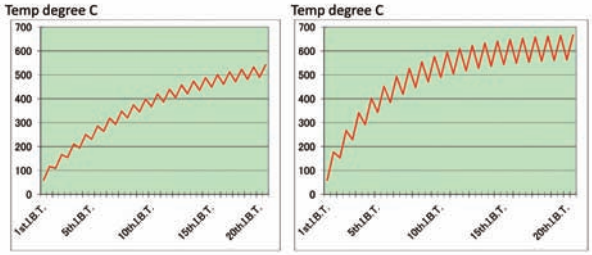

Conventional Rotor Perimeter Rotor

- Rotor weight can be reduced 3kg in this case, if pad allows 200deg. higher final rotor temperature than current resin pad.

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d) Friction materials

Comparison between sinter pad and resin pad

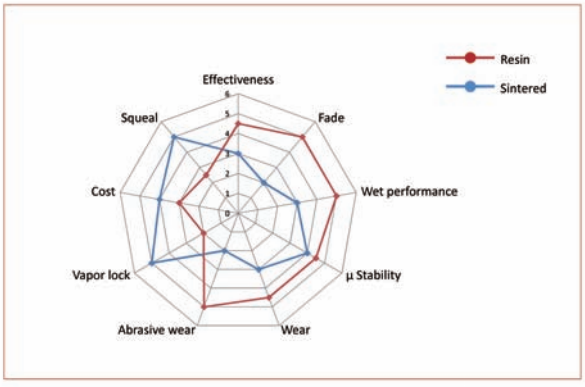
	Resin pad	Sintered pad
		
Base material	Phenol	Metal (copper free)
Heat treatment temp. at manufacturing	130 - 200°C	800 - 900°C
Operating temp. limit	< 300°C	< 800°C
Heat conductivity	0.13 – 0.25 W/m・K	10 – 30 W/m・K

Sintered pad can be used at high temp. compared to resin pad.

Offered by Tungaloy

16

- Characteristics of sinter pad



- Fade test by resin pad and sintered pad

Test conditions

- Inertia : 26.95kg・m²
- Velocity : 100→0km/h
- Fluid pressure : 2.5MPa
- Interval : 640m
- Number of braking : 10times
- Caliper piston area : 11cm²
- Brake rotor : SUS disc, dia. 298mm, t5.0mm
- Brake pad area : 20cm²

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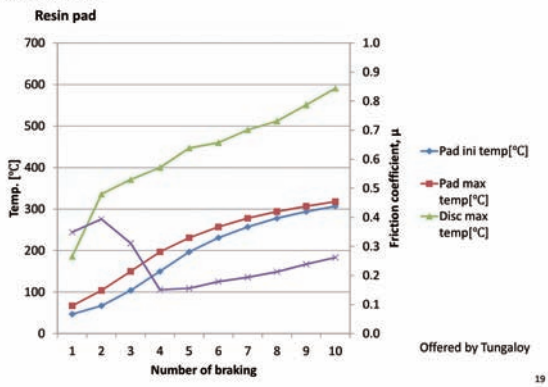
• Fade test result



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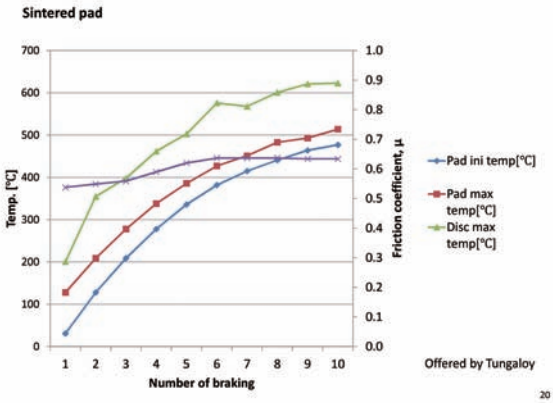

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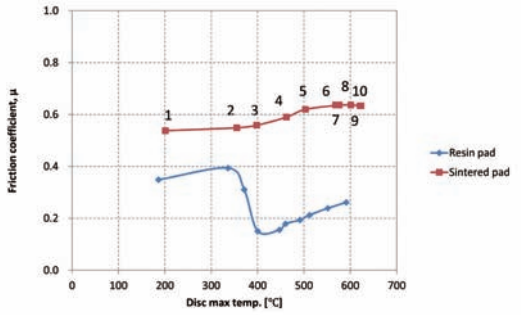

Offered by Tungaloy

• Sintered pad allows 200degree C higher disc temperature compared with resin pad

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7. Brake performance

Performance	Method to achieve the objective	Future study
Effectiveness	• Small EMB with appropriate power • Larger effective radius by perimeter disc • High effectiveness by sintered pad	• Friction materials which has high heat resistance
Brake feel	• Motor drive stroke simulator tuning	• Usage of accelerator pedal for braking
Wear	• Reducing brake load by utilizing regenerative brake	• Minimize brake pad volume
NVH	• Prevention of DTV growth by the clearance between rotor and pad • Squeal elimination by no usage of mechanical brake in lower deceleration	• Brake response at emergency situation • Usage of motor for low speed brake apply
Weight reduction	• Small size EMB, elimination of brake pipe • Thin perimeter rotor	• Cost saving • Utilizing wheel heat capacity
Environment Regulation	• Drag elimination by the clearance between rotor and pad • Elimination of hazardous substance by adopting sintered pad	• Pad and rotor surface refreshment • Conformation for US hazardous substance requirements

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8. Conclusions

- HV and EV vehicles are rapidly increasing and auto pilot is expected to increase.
- The brake system which is considered cooperating with regenerative brake is required.
- Regenerative brake should cover whole normal brake usage.
- Foundation brake should cover high deceleration range including battery full charge and emergency situation.
- Foundation brake can be downsized by using regenerative brake. However, enough brake power for battery full charge and emergency situation should be ensured.
- Therefore, larger effective radius is higher priority than heat capacity.
- EMB with perimeter disc and sinter pad are the solutions for high effectiveness.
- Sintered pad may be one of solution for cover high temperature friction surface by smaller heat capacity from downsizing in battery full charge and emergency situation.
- Current foundation brake issues, wear and DTV growth, can be resolved by utilize regenerative brake.
- The quest of regenerative brake performance is important for designing foundation brake system for foundation, regenerative cooperative brake system

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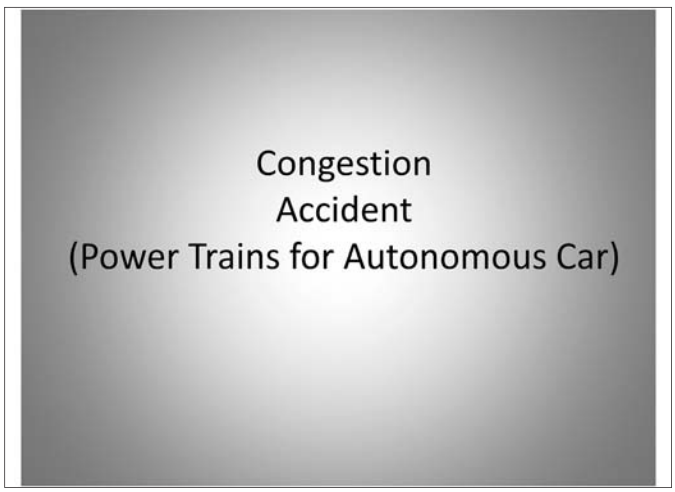
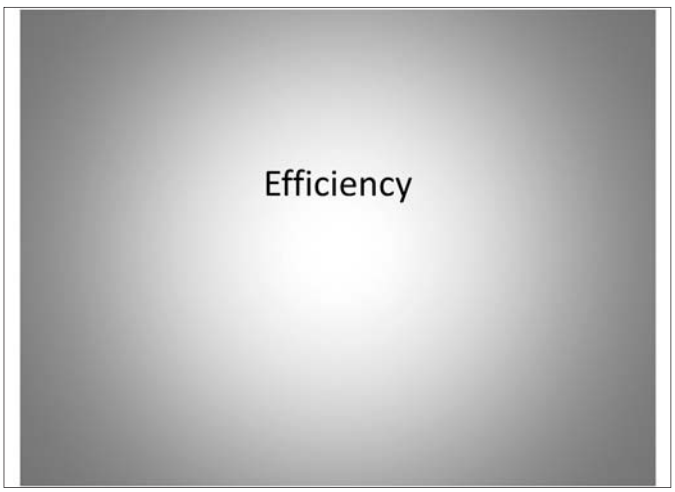
Big Challenges In Future Automobile Power Trains

Tokuta Inoue
Senior Research Fellow, New Industry Creation Hatchery Center, Tohoku University, Japan





Electrification

Complete Different
Power Train Design

Fully Flexible
Power Train Control

Combustion Engine
VS
Fuel Cell

Customer Demands

Thank you for your attention

The Day, "Automobile" becomes Auto-Mobile

Tatsuhiko Yoshimura
Senior partner, GD Cubed Consulting, Japan

The Day, "Automobile" becomes Auto- Mobile

Tatsuhiko Yoshimura
GD Cubed Consulting

Why Automobile is Auto?

- Automobile is called as "Auto", because it move Automatically without hoses at a coach.
- And this type Automobile continues to exist until now.
- We call it as the 1st stage Automobile here.
- Now it is progressing to Auto-Mobile without driver.
- We call it as the 2nd stage Automobile here.

The 2nd stage Automobile is completely different from The 1st stage Automobile

- Currently many engineers are struggling between the extreme 1st stage automobile where a driver is fully assisted by electric systems etc. and the 2nd stage Auto Mobile where a driver doesn't need to drive, so there doesn't need to exist any operating devices.
- The 2nd stage automobile is completely different from the 1st stage automotive.

Misunderstanding

- Recently, "the auto brake system" is advertised like the 2nd stage automobile.
- It is one of brake assisting system, because it needs a brake pedal even now.
- But the advertising information produced misunderstanding for this system that it were automatic system, customers do not need to use brake pedal at any condition.

Which is responsible?

- The 1st stage automobile will progress repeating such confusion.
- Over advertising for effect of new system and misunderstanding by customers, which is wrong & which is responsible?
- It depends on the current state of development of new system.

To prevent customer's misunderstanding

- When 1990s, A car maker made full application of ABS system for all vehicle in Japan.
- At that time they made a special advertising to prevent customer misunderstanding for ABS.
- But currently, in the adverting of many car makers we cannot find such consideration to prevent misunderstanding by customer.
- The assist system will be produced more & more.
- We need such action to prevent misunderstanding by customer.
- Most important point is to share the understanding for difference between "assist" and "auto" clearly.

Can you image to state of the world produced by the 2nd stage Automobile

- Most engineers make effort to produce full assisting system and some of them think the 2nd stage automobile is extension of it.
- But they are completely different.
- I think we need to think about the state of world produced by the 2nd stage automobile more.
- Can you image the automobile on which driver is not exist, any operating devices are not exist , also.
- Can we call such system as automobile?
- Is it happy?

Future must Exist in Past

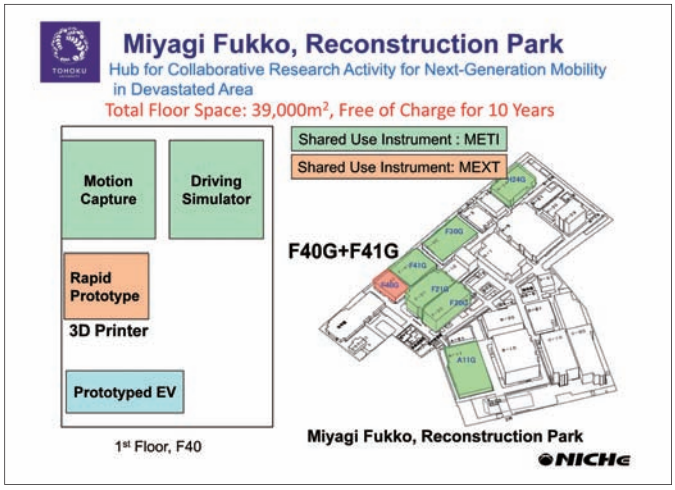
- Formerly. Mr. Fujisawa (Honorary Senior Advisor of Honda) said to Mr. Kume (the 3rd President of Honda Motor)
- "You are searching future hardly, but there is not future. Even though you want to see & find future, you never only see future. You have to look for it in the past.
- When you do it, you can find the key to open the door of your future."
- This is very important words to think about future.

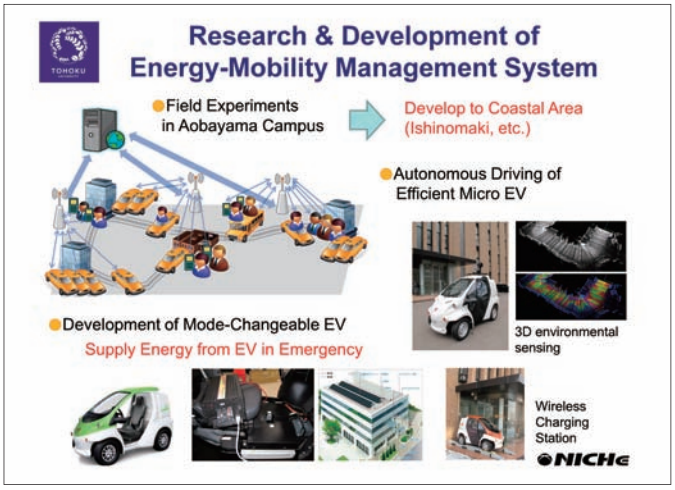
This is only a posing of a Question

- We need to think about the state of the world produced by the 2nd stage automobile more.
- When we do it, we should see past experiences again, for example, the time when the 1st stage automobile was produced.

Next-Generation Advanced Mobility System
- Promotional activities supporting local industries -

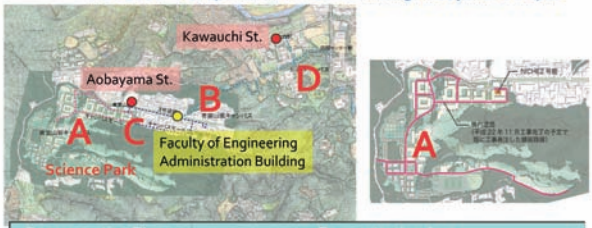
Fumihiko Hasegawa
Professor, Deputy Director, New Industry Creation Hatchery Center, Tohoku University, Japan





Aobayama New Campus & Subway Tozai Line

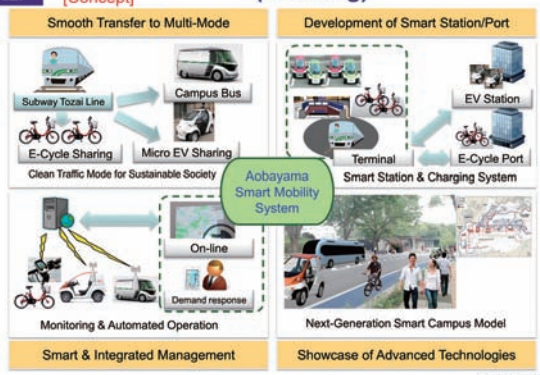
Up to 10 thousands Commuter, Only One Subway Station
No Feeder Transportation in New & Existing Aobayama Campus



Demonstration Phase	Demonstration Area
2013FY ~ Vehicle Development	Campus Mall Zone, Aobayama New Campus (A)
~2015 FY Pilot Study 1	(A) Aobayama, New Campus & East Zone (B) Determine the best way to the Mobility in Aobayama
Pilot Study 2	(C) (D) Aobayama & Kawauchi Stations and Other Campuses

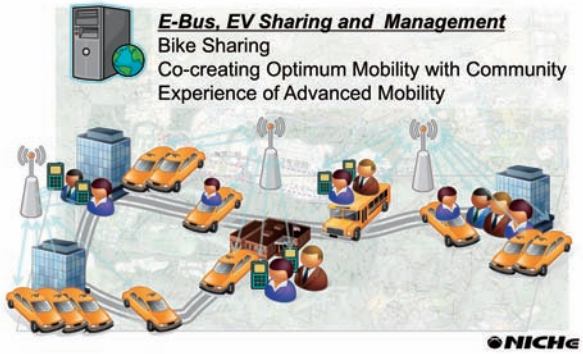
Aobayama Campus Smart Mobility Vision (Planning)

[Concept]



Subway Station: As a Hub for Next Generation Mobility

E-Bus, EV Sharing and Management
Bike Sharing
Co-creating Optimum Mobility with Community
Experience of Advanced Mobility



Automated Car-Sharing Dispatch and Surveillance using Robot Technology

- Development of environment recognition and control technology for autonomous driving on public road
- Development of traffic data collection technology and cooperation with data analysis

<Application example>

- Efficient operation by automation of a part of car-sharing (night-time, closed space)
- Automated surveillance at night or in emergency in campus

Sendai, Miyagi Social Innovation Creation Special Ward

- Reformation Base for Promotion of Woman Activities & Social Business -

<仙台市を取り巻く環境>

近年、女性による起業相談件数が急増

震災後、起業マインドが大きく変化

東北地方は課題先進地域

Promotion of Social Business
- ＮＰＯ法人の設立認証の手続期間を約半分に
- 公証人の定款認証が公証役場外でも可能に
- 起業直後の企業等に雇用ルールを説明して労働関係紛争を未然防止

Promotion of Woman Social Participation
- 地域限定保育士試験の実施により保育士不足を解消
- 都市公園内への保育所設置により待機児童を解消

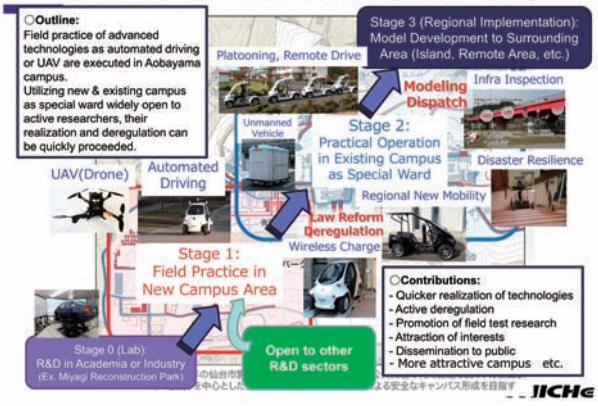
Field Practice of Advanced Technologies

New Innovation Creation by Field Tests of Automated Driving with Tohoku University

2

Advanced Technology Field Practice Special Ward :

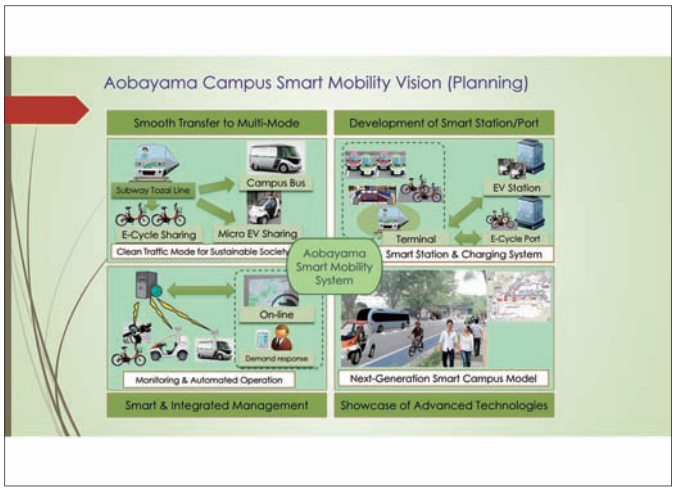
"Creation of Aobayama Campus Next-Generation Advanced Mobility System Practice Field"
=> Authorized as "Sendai Social Innovation Creation Special Ward" (2015)

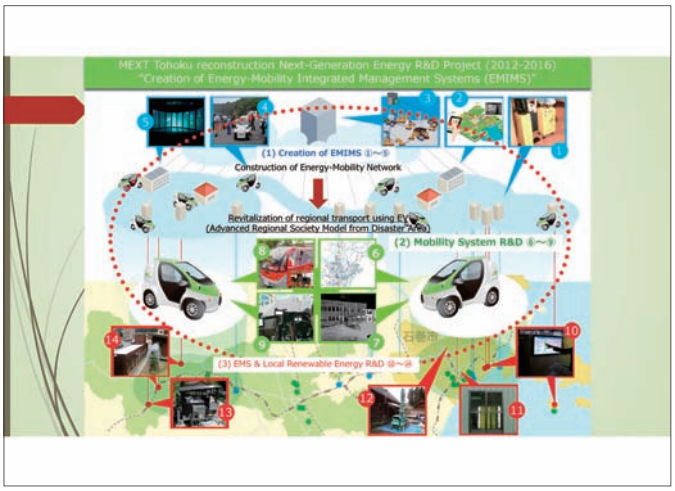


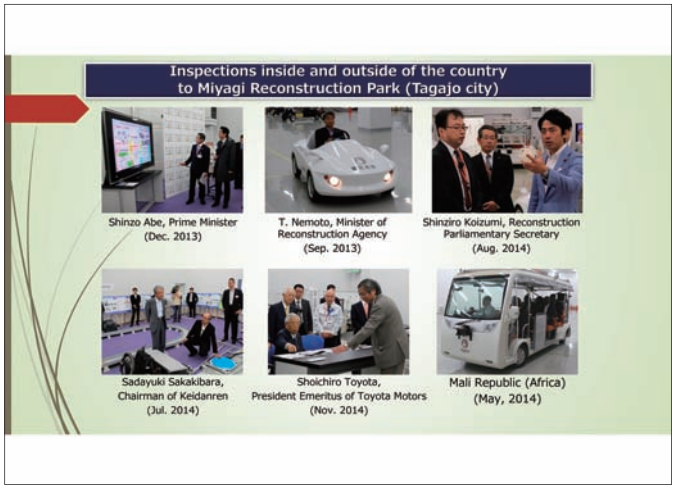
Next-Generation "Regional" Transport using Automated Driving Technology and Special Ward for Field Practice

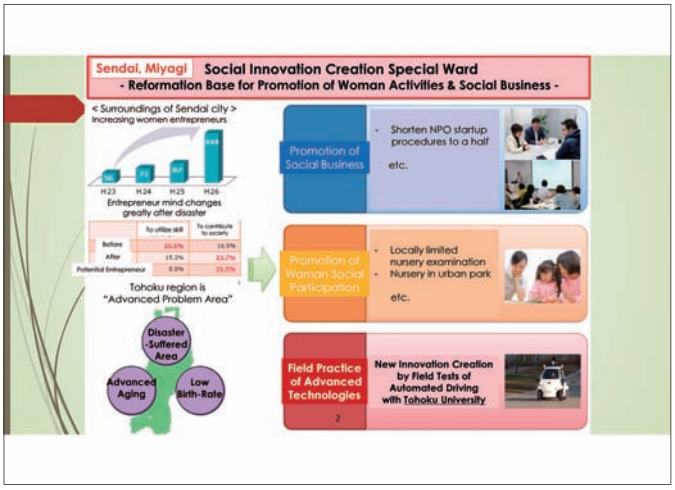
Takahiro Suzuki

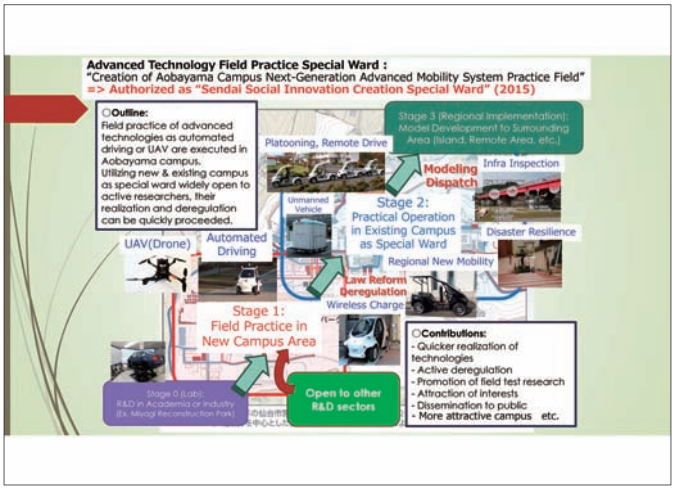
Professor, Deputy Director, New Industry Creation Hatchery Center, Tohoku University, Japan

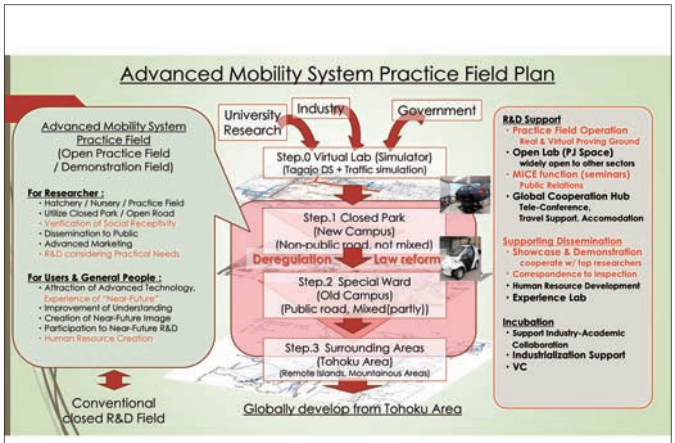




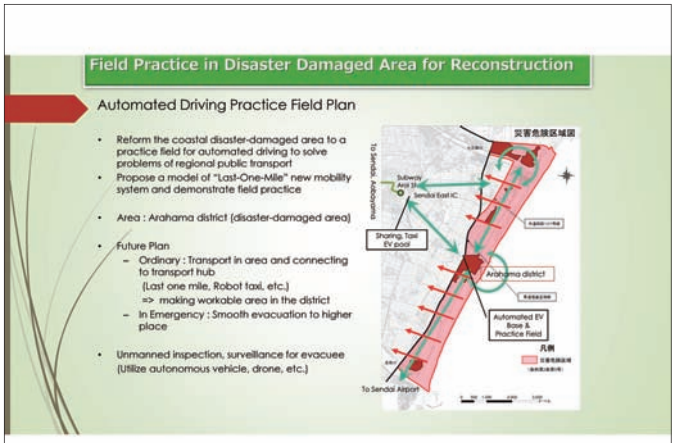




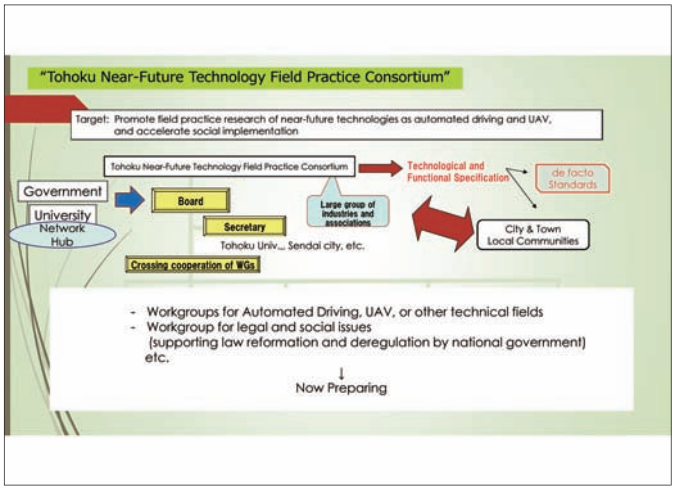

Advanced Technology Field Practice Special Ward :
"Creation of Aobayama Campus Next-Generation Advanced Mobility System Practice Field"
=> Authorized as "Sendai Social Innovation Creation Special Ward" (2015)
○Outline:
Field practice of advanced technologies as automated driving or UAV are executed in Aobayama campus.
Utilizing new & existing campus as special ward widely open to active researchers, their realization and deregulation can be quickly proceeded.
Stage 3 (Regional Implementation): Model Development to Surrounding Area (Island, Remote Area, etc.)
Platooning, Remote Drive
Modeling Dispatch
Infra Inspection
Unmanned Vehicle
Stage 2: Practical Operation in Existing Campus as Special Ward
Disaster Resilience
UAV(Drone)
Automated Driving
Regional New Mobility
Law Reform Deregulation
Wireless Charge
Stage 1: Field Practice in New Campus Area
○Contributions:
- Quicker realization of technologies
- Active deregulation
- Promotion of field test research
- Attraction of interests
- Dissemination to public
- More attractive campus etc.
Stage 0 (Lab): R&D in Academia or Industry (Ex. Miyagi Reconstruction Park)
Open to other R&D sectors


Advanced Mobility System Practice Field Plan
Advanced Mobility System Practice Field
(Open Practice Field / Demonstration Field)
University Research
Industry
Government
Step.0 Virtual Lab (Simulator)
(Tagajo DS + Traffic simulation)
For Researcher :
• Hatchery / Nursery / Practice Field
• Utilize Closed Park / Open Road
• Verification of Social Receptivity
• Dissemination to Public
• Advanced Marketing
• R&D considering Practical Needs
Step.1 Closed Park
(New Campus)
(Non-public road, not mixed)
Deregulation
Law reform
For Users & General People :
• Attraction of Advanced Technology, Experience of "Near-Future"
• Improvement of Understanding
• Creation of Near-Future Image
• Participation to Near-Future R&D
• Human Resource Creation
Step.2 Special Ward
(Old Campus)
(Public road, Mixed(partly))
Step.3 Surrounding Areas
(Tohoku Area)
(Remote Islands, Mountainous Areas)
Conventional closed R&D Field
Globally develop from Tohoku Area
R&D Support
• Practice Field Operation
Real & Virtual Proving Ground
• Open Lab (PJ Space)
widely open to other sectors
• MICE function (seminars)
Public Relations
• Global Cooperation Hub
Tele-Conference,
Travel Support, Accomodation
Supporting Dissemination
• Showcase & Demonstration
cooperate w/ top researchers
• Correspondence to Inspection
• Human Resource Development
• Experience Lab
Incubation
• Support Industry-Academic Collaboration
• Industrialization Support
• VC


Ex. Jeju Global Smart Grid Platform


Field Practice in Disaster Damaged Area for Reconstruction
Automated Driving Practice Field Plan
• Reform the coastal disaster-damaged area to a practice field for automated driving to solve problems of regional public transport
• Propose a model of "Last-One-Mile" new mobility system and demonstrate field practice
• Area : Arahama district (disaster-damaged area)
• Future Plan
– Ordinary : Transport in area and connecting to transport hub
(Last one mile, Robot taxi, etc.)
=> making workable area in the district
– In Emergency : Smooth evacuation to higher place
• Unmanned inspection, surveillance for evacuee (Utilize autonomous vehicle, drone, etc.)
災害危険区域図
Subway
Sendai East IC
Sharing, Taxi EV pool
Arahama district
Automated EV Base & Practice Field
To Sendai Airport


"Car-sharing" to create "community" (in Ishinomaki)
Japan Car-Sharing Association: http://www.japan-csa.org/

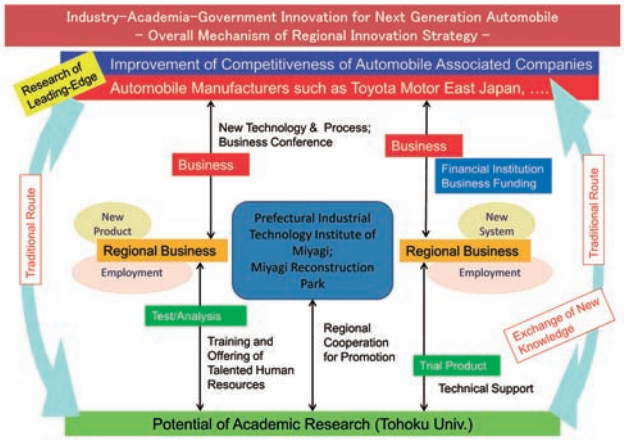

"Tohoku Near-Future Technology Field Practice Consortium"
Target: Promote field practice research of near-future technologies as automated driving and UAV, and accelerate social implementation
Tohoku Near-Future Technology Field Practice Consortium
Technological and Functional Specification
de facto Standards
Government
Board
University Network Hub
Secretary
Large group of industries and associations
Tohoku Univ., Sendai city, etc.
City & Town Local Communities
Crossing cooperation of WGs
- Workgroups for Automated Driving, UAV, or other technical fields
- Workgroup for legal and social issues
(supporting law reformation and deregulation by national government)
etc.
↓
Now Preparing

Global/Local innovations for Next Generation Automobiles Miyagi Area – Project Report

Katsuto Nakatsuka
Project Director, Intelligent Cosmos Research Institute, Japan

Global/Local innovations for Next Generation Automobiles Miyagi Area – Project Report

Katsuto Nakatsuka* and Akira Miyamoto**
*Intelligent Cosmos Research Institute
*new Industry Creation Hatchery Center, Tohoku Univ.



objects

1. human resource development
   - Human resources
     - Researchers, developments and production engineer
     - management personnel(management strategies/educations/business promotions)
2. Constructing strong network of researchers and engineers Network
3. arrangement of conditions for research and technology developments.
4. Research program : Current situation of automobile and main subjects to be considered.

1.Human resource development

Researchers: university professors, assistant professors and development engineers from related companies, graduate school students
Engineers : engineers working as backbones of companies in this area. Teachers of associated educational administrations.
Business managers : university professors of business management, government associated administrative officers.
Business : actions of automobile industry, key technology of automobiles and development trends, seeking for university laboratories inquiry ,
Regional Enterprises Tours, providing, various seminars and trainings.

. Outcome (total participants of 2014)

year	Basic phrase and technological training	Advanced Phase
Participants	408	448

- *57young students participated human resource development program "car intelligent " to learn about car .

2. Constricting researchers and engineers Network

- implementation of workshops and seminars for 54 university professors and researchers as a result 60 engineers of 42 local companies made 50 pairs of partnership between university and local companies

3. arrangement of conditions for research and technology developments.

- Commoditizing research equipment, devices etc. of local institution / university

Implementing agency:	TOHOKU UNIVERSITY	(Industrial technology institute .Miyagi prefectural government
Number of equipment	66	95

- maintain the use enforcement system ,a use procedure and the charging system of equipment and devices.
- usage performance 347 enterprises, 14,224 hrs. (6.2% of total available time 22,800 hrs.)

4.Research Programs

Current situation of automobile and main subjects to be considered.

4-1 Population and amount of passenger cars
Japan
Working-age population : 7,682 million(2010)
Number of passenger cars : 7,298 million(2010)
Spread(%) : 95 %
The whole world
Working-age population : 5.8 billion(assumed by 7.2 billion in 2010)
Number of passenger cars : 1.2 billion
Spread(%) : 20 %

4-1-1 Regulations brought by the progress of the industry and society

In developed countries, the spread of current cars will be plateaued out. The increase of population in developed countries will saturate because birthrate tends to decrease with time. Adding it, the remarkable aging is being observed due to the elongation of people's life time in Japan.

Furthermore, young people tend to concentrate into city area, resulting into an aging society of country area. Aged people thus remained needs a new transportation systems in order to keep their daily activities.

On the other hand, the ownership rate of mobile is still 20% in worldwide scale, conventional mobile will increase continuously in several ten years, depending on the economic growth of the developing countries.

4-1-2 Regulations by the energy resources and environmental problems.

- The finite nature of petroleum resources, especially the depletion of gasoline equivalent fuel is a serious problem, not only from economic view point but also the environmental requirements

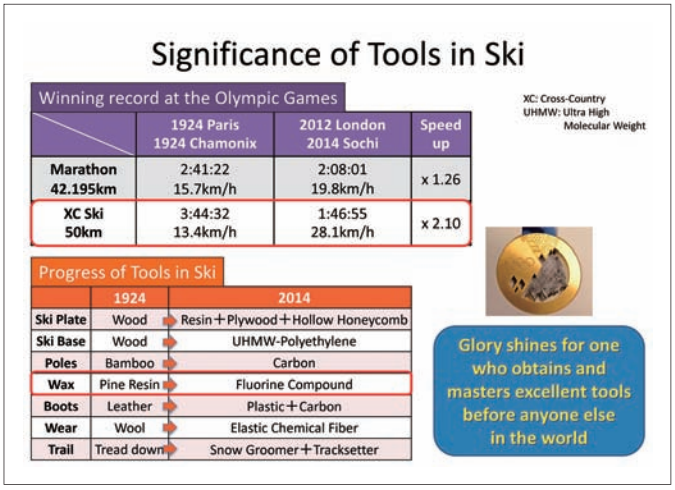
4—2 The direction of the research for the "Next Generation Automobile Research"

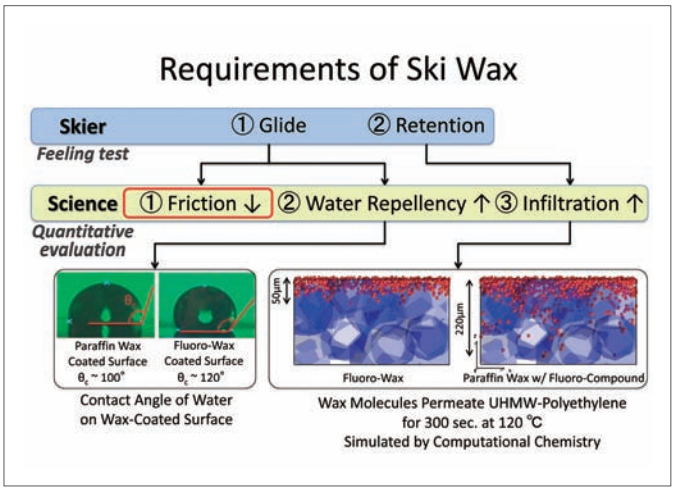
- We do not have any full-fledged oil production in Japan. Still, Japan has kept the commensurate society level for 70 years, owing to the petroleum civilization age supported by the whole world.
- And now at the beginning of the oil depletion era, we have to find some direction of the future of automobile industries which we have long depended on. Its direction will be a realization of highly efficient automobile introducing an alternative energy, actually, the electric energy.
- Lightweight vehicle body, and high performance electric mobile will be important for the use of aged person.
- Instead, the development of environment-friendly diesel-engine will also be essential for the transportation of heavy goods in the future, for reinforcing the present track vehicles.

Measuring Coefficient of Friction in Ski

Naoto Miyamoto

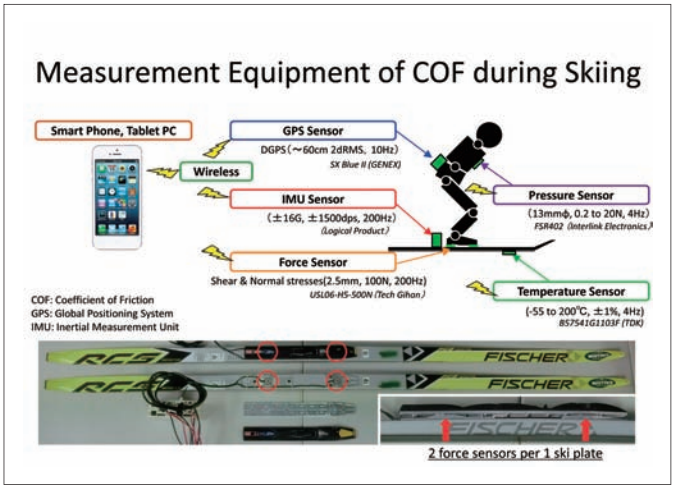
Associate Professor, New Industry Creation Hatchery Center, Tohoku University, Japan





Motivation of Friction Measurement

- Factors that affect wax selection include Temperature, Snow crystals, Humidity, Wind, Course, and Sunshine.
- Currently, national team accompanies a wax expert called "Waxman" who selects race wax from several hundreds of combinations based on the factors.
- But he keeps the wax selection secret, and never leak even to ski player what kind of wax was used.
- Therefore coefficient of friction (COF) of wax has never been subject to systematic research.
- COF can be estimated using sensor fusion, though it is difficult to measure sliding friction directly.
- We have started developing a wearable COF estimator with which ski player does not feel uncomfortable during skiing.

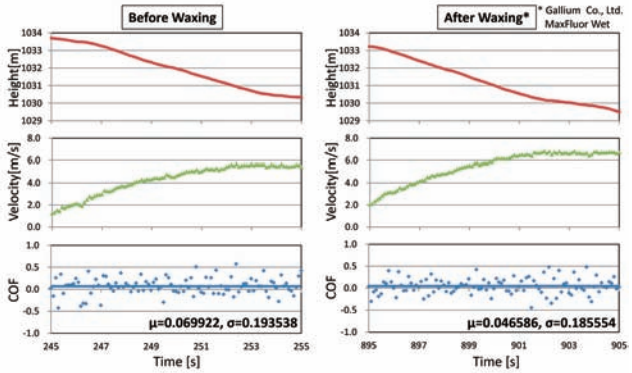


Measurement Condition

Date: 4th Apr. 2015 13:35～14:14
Weather: Fine
Wind Speed: 0～3m/s
Air Temperature: 15℃

Snow Temperature: +0.3℃@Surface,
-0.2 to -0.4℃@5cm Below Surface
Snow Quality: Granulated, Sintered 0.5365g/cc
Skier: Junichi Sato (an expert of wax test)

Measurement Results



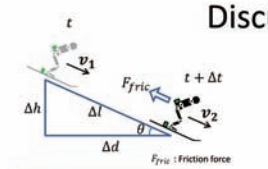
Measurement Results (Cont'd)

* Stored in warehouse for several years　　** MaxFluor Wet (Gallium Co., Ltd.)

	Before Waxing*			After Waxing**		
Test No.	COF	σ	Top Speed [km/h]	COF	σ	Top Speed [km/h]
1st	0.06992	0.19354	7.3620	0.04659	0.18555	8.8200
2nd	0.06768	0.21690	7.8552	0.04766	0.15475	8.9496
3rd	0.06810	0.19163	7.5780	0.04701	0.16135	8.8560
4th	0.06830	0.16676	7.9236	0.04616	0.19038	8.6472
Average	0.06850	0.19221	7.6797	0.04686	0.17301	8.8182
		33%↓			15%↑	

COF is effective because it is more sensitive than speed.
However standard deviation (σ) is not small enough.

Discussion



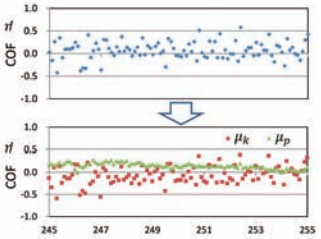
$$mg\Delta h = \frac{1}{2}m\Delta v^2 + F_{fric}\Delta l$$

$$\mu = \mu_k + \mu_p$$

where

$$\mu_k = -\frac{1}{2g\Delta d}\cdot(v_1{}^2 - v_2{}^2) = -\frac{1}{2g\Delta d}\cdot(v_1+v_2)(v_1-v_2)$$

$$\mu_p = \tan\theta$$

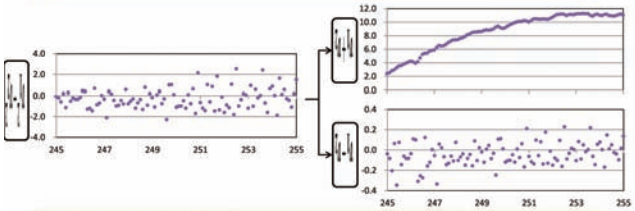


μ_k : COF from kinetic energy
μ_p : COF from potential energy

μ_k is more variable than μ_p

Discussion (Cont'd)

$$\mu_k = -\frac{1}{2g\Delta d}\cdot(v_1{}^2 - v_2{}^2) = -\frac{1}{2g\Delta d}\cdot(v_1+v_2)(v_1-v_2)$$



Variability of COF is due to speed difference $\Delta v = v_1 - v_2$
We have developed more accurate GPS with accelerometer in order to reduce the variability

Conclusion

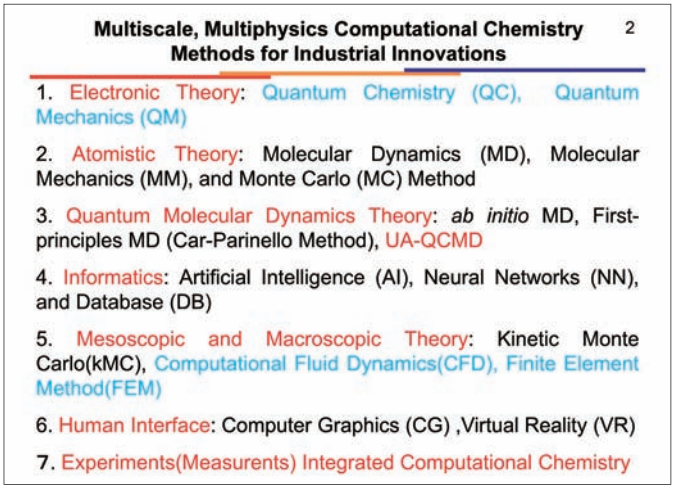
- **Coefficient of friction (COF) is very important in ski**
- **We have successfully measured and estimated COF during skiing**
- **Results show that COF is more than twice as effective as conventional speed test.**
- **Variability in COF estimation is the issue, but we have already developed a solution which we plan to evaluate in this season.**

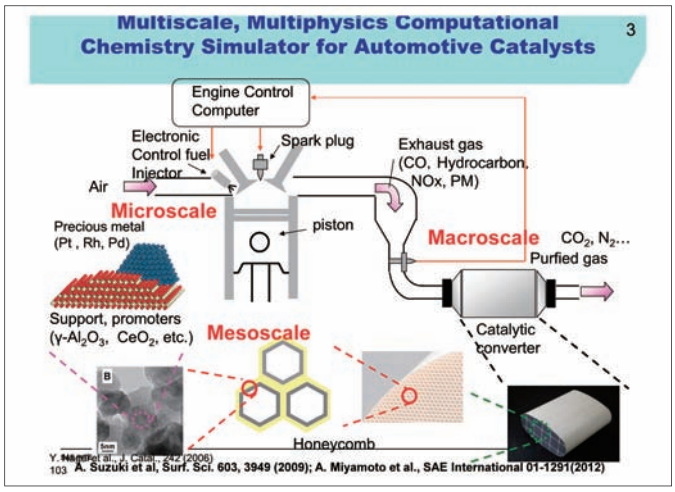
This research is supported by
SIP (Cross-ministerial Strategic Innovation Promotion Program)
Innovative Design/Manufacturing Technologies

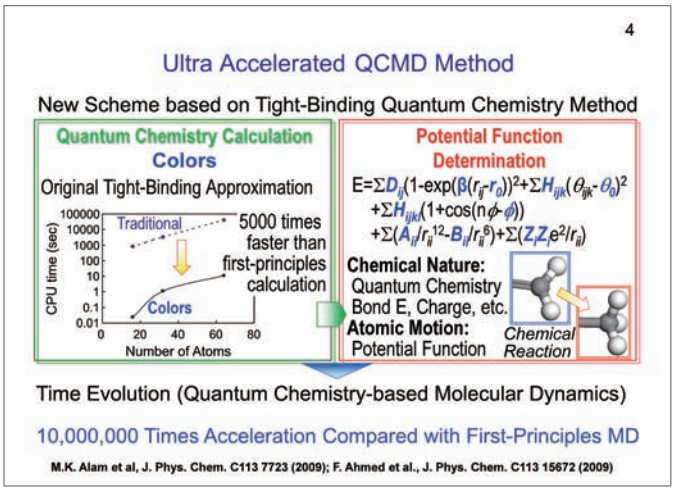
Multiscale, Multiphisics Computational Chemistry Methods for High Performance/Durability Automotive Catalysts

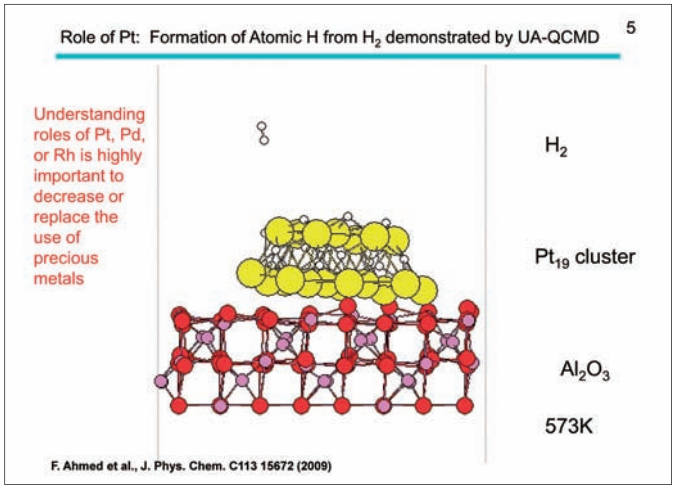
Nozomu Hatakeyama

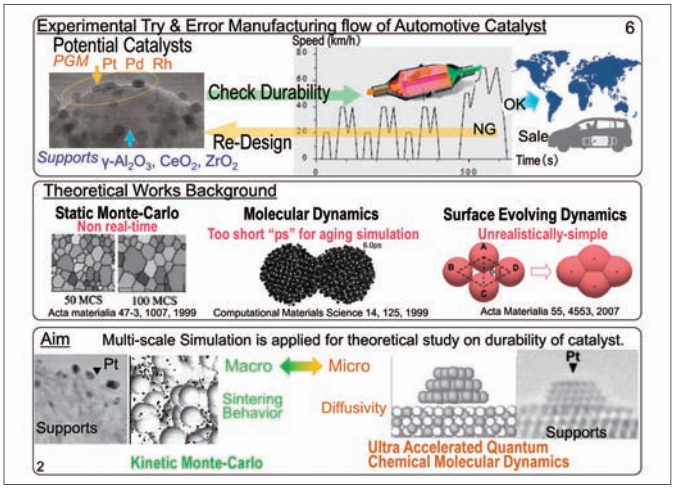
Associate Professor, New Industry Creation Hatchery Center, Tohoku University, Japan











Sintering Simulator of Supported Metals and Supports

7

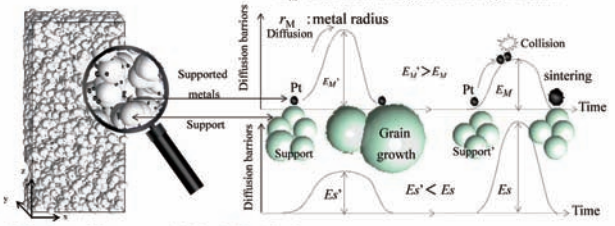
Diffusion of Supported Metals: Pt, Pd, Rh

$$D_M(r) = D_{M0}(2r_M)^{-n}\exp(-\frac{E_M}{RT})$$

D_{M0}: Diffusion coefficient of supported metals

E_M : Activation energy for sintering of metals

r_M : metal radius



Diffusion of Supports: Al_2O_3, ZrO_2, CeO

$$D_S(r) = D_{S0}(2r_S)^{-n}\exp(-\frac{E_S}{RT})$$

D_{S0}: Diffusion coefficient of supports

Es : Activation energy for grain growth of supports

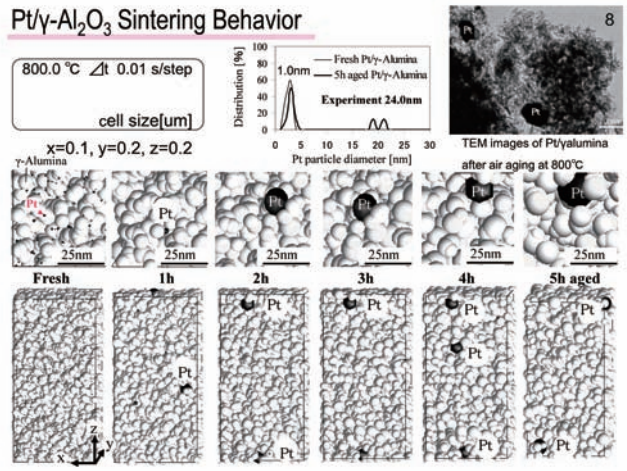
r_S : support radius

n : Grain-size exponent R : Universal gas constant T : Absolute temperature

A. Suzuki et al, Surf. Sci. 603, 3949 (2009); A. Suzuki et al., SAE Int. J. Fuel. Lub. 2(2) (2010)

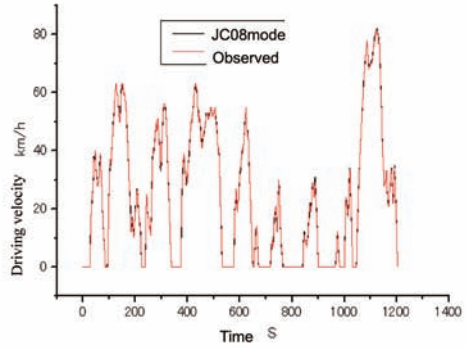
$Pt/\gamma\text{-}Al_2O_3$ Sintering Behavior

8



Chassis Dynamometer Driving Velocity: Comparison between JC08 mode and Observed one

9



Elementary reactions on precious metal

10

Reaction
NO(g)+th_V_Pt → NO(a-Pt)
NO(g)+th_V_Pt ← NO(a-Pt)
O2(g)+2th_V_Pt → 2O(a-Pt)
O2(g)+2th_V_Pt ← 2O(a-Pt)
NO(a-Pt)+O(a-Pt) → NO2(a-Pt)+ th_V_Pt
NO(a-Pt)+O(a-Pt) ← NO2(a-Pt)+ th_V_Pt
CO(a-Pt)+O(a-Pt) → CO2(a-Pt)+th_V_Pt
CO(a-Pt)+O(a-Pt) ← CO2(a-Pt)+th_V_Pt
CO2(g)+th_V_Pt → CO2(a-Pt)
CO2(g)+th_V_Pt ← CO2(a-Pt)
H2O(g)+th_V_Pt → H2O(a-Pt)
H2O(g)+th_V_Pt ← H2O(a-Pt)
C3H6(g)+th_V_Pt → C3H6(a-Pt)
C3H6(g)+th_V_Pt ← C3H6(a-Pt)
C3H6(a-Pt)+9O(a-Pt) → 3CO2(a-Pt)+3H2O(a-Pt)+4th_V_Pt
NO(a-Pt)+th_V_Pt → N(a-Pt)+O(a-Pt)
NO(a-Pt)+th_V_Pt ← N(a-Pt)+O(a-Pt)
NO(a-Pt)+N(a-Pt) → N2(g)+O(a-Pt)+th_V_Pt
2N(a-Pt) → N2(g)
NO(a-Pt)+O(a-Pt) → NO2(a-Pt)+ th_V_Pt
NO2(g)+th_V_Pt ← NO2(a-Pt)

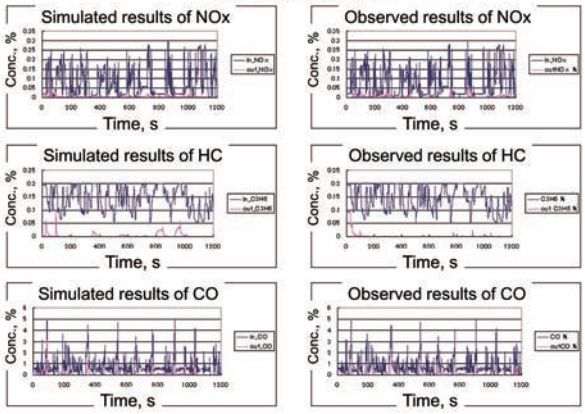
(g) : Gas phase

(a-Pt) : Adsorbed site on Pt

th_V_Pt : Vacant site on Pt

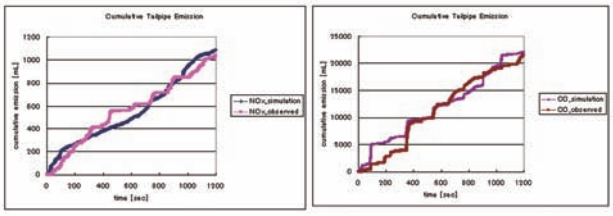
Macroscopic Simulation of Chassis Dynamometer Automotive Catalytic Performance

11



Comparison of Cumulative Tailpipe Emission in the Simulation and the Experiment: NOx and CO

12



Multiscale, Multiphysics Simulator is Effective for the Analysis/Simulation of Chassis Dynamometer Results of Automotive Catalysts

Water sorption in nanoporous silica via molecular simulations

Patrick A. Bonnaud

Assistant Professor, New Industry Creation Hatchery Center, Tohoku University, Japan

Water sorption in nanoporous silica via molecular simulations

P. A. Bonnaud, R. Miura, A. Suzuki, N. Miyamoto, N. Hatakeyama, and A. Miyamoto

New Industry Creation Hatchery Center
Tohoku University – Sendai, Japan

October 27-29, 2015

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Porous Materials in cars

2

Sensors (e.g., ensure an optimum engine combustion)[1,2]

http://www.autoevolution.com

Gas capture (e.g., catalytic converter to reduce greenhouse gas emissions)[1,2]

[1] D. J. Wales et al. *Chem. Soc. Rev.* 44 (2015) 4290
[2] T. Wagner et al. *Chem. Soc. Rev.* 42 (2013) 4036

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Porous Materials Design

3

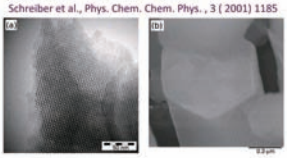
Reduce cost: use cheap and robust porous materials

(e.g., reduce the use of precious, expensive materials (Platinum, Palladium, Rhodium, ...) like in catalytic converters)

Silica (Zeolites, mesoporous silica (e.g., MCM-41, SBA-15))

Transmission Electron Microscopy (TEM) image of MCM-41

Schreiber et al., Phys. Chem. Chem. Phys., 3 (2001) 1185



Hydrophilic materials

Sensor for monitoring the amount of water vapor

Ideal internal combustion in engines:
Hydrocarbons + O_2 → H_2O + CO_2

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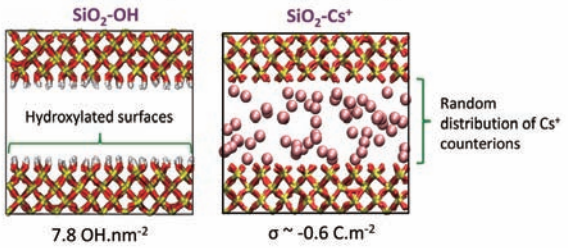
Molecular simulations and models

4

2 molecular models (effect of surface chemistry)



+ Grand canonical Monte Carlo to simulate water sorption isotherms

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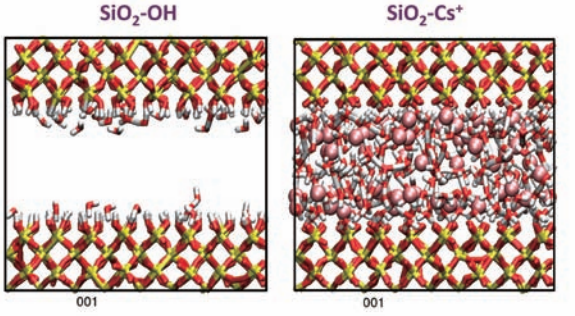
Pictures of water sorption mechanisms

5



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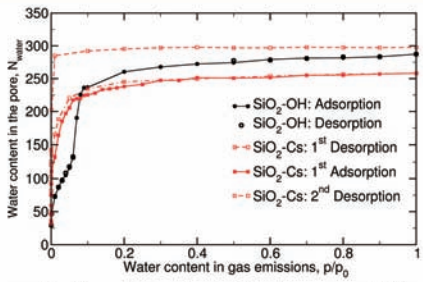
Water sorption isotherms

6



We can relate the water content within the pore with the water content of car gas emissions **(combustion efficiency)**

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Summary

- Nanoporous silica is a good candidate for the design of sensors in car industry
- We explored different surface states (chemistry) in silica nanopores in order to observe the effect on water sorption
- The structure of bi-component confined fluids (water and Cs^+ counterions) affects water sorption properties

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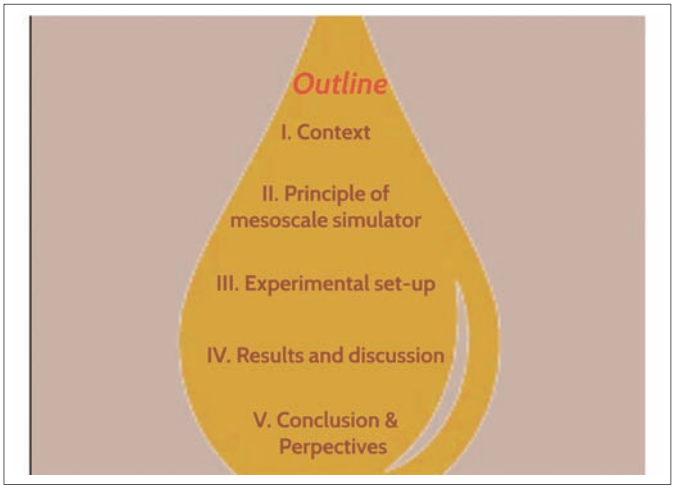
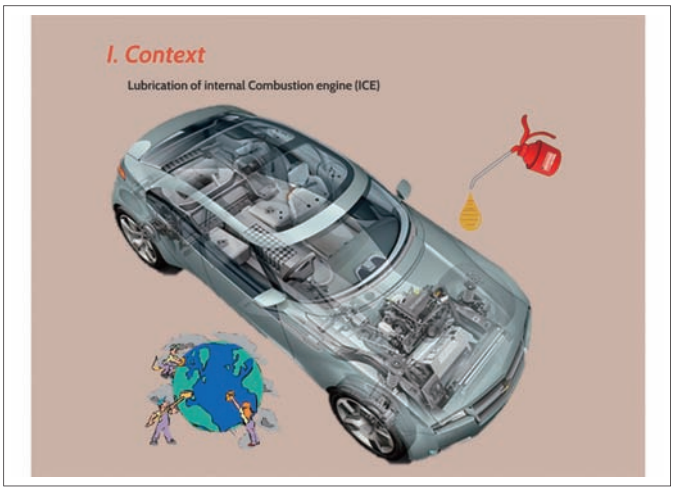
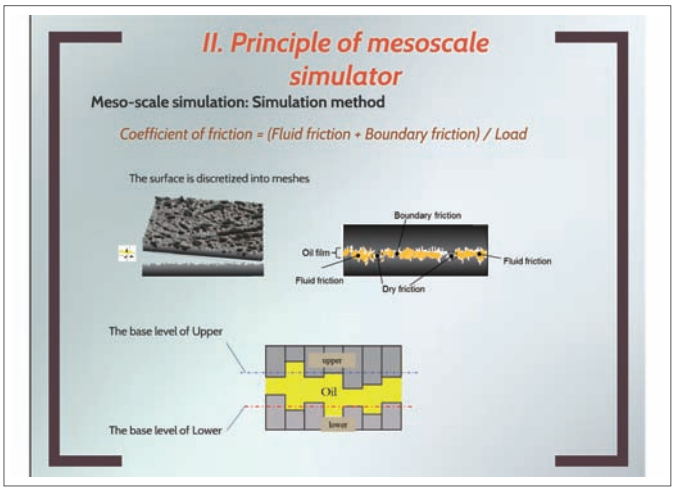
Mesoscale approach to understand tribological behavior of lubricants

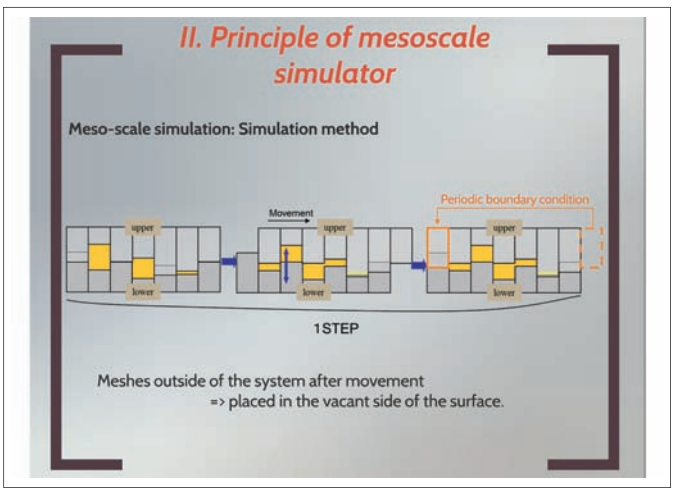
Sophia Berkani

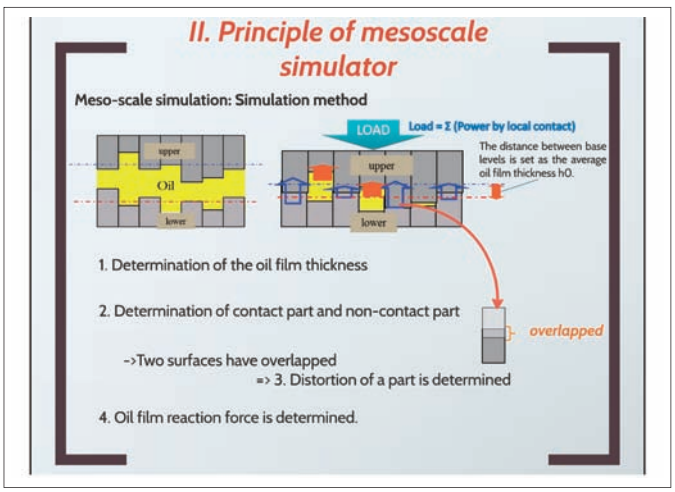
Researcher, Total Marketing & Services, Research Division - Solaize Research Center, France





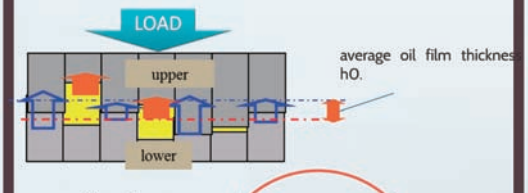






II. Principle of mesoscale simulator

Determination of the oil film thickness (considering the elastic deformation)



$$h_{k,l} = \frac{x_k^2 + y_l^2}{2R} + w_{k,l} + constant$$

$h_{k,l}$: oil film thickness
x, y: Cartesian coordinates
R: Reduced radius

The constant being that the required load is give by the pressures calculated from Reynolds equation (decided by convergent calculation).

II. Principle of mesoscale simulator

Basic Equation Currently Used in the Simulation

The formulas of frictional force

Coefficient of friction = (Fluid friction + Boundary friction) / Load

Non-contact part

Fluid friction:

$F = \eta \cdot U \cdot A / h_0$

η : Coefficient of viscosity
U : Sliding velocity
h_0 : Average film thickness
A : Area of a friction surface

Determination of contact part

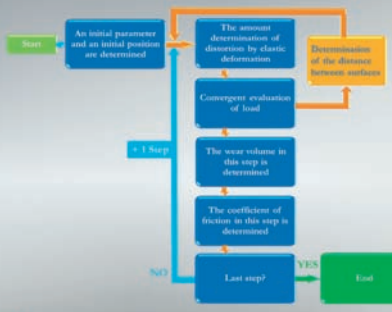
Boundary friction:

$F = A\{\alpha s_m + (1-\alpha)s_t\}$

A : Load burden area
α : The rate which touches directly
s_m : Shearing strength of metal and metal
s_t : Shearing strength of a boundary film

II. Principle of mesoscale simulator

Meso-scale simulation: Simulation algorithm



III. Experimental set up

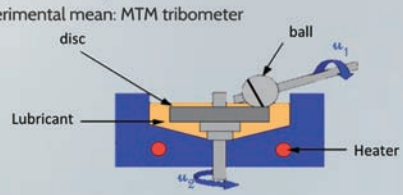
Tribological condition

Conditions

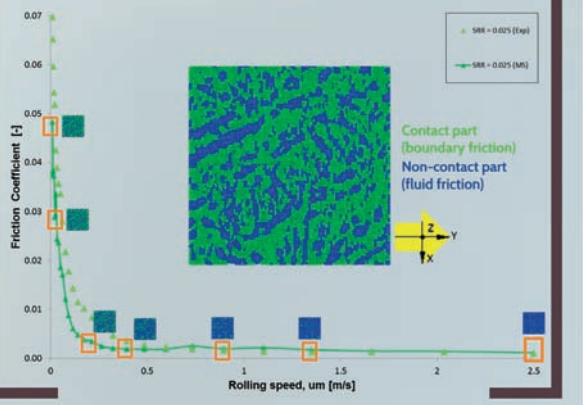
Contact:	Steel/steel AISI 52100
Temperature:	100°C
Oil:	Base oil group III
Normal load:	10 N
Rolling speed:	2500 -> 10 mm/s
SRR:	0.025 to 0.5

Comparative study

Experimental mean: MTM tribometer



IV. Results and discussion



V. Conclusion

- *A simulator on prediction of friction using a meso-scale approach for rough contact, was performed.*
- *The simulator allowed us to approximate the friction response over a large range of shear rates for base oil in good agreement with experimental data at 100 C and for low SRR .*
- *This simulator allowed us to make a link between simulation at meso and macro scale.*

A new concept car for Fun and Health to drive !
as campus commuter, golf cart, land-water cruiser , etc.

Hideomi Koinuma
Visiting Professor, Tokyo University, Japan

次世代自動車シンポ@仙台、10/27-29/15

A new concept car for Fun and Health to drive !
as campus commuter, golf cart, land-water cruiser , etc.

Hideomi Koinuma
Niche, Tohoku University

Questions posed to cars
1, Can we live without car ?
2, What are main problems in currently used cars ?
3, Why is car prevailing in the world and what will be coming as a result ?

Answers to the above questions and possible solutions will be presented and discussed.

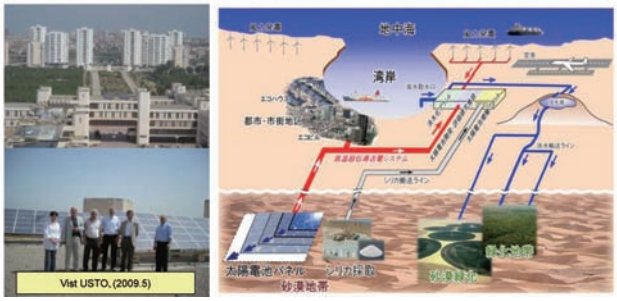
Fun and Health to drive !
New concept cars for campus commuter, golf cart, water fronter, etc.

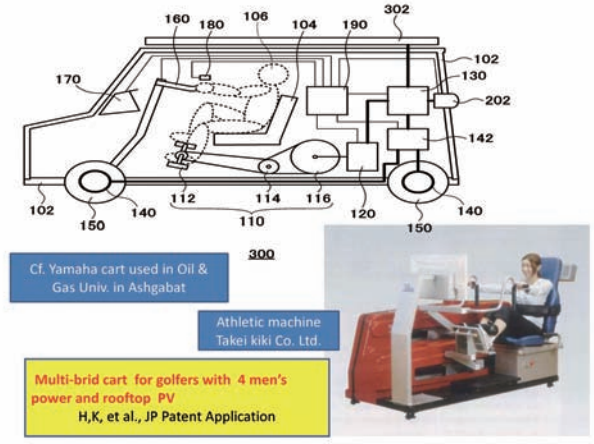
Questions posed to cars
1, Can we live without car ?
2, What are main problems in currently used cars ?
3, Why is car prevailing in the world and what will be coming as a result ?

Answers and solutions:
1) Yes, but not easy
2) Energy and environment--> Fuel cell car or PHEV or else ?,
Safety for drivers and walkers--> Airbag, Autodrive --> Fun to drive ?
3) Free, convenient, status;
Driving is not healthy, Global warming,
Shortage of parts: Battery materials, Rare earth, Rare metals, Rubber

SSERC to make SSB dream come true by cooperation with Asia and Arab
- Not just equipment supply but promotion of science, technology,human resourses

Research in SSERC:
Production of pure silica and SOG-Si
Realization of solar breeder concept
Utilization of solar PV power
Feasibility study on long distance dc transmission by HTSC cable
Education and training of graduate students and young engineers
- Initial sites : USTO, Saida Univ. CDER Adrar)





Multi-brid car (MBC)
** *New concept car equipped with health care and athletic gym function.***

Why ? EV has a serious weak point for deployment in cold local areas, if the air-conditioning, especially heating, is driven by the battery.
What is MBC ? Man power is not so big (100~600 W), but it can help not only battery charging but also warm up his body from inside.
How, who, where, and when ? Install bicycle-type electric power generator at driver's and passengers' seats. People can work and relax as they like under monitoring their health care sensors.
Thus, automobile can be an athletic room, in addition to transportation tool.

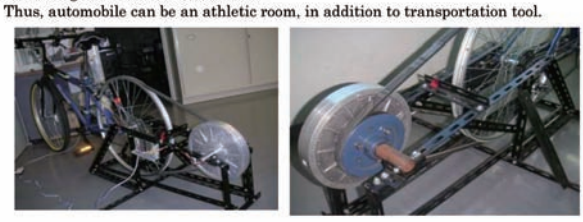
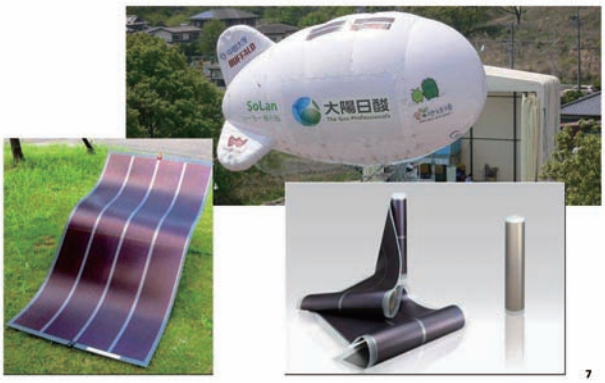


Fig. 1 Bicycle type human power electric generator : 200 ~600 W Prof. Hatta @ Kochi Inst. Tech

Flexible solar cell: PV on plastic film (PI, Pen, etc. or metal foil)



7

Land-Water front leisure EV

Youtube: SSB-"Super Apollo program"

Proposed originally to SCJ in 2007 as an innovation 25 project, forwarded to G8+5 Academies' meetting in Rome, 2009, and initiated as SATREPS –SSERC project in 2010

WMV

YouTubessbPreview_EN.wmv

- Why Si-PV from desert sands ?
- Compare with satellite PV and nuclear power
- Youtube in Japanese and English
- IE^3 Journal: Spectrum, Superconductor News

"Global Apollo program"

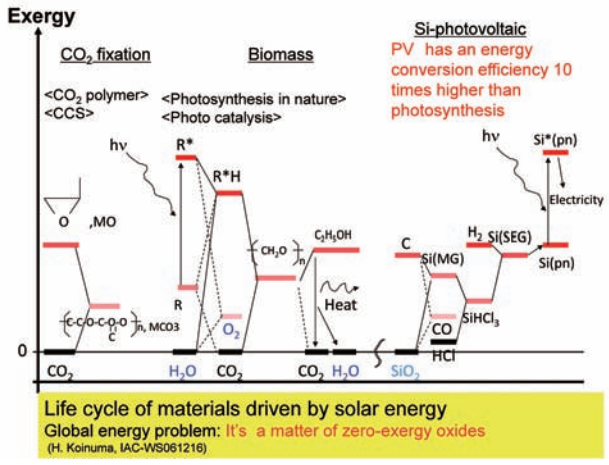
proposed from UK in 2015

- Global Apollo Programme
- **U.K. researchers propose $15 billion for clean energy**
- http://news.sciencemag.org/funding/2015/06/u-k-researchers-propose-15-billion-clean-energy
- A group of high-profile scientists, economists, and business leaders has called on world governments to launch an Apollo space program–style effort to limit climate change to no more than a 2° C rise in temperature above preindustrial levels through more research into carbon-free energy production. Governments that sign on to the proposed Global Apollo Programme, described in a report released today, would commit to spend at least 0.02% of gross domestic product on energy research so that renewable technologies—principally wind and solar—become cheaper than coal in 10 years.
- The report was authored by six members of the U.K. House of Lords, including Astronomer Royal Martin Rees and economist Nicholas Stern, as well as David King, a former U.K. government chief scientific adviser. The effort will require an international commission to avoid duplication of effort and identify bottlenecks in development, the authors note. King told BBC he expects the project to launch in November.
- 0603: **Global Apollo programme seeks to make clean energy cheaper than coal**
- http://www.theguardian.com/environment/2015/jun/02/apollo-programme-for-clean-energy-needed-to-tackle-climate-change

Stem technology initiative

- What happens if the sun stop shinning ?
- What happens when living matters stop their life ?
- Can life be defined only for organic matters ?
- Is exergy concept useful for evaluating and designing the new energy and environment world ?

SSB is our proposal for answering these questions so we could pass the baton to the next generations



Life cycle of materials driven by solar energy

Global energy problem: It's a matter of zero-exergy oxides

(H. Koinuma, IAC-WS061216)

Poster Presentations

Academic Presentation

International Presentation

Industrial Presentation

Academic Presentation
Research and Technology at the Tohoku University

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

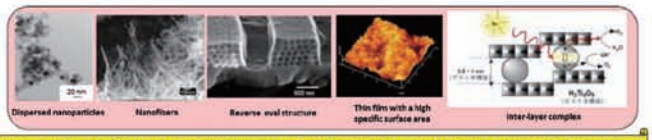
The Development of Innovative Three-way Catalysts via Solvothermal Reactions

Tsugio Sato Lab, Institute of Multidisciplinary Research for Advanced Materials (IMRAM),Tohoku University

MEXT TOHOKU ECONOMIC FEDERATION Tohoku University 宮城県 七十七銀行 ICR

Property improvement of ceramic materials by controlling composition and morphology

- Soft chemical reaction
- Synthesis of functional ceramic materials
- Improving the function of ceramic materials which can contribute to energy saving, environmental conservation and human health



Solvothermal reaction: An effective environmentally friendly soft material synthesis process, which can improve function of ceramics by controlling composition, structure and morphology.

●Challenge
- Improved performance for strict emission regulations and environmental safety
- Reducing the amount of Ce and development of non-ceria catalyst to overcome rising prices of Ce

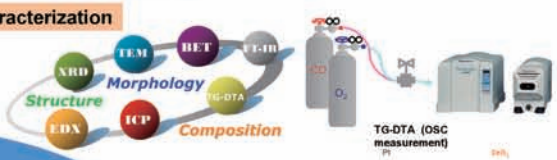
To solve problems ...

Enhance the oxygen storage capacity (OSC) of CeO_2 by controlling composition and morphology → · Improve catalytic performance · Substitute Ce or reduce the using of Ce

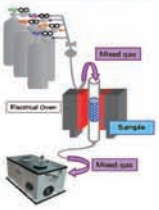
Development of innovative automobile exhaust gas purification catalyst by precisely controlling the morphology and composition

Synthesis

Characterization



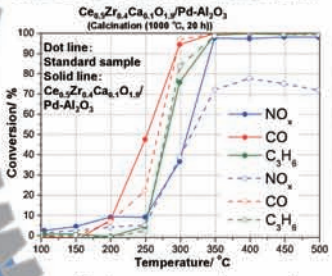
Three-way catalysts (TWCs) performance evaluation



FT-IR (Automobile exhaust gas purification measurement)

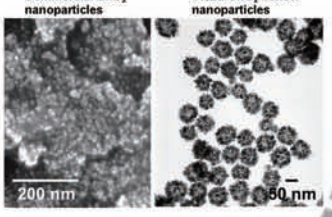
Innovative automobile exhaust gas purification catalysts

Ceria-based catalyst performance evaluation



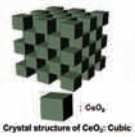
Performance was improved by the composition control !

Non-ceria catalyst performance evaluation



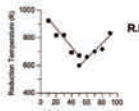
Performance was improved by the morphology control !

Ceria-based automobile exhaust gas purification catalyst— $Ce_{1-x-y}M_xZr_yO_z$



Crystal structure of CeO_2: Cubic Ce^{4+} is small to form the fluorite structure

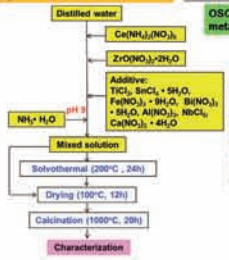
MO_8 oxide ideal $r(M^{n+})/r(O^{2-})=0.732$
CeO_2 $r(M^{n+})/r(O^{2-})=0.703$



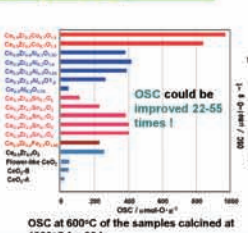
R.D.Monte, J. Alloy Comp., 275-277, 877 (1998).

Ion	8 coordination ionic radius (nm)	Ion	8 coordination ionic radius (nm)
Ce^{4+}	0.097	Tl^{3+}	0.067
Zr^{4+}	0.084	Sn^{4+}	0.077
Ca^{2+}	0.112	Nb^{5+}	0.071
Fe^{3+}	0.072	Bi^{3+}	0.071
Fe^{2+}	0.087	Co^{3+}	0.068
Al^{3+}	0.059	Co^{2+}	0.083

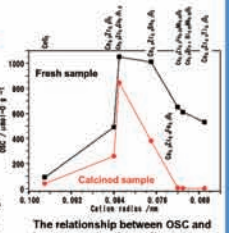
Synthesis of ceria-based solid solution



OSC can be improved by co-doping of small metal ions (< radius of Zr^{4+})



OSC at 600°C of the samples calcined at 1000°C for 20 h

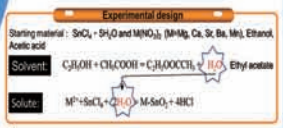


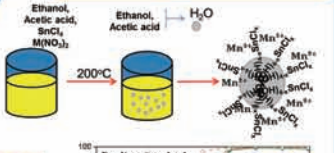
The relationship between OSC and incorporated cation radius

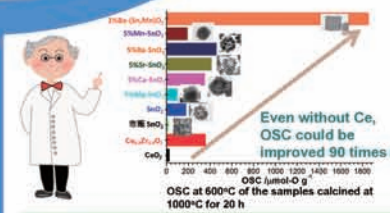
Oxygen storage capacity (OSC) of CeO_2, could be improve 22 times by co-doping Zr and Sn into CeO_2, which is a well know automotive co-catalytic material. It was possible to reduce the consumption of Ce more than 30%.

Q. Dong, S. Yin, T. Sato, *Chem. Lett.*, 41, 12501252 (2012); *RSC Adv.* 2, 12770 (2012); Catalysis Sci & Tech, 2, 2521 (2012).

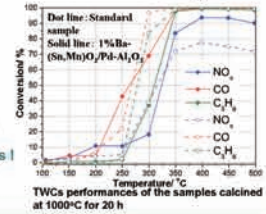
Non-ceria automobile exhaust gas purification catalyst— M-SnO_2







OSC at 600°C of the samples calcined at 1000°C for 20 h



TWCs performances of the samples calcined at 1000°C for 20 h

Message to Company

Innovative automotive exhaust gas purification catalysts were developed using general-purpose elements. The preparation of new material that can reduce or completely substitute rare element Ce can be expected. We are very interesting in research cooperation with company !

Katahira 2-1-1, Aoba-ku, Sendai 980-8577 TEL&FAX: 022-217-5597 / E-mail: tsusato@tagen.tohoku.ac.jp

Professor
Tsugio SATO

Associate professor
Shu YIN

Assistant professor
Qiang DONG

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

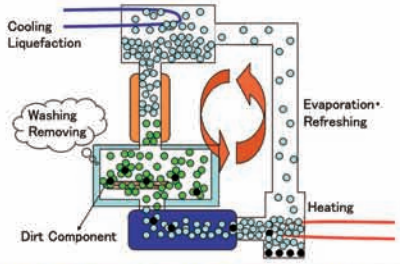
Supercritical Fluid Technology

—Cleaning, Functional material preparation—

Research Center of Supercritical Fluid Technology,
Tohoku university, Graduate School of Engineering

MEXT | TOHOKU ECONOMIC FEDERATION | Tohoku University | 宮城県 | 七十七銀行 | ICR

Cleaning& Drying using SC-CO_2



Utilization of large density change with temperature gradient

Pump-less, Thermal Circulation & Solvent refreshing

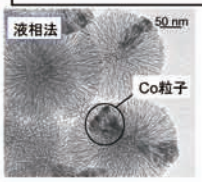
No drying process
No solvent remaining
Applicable to
- water-prohibit materials
- Very fine structured materials
- Hybrid materials

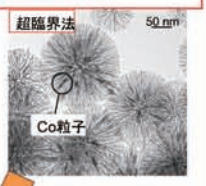
Ex; *Cloth Dry cleaning,*
Fine metal devices
HEPA Filters, etc

Catalyst Preparation by Supercritical Fluid

Previous Works : Metal Doping on Porous Silica

	Liquid Solvent	SCF Solvent
Diffusion	Low	High
Surface tension	High	Low
Penetration	Low	High
Drying	Aggregation	No need





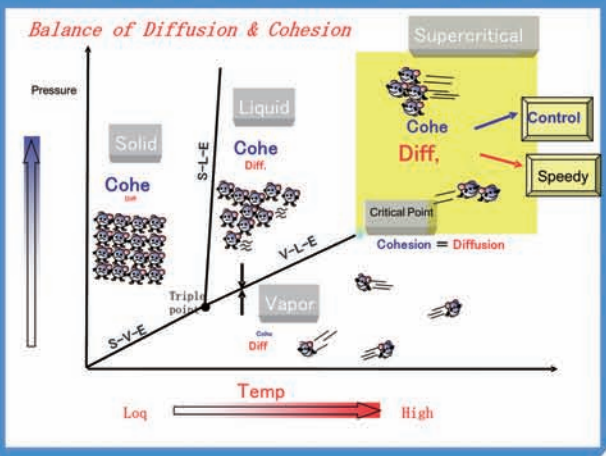
Efficient Utilization of micro pores
High dispersion of metal particles

High Penetration Ability

Particles Aggregation Control during Drying Process

Specific Feature of SCF
High diffusivity,
Low surface tension & viscosity

Dissolve Metal Complex, Penetrate into porous media



Prediction of Adsorption in Porous Materials

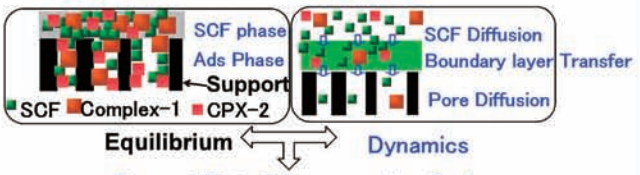
Catalyst Preparation by SCF

Precursor Dissolution
→ Adsorption on Support →Calcine

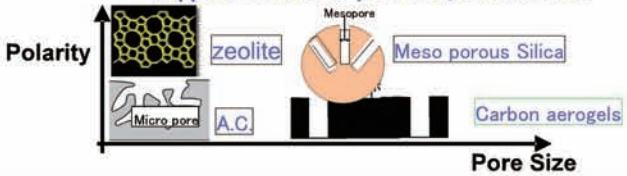
For Designing・

Adsorption Behavior Prediction
- Equilibrium
- Dynamics (adsorption/desorption rate)

Development of Prediction Methodology for equilibrium, dynamics and support materials



Support Materials: *pore size, Surface area*



Applying to Automobile Exhaust -Rh/CeO_2-

CeO_2・・・
Oxygen Storage Capacity
→ Doping Precious Metal
→ Increasing OSC value

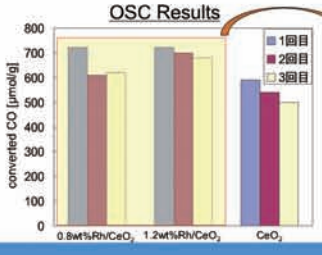
Preparation of Rh/CeO_2 by SCF doping
↓
Test its OSC performance

TEM Observation

EDX showing the existence of Rh
But, TEM cannot detect Rh particles

Highly dispersion of very small Rh particles ??

OSC Results



Rh Doping increases OSC

Rh-Support Interaction plays am importance role

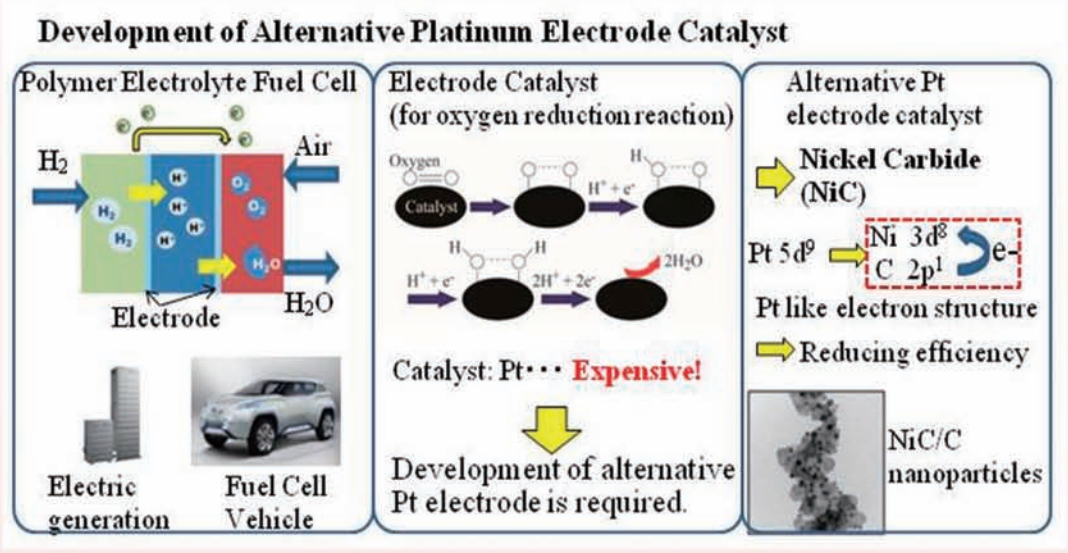
Extending this method to Other metals on CeO_2-Al_2O_3

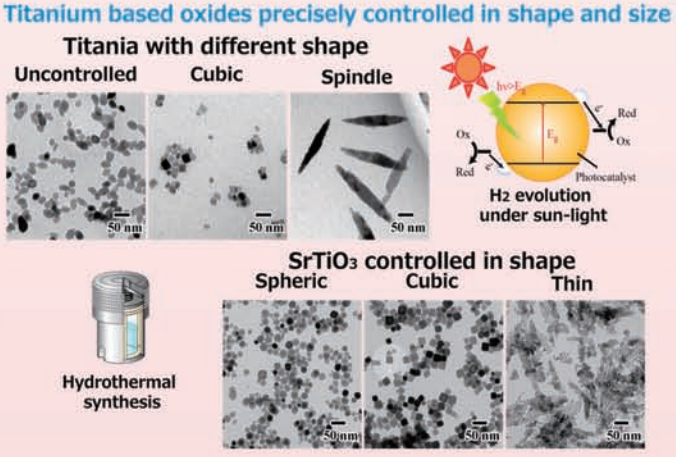
Synthesis of Hybrid Nano-Particles and Application to Functional Materials

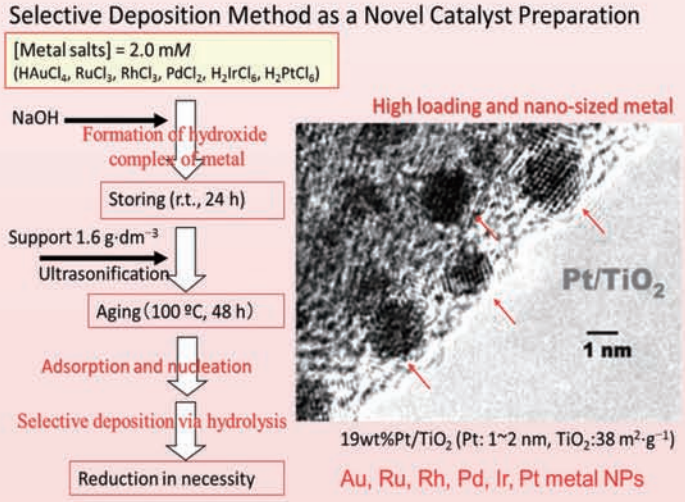
Institute of Multidisciplinary Research for Advanced Materials, Tohoku Univ.

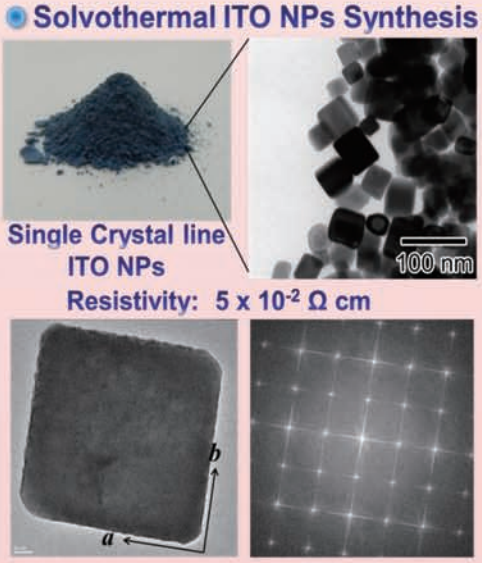
Muramatsu Laboratory

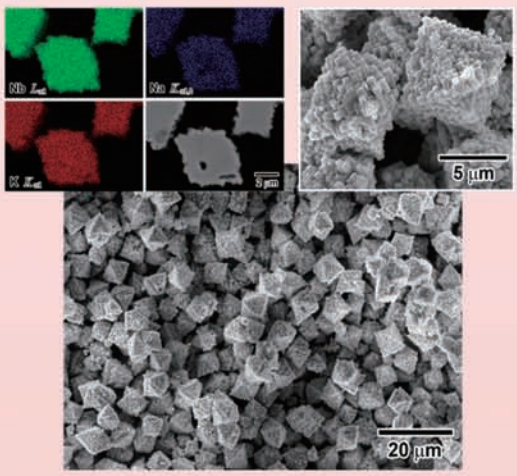
mura@tagen.tohoku.ac.jp











Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

Fabrication and OSC Property of Oriented Fe-based Complex Oxide Grains by Microwave Irradiation

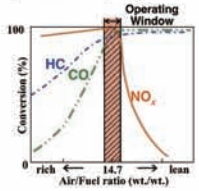
○T. Nakajima, J. Fukushima, Y. Hayashi, H. Takizawa
Graduate School of Engineering, Tohoku University

MEXT | TOHOKU ECONOMIC FEDERATION | Tohoku University | 宮城県 | 七十七銀行 | ICR

1. Research Background

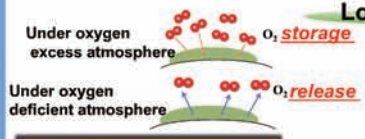
TWC : Three-Way Catalyst and Promoter

Three-way catalysts (TWCs) remove the pollutants such as carbon monoxide (CO), nitrogen oxide (NO_x), and hydro carbons (HC_s) in automobile exhaust gas.



It is absolutely imperative to *suppress the air to fuel ratio* in order to remove the pollutants efficiently.

problem
Expensive precious
Low OSC property under 500˚C



Requirements
- Rare earth free OSC materials
- High OSC performance under 500˚C

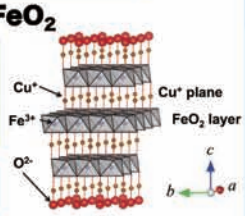
2. Research Target and Method

Delafossite-type $CuFeO_2$

- Composition of Cu^+ and Fe^{3+} without rare earth element
- Oxygen storage/release behavior start in low temperature ranges

Space group : *R3c* layered structure

$CuFeO_2 + \delta/2O_2 \longrightarrow CuFeO_{2+\delta}$



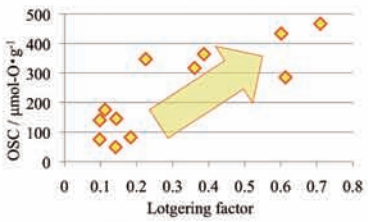
Crystal structure of delafossite-type $CuFeO_2$

Experimental condition
Temperature : 500～1000 ˚C
Time : 10 min
Atmosphere : N_2 or Air
☆ comparison : electric furnace

Starting materials
Cu_2O, γ-Fe_2O_3
↓
Grinding・Pelletization
↓
2.45 GHz Microwave Irradiation
↓
Characterization

Expectative effect...
Promotion of *anisotropic grain growth*
↓
Influence OSC property

OSC measurement at 500˚C



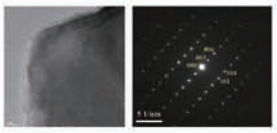
Maximum OSC value : 466 μmol-O/g

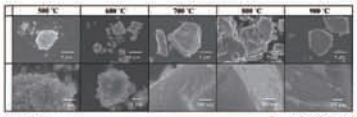
Phase stability and OSC rate during oxygen uptake-release behavior was promoted

Anisotropic $CuFeO_2$ synthesized by microwave irradiation shows high OSC value as compared to conventional heating samples.

3. Results

TEM and SEM observation

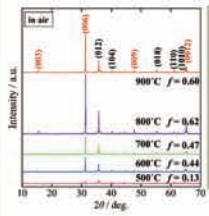




isotropic → *anisotropic*

$CuFeO_2$ grains have *layered structure* when prepared at high temperature.

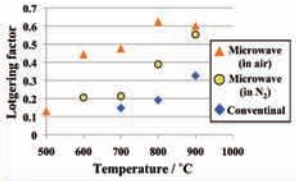
XRD analysis



The degree of orientation, *f*, calculated from equation (1)

$$f = \frac{P - P_0}{1 - P_0} \quad (1)$$

f : Lotgering Factor
$P : \sum I_{(00l)} / I_{(hkl)}$
P_0 : *P* value of oriented sample for randomly
Non-orientation $f = 0$
Complete orientation $f = 1$



Microwave heating promoted *anisotropic grain growth*.

4. Discussion

Anisotropic grain growth

The cause of anisotropic grain growth by microwave processing
↓
difference of *microwave penetration depth*

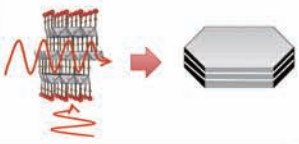
The depth of microwave penetration

$$\delta = \frac{1}{\sqrt{\pi f \mu \sigma}}$$

f : Frequency of microwave [GHz]
μ : Magnetic permeability [H・m-1]
σ : Electrical conductivity [S・m]

Mechanism of anisotropic grain growth

	Penetration depth
c-axis	Shallow
ab-plane	Deep



5. Conclusion

☆ Microwave heating promoted *anisotropic grain growth* based on intrinsic layered structure.

☆ Anisotropic $CuFeO_2$ samples synthesized by microwave irradiation show *high OSC value*.

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Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

New catalyst for automobile using organic-inorganic Hybrid nanoparticles

New Industry Creation Hatchery Center, Tohoku University
Adschiri laboratory

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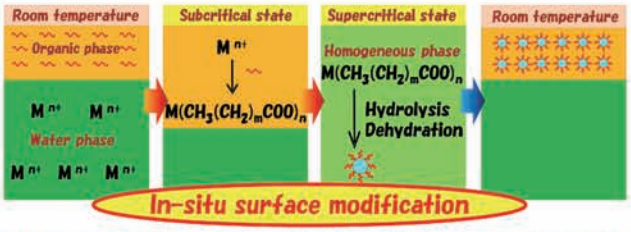
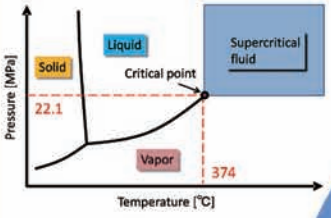
What is supercritical fluid?



We can create nanoparticle and modify organic molecules on the surface simultaneously



Supercritical fluid has gas like diffusibility and liquid like solubility

How to create nanoparticle?

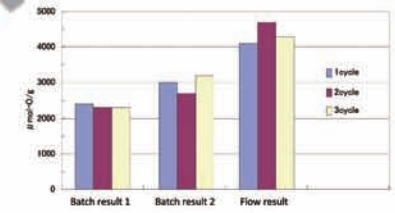
Determination of reaction temperature, pressure, pH condition etc. by batch type reactor

Create nanoparticle continuously by flow type

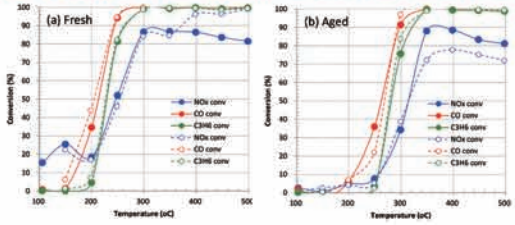
10t/year
Substantiation instrument (Momi-cho GIGA)

Middle type instrument (Momi-cho)

Table type compact instrument (Momi-cho mini)

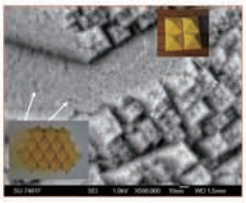


OSC results by Zirconium – Iron nanoparticles

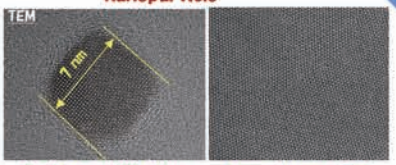


Results of the conversion of exhaust gases

Filled circle: new nanoparticle
Open circle: CeO_2 conventional catalyst



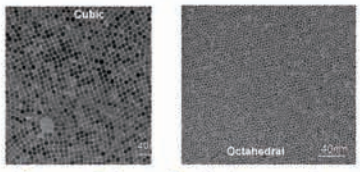
We can control the structure of nanoparticle



Surface modification nanoparticle

mono-dispose CeO_2 nanoparticle

Increase modifier concentration

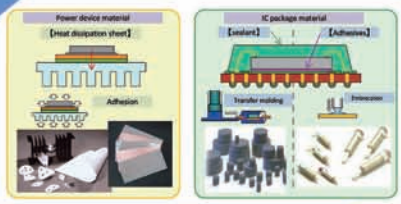


No surface modification CeO_2 nanoparticle (in water)

Surface modification CeO_2 nanoparticle hexane)

Nano particle can dissolved in several organic solvent if we use organic agent which has different type of functional group

Example of creation nanoparticles



How to use nanoparticle for Automobiles

Message

- Let's create a new material of a car using nanoparticle -

In Adschiri laboratory, we are investigating new material using the hybrid organic-inorganic nanoparticle.

Please contact us, if you are interest.

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

Synthesis of Ceria Nanoparticle-Assembled Hollow Mesoporous Silica Composite Particles

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konno@mickey.che.tohoku.ac.jp, ishii@mickey.che.tohoku.ac.jp

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Introduction

Nanoparticles
- (positive) High catalytic activity derived from nano-size effect
- (negative) Low thermal stability, Aggregates and Sintering

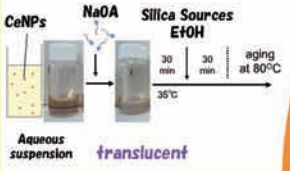
Assembling of Nanoparticles
- Novel properties different from nanoparticle itself
- Higher catalytic activity

This Study
- Silica coating of nanoparticle assembly
- Catalytic evaluation of obtained particles for automotive three-way catalyst

Methods

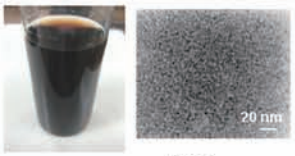
Ceria nanoparticles (CeNPs)
- Aqueous precipitation of a cerium salt in the presence of trisodium citrate

Particle synthesis
- mixing of sodium oleate (NaOA) with CeNPs, followed by addition of silica sources



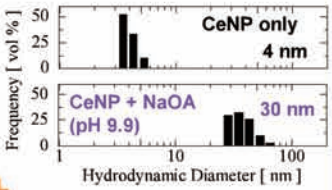
Self-assembly formation in CeNP-NaOA suspensions

Characterizations of CeNP



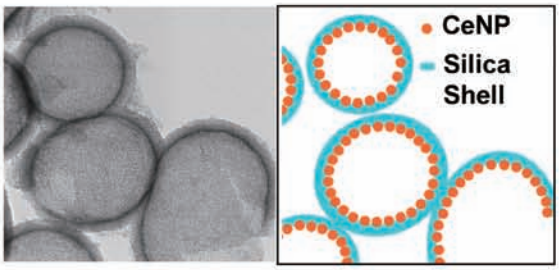
-Well-dispersed suspension
-Particle size: 3 ± 0.3 nm
-Fluorite structure (determined by X-ray diffraction)

DLS measurements of CeNP-NaOA suspensions



-Dispersion size increased after NaOA addition (pH 9.9).
-A self-assembly can form in the CeNP-NaOA suspensions at pH below 10.
- There was no change in the dispersion size at pH more than 10.

As-synthesized particles contain
-Hollow assembly of ceria nanoparticles
-Mesoporous silica shell

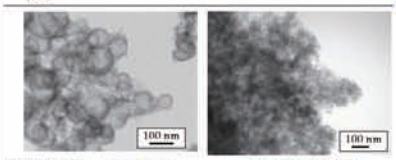


H. Ishii *et al.*, *Colloids and Surfaces A, in press.*

Applications
- Automotive three-way catalyst
- Catalyst for CO oxidation

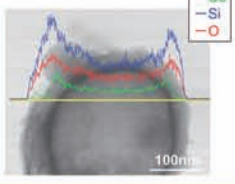
Particle Syntheses & Characterizations

TEM images of obtained samples



-Particle shapes were obtained in the CeNP-NaOA suspension at pH 9.9, whereas aggregates formed in that at pH 10.7.
-Self-assembly formed in the suspension is key for the particle formation.

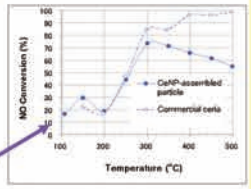
EDX analyses



-The distributions of Ce and Si corresponded to the thin layer of black dots and the light gray outer shell, respectively.
-On the particle surface, peaks of the three elements were observed. → Hollow structure
-After calcination, the particle had meso-pore and CeNPs inside particle had same crystalline size as that in CeNPs as before.

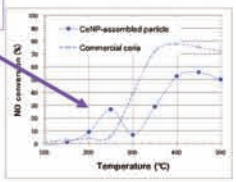
Catalytic activities

Fresh Sample



Effect of nano-size? or nanoparticle assembly?

Aging at 1000 ℃ for 20 h



Three Way Catalyst
Ceria + γ-alumina with 2.5 % palladium (Pd)
(mixing weight ratio: 1:2)

Reaction Gas
Mixed gas with similar composition to exhaust gas.

Conclusion

-A catalytic particles that contain hollow assembly of ceria nanoparticles with mesoporous silica shell were obtained in aqueous synthesis with sodium oleate.
-The uses of nanoparticles and nanoparticle assembly can be effective for improving catalytic activity.

Prof. Mikio Konno

Associate Prof. Daisuke Nagao

Assistant Prof. Haruyuki Ishii

Konno Laboratory Members

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

Catalysis for conversion of next-generation resources

Keiichi Tomishige
Department of Applied Chemistry, School of Engineering, Tohoku University

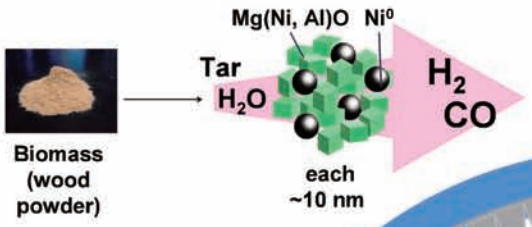
MEXT TOHOKU ECONOMIC FEDERATION Tohoku University 宮城県 七十七銀行 ICR

Production of syngas from biomass

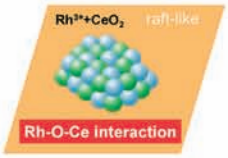
Biomass + O_2 or H_2O → H_2 + CO

Combination with FT synthesis accomplishes BTL (Biomass To Liquid) process.

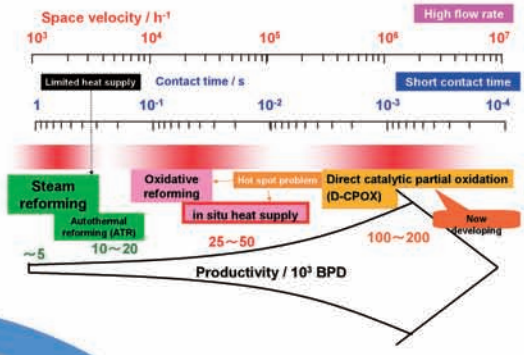
Ni-oxide nanocomposite catalysts



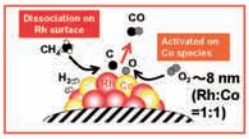
Rh-CeO_2 interface



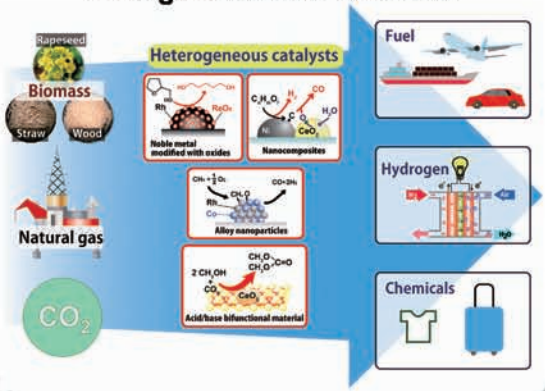
Production of syngas from natural gas



Rh-Co alloy particles for D-CPOX

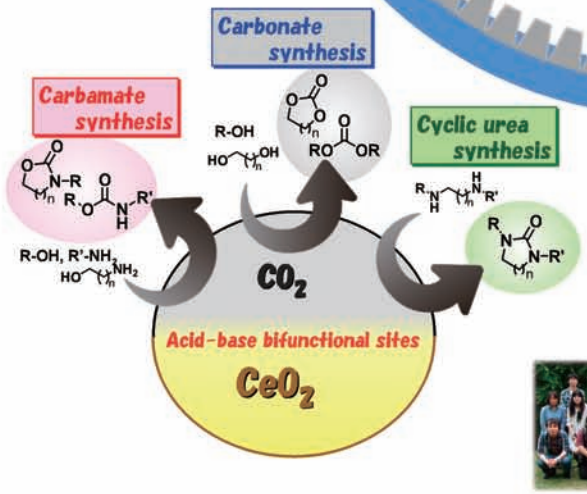


We are developing new catalysts for upgrading next-generation resources.

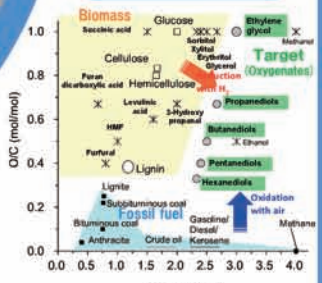


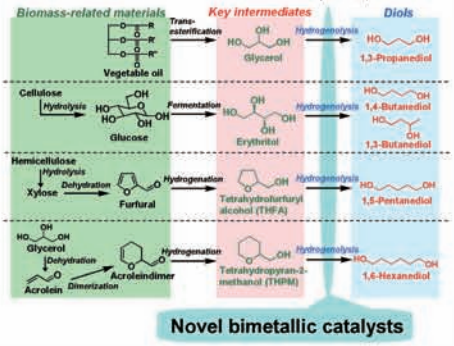
Production of chemicals from CO_2

We discovered that acid-base bifunctional material such as CeO_2 can activate CO_2.



Production of chemicals from Biomass





Novel bimetallic catalysts

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

Next-Generation Advanced Mobility System

Fumihiko HASEGAWA, Masahiro NISHIZAWA, Kazunori OHNO, Shigeyuki YAMABE, Yusuke HARA, Hidetoshi MATSUKI
New Industry Creation Hatchery Center, Tohoku University
Aramaki Aoba, Aoba-ku, Sendai, Miyagi 980-8579

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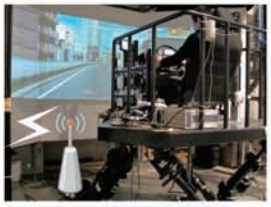
The automotive technology studies and development base

The demonstration place is a new campus in Tohoku University.



Driving simulators

Energy information

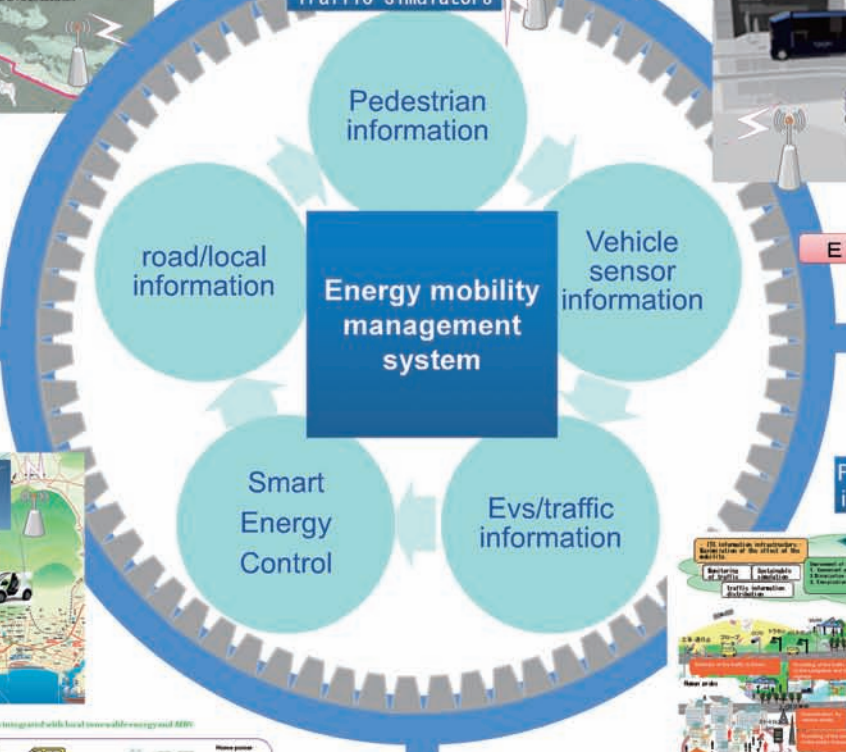
Information Displays

Small EV

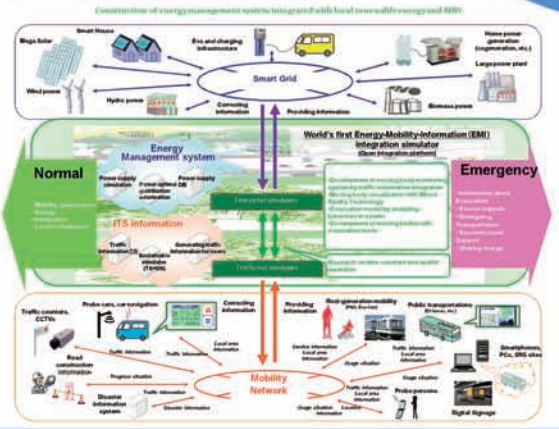
EV buses

ITS information infrastructures

Traffic simulators



Experimental implementation



Function of integrated system

Social mode change for emergency state

Ordinary state

Emergency state

New Industry Creation Hatchery Center, Tohoku University
Aramaki Aoba, Aoba-ku, Sendai, Miyagi 980-8579

http://mobility.niche.tohoku.ac.jp/
mobility-office@niche.tohoku.ac.jp
+81-22-795-4740

Vehicle and Driver evaluation technology for the next generation mobility

New Industry Creation Hatchery Center(NICHe), Tohoku University
Associate Professor Shigeyuki YAMABE,
Professor Fumihiko HASEGAWA and Professor Takahiro SUZUKI

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What driving simulator does is

To reproduce real vehicle motions with real car cabin on motion device of 6 axes (X: front/back, Y: right/left, Z: up/down; roll, pitch, yaw)

<SPEC>

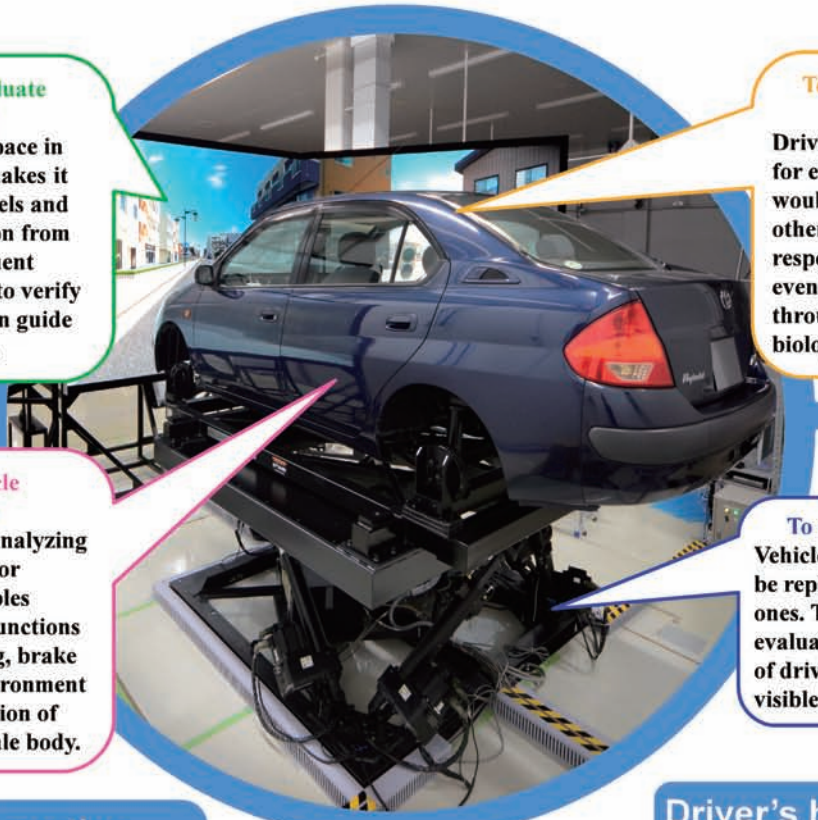
	X	Y	Z	Roll	Pitch	Yaw
Operation range	-200mm～ +180mm	-190mm～ +190mm	–190mm～ +230mm	-12deg～ +12deg	-12deg～ +11deg	-11deg～ +11deg
MAX velocity	300mm/s	300mm/s	300mm/s	20deg/s	20deg/s	20deg/s
MAX acceleration	4.9m/s²	4.9m/s²	4.9m/s²	-	-	-

To preliminarily evaluate infrastructure

Construction of virtual space in various infrastructures makes it easy to find layout of panels and signs for better recognition from drivers and analyze frequent accident zones as well as to verify effectiveness of evacuation guide paths toward restoration.

To evaluates driver's response

Driving simulator is useful for experiments which would be dangerous otherwise. Drivers' response to hazardous events can be evaluated through drive actions and biological signals.



To evaluates vehicle characteristics

CarSim, vehicle motion analyzing simulator, incorporated for vehicle control. This enables evaluation with desired functions such as automatic driving, brake assist, camera-based environment sensing as well as evaluation of cabin layout with real scale body.

To evaluates simulator

Vehicle on the simulator can be replaced with different ones. This enables simulator evaluation for better reality of driving operation and visible images.

Emergency evacuation procedures by a vehicle at the earthquake disaster

- Proposal of emergency evacuation by driving on opposing lane
- Evacuation drills in the simulator

Driver's health monitoring system

- Measurement system to determine from constant monitoring (EEG, ECG, and bloodstream et al.) of various biosignal signal of the driver.

Construct of system which can perform health checks while riding in the vehicle

Administrator :
Associate Professor
Shigeyuki YAMABE
yamabe@niche.tohoku.ac.jp

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

Motor Technology for Next Generation Automotive

Hiroki Goto, Kenji Nakamura, Osamu Ichinokura
Tohoku University, 6-6-05 Aoba, Aramaki, Aoba-ku, Sendai, Japan

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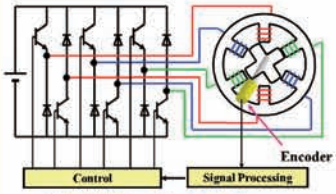
HIGH PERFORMANCE ELECTRIC MACHINE

Switched Reluctance Motor

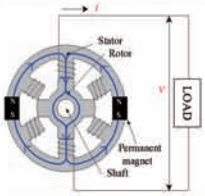


High Reliable & Rare Earth Free

Planetary type Magnetic Gear

Contactless High Power Transmission

PM Reluctance Generator

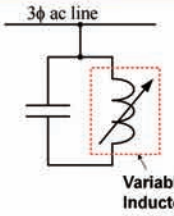


High Power without Rare Earth Magnet

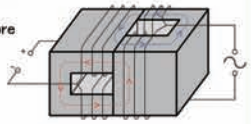
We are studying about High Performance Rare-Earth Free Motor/Generator and Planetary type Magnetic Gear for Contactless High Power Transmission.

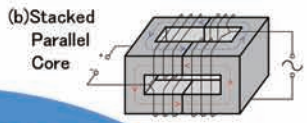
Motor Bench for In-Wheel Motor

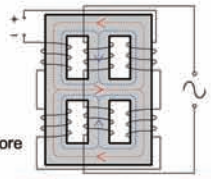
HIGH QUALITY POWER CONVERSION & CONTROL



We are studying about electrical controlled Variable Inductor to solve the problem of power quality and reduced voltage fluctuation of the power system.



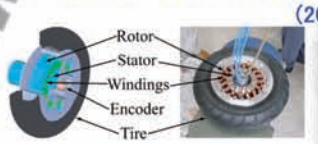


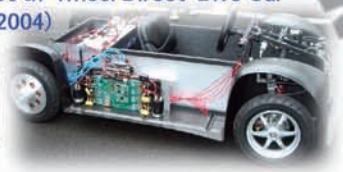


Field Test of Variable Inductor

NEXT GENERATION ELECTRIC VEHICLE

World 1st Rare-Earth Free In-Wheel Direct-Dive Car (2004)

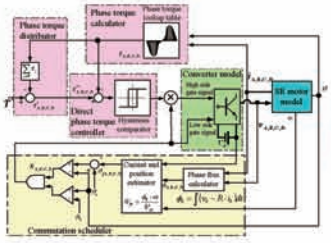




World 1st Success of Driving with 3D Structure Rare-Earth Free In-Wheel Direct-Drive Motor (2012)

Fully Digital Controlled Inverter

Computing Room



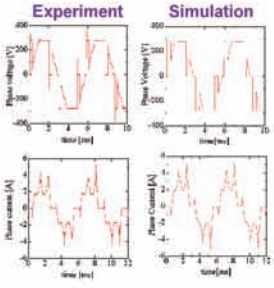
Novel Torque Control for SR motor

We are studying about Control Method to reduce torque ripple and get high efficiency of SR motor.

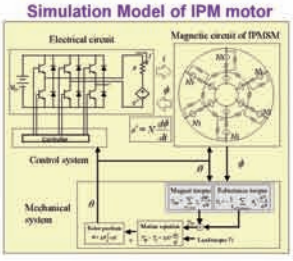
Motor Simulation by Magnetic Circuit Method

We are studying about Simulation Method to motor drive system using Magnetic Circuit Method. Proposed Simulation Method enables high speed and high accuracy simulation integrated with electric circuit, control, and mechanical system.

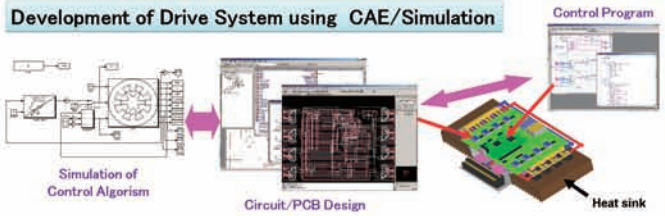
Experiment Simulation



Simulation Model of IPM motor



Development of Drive System using CAE/Simulation



POWER ELECTRONICS & CONTROL

ANALYSIS & SMULATION

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

Recycling Technologies for End of Life Vehicles

Takashi Nakamura, Etsuro Shibata, Atsushi Iizuka
Institute of Multidisciplinary Research for Advanced Materials, Tohoku University

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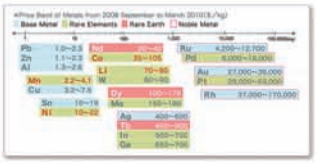
Many materials are used in various components for automobiles, which bring the advanced performance to advanced cars like EHV. miner rare metals are essential substances for high performance automobiles, while their supply chains have been recently unstable and their price change is strongly intense. Recycling of miner rare metals from the ELVs is one of the good ways to secure their supplies. In our laboratory, several research works on recycling technologies of miner rare metals from ELVs are under research, as well as on recycling of other materials from ELVs.

Miner Rare Metals Used in Vehicles

Several miner rare metals are contained in materials of the important automobile components.

Fig.1 Miner Rare Metals Application for Automobiles

Fig.2 Price of Metals



Demand of Li will be rapidly grown, and it is supposed that this rapid demand growth is caused due to growth of electric vehicles. Furthermore, the demand of Li will exceed the supply in 2020.

Table1. Supply and Demand Forecast of Li

year	2010	2015	2020
Supply(kilo-ton)	137	166	214
Demand(kilo-ton)	90	144	313
For Automobiles	5	40	186
For Others	85	104	127

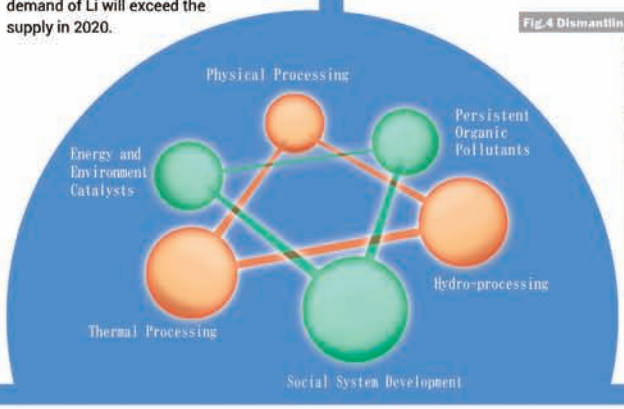
Recycling on Automobile Components

In Japan, ELVs are disassembled based on the automobile recycling law, and disassembled components are reused as used components, or are supplied to material recycling.

Fig.3 Utilization of Disassembled Components from Scrapped Vehicles

Fig.4 Dismantling of Electric Motor in Electric Vehicle

In case of magnet recycling from a motor, de-magnetism of magnet is essential. Recycling of Nd and Dy from Neodymium Magnet is at present under research.



Research Works on Recycling Technology

At **NAKAMURA Laboratory** in Institute of Multidisciplinary Research for Advanced Materials, Tohoku University, the following research works on recycle processing technology are at present implemented, in order to accomplish recycling-oriented society.

1 High Efficiency Rare Elements Extraction Technology Area Project

(supported by Ministry of Education, Culture, Sports Science and Technology,)
In order to recover miner rare metals efficiently from disposed electronics devices, recycling technology is under research, which contains physical separation and soating, chemical extraction and engineering technology.

2 Research on High-Temperature Processing Technology

In order to develop new natural resources of miner rare metals and non-ferrous base-metals like copper, fire smelting technology of seafloor hydrothermal deposits is under research.
Also, the environment-friendly refining technology of rare earth metal is developed.

3 Research on Hydrometallurgical Processing Technology

In order to develop new resources of non-ferrous base-metals and miner rare metals, new mineral dressing and refining technologies are under research, for example, arsenic removing from copper smelting and boron removing from Nd-Fe-B magnet recycling proccesss.

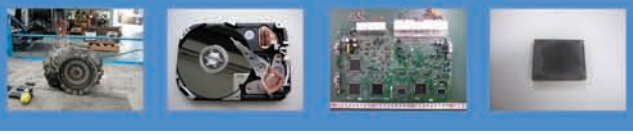
About the Concept "Urban Mine"

Prof. Nanjo, a professor at the Research Institute for Mineral Dressing and Metallurgy (a forerunner of the current Institute of Multidisciplinary Research for Advanced Material) at Tohoku University, pointed out the importance of metal recycling and also the importance of miner rare metals for the Japanese industries. This is the concept "Urban Mine". Therefore, with Tohoku University at its hub we will establish the 'science of metal cycles' integrating the knowledge from the areas of the 'extraction and separation' area, the field of quantum chemistry, , as well as reaction analysis, and aim for its application in the collecting and recycling of minor rare metals from urban mines.

Contact Information

Nakamura. Laboratory
http://www.tagen.tohoku.ac.jp/labo/nakamura/en/

High Efficiency Rare Elements Extraction Technology Area
http://tohoku-timt.net/rare-elements/en/



Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

Automation of physical distribution and traffic using robot technology

Tadokoro, Ohno, Takeuchi, Okada/Konyo, Nagaya Lab.
Graduation School of Information Sciences, Tohoku University

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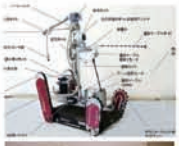
Heightened needs for the robot technology



- Use of robot technologies for decommissioning process of Fukushima Daiichi nuclear power plant.
- Automation of the physical distribution in a factory or an industrial complex
- Automation of conveyance of drug, charts and meals in hospitals
- Safe driving cars for patients and elder persons using robotic technologies

Market size prediction of robots in 2020
(Fuji economic intelligence 2012.05)

- World market of industrial robots :
  $6.6 billion
  166.2%up from 2011
- Domestic market of service robots: $ 1.3 billion
  751.6%up from 2011

Core technologies for autonomous robots

System integration
Robotic system is built according to target tasks and on-site demands, by combining the following key technologies .

Sensing
- 3-D measurement
- Environmental recognition

Probabilistic logic
- Recognition & planning
- Localization

Control
- Actuator control
- Motion generation

Robotic Technologies for Safety, Security and Welfare of the Life

Disaster Response Robots
(Active scope camera, Quince, Search and rescue dog)

Pedal-driven wheel chair

Autonomous unmanned carrier

Autonomous driving electric vehicle

Autonomous quad rotor






Problems for autonomous driving in outdoor environment

1. Weather and bad road surface condition

2. Obstacles: Peoples & cars

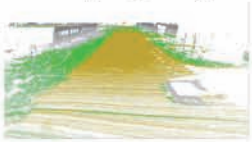
3. Laws

Collaborative project:

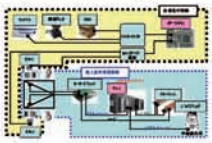
Development of autonomous unmanned carrier in snowy region

Hardware development

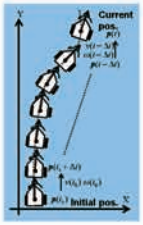

3-D mapping using LIDAR



System integration



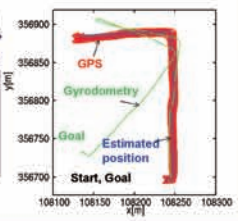
Precise & robust localization using Bayes filter



$$p(\mathbf{x}_t \mid \mathbf{z}_{1:t}, \mathbf{u}_{0:t-1}) = \eta \; p(\mathbf{z}_t \mid \mathbf{x}_t) \int p(\mathbf{x}_t \mid \mathbf{u}_{t-1}, \mathbf{x}_{t-1})$$

Correction Estimation

Correction Using External Sensor	Estimation using internal sensor
•LIDAR •Ultrasonic •Millimeter wave •GPS	•Odometry •IMU •Optical flow



Recommendation of collaborative project

Our lab. can support development of next-generation robotic products.

Our robotic technologies

Your unsolved applications

Development of product accepted in the world

Message for company persons

We have the know-how of advanced sensing technology, control technology, and position estimate technology, which are required for automation. These know-how can help company to make next-generation robotic products. Please contact us if you are interesting in our researches!

Contact: Satoshi TADOKORO (Professor)
TEL: +81-22-795-7025
Address: 6-6-01 Aramaki Aza Aoba, Aoba-ku, Sendai-shi, Miyagi, Japan
URL: http://www.rm.is.tohoku.ac.jp
Email: staff@rm.is.tohoku.ac.jp

System Robotics Laboratory

Department of Bioengineering and Robotics
Graduate School of Engineering
Tohoku University

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Coordinated Motion Control of Multiple Robots

Control algorithms for coordination of multiple manipulators, multiple mobile robots, and multiple mobile manipulators, multiple mobile dual manipulators for handling a single object in coordination have been developed in our laboratory and have been applied to real issues so far.

iCART(Intelligent Car Autonomous Robot Transporters)

Mobile Dual Manipulators Coordination

Multiple Robots Coordination

Manipulation of a rigid object (1989)

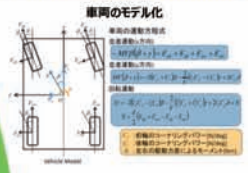
Manipulation of a flexible object (1995)

Parts Assembly By Dual Manipulators (1994)

Next Generation of Advanced Vehicle Control System

Most of conventional control systems of a vehicle have been developed for grip driving. In order to broaden the driving condition, we are developing an advanced vehicle control system which controls a vehicle with drift. An experimental system using a model car has been developed and has shown that the proposed system could control a vehicle with drift condition.

Design of New Control Systems



System Robotics

for creating transformative robotics technology, and integrating it into our society

A robot is a system, which consists of hardware, such as sensors, actuators, and mechanisms, and software, which controls these hardware devices so that the robot performs desired intelligent functions. The robotics is one of the key technologies for solving today's issues of the glove and the aging society.

System robotics is a new field of robotics dealing with issues in real environments and to give solutions for them. Several prototypes of real world robots have been designed and developed based on robot technologies developed in our laboratory.

Human Power Augmentation System (1993)

Mobile Robot Helper (1997)

Human-Robot Interaction

PaDY (Parts/tools Delivery to You Robot)

Concept of PaDY

Partner Ballroom Dance Robot (2005)

A human power augmentation system, a mobile robot helper, and distributed mobile robot helpers have been developed based on the robot helper concept in our laboratory. A dance partner robot has been developed as a research platform for human-robot collaboration. PaDY has been developed as a co-worker robot for an assembly process in an automobile production system and has shown the effectiveness of the concept.

Partner Robot

Passive Intelligent Walker

Assistive Technology

Wearable Walking Helper

Advanced Power assisted cycle chair

Wearable Walking Assist System & Intelligent Passive Cane

Assistive robot systems, such as a passive intelligent walker, a wearable walking assist system without using EMG signal, an advanced power assisted cycle chair, etc., have been developed in our laboratory. Intelligent passive systems driven by servo brake systems, such as the passive intelligent walker, have been developed based on the Passive Robotics principle.

Motion Support System

Professor : Kazuhiro Kosuge
Telephone : +81-22-795-6914
Address : 6-6-01 Aoba, Aramaki, Aoba-ku, Sendai 980-8579, JAPAN
URL : **http://www.irs.mech.tohoku.ac.jp/**

Joint research and development proposals of new real-world robot systems for solving real-world issues based on our advanced and transformative robotics technologies are welcome.

Applying Robot Technologies to Design of Next-Generation Car

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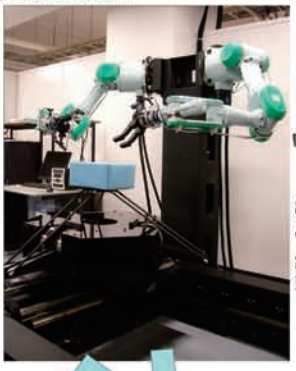
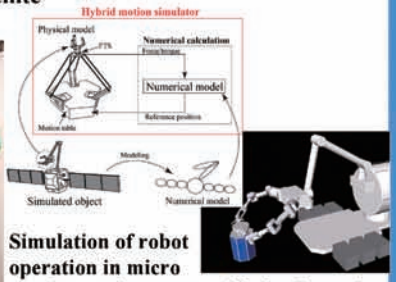
Space robot teleoperation & Microgravity simulator

Teleoperation between a satellite and the earth

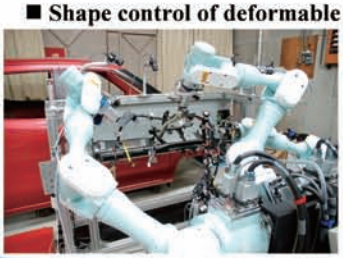




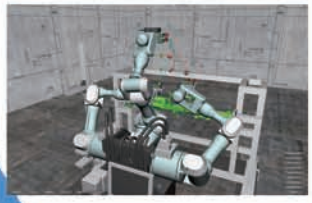
Simulation of robot operation in micro gravity environment with hardware-in-the-loop simulation

Automatic assembly of wire-harness with robot

- Assembly task planning with CG based simulator
- Vision based measurement of wire-harness
- Shape control of deformable object

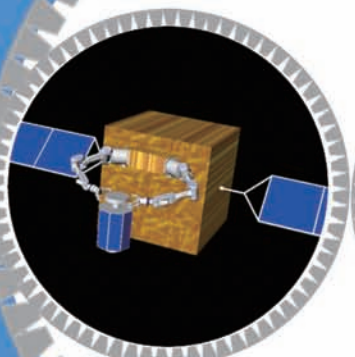


Robot system designed for automatic assembly of wire harness in automobile plant

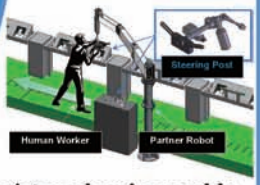


CG based simulator used for task planning

Make a Robotic car!



The kit car under development



Assist workers' assembly

Drifting experiment

- Development of steer-by-wire system
- Driving state estimation using on-board sensors
- Driving assistance utilizing car dynamics

Research on driving assistance

Tested in a practical assembly line

Developed robot

Partner robot in automobile assembly line

Contact
Person in charge: Prof. Masaru Uchiyama
TEL: +81-022-795-6970 FAX:+81-022-795-6971
Address: 6-6-01 Aoba-yama, Sendai 980-8579, Japan
URL: www.space.mech.tohoku.ac.jp

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

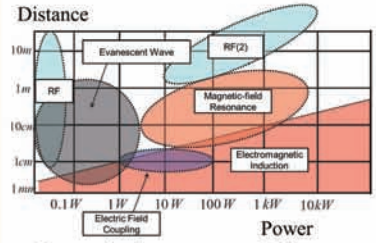
Frontier of Wireless Power Transmission

Graduate School of Biomedical Engineering & Graduate School of Engineering, Tohoku University
Matsuki & Sato Laboratory

MEXT　TOHOKU ECONOMIC FEDERATION　Tohoku University　宮城県　七十七銀行　ICR

Wireless power transmission (WPT)

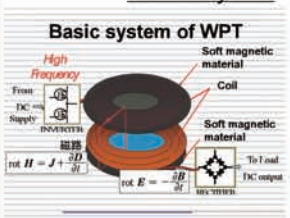
Wide range power (about 1 mW～ 150 kW)
Adapt to every needs for contactless power supply



Transmission power and distance of WPT system

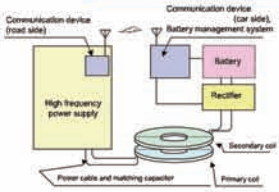
High Efficiency, High Power based on LC-booster method

Our laboratory constructs high performance (efficiency & power level) wireless power transmission(WPT) system with high-Q receiver coil called LC-booster.
We design LC-booster system for many types of application, not only electric vehicle but also medical and consumer devices.



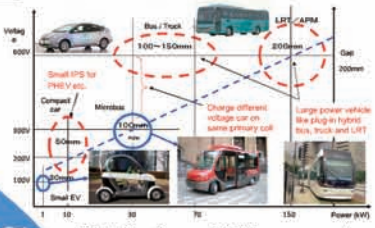
Example of basically WPT system

Flexible WPT system with LC-booster for Electric Vehicle (EV)



- WPT system can transmit (charge) power wirelessly to EV when parking and running.
  →Cable less power supply, Downsizing battery, Car weight reduction
  →Improve environmental performance of EV
- Transmitting Power: ～150kW
  →Apply to compact car, truck, bus, train

WPT system for EV charging



Distribution of EV parameter

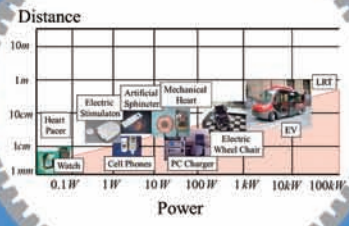
WPT coil for Electric Bus (30kW)

Integration of Medical and Engineering

～Future of Wireless Power Transmission～

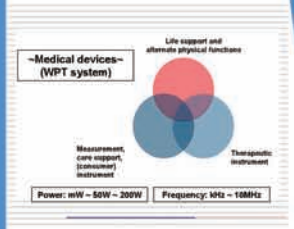
Optimized WPT system for each load

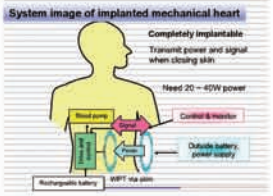
LC-booster, Wireless power rooter, Flexible charging



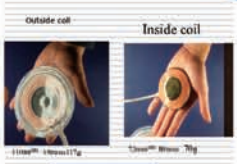
Highway IPS system

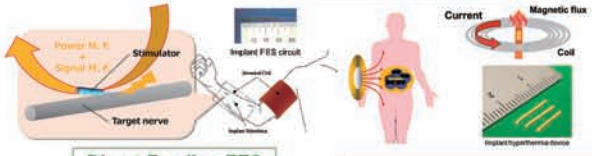
Future of Energy Transfer





WPT system for mechanical heart

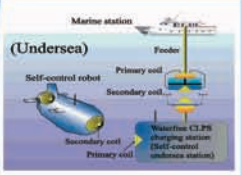




Direct Feeding FES
Treatment for spinal cord injury, Reconstructing exercise function

Soft-heating Hyperthermia
Advanced cancer therapy

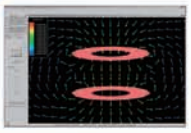
WPT system for implantable medical devices



WPT system for Underwater
Underwater robot, Underwater energy network

Advanced Assistive Vehicle
Intelligent power conditioning

3D magnetic field simulation about WPT coil



WPT system for consumer and industrial equipment

For companies

～Call for joint research and technical development～

WPT technology is a most important 10 technology in future 100 years. Wireless and ubiquitous power supply can innovatively develop new products. Our laboratory will help your development with stored data and know-hows. Please notice if you need our assistance.


Prof. H. Matsuki


Assoc. Prof. F. Sato


Assist. Prof. T. Takura


Research fellow T. Sato

Contact
Officer: Assoc. Prof. Fumihiro Sato (Prof. Hidestoshi Matsuki)
E-mail : fsato@ecei.tohoku.ac.jp
URL : http://www.ecei.tohoku.ac.jp/matsuki/

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

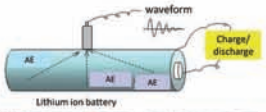
Development of In Situ Measurement Techniques for Lithium-ion Batteries

Naoaki Kuwata, Yoshiki Iwai, Yasutaka Matsuda, Junichi Kawamura
Solid State Ion Physics, Research Center for Sustainable Science & Engineering,
Institute of Multidisciplinary Research for Advanced Materials, Tohoku University

MEXT TOHOKU ECONOMIC FEDERATION Tohoku University 宮城県 七十七銀行 ICR

Doctor of a battery: degradation diagnosis

Acoustic emission (AE) from lithium battery




Li-ion battery for mobile phone


Li-ion battery for laptop (18650-type)

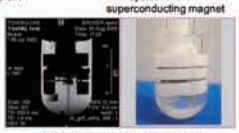

AE measurement system


AE signals from lithium battery (fracture of SnO anode)

MRI of lithium battery (Magnetic resonance imaging)

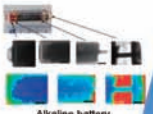

MRI of human brain


MRI system with superconducting magnet


MRI of a model lithium ion battery

X-ray picture

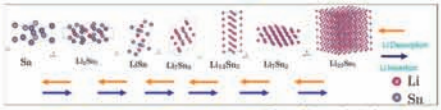

Li-ion battery


Alkaline battery

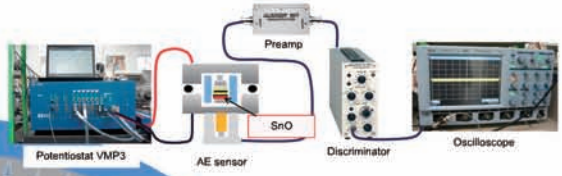
Degradation detection of the lithium battery by acoustic emission (AE)

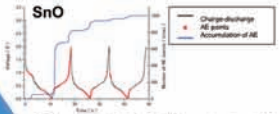
Large reversible capacity; 800 mAh/g → Anode material for next-generation

Fracture of SnO anode during charge/ discharge can be detected *in situ* by AE measurement.

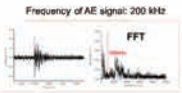


Volume expansion > 400% → Degradation due to the fracture of electrode



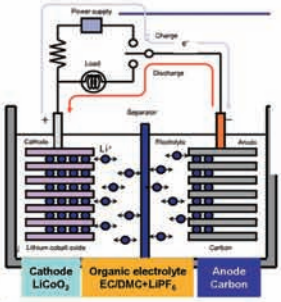


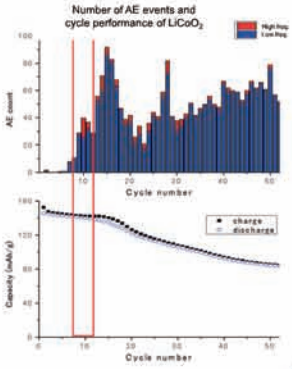
- AE signals are detected for lithium extraction at 1st cycle.
- Different waveforms were observed several regions.



Fractures of SnO cause 200 kHz AE signals

Application of AE measurement: $LiCoO_2$ cathode

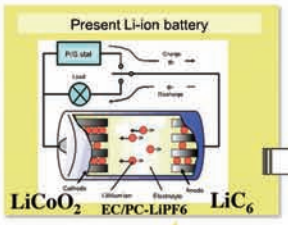




Relationship between AE signal and capacity fading is found.

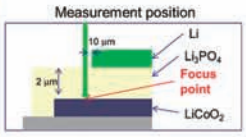
Solid-state thin-film battery

Thin-film battery fabricated by pulsed laser deposition (PLD)

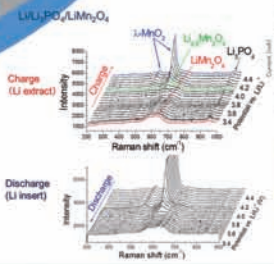


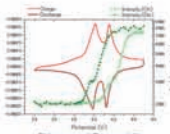

Fire accident of Li-ion battery (Organic liquid electrolyte)

In situ Raman spectroscopy



Li/Li_3PO_4/$LiCoO_2$ thin-film battery





- Reversible change is observed for $LiMn_2O_4$.
- Raman intensity shows 2-step transition.

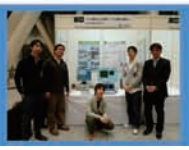
$LiMn_2O_4 \rightarrow Li_{0.5}Mn_2O_4 \rightarrow \lambda\text{-}MnO_2$

In situ techniques for monitoring Li-ion batteries

We investigate solid state ionic conductors and application for Li-ion battery on the basis of solid state ionics. Several *in situ* techniques have been developed for monitoring the degradation of Li-ion batteries.

We have collaborated with companies by acoustic emission, PLD, thin-film solid electrolyte, micro Raman spectroscopy, etc. We are grateful if you can collaborate with us.








Professor Junichi Kawamura

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

Development of Thermal Barrier Coating for Black Automobiles

Hiroki Gonome[1], Mehdi Baneshi[2], Junnosuke Okajima[3], Atsuki Komiya[3], Shigenao Maruyama[3]
[1] Graduate School of Engineering, Tohoku University, Sendai, Miyagi 980-8579, Japan
[2] School of Mechanical Engineering, Shiraz University, 71936-16548, Iran
[3] Institute of Fluid Science, Tohoku University, Sendai, Miyagi 980-8577, Japan
E-mail of corresponding author: hiroki1006@pixy.ifs.tohoku.ac.jp

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Background

Car paint

http://image4.kurumaerabi.com/

Dark color is popular for car.

Disadvantage
- ✓ **High absorption** against sunlight
- ✓ Increasing **indoor temperature**
- ✓ Increasing **cooling load** demand

Too much energy usage

Environmental problem

Greenhouse effect

http://is92zfrt.edu.glogster.com/climate-change-polar-bears-by-jessica-gaalema/

Cool black-color coating

Typical black paint | CuO coating | °C: 45.3, 41.5, 37.7, 33.8, 30.0

Visual and infrared images

Experimental evaluation

Reflectance measurement

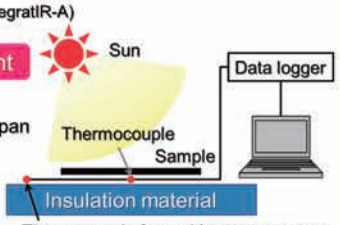
- M. Baneshi, et al., *JQSRT*, 113, (2012), 594.
- H. Gonome, et al., *ASME/JSME 2011 8th Thermal Engineering Joint Conference*, (2011), AJTEC2011-44622.

VIS region
- UV-VIS spectrometer (Shimadzu UV-2450)
- Integrating sphere (Shimadzu ISR-2200)

NIR region
- FTIR (Shimadzu IRPrestige-21)
- Integrating sphere (Shimadzu IntegratIR-A)

Temperature measurement

Place
IFS, Tohoku University, Japan



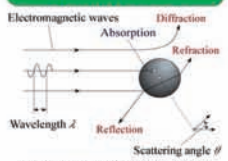
Schematic of the temperature measurement

Exposure experiment

Design

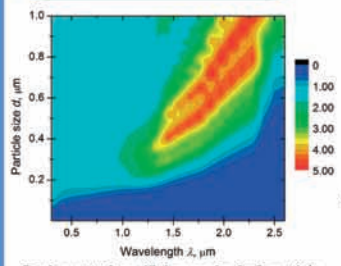
- M. Baneshi, et al., *JQSRT*, 110, (2009), 192.
- M. Baneshi, et al., *J Therm Sci Tech-JPN*, 4, (2009), 131.
- M. Baneshi, et al., *JQSRT*, 112, (2011), 1197.

Nano scale radiation effect



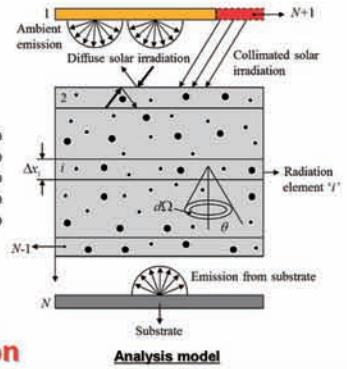
The interaction of a small particle and radiation

- Shape
- Size
- Material
- Clearance



Back-scattering efficiency of a CuO particle

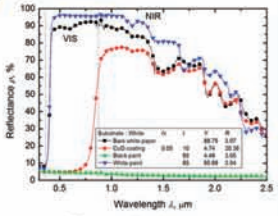
Theoretical optimization



Analysis model

Result

- Baneshi M., et al., *JQSRT*, 113, 594-606, 2012.
- Gonome H., et al., *JQSRT*, Corrected proof, 2013.



Measured reflectances

Measured temperatures of the coating

	Temperature [°C]
CuO coating	61
Typical black paint	82

Cool & Dark was achieved.

For company

- *Our group can design several color paint and optimize thermal performance.*
- *If you have any problem about the control of optical and thermal properties, please ask us!*

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

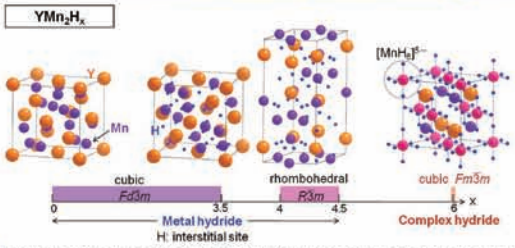
Development of Novel Hydrogen Storage Materials

Institute for Materials Research / WPI Advanced Institute for Materials Research, Tohoku University
Orimo Laboratory

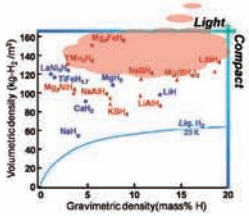
MEXT | TOHOKU ECONOMIC FEDERATION | Tohoku University | 宮城県 | 七十七銀行 | ICR

The special property of YMn_2 hydrides...

Transition from Metal hydride to Complex hydride



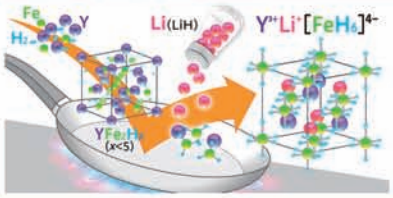
- Hydrogen/metal ratio rise through the transition of hydrogen bonding state
- Apparent advantage of *complex hydrides*: high hydrogen density



Extend to general transition metal hydrides

Charge neutrality in complex hydrides should be considered

Adding lithium to synthesize novel hydrides of general transition metal



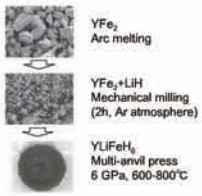
Although YFe_2 has the same crystal structure with YMn_2...

YFe_2 —hydrogenation→ $Y^{3+}Fe^{2+/3+}[FeH_6]^{4-}$ ×

YFe_2 —Li, hydrogenation→ $Y^{3+}Li^{+}[FeH_6]^{4-}$ ○

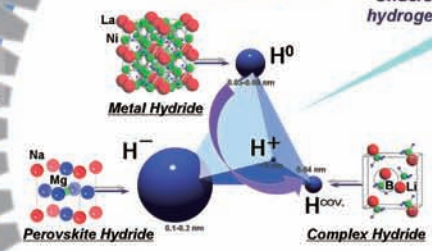
Research on the fundamental property and transition of hydrogen bonding state

For developing hydrogen storage materials and fuel cell



Hydrogen diagram

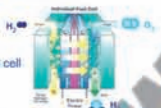
"Understanding the transition of hydrogen bonding states in hydrides."



Unique synthesis methods

Efficient analysis instruments

"Exploring the undiscovered properties in hydrides."



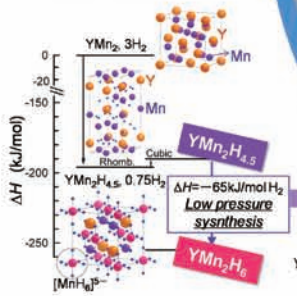
Advanced energy devices

- ✓ High density hydrogen storage materials
- ✓ High energy density electric power storage materials
- ✓ Superconductivity

Subject:
Low pressure synthesis is necessary

* YMn_2 → YMn_2H_6 one step reaction: 170 MPa H_2 is needed...[1]

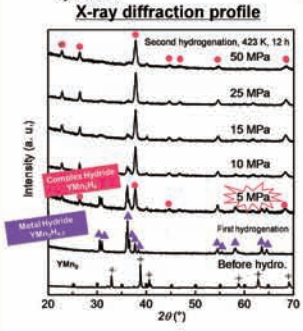
First-principles calculation [2]



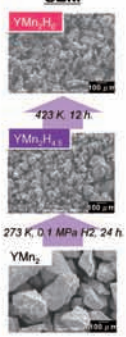
As a result... YMn_2H_6 is synthesized under 5 MPa H_2

Synthesis:

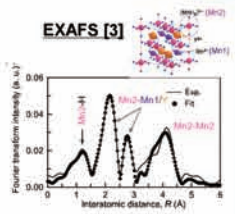
X-ray diffraction profile



SEM



EXAFS [3]



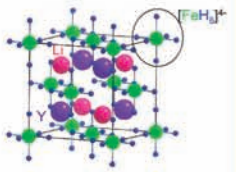
	Distance (Å)
Mn1–H	2.15(3)
Mn2–H	1.67(5)
Mn2–Mn1/Y	2.73(2)
Mn2–Mn2	4.76(5)

Mn-H bonding in the complex ion

[1] V. Paul-Boncour, S.M. Filipek, M. Dorogova, F. Bourée, G. André, I. Marchuk, A. Percheron-Guégan, R.-S. Liu, *J. Solid State Chem.* 178 (2005) 356.
[2] M. Matsuo, K. Miwa, S. Semboshi, H.-W. Li, M. Kano, S. Orimo, *Appl. Phys. Lett.* 98 (2011) 221908.
[3] M. Matsuo, D. Matsumura, Y. Nishihata, G. Li, N. Hiyama, S. Semboshi S. Orimo, *Appl. Phys. Lett.* 100 (2012) 044101.

Subject:
Characterize the novel hydride.

First-principles calculation



Structural properties
F-43m (No. 216), a=6.851 Å

Atom	Wyckoff notation	x	y	z
Fe	4a	0	0	0
Y	4c	1/4	1/4	1/4
Li	4d	3/4	3/4	3/4
H	24f	0.2377	0	0

Experimental results [4]

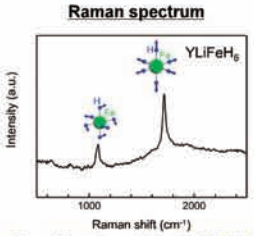
Vibrational mode — *Structural characterization*

Optical Γ-point phonon frequencies

Mode	Frequency (cm⁻¹)				
A_1 (R)	1787				
E (R)	1778				
T_1	364	931			
T_2 (R, IR)	208	248	765	1044	1677

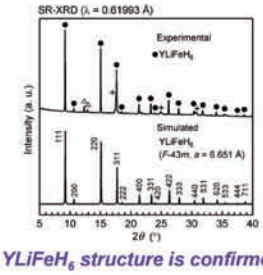
R: Raman active IR: IR active

Raman spectrum



Covalent bonding in $[FeH_6]^{4-}$ is detected

SR-XRD



$YLiFeH_6$ structure is confirmed

[4] M. Matsuo, H. Saitoh, A. Machida, R. Sato, S. Takagi, K. Miwa, T. Watanuki, Y. Katayama, K. Aoki, S. Orimo, *RSC. Adv.* 3 (2013) 1013.

Exploring and understanding the transition of hydrogen bonding states in hydrides

To synthesize novel hydrides for advanced hydrogen storage materials

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

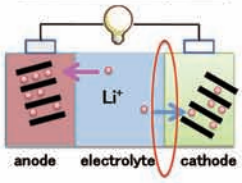
Development of Nano-Scanning Electrochemical Cell Microscopy for Analyzing Ion Transport in Lithium-ion Batteries

Advanced Institute for Materials Research, Tohoku University
Matsue Lab.

MEXT TOHOKU ECONOMIC FEDERATION Tohoku University 宮城県 七十七銀行 ICR

Motivation

Lithium-ion battery (LIBs)



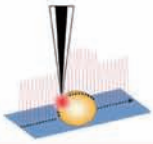
Toward High performance LIBs:

high output-voltage and high capabilities

Key:

➢ high ionic transport at interface between electrode & electrolyte

Develop electrochemical microscope to understand ion transport at interface with nanometer resolution

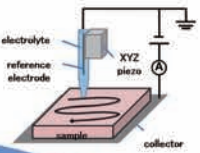


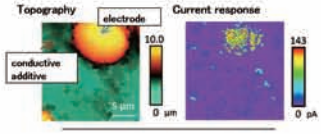
Key Technique

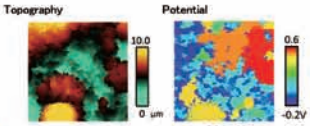
nanoSECCM (scanning electrochemical cell microscopy)

Y.Takahashi *et al.*, Nature Communications 5 5450 (2014).

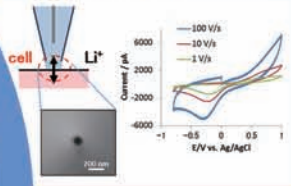
➢ Visualization of ion transport: Topography and Electrochemical response





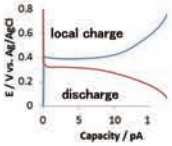


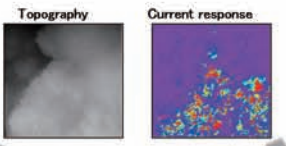
➢ Electrochemical measurement through a meniscus (cell)



Realization of nano-scale imaging and local electrochemical measurement for lithium-ion batteries

nanoSECCM

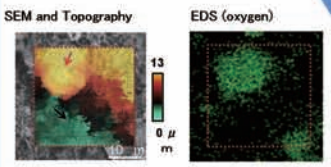




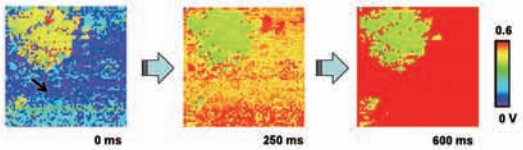
Practical Electrode

Composite electrode

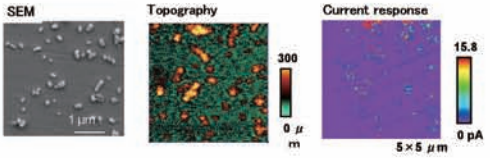
$LiFePO_4$ + PVdF + acetylene black



Potential Images during discharge state (above area)



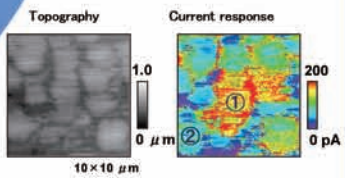
Single particle measurement with nanometer resolution



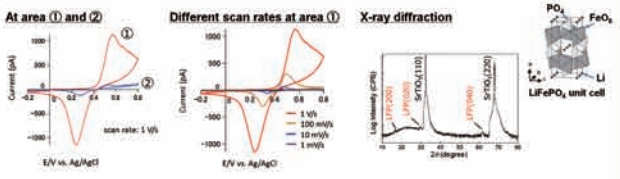
Model Electrode

Thin films electrode

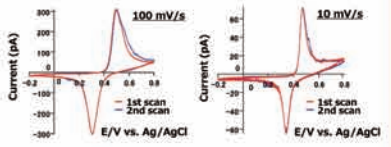
$LiFePO_4$ polycrystalline thin film



Electrochemical measurement at localized area



Meniscus stability during measurement



Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

Energy Conversion Devices Based on Solid State Ionics

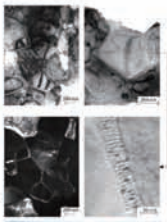
H. Takamura
Graduate School of Engineering, Tohoku University

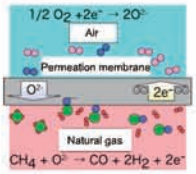
MEXT TOHOKU ECONOMIC FEDERATION Tohoku University 宮城県 七十七銀行 ICR

Hydrogen Production using Oxygen Permeation Membranes

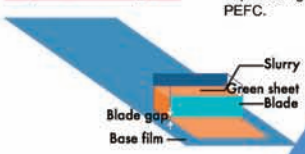
Oxygen permeation membranes for hydrogen production.

	Composition	Flux μmol·cm⁻²·s⁻¹	Temp. °C	Ref.
BSCF	$Ba_{0.5}Sr_{0.5}Co_{0.8}Fe_{0.2}O_3$	8.6	875	Shao *et al.*, 2001
LSGF	$La_{0.7}Sr_{0.3}Ga_{0.6}Fe_{0.4}O_3$	8.2	1000	Ishihara *et al.*, 2002
PSAF	$Pr_{0.7}Sr_{0.3}Fe_{0.8}Al_{0.2}O_3$	8.2	1000	Takamura *et al.*, 2002
Ceria-MFO	(Ce, Sm)O_2–15vol%$MnFe_2O_4$	10.0	1000	Takamura *et al.*, 2002
LBSFI	$(La_{0.3}Ba_{0.7}Sr_{0.3})(Fe_{0.8}In_{0.4})O_3$	10.6	1000	Aizumi *et al.*, 2004



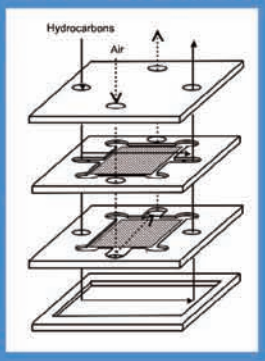


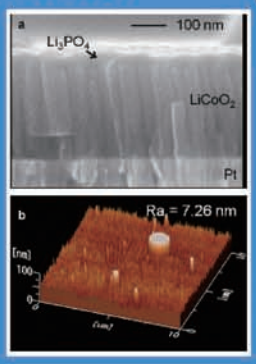
- Sm-doped CeO_2 –$MnFe_2O_4$ Nano composite
- 10 μmol·cm⁻²·s⁻¹ (=13.4[STP]cc·cm⁻²·min⁻¹)
- 10 sheets with dimensions of 5 cm x 5 cm are capable of producing H_2 for 1 kW PEFC.



Mass Production of Functional Materials by Tape Casting

Applications of Solid State Ionics Materials to Energy Conversion





- Simultaneous process of O_2 separation and H_2 production
- Compact & High efficiency

Membrane reformer

- Interface between cathode and electrolyte is key issue
- 30 cycles of charge-discharge are confirmed.

All-solid-state LIB

All-Solid-State Lithium Battery using $LiBH_4$–based electrolytes

Mobile phones
6.7Wh, 43g

Electric vehicle (from Nissan)
24kWh, 294kg

Stationary UPS (from GS Yuasa)
10.8kWh, 340kg

- Large scale, high capacity batteries are demanded.
- In such the large scale battery, the risk of fire is serious.

Solution All-solid-state lithium battery
Solid electrolytes are used instead of flammable organic solvent.

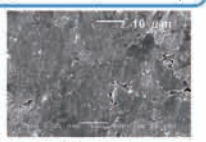
Conventional LIB

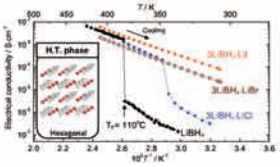
- Organic solvents are volatile and flammable.

All-solid-state LIB

- Solid electrolyte
- Higher safety
- Wide temperature range

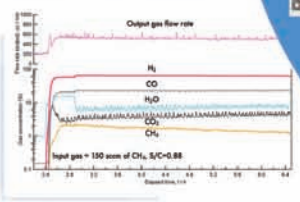
High σ_{Li} and plasticity : $LiBH_4$





Actual performance

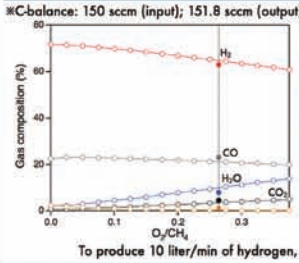
CH₄ reforming properties

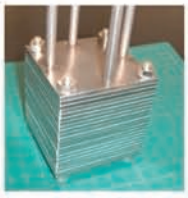


CH₄ reforming properties

No. of modules	CH_4 (sccm)	Air (sccm)	Temp. (°C)	S/C	jO_2 (μmol/cm² s)	CH_4 conv. (%)	CO selectivity (%)	H_2 selectivity (%)
1	150	500	780	0.88	3.3	96	84	89

※C-balance: 150 sccm (input); 151.8 sccm (output)



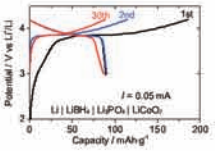


To produce 10 liter/min of hydrogen, stack of 20 modules is required.

Intermediate layer between $LiBH_4$|$LiCoO_2$

Intermediate lyaer
Li_3PO_4
Thickness ≈10 nm
Prepared by PLD

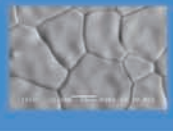
working!

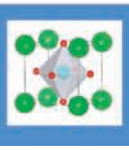


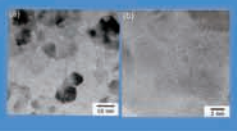
For those who are interested

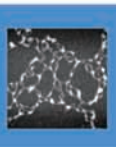
Our focus: Material design of solids in which ion is highly mobile, and its application to energy conversion & storage

Application : Fuel cells, Secondary batteries, Sensors









Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

Tohji Laboratory: Development of functional nano-eco materials for energy and environment in the environmentally benign systems

Professor: Kazuyuki Tohji, Associate Professor: Hideyuki Takahashi, Assistant Professor: Shun Yokoyama

MEXT | TOHOKU ECONOMIC FEDERATION | Tohoku University | 宮城県 | 七十七銀行 | ICR

Research Targets

The researches of Tohji Laboratory focused on how to develop the well defined nano materials and how to utilize these materials to our life. Especially, we develop the synthesis and utilizing methods for useful nano material which utilize the surface properties, such as alloy and/or oxide-sulfide hybrid catalysts and electric integration materials, and for energy materials to solve the global environment problems, such as thermoelectric alloy nanoparticles. Moreover, the application of novel photocatalysts, called as stratified photocatalysts, to effective hydrogen generation system and environmental catalysts is researched. Our research objectives can be classified as follows.

Natural energy conversion materials
(A-1) Photocatalysts with specific morphology
(A-2) Thermoelectric alloy nanoparticles
(A-3) CIGS alloy nanoparticles for solar cell
Functional nano-eco materials
(B-1) Uniform and well crystallized alloy nano materials
(B-2) Well defined electric integration nano materials
(B-3) Precise control of nano catalysts for fuel cell
Utilization of the precise control for metal complexes condition
(C-1) Novel extraction methods of rare metals

Among these, (A-1) and (B-1) s Introduced in this poster.

Photocatalysts with specific morphology: Stratified Photocatalysts

The direct conversion of solar energy into storable energy in the form of hydrogen will provide not only clean energy but also solve the environmental problem caused by the discharge of CO_2 from the consumption of fossil fuel. Therefore, various researchers vigorously synthesized the high performance photocatalysts to show the effective splitting water and investigate the reaction mechanism. Many researchers succeeded to generate the hydrogen and oxygen gas from water with the ratio of 2:1, however, it is also true that the reaction rate is low and also cost for the total system construction as compared to the hydrogen generation from fossil fuel degradation is high. This is considered to originate from the degree of the decomposition potential of the reactants (water) which need relatively large energy (c.a. 1.3eV). On the other hand, H_2S can be easily decomposed, since it has low potential (0.298eV).

Thus, photocatalytic decomposition of H_2S is considered as an efficient route to produce new energy (hydrogen) compared with the splitting of water. Moreover, decomposition of H_2S by using solar energy and photocatalysts may gives us the candidate for the solution of environmental problems, since quite large amounts of energy was consumed for the decomposition of H_2S which evolved from the distillation of fossil fuel. Among the various semiconductor materials, only the sulfide type photocatalysts, such as ZnS, can act stably in the H_2S solution condition, while metallic and/or oxide type photocatalysts are sulfurized. Moreover, capsule like morphology is considered to effective, since catalytic reaction is progressed only on the surface of photocatalysts.

These consideration indicate that effective hydrogen generation can be achieved by the combination of "H_2S as the reactant", "sulfide type photocatalysts", "capsule like morphology", and "solar energy". Thus, photocatalytic decomposition of H_2S into H_2 by using these type photocatalysts gives us the efficient route for the conversion of natural energy into clean energy (H_2).

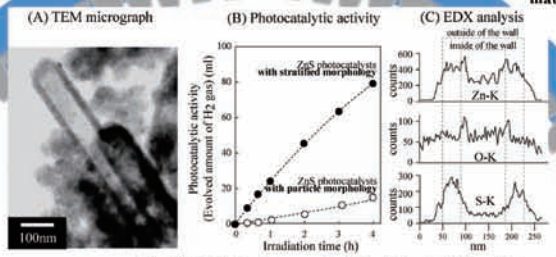


Fig.1 (A) TEM micrograph, (B) photocatalytic activity and (C) EDX analysis of stratified ZnS photocatalysts

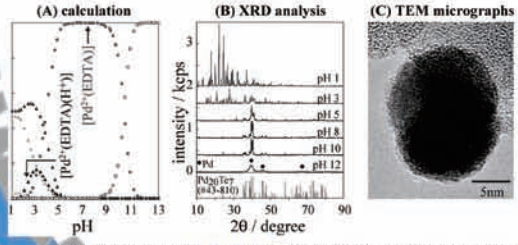


Fig.2 (A) Results of calculation for Na_2PdCl_4 - H_4EDTA system, (B) XRD analysis of synthesized materials and (C) HR-TEM micrographs of uniform and well crystallized $Pd_{20}Te_7$ alloy nanoparticles synthesized by obeying to this method

Many attempts to prepare the alloy and metallic nanoparticles by various methods have been reported. However, in spite of the objective to obtain alloy materials, the as-prepared metallic nanoparticles often exhibited inhomogeneous compositions and multi-crystalline structures, which does not adequate for the industrial applications, such as catalysts and electronic devices. Depending on the synthesis conditions, alloy catalysts with various structures and compositions can be prepared. As a consequence, undesirable by-products may co-exist, or the entire catalytic activity may be reduced through catalytic reactions due to the formation of compounds with various surface structures and compositions other than those of objective alloy. Thus, the synthesis method for "uniform" and "well-crystallized" alloy nanoparticles should be developed.

Metallic nanoparticles are well known to be easily synthesized in the liquid phase by the reduction of metal ions and/or complexes by many traditional methods. In this system, various metal salts and metal complexes are formed simultaneously and their consequent reduction gives rise to a mixture of various kinds of particles, such as single metal, alloy nanoparticles, etc. In other words, the concomitance of various ions and/or complexes in the starting solution leads to uncontrolled reduction, consequently followed by the formation of undesired mixtures of metal particles caused by the differences in reduction rates of different metal complexes that originated from different precursory metal species that existed in the solution. Finally, the as-prepared alloy nanoparticles have various crystal phases and/or inhomogeneous structures. Thus, in order to synthesize uniform and well-crystallized alloy nanoparticles, the reduction rates of metal species in the starting solution should be made equal. Therefore, the idea based on the predicted concentration of metal complexes in an aqueous solution as a function of pH was introduced for the particle synthesis system.

Uniform and well crystallized alloy nano materials

Staffs

Professor: Kazuyuki Tohji

Assistant Professor: Shun Yokoyama

Associate Professor: Hideyuki Takahashi

This method can applicable to various materials. So, if you have some questions, please contact to us.

Our address

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Nanocrystalline Li_2MSiO_4 and Li_2MPO_4F (M=Fe, Mn, Ti and Co) cathode materials synthesized via supercritical process

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Energy Materials

Goal: High Energy Density Nanostructure Cathode Materials

High-energy density (gravimetric and volumetric) cathode materials is equivalent to high-capacity (per Kg), high-potential, high packing bulk density cathode materials

Li_2MSiO_4 very interesting cathode materials

The extraction/insertion of 2-Li ions can lead to the delivery of 333mAh/g capacity according to the following scheme:

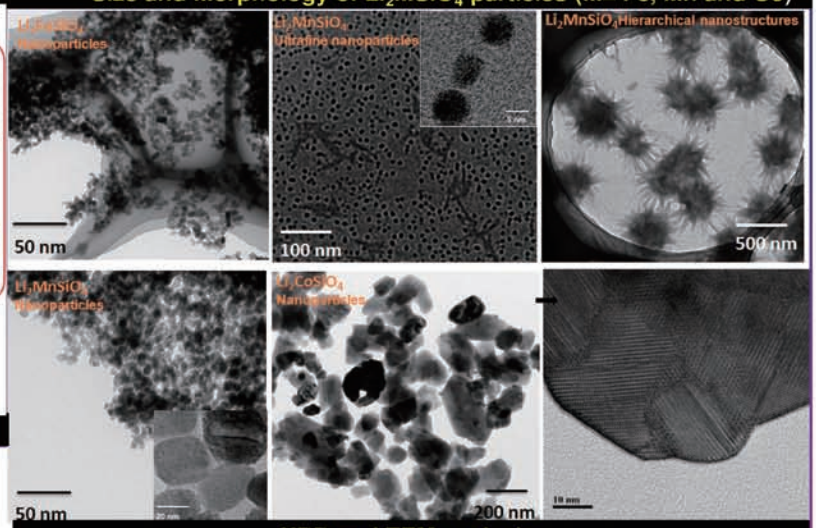
$Li_2Mn^{2+}SiO_4 \longrightarrow Mn^{4+}SiO_4 + 2Li^+ + 2\bar{e}$

Strong covalent Si-O bonds can be good for safety, high thermal stability

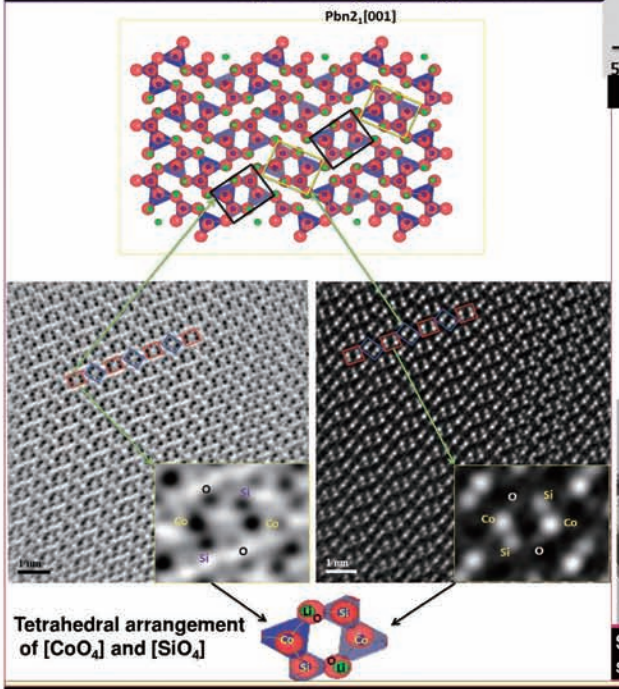
Li_2MPO_4F

1-D chains of metal octahedra interconnected by polyanion tetrahedra, Li^+ afford open pathways for 3-D ion transport

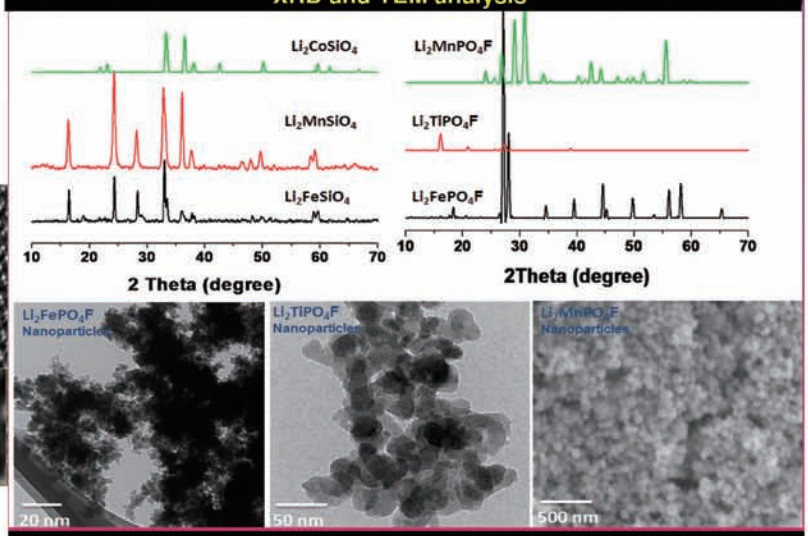
Size and Morphology of Li_2MSiO_4 particles (M= Fe, Mn and Co)



ABF and ADF analysis of Li_2CoSiO_4 particles

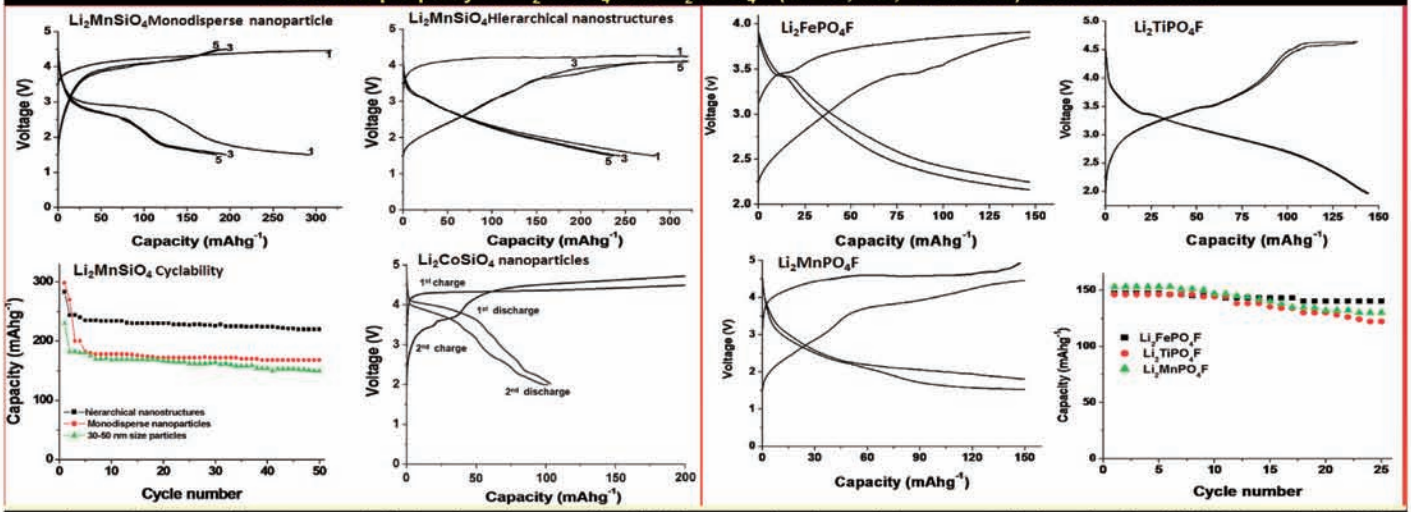


XRD and TEM analysis



Size and morphology of electrodes were controlled by changing the solvent and surfactants ratio . Single phase cane be synthesized via supercritical fluid process

Electrode property of Li_2MSiO_4 and Li_2MPO_4F (M=Fe, Mn, Ti and Co) cathode material



In conclusion, we have successfully developed supercritical fluid process for size and shape controlled synthesis of Li_2MSiO_4 and Li_2MPO_4F cathodes. The nanocrystals of Li_2MPO_4F and Li_2MSiO_4 cathode materials showed excellent electrode property, Li_2MnSiO_4 cathode showed capacities of nearly two lithium ion. Hence, the process can produce high quality cathodes for Li-battery.

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

Green Nanodevice by Super Low Damage Process

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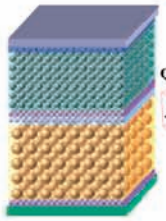
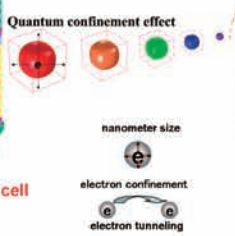
Quantum Dot Solar Cell

Theoretical conversion efficiency >60%

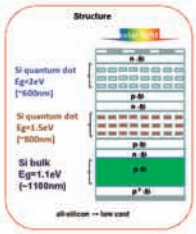


Quantum confinement effect



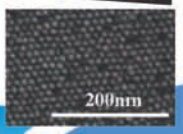
Quantum dot solar cell

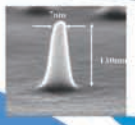
Low recombination probability of electron and hole
Multiple bandgaps
Electron and hole can move by tunnel effect



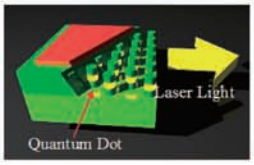
Solar spectrum can be efficiently utilized by only one material

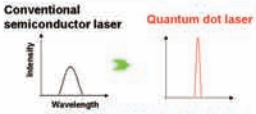
Bio-template ultimate top-down process



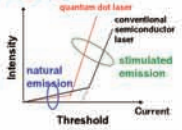


Quantum Dot Laser





Narrow peak width, high gain



Low threshold

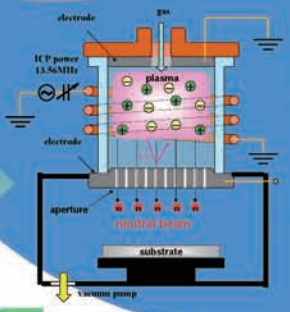
Ultralow-damage neutral beam process

Biomolecules
Bottom-up Process
Bio-template technology

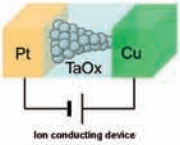
Low-damage
Top-down Process
Neutral beam technology

Low-power-consumption semiconductor devices

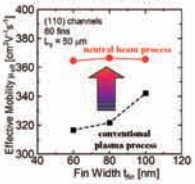
- 3-dimensional MOS transistor
- Ion conducting devices
- Graphene transistor
- Germanium transistor
- Single electron transistor

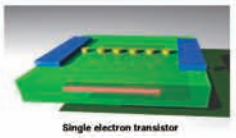


3-dimensional MOS transistor

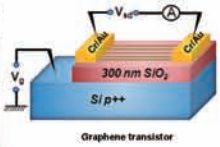


Ion conducting device





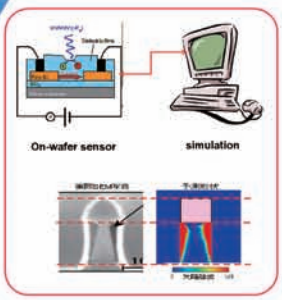
Single electron transistor



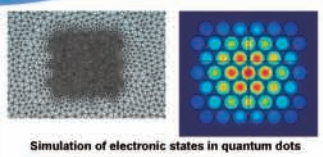
Graphene transistor

Development of low-power-consumption devices with low environmental footprint

Simulation for processes and devices



Prediction of plasma process damage



Simulation of electronic states in quantum dots

Message for industry

We are developing innovative green nano-devices to realize generation, storage, and saving of energy, by utilizing our original ultra-low-damage neutral beam processes. We established an industry-academia consortium on solar cell, secondary battery, fuel cell, and energy optimized integrated system in April 2013. We aim researches to be industrialized.

Prof. Seiji Samukawa

http://www.ifs.tohoku.ac.jp/samukawa/index.htm

IER | Core Technology Consortium for Advanced Battery Devices | ナノ・マイクロクラスター

Core Technology Consortium for Advanced Energy Devices

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Outline

Since the Great East Japan Earthquake, the development of new clean and renewable energy sources and the realization of efficient and smart stand-alone energy systems using the best mix of energy have been urgently sought.

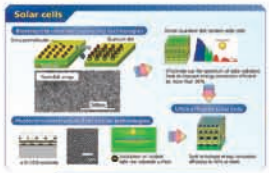
Therefore, we intend to support the reconstruction of the Tohoku area and the renewal of Japan, and to contribute to the establishment of an energy-technology nation, through the realization of state-of-the-art core battery technologies (solar cells, secondary batteries, fuel cells) and their energy optimization integrated systems.

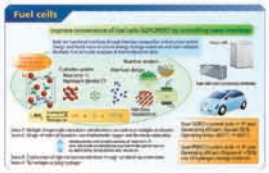
Our efforts will be realized through open innovations in an industry-academia collaboration setting with a vertically-integrated group of companies. The innovations are based on nano-structure interface control technologies, which Tohoku University has been accumulating for many years.

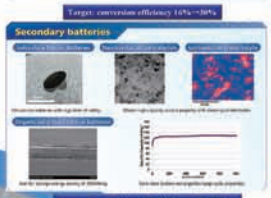
Features

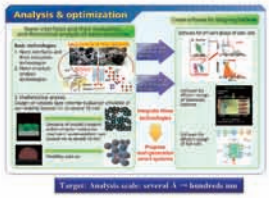
1. Unique consortium aiming at establishment of *optimized nano-energy system* created as a fusion of solar cells, secondary batteries, and fuel batteries.
2. Strategic research and development by gathering technologies from *vertical integration type firms* based on nano-interface material structure control technologies accumulated specifically by the university.
3. Restoration to society, job creation, and national profit increments by *strengthening TLO*.
4. We propose our own intellectual property strategy of "*Patent Marché*" for the gathering of technologies.
5. For the cultivation of world-class human resources, we propose *soulful human resource exchange systems between firms and the university*. (Practical cultivation and exchange of human resources).
6. For support of the basis of the battery industry, a facility-sharing system "*Coin operated type battery manufacturing device*" is constructed based on the Sendai Material Valley.

Research and Development

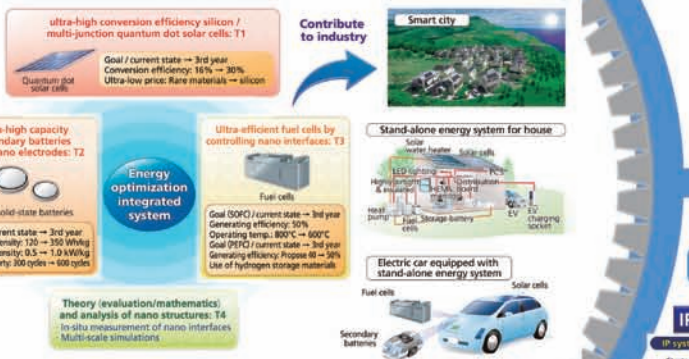








Our Target

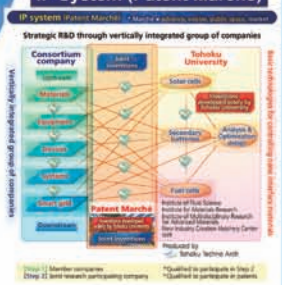


http://www.ifs.tohoku.ac.jp/consortium/eng/index.html
consortium@Sammy.ifs.tohoku.ac.jp

Organization

Open Innovation

IP System (Patent Marché)



Human resource cultivation

Equipment sharing program

Membership application

Prospective member companies are welcome to apply to the Consortium at any time.
A company applies to the Consortium by applying to "provide academic guidance." Download the Academic Guidance application form and academic guidance contract sample form from the "Member Application" webpage. Complete and submit the application.
If a consortium company is interested in joint research, please submit a joint research application form.

See: http://www.ifs.tohoku.ac.jp/consortium/eng/application.html
http://www.ifs.tohoku.ac.jp/consortium/jpn/application.html (Japanese)

Members

Director	Institute of Fluid Science (IFS) and Advanced Institute for Materials Research (AIMR), Professor	S. Samukawa
Solar cells	Institute of Fluid Science (IFS) and Advanced Institute for Materials Research (AIMR), Professor	S. Samukawa (Leader)
	Nagoya University Professor and Tohoku University Visiting Professor,	N. Usami
	Institute of Multidisciplinary Research for Advanced Materials, Professor	I. Honma
Secondary batteries	Institute of Multidisciplinary Research for Advanced Materials (IMRAM), Professor	I. Honma (Leader)
	Advanced Institute for Materials Research (AIMR) and Institute for Materials Research (IMR), Professor	S. Orimo
	Advanced Institute for Materials Research (AIMR), Lecturer	A. Unemoto
Fuel cells	Institute for Materials Research (IMR), Lecturer	M. Matsuo (Leader)
	Advanced Institute for Materials Research (AIMR), Institute for Materials Research (IMR), Professor	S. Orimo
	Institute for Materials Research (IMR), Researcher	T. Ikeshoji
	Institute of Multidisciplinary Research for Advanced Materials (IMRAM), Professor	K. Amezawa
Analysis and optimization	Institute of Fluid Science (IFS), Associate professor	T. Tokumasu (Leader)
	Institute of Fluid Science (IFS), Assistant professor	K. Shimoyama
	Institute of Multidisciplinary Research for Advanced Materials (IMRAM), Professor	K. Amezawa
	New Industry Creation Hatchery Center (NICHe) , Professor	A. Miyamoto
Research Management Group	Institute of Fluid Science (IFS), Associate Professor,	T. Kubota (Leader)
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Manufacturing Technology of Automotive Power Semiconductors

New Industry Creation Hatchery Center, Tohoku University
Fluctuation Free Facility

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Radical Oxidation and Nitridation

Oxidation : Oxide film formation on Silicon

$Kr + e \rightarrow Kr^* + e$
$Kr^* + O_2 \rightarrow Kr + 2O^*$
$Si + 2O^* \xrightarrow{R.T.} SiO_2$ {(O* Radical reaction) (On any crystal orientation surface)}
Current: $Si + O_2 \xrightarrow[\text{Thermal energy}]{1000^\circ C} SiO_2$ {(O_2 Molecular reaction) (Only on (100) silicon surface)}

Kr : Krypton
O : Oxygen
Si : Silicon

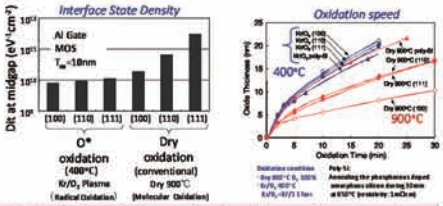
Nitridation : Nitride film formation on Silicon

$Xe + e \rightarrow Xe^* + e$
$Xe^* + NH_3 \rightarrow Xe + NH^* + H_2$
$3Si + 4NH^* \rightarrow Si_3N_4 + 2H_2$

Xe : Xenon
NH_3 : Ammonia
Si : Silicon

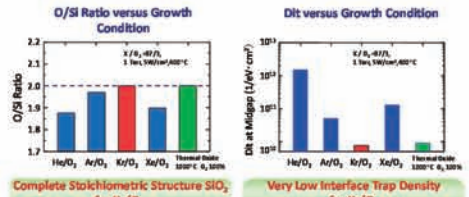
★The technology that the students study at the university becomes available on the practical production site.
★Very high integrity SiO_2 and Si_3N_4 can be formed on any crystal orientation silicon surface with the same formation speed.
★Very expensive gases (Kr, Xe) ⇒ Complete reuse and recycling system
99.9% for Kr, 99.99% for Xe

Film Properties Fabricated by the Plasma Oxidation



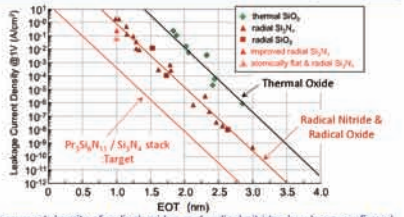
Radical oxidation has been confirmed to exhibit same formation speed on any crystal orientation silicon surface, i.e., LSI can be fabricated on any crystal orientation silicon surface and very high performance power device IGBT can be fabricated.

Film Properties fabricated by the radical oxidation method



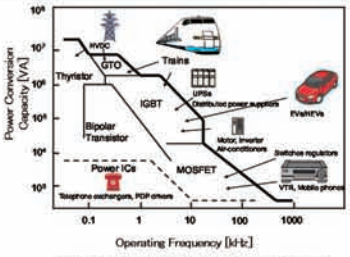
In Kr / O_2 gas combination, there generate O* radicals only while O_2^+ and O_3 are generated in other gas combinations. O* radicals can move freely in oxide films even at low temperature such as 400°C, resulting in complete oxidation of Si.

Leakage Current (@1.0V) as a Function of Equivalent Oxide Thickness



Leakage current density of radical oxides and radical nitrides has been confirmed to decrease down to less than 1/1,000 compared to that of thermal oxides. Integrity of $Pr_2Si_6N_{11}$(k=30) can be drastically improved by introducing new plasma equipment such as 915 MHz Metal Surfacewave Excitation Plasma (MSEP)

Application of Power Semiconductors

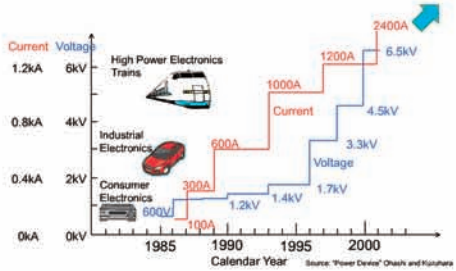


Used Area of Si Power Semiconductors

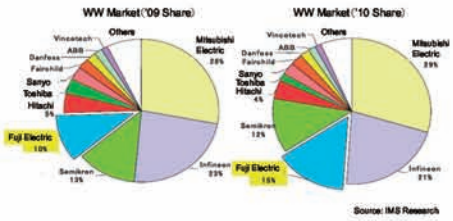
Structure and Electrical Properties of Major Power Semiconductors

	Diode	Cyristor	GTO	BJT	MOSFET	IGBT
Junction Structure						
Circuit Symbol						
ON-state voltage [V]	1.8	2.5	3.5	2.5(saturation)	50(1Ω)	2.5
Switching time [μs]	–	400	25	18	0.35	<1
Rated voltage[V]	4000	4000	4500	1200	500	600~6500
Rated current[A]	1600	3000	3000	600	50	50~2400

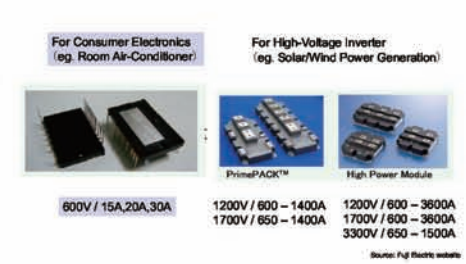
Progress of IGBT toward High Voltage and Large Current



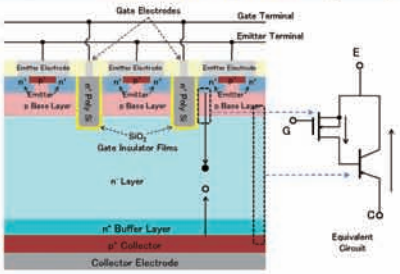
IGBT Market Share



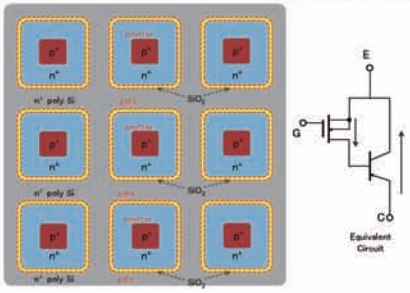
IGBT Products of Fuji Electric Co., Ltd.



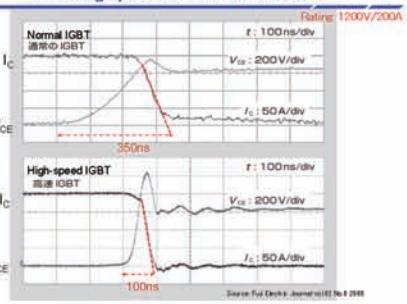
Cross-Section View of IGBT



Plane View of IGBT Emitter and Gate Electrodes



Switching Speed and Turn-off Waveform



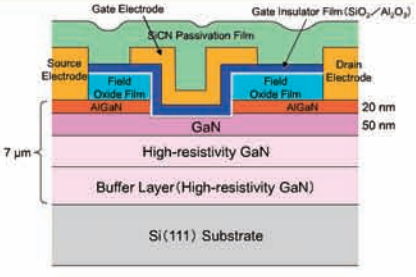
Physical Property of Si and Wide Band Gap Semiconductors

	Si	3C-SiC	6H-SiC	4H-SiC	GaN
Band gap[eV]	1.1	2.2	3.0	3.3	3.4
Relative dielectric constant	11.8	9.6	9.7	10	9.5
Electron mobility[cm²/V·s]	1350	900	370	1000	1200
Breakdown field[10⁶V/cm]	0.3	1.2	2.4	3.0	3.3
Electron saturation velocity[10⁷cm/s]	1.0	2.0	2.0	2.0	2.5
Thermal conductivity [W/cm·K]	1.5	4.5	4.5	4.5	2.1

AlGaN/GaN/(111)Si Power Semiconductors

⇨ Depth of the n- drift region is 1/10 of the Si device at the same maximum rated voltage
⇨ ON-state voltage is less than 1/1000 of the Si device

AlGaN/GaN/(111)Si Power MOSFET



Features of the Proposed GaN Power Semiconductors

☆ Gate Insulator Film
SiO_2(60nm) / Al_2O_3(3nm) / GaN
⇨ Introducing Al_2O_3 prevents Ga diffusion

☆ SiCN Passivation Film
Adding 10% C(carbon) in Si_3N_4 minimizes stress on the GaN ⇨ Current increases

☆ Integrated Control Circuit
Radical oxidation/nitridation enables CMOS transistors fabricated on Si(111) substrate

☆ We Recommend that Power Device is GaN, and Its Controller is Integrated on Si(111) Substrate

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

Development of Al doped $Ca_3TaGa_3Si_2O_{14}$ piezoelectric crystals

T. Kudo[1], Y. Yokota[2], M. Sato[3], K. Tota[3], K. Onodera[2,3], S. Kurosawa[1,2], K. Kamada[1], A. Yoshikawa[1,2]
1.Institute for Materials Research, Tohoku University 2. New Industry Creation Hatchery Center, Tohoku University
3. TDK corporation E-mail : t_kudo@imr.tohoku.ac.jp

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Introduction

Sensing in the engine section oxygen sensor for the lean burn systems

⇨ Combustion pressure sensor

	Quartz	PZT	Langasite-type crystal
Curie temperature(℃)	573	~300	>1300
Piezoelectric constant(pC/N)	2.0	~300	4 - 7
Electromechanical coupling factor(%)	10	30 - 70	~ 15
Mechanical quality factor	> 10^5	100 - 900	10^3 - 10^5

Advantage of Combustion sensor

- Increasing the combustion efficiency
- Decreasing the amount of the NO_x and CO_2 emission

Langasite-type crystals with high properties have been expected for the elements in the sensor device.

Problems

High cost of manufacturing the langasite-type crystal

In 1980s, $La_3Ga_5SiO_{14}$ (LGS) was developed.

⇩ La free

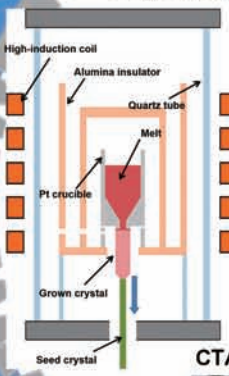
After 1998, $Ca_3TaGa_3Si_2O_{14}$ (CTGS), $Ca_3NbGa_3Si_2O_{14}$ (CNGS) has been developed.

Motivation

To reduce amount of Ga ion in the crystal, Al doped CTGS crystal with various Al concentrations were grown.

Key Technology

- Crystal growth by μ-PD method
  - Materials screening with fast growth rate
- Langasite-type piezoelectric crystals
  - High piezoelectric properties at high temperature
  - Low crystal impedance
- Al doped CTGS crystals
  - Reductions of manufacturing cost and amounts of rare metals



CTAS crystal

Experimental

Crystal Growth by μ-PD method

Liquid-solid interface during crystal growth

Starting material: $CaCO_3$, β-Ga_2O_3, α-Al_2O_3(>4N) and SiO_2(>3N)

The powders were mixed as nominal compositions of $Ca_3Ta(Ga_{1-x}Al_x)_3Si_2O_{14}$ [x = 0, 0.2, 0.4, 0.6, 0.8 and 1].

The mixed powders were sintered at 1200° C for 12 hour in air three times.

Sintered powder was set in Pt crucible.

The crucible was heated in air up to melting point by high-frequency induction coil.

⇩

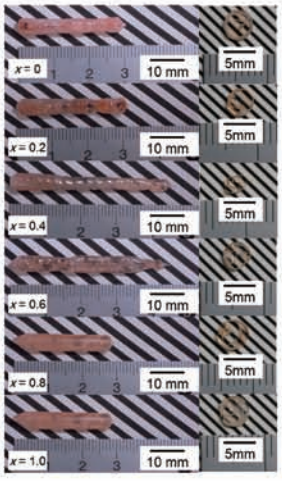
Crystal growth was performed by pulling down the melt
Seed crystal: LTG crystal with *a*-axis
Growth rate is 0.5 mm/min.

Evaluations

X-ray diffraction (XRD)
Scanning electron microscope (SEM)
Electron probe micro-analyzer (EPMA)

Results & Discussions

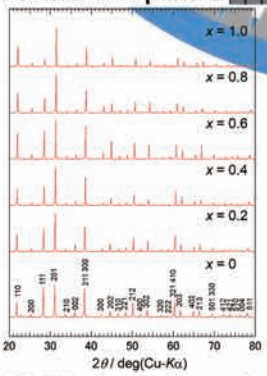
$Ca_3Ta(Ga_{1-x}Al_x)_3Si_2O_{14}$ crystals grown by μ-PD method



Insides of the crystals had high transparency.

There were some cracks in the crystals due to high temperature gradient during crystal growth.

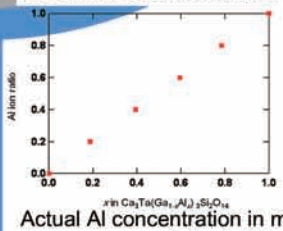
Powder XRD pattern



All diffraction peaks were identified by langasite-type structure.

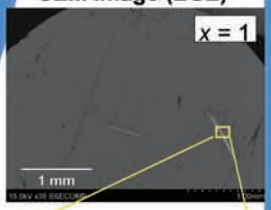
Lattice parameters were systematically decreased with Al concentration

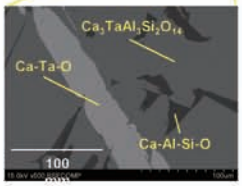
Actual Al concentration



Actual Al concentration in main phase was consistent with nominal composition.

SEM image (BSE)





- Main phase was almost same as nominal compositions.
- There were some impurity phases in the periphery areas.

Future plans

Investigation of congruent composition and suitable growth condition to obtain Al doped CTGS crystals without inclusion and crack.

Nanotechnology Platform : Structural Analysis

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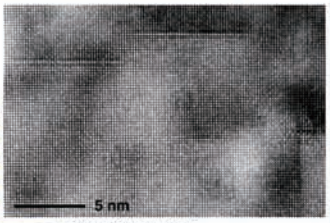
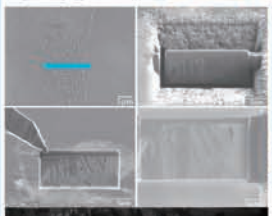
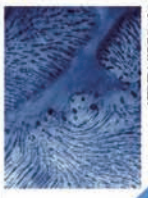
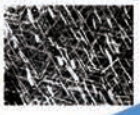
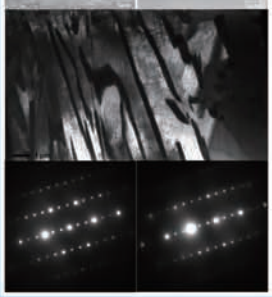
IMR

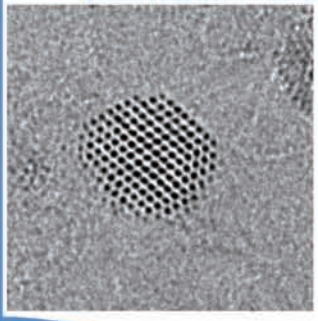
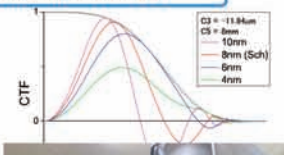
Institute for Materials Research

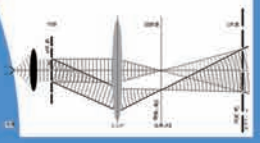




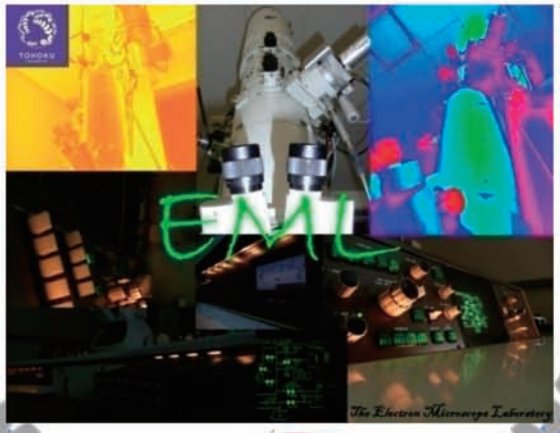
Art of Advanced Electron Microscopy

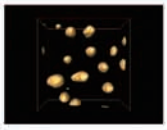



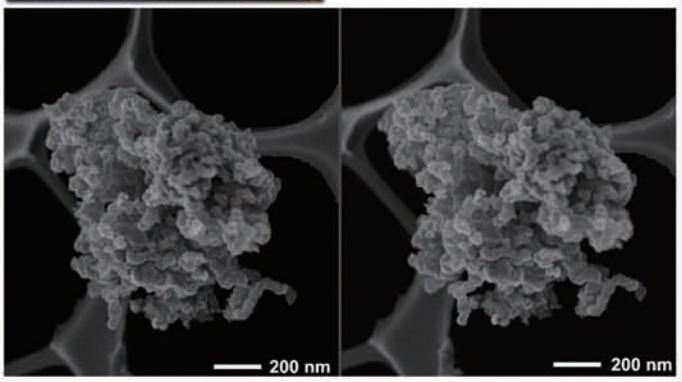
CENTER FOR INTEGRATED NANOTECHNOLOGY SUPPORT

CINTS

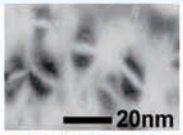


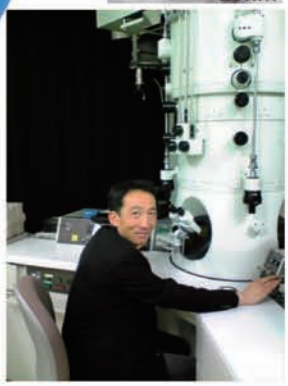
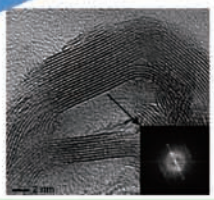
Materials for Environment





Materials for Safety



Center for Integrated Support for Nanotechnology is open to researchers in industries and academia. Our mission is to help understand the property of materials to ensure their functionality and usability through state-of-art characterization techniques.

http://cints-tohoku.jp/
cintsoffice@rpip.tohoku.ac.jp 022-217-6037

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

Ultra-low Friction Technology Area, Tohoku Innovative Materials Technology Initiatives for Reconstruction (TIMT)

Kazue Kurihara (WPI-AIMR & IMRAM, Tohoku University)

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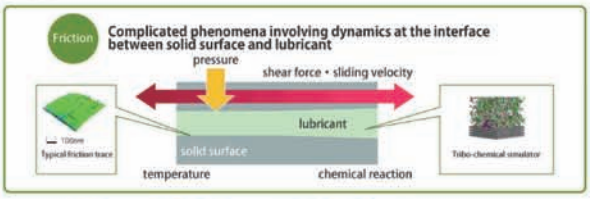
Friction Technology

Friction-reducing technology plays an important role in energy efficiency in automobile engines and many other mechanical systems.
(e.g. friction losses in automobiles amount to 20% of the total energy loss)

Major fuel efficiency improvement through optimized lubrication technology at nano-interfaces

We develop optimized ultra-low friction technology based on nano-scale measurements and theoretical explanations of friction mechanisms through fusion of mechanics and chemistry/materials science.



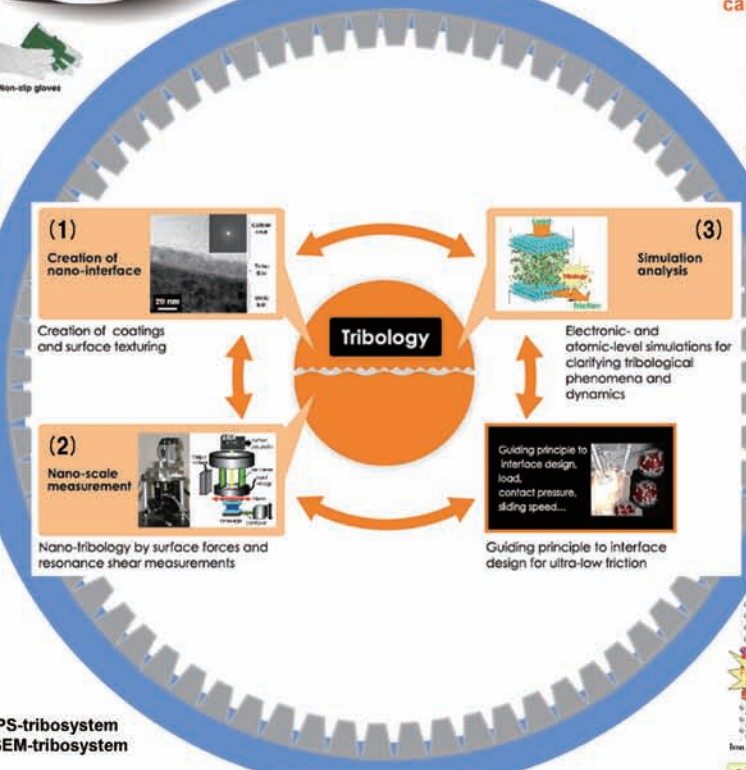
- **Economic influences of tribology (study of friction) is about 2 % of GDP**
- **Friction problems at contact interfaces of machines cause mechanical deterioration, damage and short life.**

control of friction/wear

Improvement of energy efficiency on mechanical systems

Guarantee of stable quality, high reliability and long life.

Innovation in Tribology



Research Topics

(1) Development of In-situ Analysis Systems of Friction/Wear and Optimized Design of Nano-interfaces realizing ultra-low friction

In-situ XPS-tribosystem & In-situ SEM-tribosystem

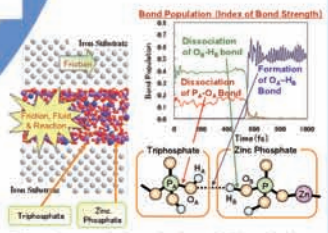
Construction of
-creation technology and argument of optimized design for nano-interafce realizing ultra-low friction
-platform for in-situ analysis of friction/wear

(2) Measurement Technology for Nano-level Elucidation of Friction & Interfacial Phenomena

surface forces apparatus(SFA)
Nano shear resonance apparatus(RSM)

Optimized design of interfaces/lubricating oils that exhibit low-friction
Establishment of the foundation for analysing nano-tribology

(3) Development of Tribo-Simulator for Analyzing Chemical Reactions on the Interface under Friction



Electric- and Atomic-Level Simulations for clarifying Tribo-Chemical Reactions

Establishment of design principals of tribo-materials/interface by Tribo-Simulator

This project aims to elucidate phenomena of friction on oil, water and solid lubrication using nano-technology and science through collaboration of mechanical and material researchers with industrial engineers. They intend to develop ultra-low friction technology based on their studies.

Collaborating Companies:

AKROS Co., Ltd, ASAHI KASEI CORPORATION, Kao Corporation, KYODO YUSHI CO., LTD, DENSO CORPORATION, TOYOTA MOTOR CORPORATION, TOYOTA MOTOR EAST JAPAN, INC, Hitachi, Ltd.

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

Development of Non-destructive Evaluation Technology and Functional Friction Materials for Safety/Relief and Energy Saving

Institute of Fluid Science, Tohoku University
Takagi / Kosukegawa / Uchimoto / Miki Laboratory

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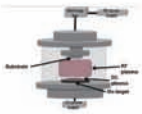
Development of functional thin film containing nanoclaster metals

Development of technique of mixing nanoclaster metals

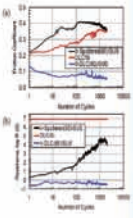
To develop the apparatus for fabricating materials utilizing plasma process



Conceptual diagram of fabricating film

Development of electro-conductive friction element

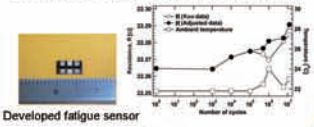
The technique, which makes contact to the object which moves without preventing a motion, is one of the required technique for a motor, a switch, etc.



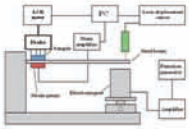
Conceptual diagram of contact monitoring

Development of thin film fatigue sensor

To use constructs of airplanes and bridges in safety, to understand the fatigue condition of the materials is important. Our lab develops novel fatigue sensor using hard carbon films.



Developed fatigue sensor

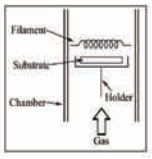


Conceptual diagram of fatigue testing

Development of low friction / low wear diamond coating

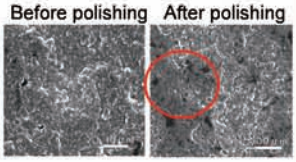
Fabrication of "polishable" diamond film

Fabrication of diamond film by utilizing hot filament chemical vapor deposition method



Rubbing both films

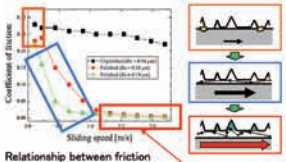
Before polishing After polishing



Polished diamond film has partially flat surface.

Materials: hydrocarbon gas, hydrogen gas

Friction velocity dependence



Relationship between friction coefficient and velocity

Super low friction !

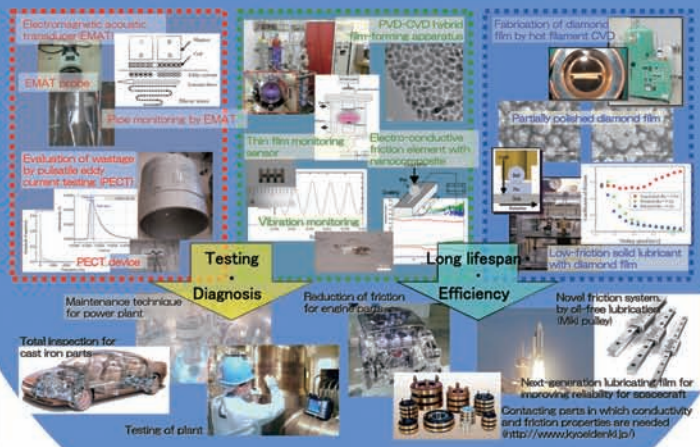
Perspectives

We succeed in fabricating diamond film on some parts of cylindrical surface, targeting linear motion bearing. We try to fabricate diamond film on the complex surface.

Linear motion bearing prototype

Laboratory Challenges

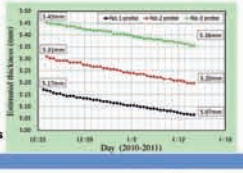
Safety and relief by diagnosis
Energy saving by low frictional lubrication



Research activities of non-destructive evaluation

Monitoring of pipe wall thinning under high temperature condition by electromagnetic acoustic resonance

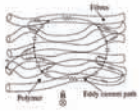
Probe installed on pipes



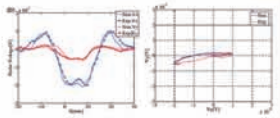
- Possible to evaluate thickness under high temperature condition at 165°C
- Error of measurement of thickness is the order of 10 μm

Non-destructive inspection of the CFRP which applies an electromagnetic phenomena

Carbon fiber reinforced by the eddy current
Defect diagnosis of plastic (CFRP)



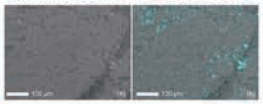
Relationship between electrical conduction path and the capacitance in CFRP internal



Numerical prediction of eddy current signal in crack on the CFRP by the finite element method

Functionality and performance of CFRP by chemical approach

Improvement of mechanical properties of CFRP of vacuum resin impregnation method origin by using a filler



- Distribute the filler which is easy to match with resin (Left figure a:SEM image in the CFRP, b: Emphasize a particle in the CFRP with blue)
- The flexural strength and flexural modulus are both increased by about 20%.

CFRP workshop

We will exchange knowledge and technology between university, public research institutions and companies in Tohoku area for targeted manufacturing, inspection, repair and recycling of CFRP.
Schedule
1st Tuesday Oct, 28 2014 Tohoku University Katahira Campus
2nd Tuesday Jan, 27 2015 Tohoku University Katahira Campus

Picture from the 1st time workshop

We are welcoming registration from enterprises which is interested in CFRP workshop anytime. You can apply for the registration by sending e-mail to the address below.
CFRP Workshop secretariat Email: cfrp-ken@mit.pref.miyagi.jp

Equipment of our lab

Analysis & Evaluation
-SEM/EDS
-XRD
-DSC
-Vibrating sample magnetmeter
-Hardness tester(Brinell Vickers)
-Fatigue tester/tensiletester
-AFM/MFM
-Nanoindenter

Non-destructive evaluation
-Ultra sound flaw detection
-Electromagnetic non-destructive evaluation apparatus

Material process
-Fabrication apparatus for diamond
-Fabrication apparatus for diamond-like-carbon
-Electrical furnace

To Enterprises

Our lab researches low friction solid lubricant system and multi-functional sensor by using carbon-based thin film, targeting clarification of mechanism and application.

We also researches cracking in metallic materials and evaluation of structure. If you would like us to evaluate, please contact our lab.

Contact
Email: web-asel@wert.ifs.tohoku.ac.jp

Manufacturing industry based on science and technology to establish a safe and secure society

Shoji Project
New Industry Creation Hatchery Center, Tohoku University

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Local strain measurement and fatigue strength evaluation by means of copper plating and EBSD method

Copper plating method:
utilizes recrystallization behavior in the copper thin film on the fatigue damaged surface depending on its cumulative strain amplitude

Electron backscatter diffraction method:
can obtain information about crystalline orientation and lattice direction in microscopically in the electron microscope

Crack path
(surface after removable of copper plate)

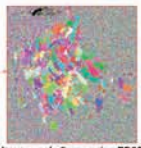
Crack path
(surface after removable of copper plate)

Crack path after fatigue test and strain measurement using copper plate

In addition to local strain, macro&micro
- metal structure
- hardness distribution

are evaluated so that preferential crack path and degree of degradation are evaluated

Analysis region on copperplate



Inverse pole figure using EBSD

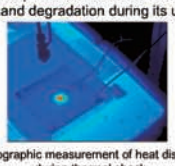
Estimation of strain amplitude and its distribution

Estimation of stress amplitude in nugget is possible during cumulative fatigue damage

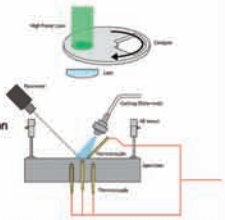
Development and evaluation of reproducing test for thermal fatigue cracking of metallic mold

・Improvement of production efficiency by preventing of accidental breakage & evaluation of residual life
・Illustration of degradation process by elucidation of surface/interface reaction and transport process

Aiming to propose methodologies for prevention of degradation in actual production site, clarification of influencing factors is carried out with proposed reproduction test.
We investigate microstructural change and surface film formation behavior by heat treatment in manufacture process. Evaluation of the relationship between those results and quality of product and degradation during its use is carried out



Thermographic measurement of heat distribution during thermal shock



Schematic diagram of thermal shock fatigue testing machine
(Local heating and cooling by laser beam and water splay)

Laboratory reproduction of thermal fatigue cracks on metal mold

Promotion of manufacturing industry supported by most advanced science and technologies

Early recovery support of Tohoku region with next generation automobile industry as core industry

"Promotion of shear of advanced facilities project" supported by MEXT
Platform of safety and security (region federated)
Iwate Univ., Fukushima Univ.

Establishment of a safe and secure society
Next generation automobile manufacturing industry supported by science and technology

cooperation

Shared use the state-of-the-art facilities for problem-solving

Illusidation of surface-interface phenomena
Aging degradation and damage during manufacturing process

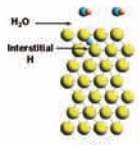
Casting・molding technology, ultra high precision machining technology

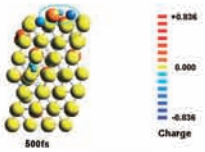
Human resource development
Small-group professional education for Mid-level member of society

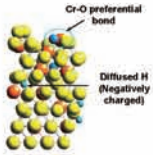
Innovations for Next Generation Automobiles

International center of excellence in aging degradation research

Expert group







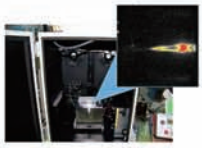
Dissociation of water and subsequent penetration of negative charged hydrogen atom into Fe-Cr binary alloy

・Evaluation of dissociation of water and hydrogen formation & penetration process by means of quantum molecular dynamics (QCMD) simulation

・Illustration of contribution process of hydrogen by in-situ measurement & evaluation of oxidation process

Degradation of structural material exposed to severe environments, especially for high temperature water is investigated through
- international cooperative researches
- development of instrumentation and measurement system for operating plant
- development of advanced analysis technique

Accelerated dissolution of iron by water dissociation and hydrogen atom penetration at iron oxide and water interface

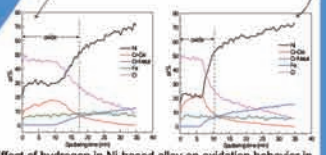


Evaluation of radical distribution by emitting light measurement with radical former using ultrasonic vibration

Build up behavior of hydrogen on metal surface

Hydrogen charged specimen

As received specimen



Effect of hydrogen in Ni-based alloy on oxidation behavior in high temperature water

Evaluation of oxidation behavior for different penetration paths of hydrogen

・Combination of surface analysis and tests in environment using specially designed fixture promotes evaluation of accelerated oxidation behavior
・Investigation of synergetic effect of of hydrogen with vacancy, dislocation, grain boundary and segregation

Unique behavior of hydrogen in metal and accelerated oxidation of the metal

Approaches

・Establishing technologies supported by fundamental science which could be a **basis of safe and secure** in various components, structures and society's infrastructure.

・Developing **Casting・molding technology, ultra high precision machining technology** and **surface integrity assessment** for safe and secure in manufacturing process.

・**Promoting of manufacturing industry and early recovery support of Tohoku region with next generation automobile industry as core industry**, that supported by most advanced science and technologies.

文部科学省地域イノベーション戦略支援プログラム　次世代自動車宮城県エリア

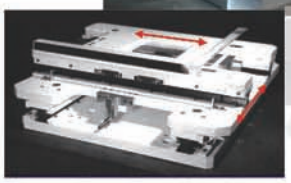
Creation of Advanced Mechanical Systems by Control of Nanointerface

Laboratory of Nanointerface Engineering, Department of Nanomechanics,
Graduate School of Engineering, Tohoku University, Japan
Adachi-Takeno Lab.

MEXT　TOHOKU ECONOMIC FEDERATION　Tohoku University　宮城県　七十七銀行　ICR

Creation of surface and interface for high friction and anti-wear ~ R&D of highly functionalized friction-driving actuators ~

Friction-drive ultrasonic motors or surface acoustic motors make it possible to achieve highly accurate positioning than ever.



We realized positioning system that increase accuracy 3 times than before and make the electron beam lithography device half in size by controling the wear at the driving point.

Creation of surface and interface for low friction ~ R&D of eco mechanical systems ~

Water or nitrogen gas make it possible to realize mechanical systems without oil.

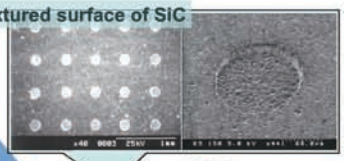
Water is lubricant in next generation

Multiple texturing on SiC surfaces allows us to realize very low friction of μ=0.0002 under 20 MPa contact pressure.

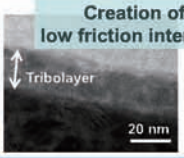
Inert gas is lubricant in next generation

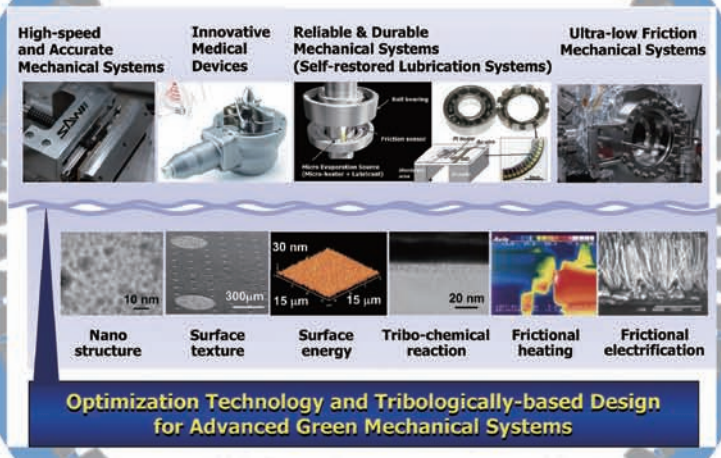
Hard thin coating can achieve friction of μ=0.004 under dry friction condition by the control of ambient.

Textured surface of SiC



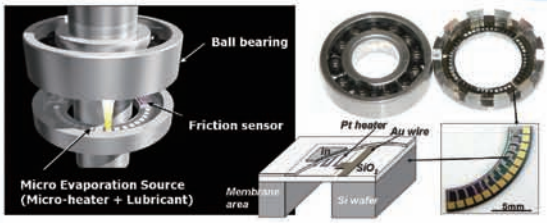
Creation of low friction interface





X-ray CT scan system

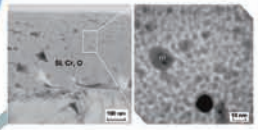
In-situ restoration system of solid lubricant can allow us to achieve semi-parmanent life-time of mechanical systems.



Self-controlling system for restoration of solid lubricant coating allows us to achieve high degree of silence that cannot be achieved before.

Creation of surface & interface for guarantee of low friction vibration for long time ~ R&D of silent medical mechanical systems ~

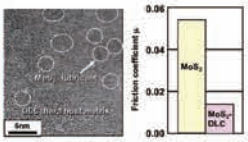
Nanointerface for low friction



Bottom-up approach

Nanocomposite coating mimicking Low friction nanointerface

Bottom-up type approach from nano-interface layer for low friction technology



Development of nanointerface optimizing technology for creation of low friction nanointerface.

- **Material design & creation**
  Control of nanostructure
- **Surface design & creation**
  Surface texturing and surface free energy
- **Design of contact condition & creation**
  Control of running-in and friction charge

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

New Solid-State Joining Processes for Automotive Industry

Hiroyuki Kokawa, Yutaka S. Sato, Hiromichi T. Fujii
Department of Materials Processing, Graduate School of Engineering, Tohoku University, 6-6-02 Aramaki-aza-Aoba, Aoba-ku, Sendai 980-8579, Japan

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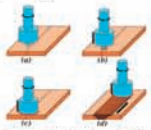
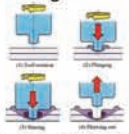
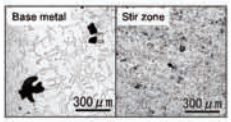
Fundamental study on FSW and FSSW

Friction stir welding (FSW)
Seam joining by solid state stirring of inconsumable rotating tool
Friction stir spot welding (FSSW)
Spot joining that utilizes friction stir welding


Friction Stir Welding (FSW)


Friction Stir Spot Welding (FSSW)

Research topics
- Joining mechanism
- Relationship between joint property and microstructure
- Microstructural evolution and control
- Dissimilar welding for iron and titanium

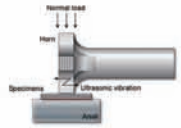


Application of FSW into cast alloys
Elimination of cast defects
Homogenization of microstructure
Enhancement of toughness and fatigue strength

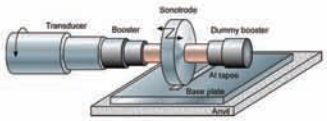
Al/Fe dissimilar FSSW
Multi-material structure

Fundamental study on USW and UAM

Ultrasonic welding (USW)
Solid state joining technique using ultrasonic energy
Ultrasonic additive manufacturing (UAM)
Additive manufacturing that utilizes ultrasonic seam welding

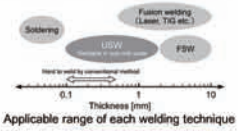


Ultrasonic Welding (USW)

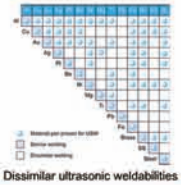


Ultrasonic Additive Manufacturing (UAM)

Research topics
- Similar and dissimilar ultrasonic welding
- Property evaluation and microstructural analysis
- Joining mechanism
- Development of UAM technique



Applicable range of each welding technique

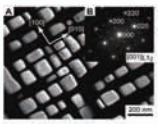

Dissimilar ultrasonic weldabilities

Novel joining technology and joining mechanism

Development of sound joint by novel joining technologies in poorly weldable materials and understanding of joining mechanism and phenomena

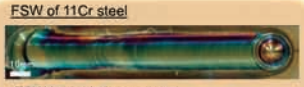
- Multi-material design of industrial components
- Energy saving and environmental load reduction


High stiffness FSW machine in Tohoku Univ.


Novel Co-based alloy FSW tool developed in Tohoku Univ.


No damage after FSW
✓ Al alloy like surface quality
✓ Excellent joint properties

FSW of 11Cr steel

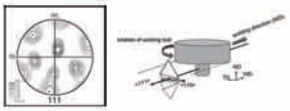

FSW in dual phase range
✓ 1.8 times as strong as base metal
✓ Higher ductility than base metal

Dissimilar FSW of 11Cr steel to 316 SS

✓ Defect free joint
✓ Fractured at base metal in tensile test

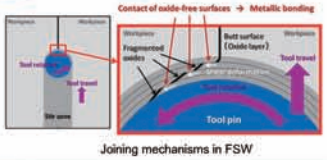
High grade joining of steels and Ti alloys


Analysis of oxide layer behavior during FSW by electron microscopy

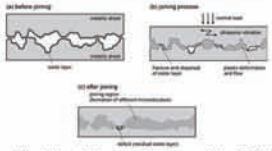

Understanding of materials flow during FSW by crystallographic analysis

Forefront microstructural analysis

Joining mechanism and phenomena



Joining mechanisms in FSW


Physical and chemical phenomena during USW

Challenges in solid state joining

～ Would you try the leading-edge joining technologies using FSW and USW? ～

Kokawa lab. is one of the handful research institutes where FSW is possible in steels and Ti alloys. USW has also been studied intensively in recent years. Feel free to ask questions!!

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

Advanced Manufacturing Technology Utilized Nano-Precision Machining

Nano-Precision Mechanical Fabrication Laboratory,
Dept. of Mech. Systems and Design, Grad. Sch. of Eng., Tohoku Univ.

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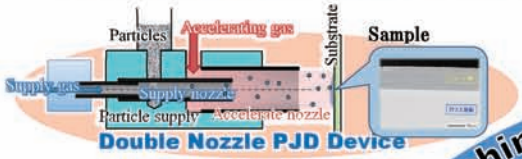
Energy storage!!
Powder Jet Deposition (PJD) for Creation of Secondary Batteries for Automobiles

Silicon negative electrodes — *Compared to Carbon*
- ✓5 times larger storage
- ✓High-temperature resistance

Vacuum-free/Room-temperature process — High deposition rate

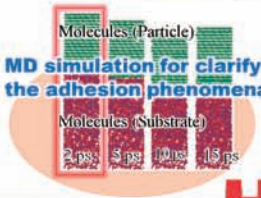
Advantages of Powder Jet Deposition (PJD)

Widely applicable technique to various materials



Double Nozzle PJD Device

SPH Simulation for clarifying the phenomena during collision



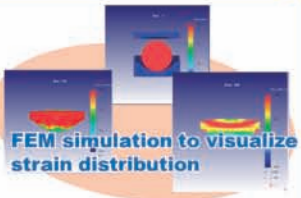
MD simulation for clarifying the adhesion phenomena

Safety and security!!
High-speed High-quality Aspherical Glass Lens Molding

Objective of usage of glass lenses
- ✓For using under severe conditions
- ✓Long-term usage
- ✓Miniaturizing of mount space

To realize Safe and Secure Next generation automobiles

Development of Aspherical Glass Mold Press Equipment

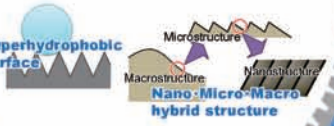


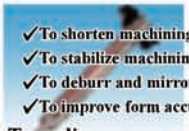
FEM simulation to visualize strain distribution

Profile analysis for nonisothermal molding press

Aspherical Molding Die Fabricated by Precision Grinding

Glass mold press Laser machining Nano precision cutting Ultrasonic machining
"Safety, Security, Comfort and Energy-saving" Elements for Next Generation Automobiles
Devices Installed in Next Generation Automobiles
High Value Manufacturing
Form + Function
Functional surface





- ✓To shorten machining time
- ✓To stabilize machining precision
- ✓To deburr and mirror-finish
- ✓To improve form accuracy

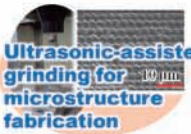
To realize
- ✓Omission of finishing
- ✓Super-high-pressure fuel injector

To realise:
- ✓Dirtproof, antireflective front window
- ✓Non-slip tires

Laser Microstructure Fabrication

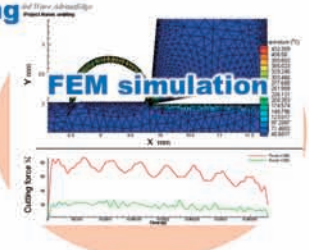
Ultrasonic Electrolytic grinding

Ultrahigh Precision Cutting for Fabrication of microgrooves



Ultrasonic-assisted grinding for microstructure fabrication

World first
3-dimensional ultrasonic-assisted machining



Energy saving!!
Ultrasonic Hybrid Machining for Manufacturing of Ultrahigh Pressure Fuel Jet Injector

Comfortable life!!
Creation of functional surfaces by various precision machining methods

For realizing "hopeful" advanced machining technology...

Our laboratory has been conducting researches to establish new machining principles and their scientific clarification, and to realize practical use on the basis of industry-academic-government circles.

Professor Tsunemoto KURIYAGAWA
TEL: +81-22-795-6949, FAX: +81-22-795-7027
Email: tkuri@m.tohoku.ac.jp

LAB

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

Development of Innovative Casting Technology

Graduate School of Engineering
Department of Metallurgy, ANZAI Lab.

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Microstructural Control of Ni Alloys

Ni alloys: excellent high-temperature strength, corrosion resistance

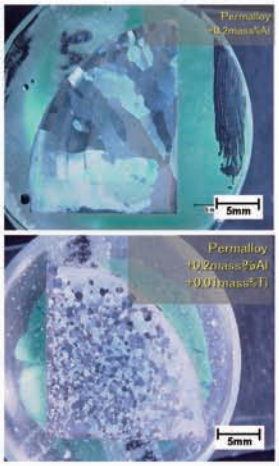
Center segregation in columnar structure

⇩ Decreasing of properties

Fine equiaxed structure is needed

⇩

Realization by elemental addition



Numerical Analysis of Macro Segregation

Background

◆Production method of special alloy

Ingot making: difficult to control quality

Macro-Segregation ⇒ Channel segregation

For optimization of operating condition

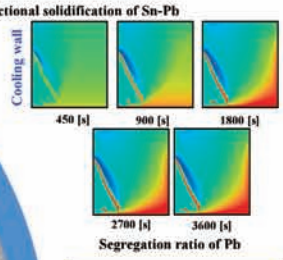
- With Computer Aided Optimization (CAO)
- Reproduction of segregation in ingot of Lab.

Purpose

Development of method of macro segregation simulation
Study for formation mechanism of channel segregation

Numerical result

Directional solidification of Sn-Pb



Reproduction of channel segregation

Anzai Laboratory

Development of Innovative Casting Technology for Making High Quality Automobile Parts

Research Topics
- Development of Casting Process Simulation
- Semi-Solid Casting
- Fluidity of Metals
- Casting Simulation using Particle Method

Members
- Professor : Koichi Anzai
- Associate Professor : Masayuki Itamura
- Assistant Professor : Naoya Hirata
- Secretary : Mai Sato
- DC Students : 3
- MC Students : 7
- BC Students : 6
- Others : 3

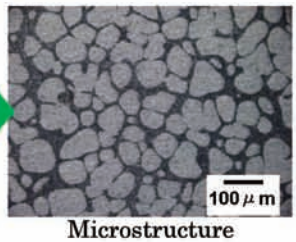
Semi-Solid Slurry Making Method

Rheocasting
- Reduction of air entrapment, shrinkage
- Excellent mechanical property
- Long life of die

Cup method
- Able to make slurry easily

Metallic vessel

AC4CH slurry



Microstructure

Casting Simulation using Particle Method

Result of interaction analysis of heat transfer and shrinkage using particle method

Particle method
- Movable computational element
- Interaction analysis: easy

⇔ ***Conventional method***
- High calculation speed
- Fixed computational grid
  → Low flexibility of shape
- Interaction analysis: difficult

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

Effect of Build Angle on Tensile Property of Inconel 718 Fabricated by Electron Beam Melting (EBM) Process

Shi-Hai Sun, Yuichiro Koizumi, Tsuyoshi Saito, Yun-Ping Li, and Akihiko Chiba
Institute for Materials Research, Tohoku University

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Introduction

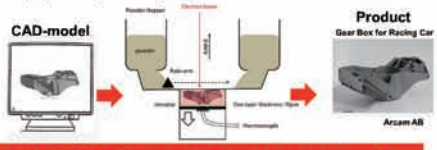
- **Inconel 718 Ni-based Superalloy**

Advantage: High mechanical strength, High corrosion resistance → application in aviation industry

Disadvantage: Low machinability, Low castability → Low productivity (diffcult to apply to automobile)

- **Electron Beam Melting (EBM) : 3D-printer for metals**

Metal parts with any shape can be produced by only CAD model & Metal powder without using mold.



Is the of the EBM-built IN718 alloy parts strong enough?

Objective To investigate the microstructures and high temperature tensile properties of Inconel 718 rods fabricated by EBM in various directions.

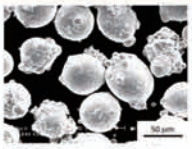
Experimental

Raw material (Gas atomized powder)

Chemical composition of Inconel 718 powder (mass %)

Ni	Cr	Mo	Nb	Ti	Co	Al	C	N	Fe
53.5	19.4	2.97	4.88	0.84	0.10	0.48	0.036	0.0077	Bal.

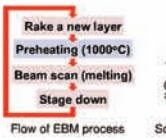
Particle size : 45~150 μm (74 μm ave.)



SEM image of powder particles.

EBM process

- Equipment : Arcam EBM A_2X
- Preheating temp. : 1000˚C
- Layer thickness : 70 μm
- Scan way : x-y scanning
- Scan speed : ~ 600 mm /s



Flow of EBM process

Scanning direction


Preheating

Heat treatment

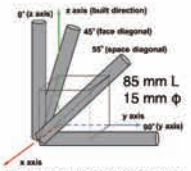
Solution treatment at 980˚C for 1 h → Water quench (WQ)
→ 1st aging at 720˚C for 8h → 2nd Aging at 620˚C for 8h → WQ

Tensile test

Temperature : 650˚C Strain rate : 1.5×10^{-4} s^{-1}

Microstructure analysis

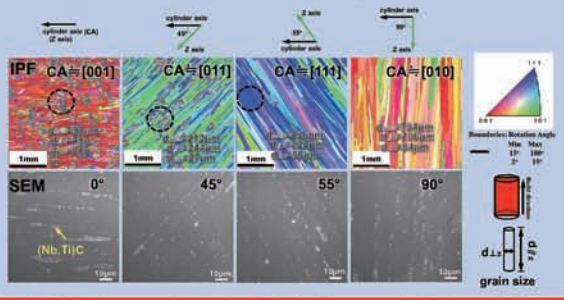
SEM-EBSD, EPMA



Schematics of of rods fabricated.

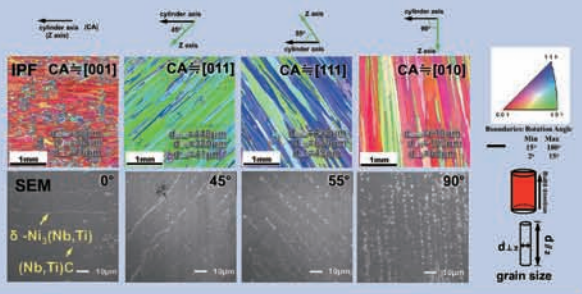
Results & Discussion

Microstructure of as-EBM-built samples



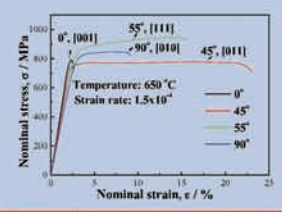
As-EBM-built rods are strongly cube-oriented in both the beam scanning direction and build-diretiaon.

Microstructure after heat treatment



The textures were maintained even after heat treatment. δ-Ni_3(Nb,Ti) precipitated.

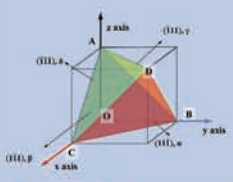
Effect of build-direction on tensile property



Comparison of strenghth and eleongation.

Sample	0.2% YS (MPa)	UTS (MPa)	Elongation %
0°	790	799	0.53
45°	756	783	20.8
55°	840	947	12.8
90°	787	852	6.4
HIP[3]	1018	1140	3
Wrought[3]	860-1000	1000-1200	12-19

The rod EBM-built in space diagonal direction (55˚ sample) is as strong as the wrought conterpart.

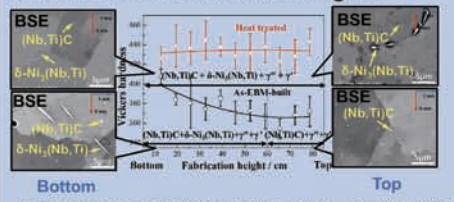


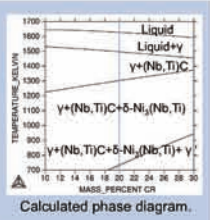
Schmid factor μ of perfect dislocation in {111}<110> slip system.

	0˚-sample	45˚-sample	55˚-sample	90˚-sample
Maximum μ in α	0.408	0	0.272	0.408
Maximum μ in β	0.408	0	0.272	0.408
Maximum μ in γ	0.408	0.408	0.272	0.408
Maximum μ in δ	0.408	0.408	0	0.408
Maximum μ in all the variants	0.408	0.408	0.272	0.408

The build-direction dependence of strenghth can be attributed to the crystal orientation dependence.

Hardness on different build heights



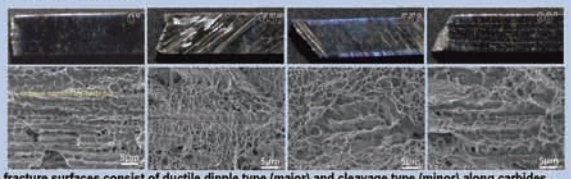


Calculated phase diagram.

The hardness of the as-EBM-built sample was not uniform along the build-height.

Uniform and higher hardness can be obtained by aing heat treatment to form δ-Ni_3(Nb,Ti) intermetallics.

Fracture surface



The fracture surfaces consist of ductile dinple type (major) and cleavage type (minor) along carbides.

The strenghth can be further improved by controlling carbon content to avoid fracture along carbides.

Conclusions

- The cylinder axes were oriented near [001], [011], [111] and [100] directions in samples whose cylindrical axes were deviated from z axis by 0˚, 45˚, 55˚, and 90˚, respectively.
- Carbides were aligned along the built-direction. Plate-like δ- Ni_3(Nb,Ti) precipitates were formed in the bottom part of the as-EBM-built samples owing to the long holding time.
- The hardness became uniform along the built height after heat treatment and was higher than that of as-EBM-built one.
- The 55ºsample exhibited the highest UTS among the samples built in different orientations.
- Crack propagates along grain boundaries owing to stress concentration caused by precipitates on the grain boundaries.
- The built condition for 0ºsample was not appropriate, and the unmelt particle lead to the low ductility.

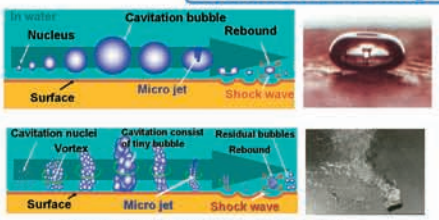
Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

Suppression of Crack Initiation of Metallic Materials by Using a Cavitating Jet in Air

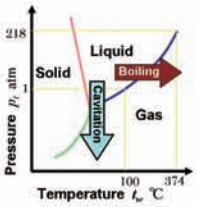
Hitoshi Soyama and Osamu Takakuwa, Tohoku University

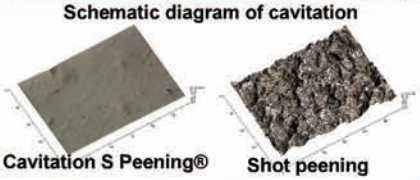
MEXT | TOHOKU ECONOMIC FEDERATION | Tohoku University | 宮城県 | 七十七銀行 | ICR

Cavitation S Peening®

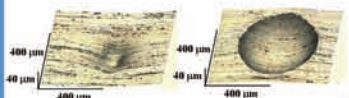


Schematic diagram of cavitation

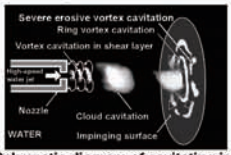




Cavitation S Peening® | Shot peening

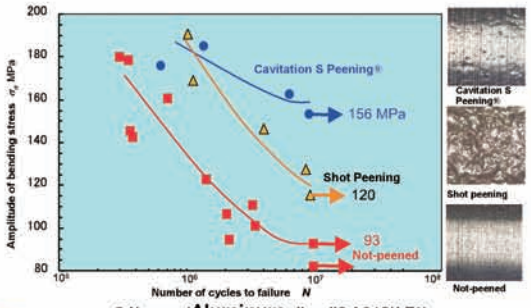


Cavitation S Peening® | Ball indentation



Schematic diagram of cavitating jet

Improvement of Fatigue Strength of Metallic Materials

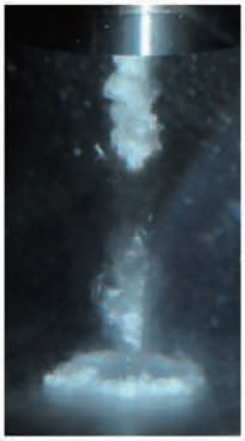


S-N curve (Aluminum alloy JIS AC4CH-T6)

Improvement of fatigue strength of gear demonstrated using a power circulating type gear tester (Carburized SCM420H)

Surface modification by using cavitation impact

Cavitation S Peening®



Cavitating jet in water

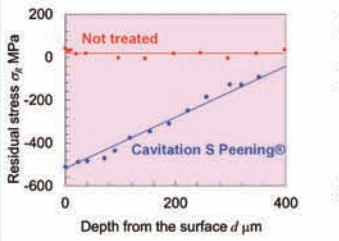
Cavitating jet in air

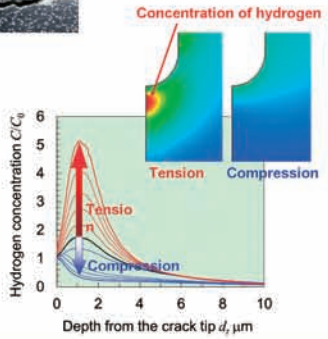
Suppression of Hydrogen Embrittlement

Introduction of compressive residual stress

⇒Suppression of hydrogen adoption

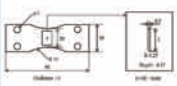
⇒Suppression of hydrogen embrittlement



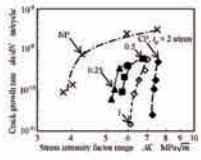


Evaluation of Materials Properties

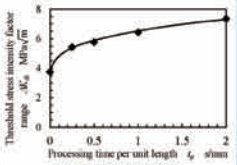
Load controlled plate bending fatigue test machine developed by Soyama Lab.



Geometry of specimen with notch



Relation between ΔK and da/dN in decremental step load test



Increase of ΔK_{th} by Cavitation S Peening®

Conclusions

In order to make clear the mechanism of improvement of fatigue strength by cavitation peening, the effect of cavitation peening on crack initiation and the threshold stress intensity factor range were evaluated. It was concluded that the cavitation peening reduced crack propagation but also suppressed the crack initiation.

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Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

Ultra Low Power Consumption Display for Next Generation Automotives: Spatially Imaged Iris-plane Head Up Display

(Uchida Lab. New Industry Creation Hatchery center Tohoku Univ.)

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1, Introduction

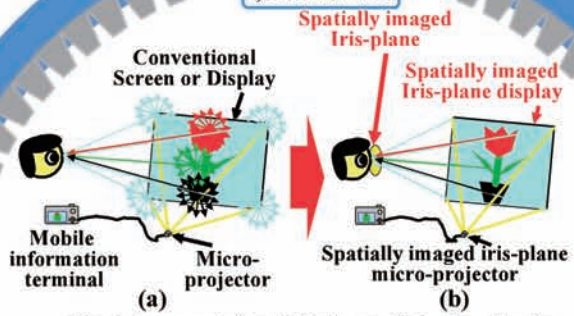

Fig. 1 A concept of spatially imaged iris-plane display
(a) a conventional display (b) a spatially imaged iris-plane display

A conventional display diffuses optical rays from screen or surface of display to free space shown as Fig. 1 (a). But only rays which pass through the pupil of which diameter is 2~8mm of human's eyes are used. The most part of rays are not used. Namely the most energy of displays goes to waste. We omitted this wasted energy and newly developed ultra low power consumption display.
A novel concept of this display is that display gathers rays of displayed images near eyes of observer in spatial and angular luminance uniformity shown in Fig. 1 (b). We call this area to which rays gather spatially imaged iris-plane. Only in this area observer can observe displayed image. Therefore the most part of rays are used and ultra high efficiency is achieved.

On the other hand observation area is limited. This trade-off is a dilemma of high efficiency and wide observation area. To solve this dilemma we introduce eye-tracking system. An eye-tracking system detects the position of observer's eyes. According to this detected position of observer' eyes a display changes the direction of rays and shifts spatially imaged iris-plane to the position of observer. When an observer moves a spatially imaged iris-plane tracks observer's eyes. By this method a dilemma of high efficiency and wide observation area is solved.

2, Principle, method, and structure

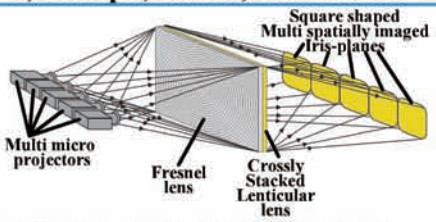

Fig. 2 Multi-view display using multi spatially imaged iris-plane technology

Spatially imaged iris-plane display is based on the technology of multi-view display. We have researched on multi-view displays [1]-[3]. Fig. 2 shows a structure of our multi-view display using multi spatially imaged iris-plane technology. By this technology the square shaped multi spatially imaged iris-planes are formed side by side in space. There is no overlap and no gap between the adjacent iris-planes. An eye-tracking system detects the position of observer's eyes and selects iris-plane in which observer's eyes exist by selecting multi projectors. Therefore ultra low power consumption display with wide observation area is achieved.

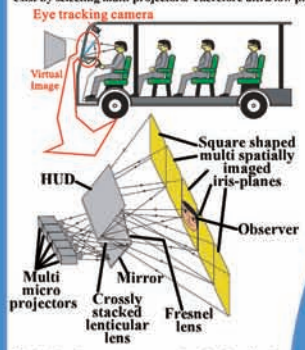

Fig. 3 Ultra low power consumption head up display by multi spatially imaged iris-planes and eye-tracking system

3, Experiment

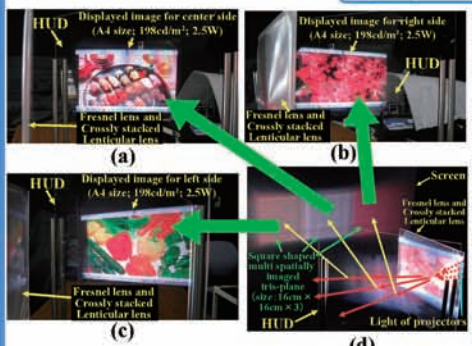

Fig. 5 An experiment and results of ultra low power consumption multi-view HUD
(a) Center side, (b) Right side, (c) Left side, (d) Multi-view HUD

Fig. 5(d) shows an experimental set-up of three-view HUD as shown in Fig. 3. In spatially imaged iris-plane an observation screen is set as shown in the upper side of Fig. 5(d). On this screen three square shaped spatially imaged iris-planes are successfully imaged side by side with no cross-talk and no gap. This is the ideal condition of eye-tracking system. Fig. 5(a), (b) and (c) show observation results of displayed images from within corresponding three spatially imaged iris-planes. It is confirmed that no cross-talk and instantaneous switching of displayed image at boundary between iris-planes. Displayed image size is A4 and luminance is 198cd/m2. Power consumption of a normal A4 size liquid crystal display is 40W. Compared with this the power consumption of our display is 2.5W. Namely ultra low power consumption of 1/16 is successfully achieved. In case of direct view shown in Fig. 2 ultra low power consumption of 1/400 is successfully achieved.

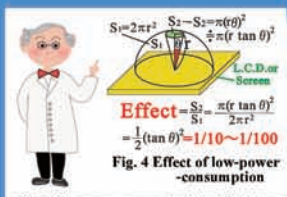

Fig. 4 Effect of low-power -consumption

Effect of low power consumption is $(\tan^2\theta)/2$ shown in Fig. 4, where θ is limited diffusion angle. This is a ratio of solid angles. S1 means a solid angle of all directional uniform diffusion in case of a conventional display or screen. On the other hand S2 means a solid angle of limited uniform diffusion in case of spatially imaged iris-plane display. Therefore S2/S1 means effect of low power consumption. Our target is 1/10~1/100. Moreover for good see-through HUD our display uses normal glass plate of which a reflective coefficient is 4%. And so in order to realize low power consumption of 1/10 on condition of 4% at a reflective coefficient effect must be needed $(1/10)\times(1/25)=1/250$. On this condition we set diffusion angle 5.1 degrees because of $(\tan^2\theta)/2=1/250$.

4, Ultra Low Power consumption HUD on EV bus

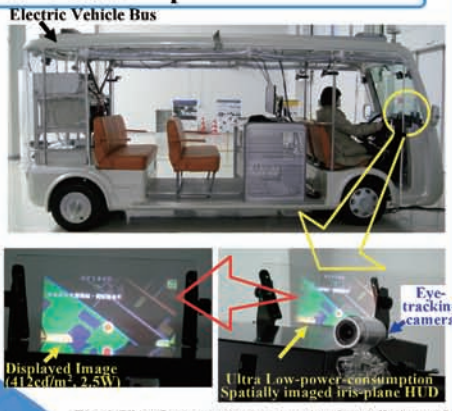

Fig. 6 Ultra Low-power-consumption Spatially imaged iris-plane HUD mounted on Electric Vehicle Bus and Displayed image

Fig. 6 and 7 show our HUD and an eye-tracking system mounted on EV-Bus. This HUD is 5-view HUD shown in Fig. 3 and range of each view is ±5 degrees. Namely total range is ±25 degrees. For practical use this range is enough. Luminance is 412cd/m2 and power consumption is 2.5W. Ultra low power consumption of 1/16 compared with a normal liquid crystal display is successfully achieved. An eye-tracking system detects the position of observer's eyes at processing speed of 50 frames per second and selects projectors to move spatially imaged iris-plane. Therefore smoothly eye-tracking by spatially imaged iris-plane is successfully achieved as shown in Fig. 7.

5, Eye-tracking system

Fig. 7 Ultra Low-power-consumption Spatially imaged iris-plane HUD and Eye-tracking system mounted on Electric Vehicle Bus

6, Conclusions

Low power consumption is more and more important for next generation motives. For this purpose we proposed and developed a spatially imaged iris-plane HUD. By this novel HUD ultra low power consumption of 1/16 compared with a normal liquid crystal display is successfully achieved. Moreover by direct view type ultra low power consumption of 1/400 is successfully achieved. We believe that this display will strongly contribute to realization of ultra low power consumption HUD for next generation automotives.

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[3] Takahiro Ishinabe, Tohru Kawakami, Noriyuki Takahashi, Tatsuo Uchida "High-resolution autostereoscopic 3-D projection display with a space-dividing iris-plane shutter" Journal of the Society for Information Display 18/8, 2010 ,pp583-588.


Tatsuo Uchida
Guest Professor


Yoshito Suzuki
Specially missioned Professor


Tohru Kawakami
Guest Associate Professor


Mutsumi Sasai
Industrially, Academically and Governmentally Associated Researcher

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

Image Sensing Technology Breaking the Limit of Pixel Resolution

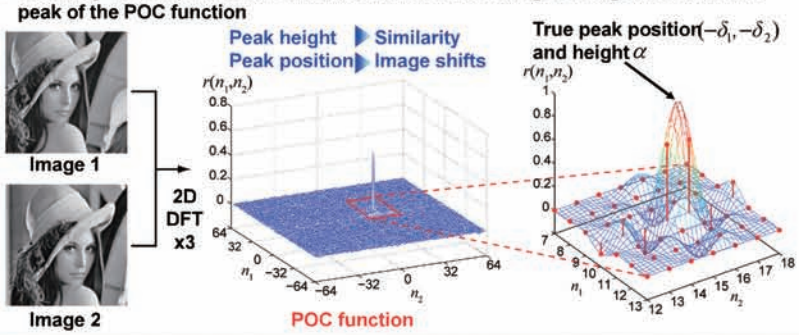
Graduate School of Information Sciences, Tohoku University, Japan
Prof. Takafumi Aoki, Assoc. Prof. Naofumi Homma and Assis. Prof. Koichi Ito

MEXT TOHOKU ECONOMIC FEDERATION Tohoku University 宮城県 七十七銀行 ICR

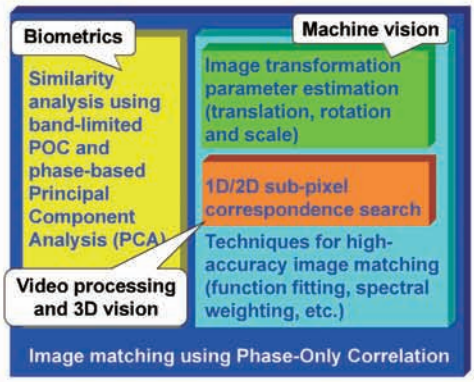
We present fundamentals of Phase-Only Correlation (POC) --- a technique for high-accuracy registration of 1D, 2D and 3D signals using phase information of discrete Fourier transform. Since 1990s, our research group has developed a novel technique of phase-based image matching for fingerprint verification and industrial machine vision. We have recently proposed an efficient image correspondence algorithm using POC, which can find pairs of corresponding points between the given two images with sub-pixel accuracy. This allows us to apply the POC technique to a wide range of applications, including smart image sensors, microscope image analysis, passive 3D vision, automotive image processing, image-based human interface, biometrics authentication, and medical image analysis.

Phase-Only Correlation (POC)

- A high-accuracy image matching technique using the phase components in 2D Discrete Fourier Transforms (DFTs) of given images
- Similarity and displacement estimation between two images using the correlation peak of the POC function



High-Accuracy Image Matching Technology




3D reconstruction from multi-view images


Projector-camera system


Automotive 3D vision for driver assistance

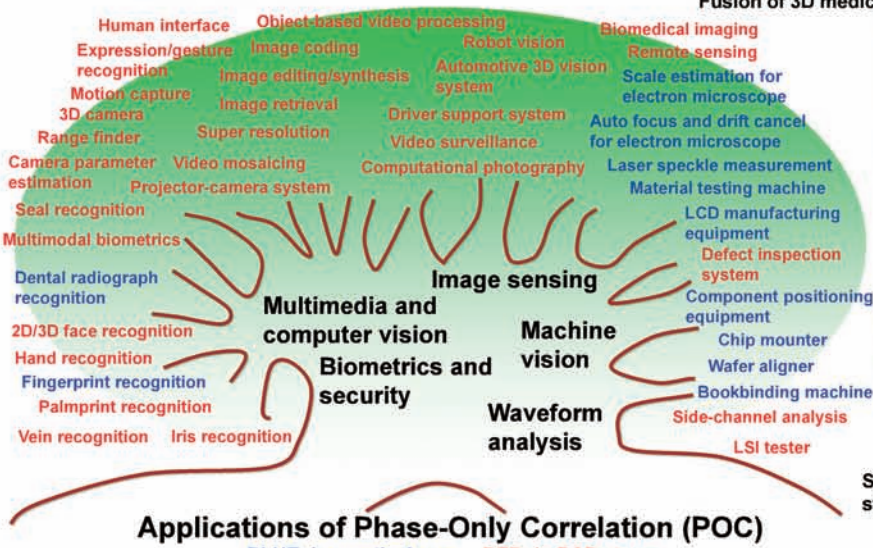

Fusion of 3D medical data and 2D face image


3D human capture


Real-time 3D measurement system


Universal image recognition sensor


Side-channel attack standard evaluation boards



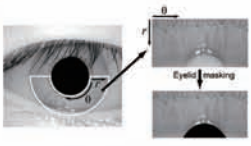
Applications of Phase-Only Correlation (POC)

BLUE: in practical use RED: in R&D stage

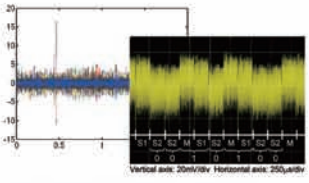

2D/3D face verification system

Dental radiograph recognition


Palmprint verification for mobile phones



Iris recognition


Waveform analysis against cryptographic circuits

Aoki Laboratory,
Graduate School of Information Sciences, Tohoku University, Japan
Web: http://www.aoki.ecei.tohoku.ac.jp/

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

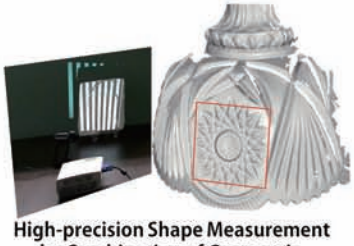
Future Created by Computer Vision

Okatani Lab.
Graduate School of Information Sciences, Tohoku University

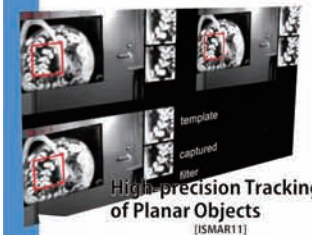
MEXT TOHOKU ECONOMIC FEDERATION Tohoku University 宮城県 七十七銀行 ICR

Basic Research

Optimization of Markov Random Fields [CVPR12, CVPR13]



High-precision Shape Measurement by Combination of Geometric and Photometric methods [CVPR12]



High-precision Tracking of Planar Objects [ISMAR11]

Mechanism of "Miniature Scene Photographs" [CVPR07]

Applications

Projector-based Virtual Reproduction of Surface Reflectance [CVA10]

Projector Super-resolution [IEEE-TIP09]

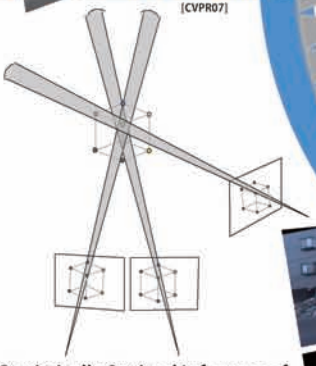
Easy Calibration of Multi-projector Displays [IJCV09]

Image Compensation of Hand-held Projectors [ACCV10]

"Gaze-reactive" Displays

Future World Shaped By Computer Vision

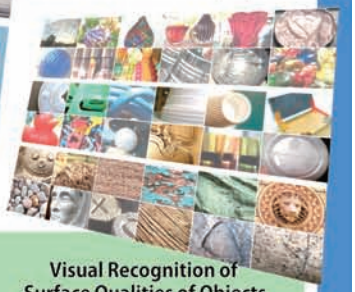
Statistical Mathematics and Numerical Computation + Physics-based Vision



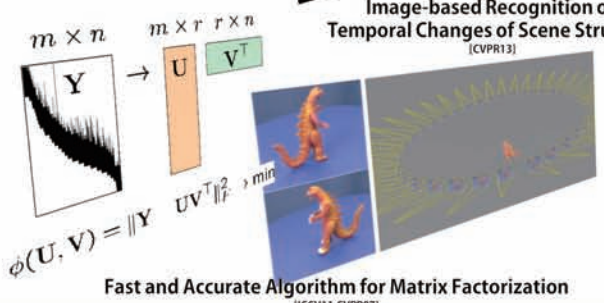
Statistically Optimal Inference of Multi-view Geometry and Numerical Computation [CVPR09,ICCV09]

Image-based Recognition of Temporal Changes of Scene Structure [CVPR13]

Image Archiving of Great East Japan Earthquake and Its Appications



Visual Recognition of Surface Qualities of Objects



Fast and Accurate Algorithm for Matrix Factorization [ICCV11,CVPR07]

Contact:
Email: okatani@vision.is.tohoku.ac.jp
http://www.vision.is.tohoku.ac.jp/

Functional Brain Imaging Prompts Innovations in Next-generation Automobiles

Department of Advanced Brain Science, IDAC, Tohoku Univ.

MEXT TOHOKU ECONOMIC FEDERATION Tohoku University 宮城県 七十七銀行 ICR

Our Seeds: Neuroimaging Facilities

Our laboratory have been managing all kinds of neuroimaging equipment. <= unique and rare


3T-MRI for Human


200-channel MEG


192-channel EEG


Multi-channel NIRs


7T-MRI for Rat


EEG for Rat


Handy EEG


Wearable NIRs


2-channel NIRs

A Message to Industrial Circles

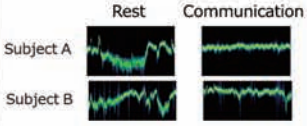
～Visualization of brain function is now ready for your R&D. Let's join us.～

We believe our new original system, which can estimate quality of communication and/or sympathy etc., will bring forth a new perspective for your developments.

A New Ultra-small NIRs System

・Total weight: 90g
・Radio transmission (currently using Zigbee)
・Enable simultaneous recording from 20 subjects

Neural activities of the dorsolateral prefrontal cortex show synchronization when participants make a well established communication.



Reformation of Convivial Society by Visualization of Communicative Activities and Sympathy

Seeds of Our University

Ultra-small NIRs system

・Real time and simultaneous measurements from multiple subjects under daily circumstances

・Synchronization of brain activities among different individuals when established good communication

Qualitative Measurements of Human Communicative Activities

Industries making products that correlate human communication

E.g. Automobile, Construction, IT, Electrical, Education, Welfare, etc.

Current social problems;

Declining birth rate and super ageing populations

↓

Social Isolation

Conception of collaborations; Reformation of convivial society which enables mutual aid.

R&D for social systems enable better communicative activities among different generation.

Examples of industrial enterprises

①Mobility which can produce good communication with driver and passengers
②Ultra-productive meeting system which can engage intense brainstorming.
③Social network services which can mediate better communication and understanding among different generation and people with different cultural backgrounds.

Establishment of Minimally Invasive Cell Therapy for Diabetes by Introducing Interdisciplinary Approach

Kimiko Watanabe and Masafumi Goto
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1-1 Seiryomachi Aoba-ku, Sendai 980-0872, Japan
E-mail goto@niche.tohoku.ac.jp

ABSTRACT

Arteriovenous malformation (AVM) is appropriately treated with total pancreatectomy (TP) with islet autotransplantation (IAT). We performed this treatment for three AVM patients and had good outcomes in two of the patients. Further optimizations based on a systematic evaluation of clinical experiences are needed to improve the outcome and safety of this promising approach. The roles of Collagenase G (ColG) and Collagenase H (ColH) during pancreatic islet isolation remain controversial, possibly due to the enzyme blends used in the previous studies. We revealed that ColH is crucial, while ColG plays only a supporting role, in rat islet isolation.

1. Introduction

The pancreatic islet transplantation has strong social impact in many of the advanced cell transplant therapies, and is the ideal "minimum invasive" treatment for the severe diabetic patients who are suffering with controlling the blood glucose levels (Fig. 1). However, multiple organ donors are still needed in order to cure a diabetic patient. Therefore, establishment of minimally invasive cell therapy for diabetes by introducing interdisciplinary approach could be necessary to make islet transplantation a standard treatment. Our chief objective is to construct the center of medical cell-engineering therapy as successful examples in Tohoku University.

2. Method

(1) Clinical Experiences in the treatment of pancreatic arteriovenous malformation (AVM) by total pancreatectomy (TP)

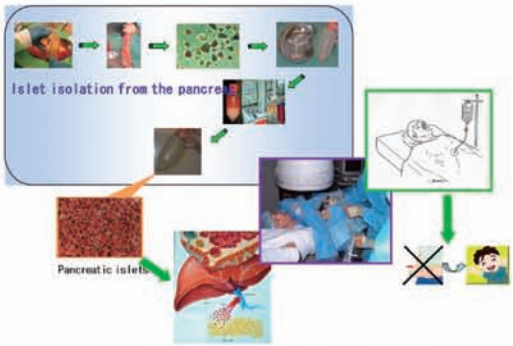


Fig. 1 Islet isolation and transplantation

with islet autotransplantation (IAT) Most AVM cases have pancreatic bleeding due to portal hypertension and the rupture of abnormal vessels and AVM is thought to correlate with pancreatitis. To prevent diabetes induced by TP, three male AVM patients underwent TP with IAT.

(2) Collagenase H is crucial for isolation of rat pancreatic isles Rat pancreases were digested using thermolysin, together with collagenase G (ColG), collagenase H (ColH), or ColG/ColH (n=9, respectively). An immunohistochemical analysis, *in-vitro*-collagen digestion assay, and mass spectrometry were also performed to examine the target matrix components of the crucial collagenase subtype.

3. Results and Discussion

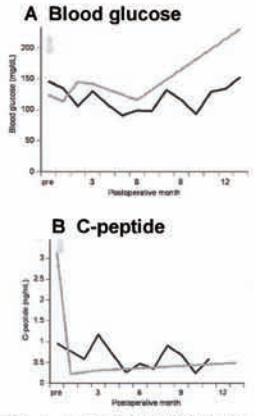
(1) Clinical Experiences in the treatment of AVM by TP with IAT
The numbers of isolated islets and total tissue volume were 355,270 islet equivalents (IEQ) and 5.7 mL (patient 1), 244,758 IEQ and 16.0 mL (patient 2), and 310,238 IEQ and 1.0 mL (patient 3). Many larger clusters derived form a cystic lesion were detected in patient 2. Thus, we had to stop patient 2's transplantation when half of the islets were transplanted. Fig.2 shows the postoperative courses of the patients. The blood glucose levels were well controlled using low-dose insulin injection in patients 1 and 3. The blood glucose of the recipients was well maintained without hypoglycemia, and a substantial level of fasting C-peptide was observed under a low dose of daily insulin supplementation (1).

(2) Collagenase H is crucial for isolation of rat pancreatic isles The islet yield in the ColG/ColH group was highest (4,101 ± 460 islet equivalents). A substantial number of functional islets (2,811 ± 581 islet equivalents) were obtained in the ColH group, whereas no islets were retrieved in the ColG group (Fig. 3). To examine the role of the collagenase subtypes, ColG and ColH were sequentially injected into the pancreatic duct of rats. An additional injection of ColG following an initial injection of ColH led to a slight increase in the islet yield (Fig. 3). On the contrary, no beneficial effects were observed following an additional injection of ColH (Fig.3). Mass spectrometry demonstrated

that ColH reacts with collagen-I and III (data not shown). In the immunohistochemical analysis, both collagen-I and III were located in exocrine tissues, although collagen-III was more pronounced (data not shown). The collagen digestion assay showed that collagen-III was more effectively digested by ColH than by ColG (2).

4. Concluding remarks

We are convinced that technical innovation through these projects contributes much more to the activation of medical industry based upon cell therapy.



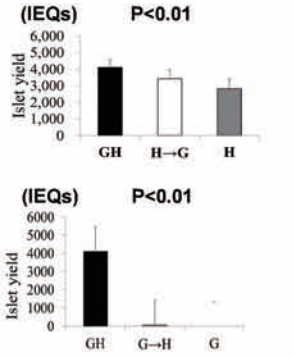


Fig.3 The effects collagenase subtypes on the islet yield.

Fig. 2. A blood glucose, B, serium C-peptide after TP with IAT in patients.
solid line: patient 1, dashed line: patient 3

(These figures were cited from Cell Transplantation, Jun 13, 2013 (Epub ahead of print) .)

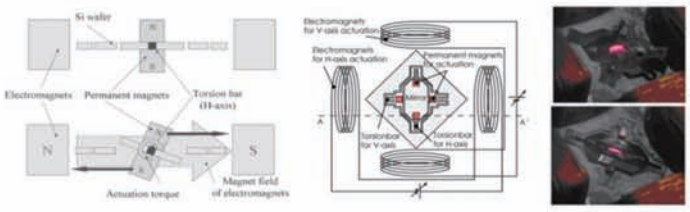
On the other hand, most of us use the motor car and spend amounts of time in a car. In the United State, estimates suggest an additional 42 accidents/year as a result of mild and moderate hypoglycemia in people with insulin-treated diabetes. Therefore, safely driving for people with diabetes requires the development of in-vehicle medical monitoring. **Therefore, in the motor car project, we would like to produce an innovative car in order to reduce the risks of medical mishaps behind the wheel.**

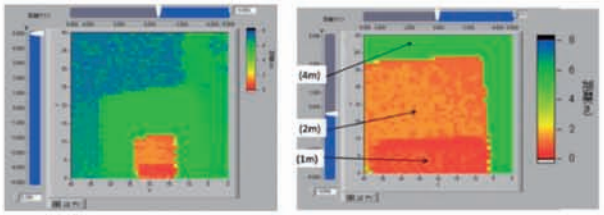
MEMS Based Safety Systems for Automotive

Masayoshi Esashi (WPI-AIMR, Tohoku Univ.)

1. Range finder with zooming function using optical scanner

(collaboration with Toyota motor, Toyota Central Research Lab. and Ricoh)

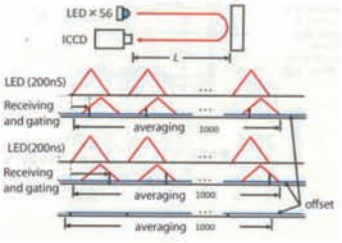


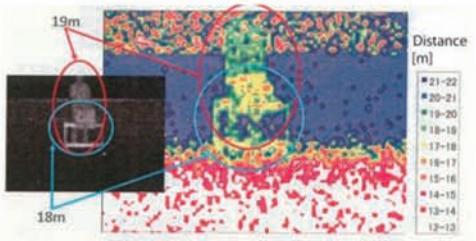


(a) Non-resonant 2D galvanic optical scanner (b) Obtained range image with zooming function

W.Makishi, Y.Kawai and M.Esashi, Magnetic Torque Driving 2D Micro Scanner with a Non-Resonant Large Scan Angle, Trans.IEEJ, 130-E, 4 (2010) 135-136

2. Range finder using LED pulse and image intensifier camera with shutter



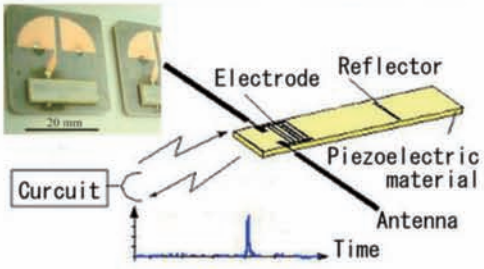


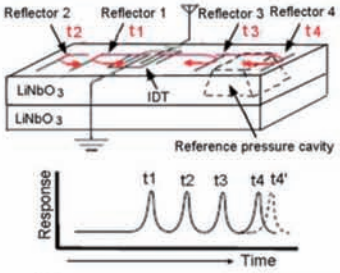
(a) Principle (b) Experimental setup (c) Experimental result

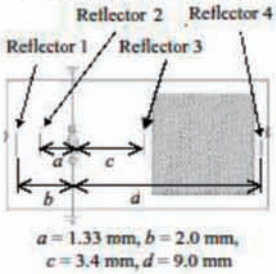
Y.Nakano, Y.Kawai, N.Ikegami and M.Esashi, Time-of-flight Range Finder Using LED Light Source, 2010 IEEJ Convention, Tokyo, (March 17-19, 2010) 1-116 p.132 (in Japanese)

3. Wireless SAW sensor for tire pressure monitoring

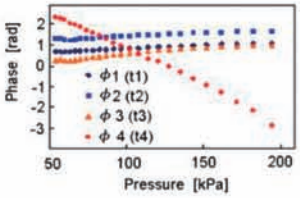
(Collaboration with Nissan motor)

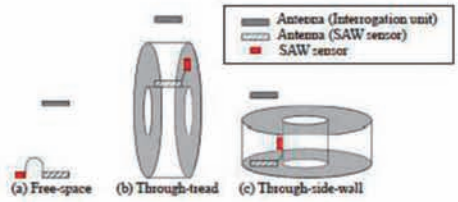






(a) Principle of SAW wireless sensor (b) Structure of SAW wireless pressure sensor





(c) Diaphragm (d) Experimental result of pressure measurement (e) Measurement scheme

S.Hashimoto, J.H.Kuypers, S.Tanaka and M.Esashi, Design and Fabrication of Passive Wireless SAW Sensor for Pressure Measurement, Trans.IEEJ, 128-E, 5 (2008) 231-234

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

Thermal Imaging using Temperature Sensitive Paint

Takashiro Tsukamoto and Shuji Tanaka
Tohoku University

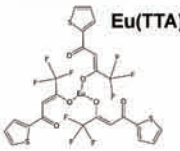
MEXT TOHOKU ECONOMIC FEDERATION Tohoku University 宮城県 七十七銀行 ICR

Temperature Sensitive Paint (TSP)

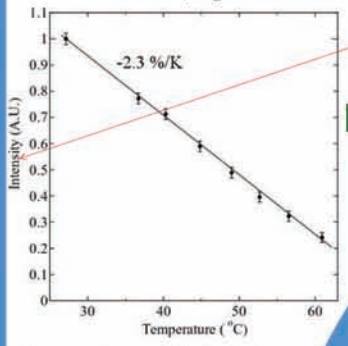
The Intensity of luminescence from the TSP is modulated by the temperature of TSP.

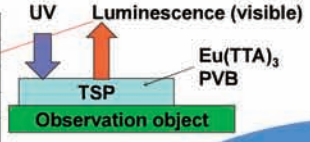
The TSP consists of $Eu(TTA)_3$ as a luminescent material and PVB as a matrix.

$Eu(TTA)_3$



A normal CCD/CMOS camera with microscope (without high-cost Ge optics)
→ Low cost, high resolution





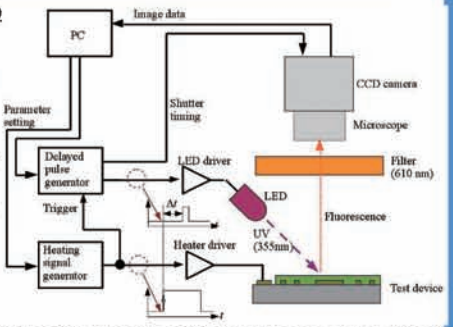
Temperature coefficient of intensity (TCI) from the TSP.

Temperature distribution → Optical image

High speed, and high resolution thermal imaging

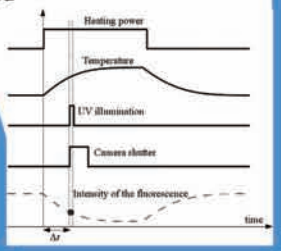
Experimental setup

LED drive signal is generated by a delayed-pulse generator, which is synchronous to an operation signal of a device under test. The luminescence is captured by a CCD camera with an optical filter.



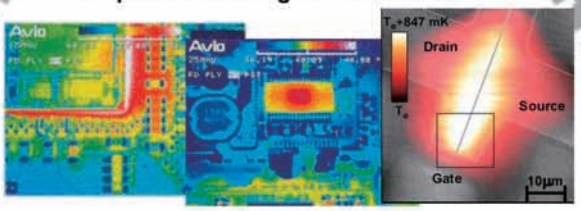
UV flashing method (for high speed imaging)

TSP is exited by a short-pulsed UV light.
A momentary luminescent image is captured by a slow-scan CCD camera



Non contact thermal imaging

Temperature sensing of microdevices



Requirements

High resolution … Usually in a μm scale
High speed … Thermal time constant is small
Non-contact … Don't disrupt an observation object
Low cost … Applicable for a wide variety of applications

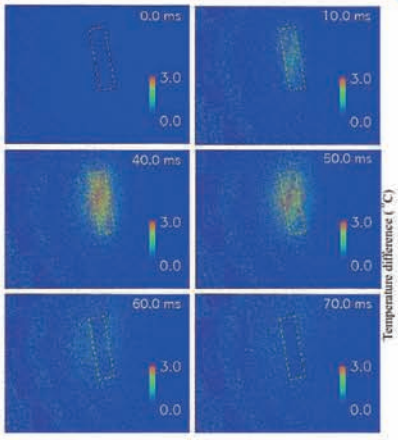
TSP is one of the candidates for the micro thermal imaging with high spatial, temporal and temperature resolutions

Obtained thermal images

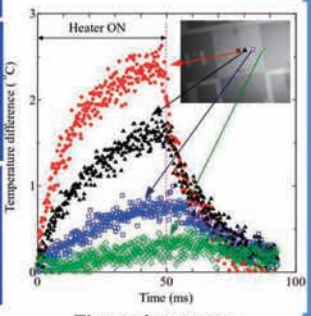
$$\Delta T(x,y) = S^{-1}\left(\frac{I(x,y)}{I_0(x,y)} - 1\right)$$

S : TCI
I : Luminescence
x, y : Address of the picture

Spatial resolution : 39 μm
Temporal resolution : 0.2 ms
Temperature flucsutaion : ±0.2°C



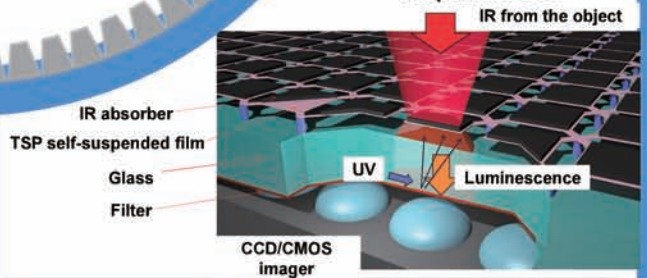
Thermal images at the each time step.



Thermal response.

Novel Thermal imager

Novel low-cost thermal Imager using TSP.
○ High thermal isolation.
→ High sensitivity
○ Easy to fabricate.
○ No electric wirings.
→easy for packaging.
→Low cost
×Response is slow



Conclusion

A novel thermal imaging method with high spatial, temporal, and temperature resolution was developed. The obtained spatial, temporal and temperature resolutions were 39 μm, 0.2 ms and ± 0.2°C, respectively. A novel thermal imaging device using self-suspended TSP was proposed.

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TEL: +81-22-795-6937
E-mail: t_tsuka@mems.mech.tohoku.ac.jp

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

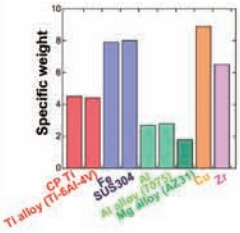
Production of Low-Cost and Highly Functionalized Titanium by Controlling the Light Elements

Takayuki Narushima and Kyosuke Ueda
Department of Materials Processing, Graduate School

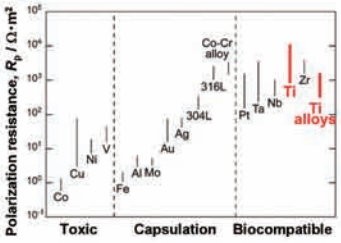
MEXT TOHOKU ECONOMIC FEDERATION Tohoku University 宮城県 七十七銀行 ICR

Titanium: *Wonder metal*

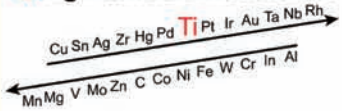
- Low specific weight
- High specific strength



- High biocompatibility



- High corrosion resistance

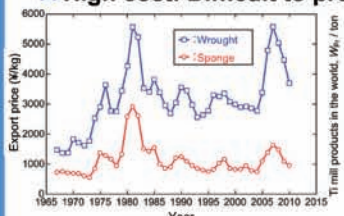


Applications for…

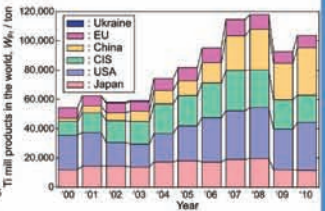
- Space aeronautics
- Medical devices
- Military
- Chemical plants

Disadvantages of Titanium

- ✕ High cost: Difficult to produce



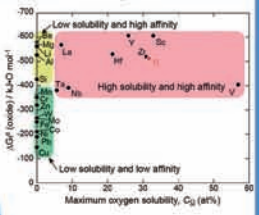
Price: 2-3 times higher than stainless steels
10 times higher than Al alloys



Amount of deposit of titanium ore: High
→Low products: Categorize to Rare Metals

Light elements

Titanium: Chemically reactive
→Ex: Oxygen will not only form oxide layer on Ti surface but also easily dissolve into Ti at high temperatures



Light elements in titanium

Oxygen, Hydrogen, Nitrogen, Carbon

- High affinity
- High solubility
- Interstitial
- Abundant

Alloy designing
Strength・elongation・ductility, Anisotropy, Elasticity, Workability, Shape memory・super elasticity

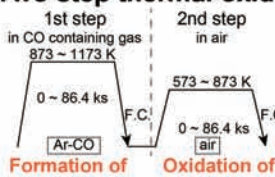
Surface designing
Corrosion resistance, Biocompatibility Photocatalytic activity, Wear resistance

Microstructure controlling
Transformation, Precipitation/dissolution, Grain refinement, Temporary alloying

Refinement process
Process of reduction and melting, Energy saving, Recycle, Purification

Improving photocatalytic activity by anatase formation

Two step thermal oxidation



Formation of Ti(C,N) layer
Oxidation of Ti(C,N) layer

Formation of Anatase layer

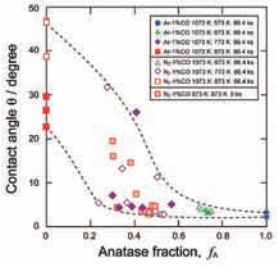


Fig. Effect of anatase fraction in TiO_2 layer on the water contact angle under UV irradiation.

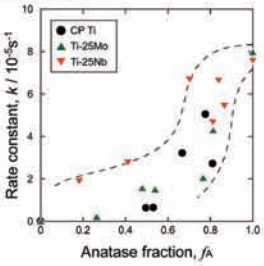


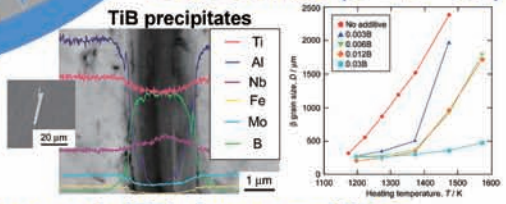
Fig. Effect of anatase fraction in TiO_2 layer on the rate constant of degradation of methylene blue under UV irradiation.

Photocatalytic activity under UV irradiation

Microstructure control of Ti alloys using micro alloying

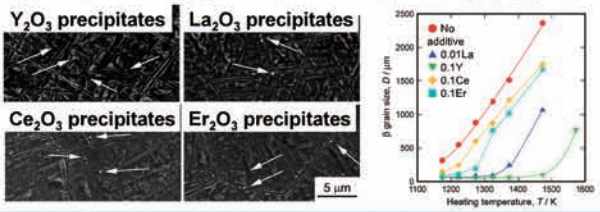
Grain refinement of Ti alloys by pinning using fine precipitates

Boron addition (Ti + B = TiB)



Rare-earth (RE) elements addition

(2RE (in Ti alloy) + 3O (in Ti alloy) = RE_2O_3 (s))



Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

Potential of Alternative Fuel Vehicles: Analysis of Disaggregated Cost Benefit

Lab. of Shunsuke. Managi,
Graduate School of Environmental Studies, Tohoku University

MEXT | TOHOKU ECONOMIC FEDERATION | Tohoku University | 宮城県 | 七十七銀行 | ICR

Cost-Benefit Analysis

Costs

1.Alternative vehicle Cost
Differences between the purchase and running costs of alternative vehicles and ICEs vehicles

2.Infrastructure for Alternative vehicles
Construction and operating costs for alternative vehicle diffusion

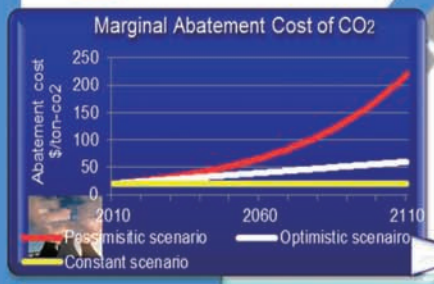
Benefits

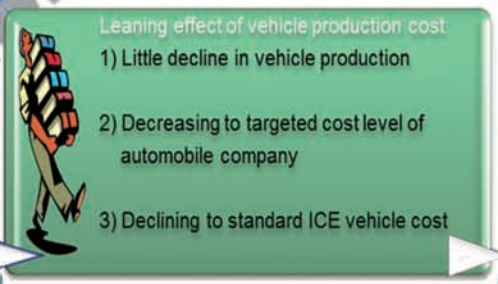
1.Emission reduction effects
The reduction levels of CO2 and NOx emission

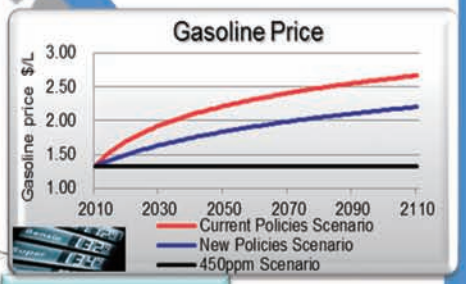
2. Resource-saving effects
The reduction levels of gasoline usage

Scenarios

1. **Scenarios in CO2 reduction costs**
   - Exponentially increasing cost
   - Linear increasing cost
   - BAU-pattern increasing
2. **Scenarios in learning effects in vehicle production**
   - Little decline in vehicle production
   - Decline to the targeted cost level of automobile company's
   - Decline to the standard ICE vehicle cost
3. **Scenarios in gasoline prices**
   - Prices under Current policies
   - Prices under New policies
   - Prices under 450ppm



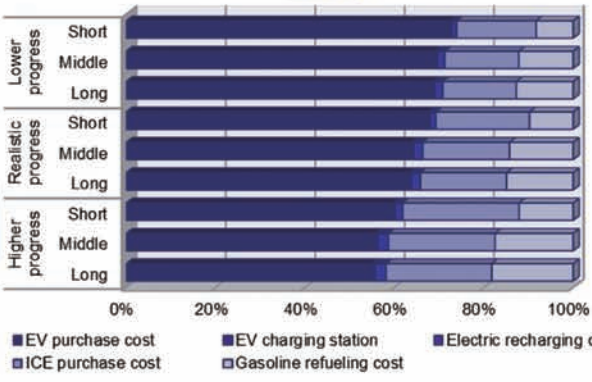




Cost | **Cost-Benefit Analysis** | **Benefit**

Power Plant | Hydrogen Purification | Hydrogen Transportation | Refueling FCV

Simulations w/ Scenarios based on Questionnaire & Public Data



e.g. The result of EV diffusion scenario cost

Contact

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Tohoku University
Tel. 81- 22-795-3216 Fax: 81- 22-795-4309
Email: Managi.s@gmail.com

·Research Interest
Green innovation, Sustainable development
Investment evaluation, Adaptation to disaster

Multiscale, Multiphysics Modeling/Simulation for Next Generation Automobiles: Catalysts, Tribology, and Batteries

New Industry Creation Hatchery Center, Tohoku University
Akira Miyamoto, Nozomu Hatakeyama, Ai Suzuki, and Ryuji Miura(Miyamoto Lab)

MEXT TOHOKU ECONOMIC FEDERATION Tohoku University 宮城県 七十七銀行 ICR

Multi-level Tribology Simulator for Material Development to Realize Long-life, High Reliability, Energy Saving Automobiles and Mechanical Systems

Development of Multilevel computational chemistry

Quantum mechanics — Electronic calculation — Molecular orbital

Molecular dynamics

Atomistic/ Mesoscopic calculation

Continuum dynamics

Macroscopic/ Practical scale calculation

Development of New Academic Domain between Chemistry and Mechanical Engineering

Application to the Medical Engineering

Contribution to the Development of Next Genaration Automobiles for Sustainable Society

Friction-free technology :

Super low mileage car

Long-term Stability of Sliding Parts : Trouble Free Technique

Alternatif Motion — Sensor Tangential force — Sensor Normal force — Linear Motor

Piston ring — Oil — Cylinder

Multiscale, Multiphysics Simulator for the Development of Practical Automotive Catalysts

Engine Control Computer — Electronic Control fuel Injector — Spark plug — Air — piston — Exhaust gas (CO, Hydrocarbon, NOx)

Microscale — Precious metal (Pt , Rh, Pd) — Support, promoters (γ-Al_2O_3, CeO_2, etc.)

Macroscale — CO_2, N_2... Purfied gas — Catalytic converter

Mesoscale — Honycomb Model

Y. Nagai et al., J. Catal. 242 (2006) 103

Automotive Parts Company — Automobile Company — Machinery Company — Heavy Industry Company — Chemical Company — Oil Company — Electric Power Company — Gas Company

Achievements of Collaborative investigation with Various Domestic / Foreign Companies using our Original Software

Molecular Dynamics
1. Integrated Molecular Dynamics System (NEW-RYUDO)
2. Tribology Simulator (TRIBOSIM)
3. Molecular Dynamics with Chemical Reaction Extention (NEW-RYUDO-CR)
4. Crystal Growth Simulator (MOMODY)
5. Grand Canonical Molecular Dynamics
6. Non-Equilibrium Molecular Dynamics (DEMD)

Quantum Chemical Molecular Dynamics
1. Accelerated Quantum Chemical Molecular Dynamics (QCMD) [Colors]
2. QCMD with Excited State Extention
3. Hybrid QCMD with Dynamic Hybridization Scheme
4. Partial Diagonalization QCMD
5. Chemical Mechanical Polishing Process Simulator
6. Plasma Process Simulator
7. Etching Process Simulator

Programs are sold by PEGASUS Software Inc. http://www.gsinc.co.jp/ Ryoka Systems Inc. http://www.ne.oo.jp/

Physical Properties Prediction Simulator
1. Electrical Conductivity Simulator (Colors-Cond)
2. Phonon-based Thermal Conductivity Simulator (THERMOSIM)
3. Conduction Electron-based Thermal Conductivity Simulator (THERMO-Colors)
4. Viscosity Simulator
5. IR Simulator

Monte Carlo
1. Grand Canonical Monte Carlo Considering Chemical Reactions (MOMTA)
2. Non-Equilibrium Monte Carlo (DEMC)
3. Kinetic Monte Carlo Considering Chemical Reactions
4. Particle Growth & Thin Film Growth Kinetic Monte Carlo Simulator

Combinatorial Computational Chemistry Systems Developed in Miyamoto Laboratory

Graphic User Interface (GUI)
1. Integrated 3D Graphic Platform with Virtual Reality (NEW-RYUGA)
2. Integrated Molecular Modeling Program (NEW-RYUKI)
3. 3D Graphic User Interface for Windows (ARRYUGA)

Practical Multi-Scale Simulator
1. Porous Structure Simulator
2. EL Device Simulator
3. Sintering Simulator
4. Macroscopic Pharmacokinetics Simulator

Design of Electronics Materials
1. Ion Implantation
2. Chemical Mechanical Polishing
3. Etching, Oxidation, Nitridation
4. Blue Phosphors
5. Organic Electroluminescence Devices
6. Plasma Display
7. Crystal Growth

Design of Catalysts
1. deNOx Catalysts for Automobile
2. Desulfurization Catalysts
3. Combustion Catalysts
4. Polyolefin Synthesis Catalysts
5. Fischer-Tropsh Synthesis
6. Photocatalysts
7. Methanol and DME Synthesis
8. Sensor Device Electrode Catalyst

Dynamics of Catalysts and Adsorbates
1. Adsorption and Diffusion of Molecules in Zeolites
2. Proton Diffusion Dynamics in Heteropolyacids
3. Sintering of Supported Precious Metal Catalysts
4. Peroxide Microporous Catalyst

Design of Ceramics Materials
1. Crystal Growth of Oxides
2. Mesoporous Ceramics
3. Hetero-Interface Junction
4. Design of Boiler Layer
5. Ferroelectrics
6. Transparent Conductors
7. Ion Conductors
8. Ferromagnetics, Spintronics

Various Applications of Combinatorial Computational Chemistry in Miyamoto Laboratory

Design of Membrane and Adsorbent
1. Pd Hydrogen Permeation Membrane
2. Hydrogen Absorption Metal Alloys
3. Carbon Nanotube
4. Zeolite Membrane
5. Oxidyss Polymer Membrane

Design of Battery and Fuel Cell Materials
1. Carbon-supported Pt Catalyst
2. Proton Exchange Membrane
3. Li Ion Battery Cathode
4. Li Ion Battery Electrolyte

Design of Mechanical Engineering Materials and Tribology Materials
1. Nano-Fabrication, Nano-Tribology
2. Traction Oil, Engine Oil
3. Solid Lubrication (DNDTP, MoDTC, DLC)
4. Lubricants for Hard Disk

Miscellaneous
1. Electrical Breakdown
2. Thermoelectric Conversion
3. Biocatalysts
4. Dye sensitizer
5. Self-Organization

Software Company — Pharmaceutical Products Company — Water Treatment Company

Legend: Al_2O_3 — CeO_2 — Pd — Rh

Multi-level Battery Cell Simulator Supporting the Development of Li-ion Battery, Fuel Cell and Solar Cell for Next Generation Automobiles

Large scale Quantum Chemical Molecular Dynamics — Cathode — Electrolyte

Modeling Tool of Meso-scaled Structure

Macro Heat and machine characteristic

Development of real structure

Diffusion

Combination with Macro Numerical Simulators

Polarization curve

Electrolyte — Catalyst Layer — GDL

Carbon-Supported Pt — electronic conduction — H_2O diffusion — Electrolyte coating — H^+ diffusion — O_2 diffusion

Inside of a macromolecule H^+/O_2 diffusion — Active spot characteristic — Pt Surface reaction — H^+ Dissociation

Calculate the electron density distribution by quantum electron dynamics

Change the electron density distribution into a mesh

According to electron density distribution, move an electron by the kinetic Monte Carlo method

Powerful Support for Industry-University Cooperation by Professors, Research Staffs, Technical Assistants and Programmers in our Laboratory

Integrate the Measuring and Modeling Technologies to Improve the Surface and Interface Structural Analysis for Practical Material Development

Sliding — crush! — SUJ2 pin — Deposited C_{60} film — SUJ2 flat

Significant Progress in Measurement Methods in Tribology

XRD Simulator — Neutron Diffraction Simulator — Raman Simulator — IR Spectroscopy Simulator — AFM Simulator — STM Simulator — TEM Simulator — SEM Simulator — EXAFS Simulator — UV-Vis Spectroscopy

Probe — Sample

"Realistic" Atomic/Molecular Structure Construction from Multi-level Computational Methods

Message to Global/Local Companies

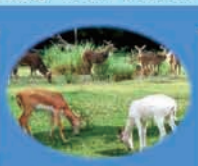
We hope to realize global/local innovations for next generation automobiles by collaborating with our practical multiscale, multiphysics modeling/simulation methods developed through many industrial collaborations.

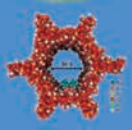
International Presentation

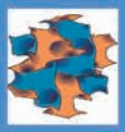
RUTHENIUM-CONTAINING ORDERED MESOPOROUS SILICA: Promising Catalyst for Reduction of NO by CO

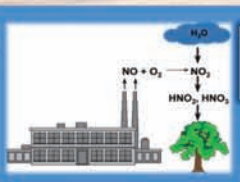
Indian Institute of Technology-Madras, Chennai, India; Indian Institute of Technology-Bombay, Mumbai, India

Parasuraman Selvam, Vilas M. Ravat and Preeti Aghalayam









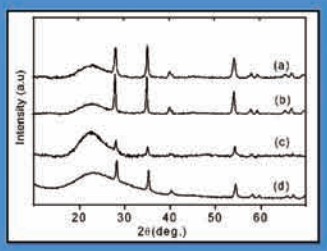
NO_x EFFECTS
Baukal
Metal Finishing
103, 2005, 18

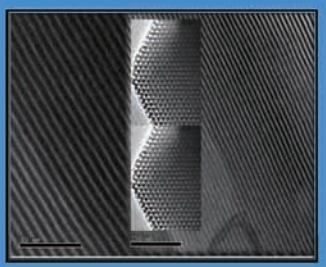
How NO_x is Controlled?

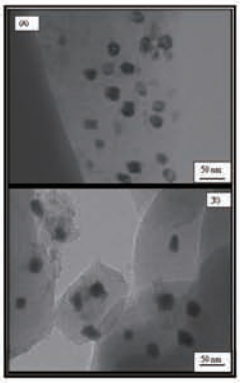
Catalytic Reduction of NO_x to N_2

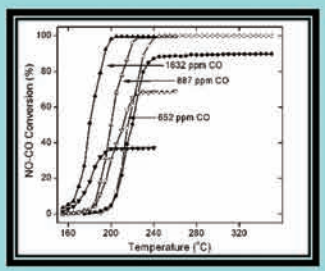
- *Selective Non-Catalytic Reduction (SNCR)*
  Requires high temperature (T >1000°C)
- *Selective Catalytic Reduction (SCR)*
  The most promising technique!
- *Dry Sorption*
  Can't be used for automobile!

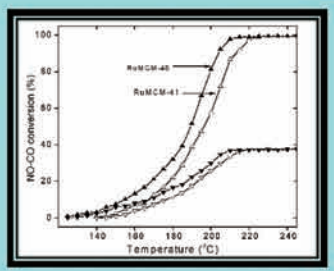
Selective Catalytic Reduction of NO_x

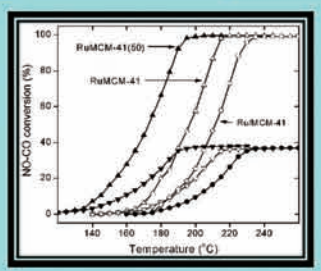


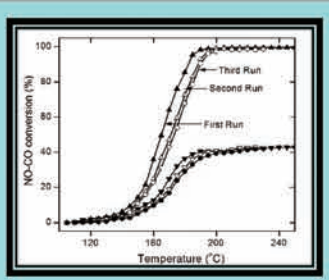












TOHOKU

iitmadras

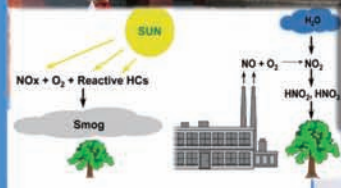
National Centre for Catalysis Research

PARASURAMAN SELVAM
NCCR / IITM – NICHe / TU

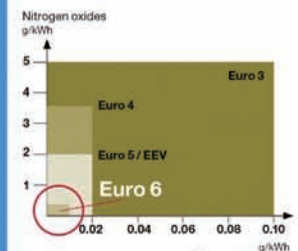
NH_3-DeNO$_x$ performance of the composite [Fe-Beta + Fe(Mn)-MCM-48] catalyst: Combining SCR activity and NH_3 oxidation activity for NH_3 slip removal

Zelinsky Institute of Organic Chemistry, Moscow, Russia; Indian Institute of Technology-Madras, Chennai, India

Alexandr Y. Stakheev, Dmitry A. Bokarev, Alina I. Mytareva, Rajesh K. Parsapur and Parasuraman Selvam



C. Baukal
Metal Finishing
103, 2005, 18
NO$_x$ Effects



How NO$_x$ is Controlled?

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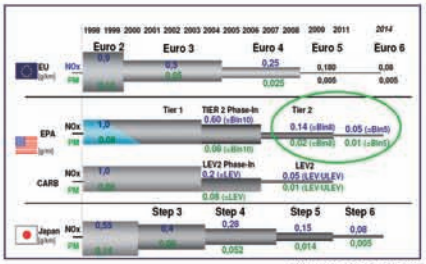
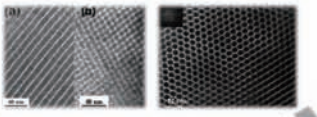
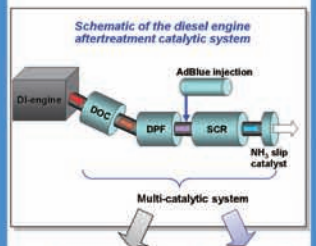
  Requires high temperature (T >1000°C)
- *Selective Catalytic Reduction (SCR)*
  The most promising technique!
- *Dry Sorption*
  Can't be used for automobile!

Tightening of the worldwide emission standards







Attractive to combine several functions in a single catalyst brick

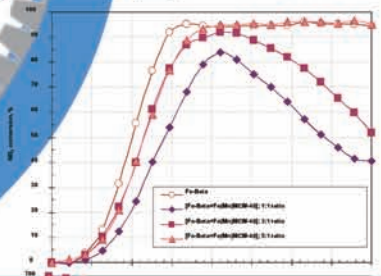
TARGET

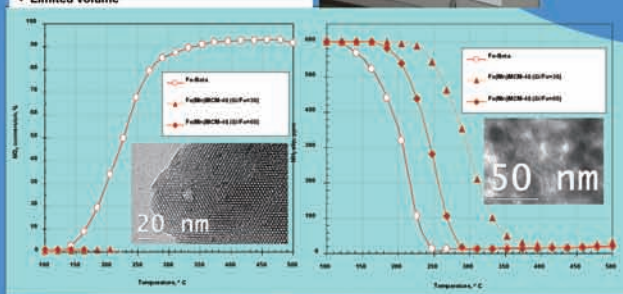
- ✓ Good soot oxidation performance
- ✓ High NH3 DeNOx activity (including T_{react} < 250°C)
- ✓ NH3-slip function is desirable
- ✓ Limited volume

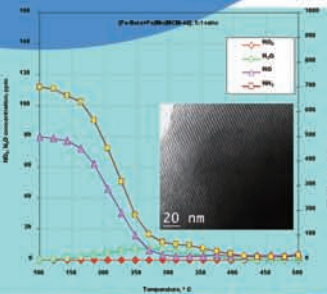
Selective Catalytic Reduction of NO$_x$

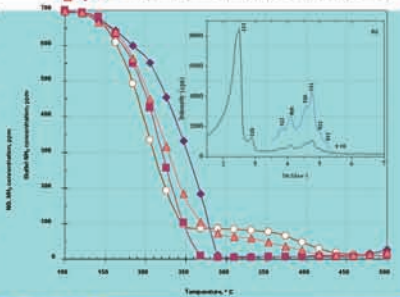
- Selective catalytic reduction of NOx by ammonia (NH3-SCR):
  $4\ NH_3 + 4\ NO + O_2 \rightarrow 4\ N_2 + 6\ H_2O$
- Selective catalytic reduction of NOx by hydrocarbons (CxHy-SCR):
  $2\ NO + C_xH_y + (x + y/4 - 1)\ O_2 \rightarrow N_2 + x\ CO_2 + (y/2)\ H_2O$

Zeolite-based catalysts promoted by transition metals are considered as the most promising catalysts for NH_3-SCR. They demonstrate favorable DeNO$_x$ activity in the Standard and especially in the Fast SCR reactions.









Industrial Presentation
Technology and business introduction of local companies

宮城県 Miyagi Prefectural Government

ITIM

Automotive Industry Support using ITIM's Open Equipment

Industrial Technology Institute, Miyagi Prefectural Government (ITIM)

MEXT | TOHOKU ECONOMIC FEDERATION | Tohoku University | 宮城県 | 七十七銀行 | ICR

EMC evaluation for car electrical components

Anechoic chamber and shielded room are open for use by automotive businesses. EMC evaluation based on international standards, shown below, are available.

CISPR25 radiated emissions

Bulk current injection (BCI) test

CISPR25 conducted RF emissions

※ Electrostatic discharge immunity test is available.

Shock test

Testing more than 1000G of shock with duration of msec is available. Evaluating durability of car electrical and mechanical components against shock is available.

Model	AVEX SM-110-MP
Half-sine Amplitude & duration	30G,18msec～1000G,1msec
Max. shock amplitude	5000G
Max. speed	1.0m/s Peak
Dimensions of test table	W410×D410mm
Max. loading weight	90kg

- Shock direction is changed by altering fixing direction.
- 3 axis acceleration measurement is available.

※Consultation of test jigs is available.

Mission of ITIM

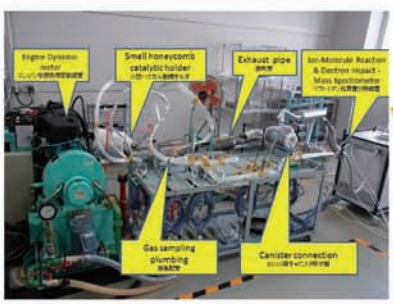
Industrial Technology Institute, Miyagi Prefectural Government

For the purposes of contributing to the promotion of local industry and aim for enhancing the support of businesses opened to local areas, we uphold an operational policy of one stop solutions based on trust, promptness, friendliness, safety, and assurance through utilization of the institute's knowledge and technical resources (facilities and technicians).

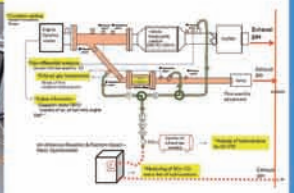
Catalyst property evaluation

Evaluating the properties of the small honeycomb catalyst is available.

	Maker, model	Main specifications
Engine Dynamo-meter	TOKYO METER CO., LTD. GWE-110/150R	Engine : 1NZ-FE, 1.496 L (which is put on Allion made in Toyota Motor CO., LTD.)
Ion-Molecule Reaction & Electron Impact - Mass Spectrometer	V&F Analyse- und Messtechnik GmbH, AirsenseCompact	Gas consumption : 100ml/min Lower detection limit : ppb Response time :20msec
Gas chromatograph and mass spectroscopy /Headspace Preconcentrator	Entech Instruments Inc., 7100A Agilent Technologies Inc., (GC)7890A(MS)5975C	3-Stage preconcentrator Detector : MS and two FID(Flame Ionization detector) Lower detection limit : ppt
Exhaust Gas sampling plumbing	NISHIKAWA KEISOKU CO.,LTD.	The Silonite Coated Tubing made in Entech Instruments Inc.
Diagnostic tester	DENSO CO., LTD. DST-2	Trouble diagnostic software for Toyota cars



- Small Honeycomb size : D25.4×60mm
- Ion-Molecule Reaction & Electron Impact - Mass Spectrometer enables the simultaneous and synchronous monitoring of NOx, CO, and hydrocarbons(Toluene, Propylene etc.) .
- GC/MS is used to analyze C_2 to C_{11} hydrocarbons (Ethylene, propylene, 1-butene, n-hexane, benzene, toluene, etc.) in automobile exhaust gas.



X-ray CT

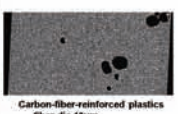
※Computed Tomography

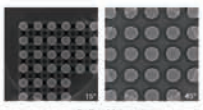
Inspecting the three-dimensional inner structure of automobile parts non-destructively is available, for example aluminum die-cast products, electronic parts, molding parts etc..

	Microfocus X-ray CT System
Manufacturer, Model	Comscantecno.Co.Ltd ScanXmate-D225RSS270
X-ray generator	Open tube/Transmission head Voltage 20～225kV (variable) Focal spot size Min. 4μm
Detector	Digital flat panel Pixel size(Pitch) 127μm/254μm Active area 235mm(H)×186mm(V)
Sample size	300dia.×300mm H , weight 15kg

	X-ray Inspection System
Manufacturer, Model	Comscantecno.Co.Ltd ScanXmate-RAA110TSS40
X-ray generator	Open tube/Directional head Voltage 20～110kV (variable) Focal spot size 3μm/5μm(selectable)
Detector	Image intensifier, 4 / 2.5 inch selectable
Sample size	Width/depth/height 400/350/50mm Weight 2kg


Aluminum sample size 30×30×10mm


Carbon-fiber-reinforced plastics fiber dia.10μm, sample size 20×20×10mm


Ball grid array

Address: 2-2,Akedohri,Izumi-ku,Sendai-shi,Miyagi-ken,981-3206,JAPAN.
Phone:+81-22-377-8700 Fax:+81-22-377-8712
http://www.mit.pref.miyagi.jp/index_e.html

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

Company Policy

【Progress with creation and service】
The interaction of light with the magnetic and electronic freezes influctuation of space. We aim to develop technologies to measure and control with high accuracy.

Kudo Electronic Corporation

An accelerator・synchrotron・superconductivity・research facility high-precision constant current power supply

Kudo Electronic Co., Ltd.

Main office Nishitaga Taihaku-ku Sendai・・・Natori place Iinozaka Natori-shi

http://www.kudo-denki.co.jp/

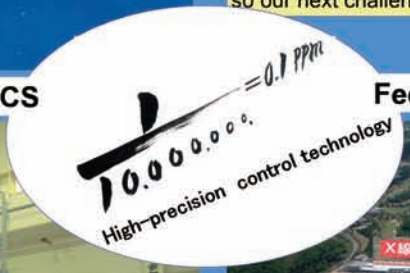
MEXT TOHOKU ECONOMIC FEDERATION Tohoku University 宮城県 七十七銀行 ICR

Since 1956 to now, our company have been supporting from Tohoku University. Technology very improved from analog generation. From this improved technology, we use this for an elementary particle, accelerator science of radiation, and big science in the field of nuclear fusion. Those technologies use at the research facility in Japan and out of Japan.

Moreover, we use this technologies for heavy particle cancer treatment, medical field of MRI etc... And, the field of semiconductor ion implantation, too.

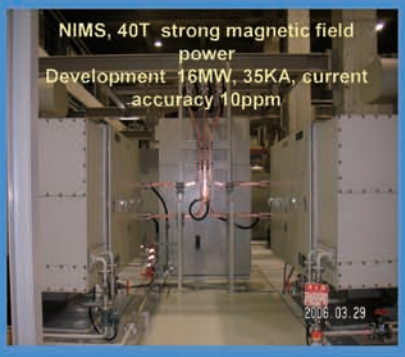
We established control stability of the DC current and voltage 0.1 ppm, so our next challenge is 0.02 ppm.

POWER ELECTRONICS



Feedback & Computer Technology

Tohoku Uni science department AVF Cyclotron magnet power supply other 45 units update



SP-series stabilized power supply

≪small high-precision DC switching power≫

0.02-0.001% current stability So suitable for the electromagnet excitation
1KW～30kW class unit power

Kudo corp・EV experiment group

- Joint research with Tohoku University next generation mobile system study group
- The Ministry of Economy, Trade and Industry " IT fusion consortium research and development project"
- Joint research with Tohoku Uni and Ishinomaki sensiyu Uni
- 4 employees organize the project
- Commercialization of next-generation electronic vehicle
- If you're interested in our industrialization, please contact us


Honda "Beat" decomposition


In- Wheel Motor


12V50AH 4 battery


Test Drive


Tagajo Reconstruction Park


EV eco-run race

Industrial labor-saving machinery・Hikichi Seiko automatic machine

～We help customer's "solution annoyances, production reform &improvement, and efficiency～

Hikichi Seiko Co., Ltd.

MEXT　TOHOKU ECONOMIC FEDERATION　Tohoku University　宮城県　七十七銀行　ICR

■Company Info

◇name： Hikichi Seiko corporation
◇Place: "main Offices" 2-8-28, Fukiage,Iwanuma- city,Miyagi-pref,989-2436 JAPAN
◇President： Masayoshi Hikichi
◇Fuoudation: May 3,1979
◇Capital: 30 million yen
◇Employee： 65people
◇Certification: ISO9001、ISO14001、&AS9100(challenge)、
◇Approval & license : general construction industry・machinery & equipment installation work

■Overview of Business

◇Business info： ・industrial labor- saving machinery・tooling, design & manufacture of various devices ・prototype, precision parts processing
◇The main delivery equipment ：
◆assembly equipment (line equipment, discrete systems)
◆Inspection equipment ◆cleaning equipment
◆Transport equipment
◆others-Automated equipment,various devices etc...
◇Major clients:
・Toyota Eastern group
・Panasonic
・Toray Engineering
・Seiko- Insutsuru
・electrical , electronics companies
・Food related companies
・Aircraft companies

◇Main Offices

"Engendering & mechanical design department"
・Making concept illustration form customer's offering
・Line equipment, a single machine, fixtures etc. All design

"Technology & control department"
・Use PLC, and make soft & hard design
・response coordination of articulated, Scala, single axis of each robot manufactures

"Manufacturing & machining department"
・We put the data in the automatic machine, and we can finish up all at one place.
・We really good at single item processing, and quick response and delivery. The challenge is cost & technology.

"Manufacturing unit assembly & adjustment department"
・Assembled, measurement data takes a stack accuracy
・The installation adjustment , check the final products
・We support the installation anywhere (domestic & international)

◇Taiwa brunch

・We express support for our ustomers .
・24 hours support for production facilities of our customer.

■Hikichi Seiko' sDNA

■To the employee's book
・The figure what is company's goal
・Knowledge as a society person & company people
・Sprits & motivation
・Self- growth & realization
・Responsibility ・・・

■5S Thoroughness
◇5S:"organizing , tidy, cleaning, cleanliness, and disciple"
Theses things made better company
・Our company think about 5S and do these things once a week.
～ We can't say " it is enough to do" because there are other companies higher than us ～

◆Management Philosophy
◆Survive the hard time
Employees knowledge: 38 Articles

■Development & spilt of challenge
・Even in the difficult cases, we never give up! We think so deeply.
・We challenge higher level, and improve ourselves.
◇Try to up technology capabilities and resilience, and in response to the needs and expectation !!!! Of course, after all …we get win & trust.

■Efforts of industry- academia government collaboration

◇Participation in the institution & organization
・Miyagi industry association
・Miyagi industrial Promotion Organization
・Miyagi prefecture industrial Technology center
・Miyagi automotive industry Promotion Council
・Toyota East Japan group
・Innovation appreciation create conference
・Machine Vision study group
・Next generation vehicles Miyagi area

■Main a Machine Tool

・As a Machine vision research meeting theme, people guide us for good development.

◆Original product development
◇Curved mirror surface for visual inspection robot
・We have established a special optical head to the articulated robot . It is a movement close to the movement of people.

・At 2011, we had received certificate from <Excellent Technology> " Miyagi Sugure MONO"

みやぎ 優れMONO
"SUGURE MONO"

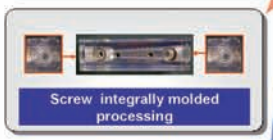
To a company making "only one"

Tohoku Electronics Co., Ltd.

MEXT TOHOKU ECONOMIC FEDERATION Tohoku University 宮城県 77 七十七銀行 ICR

Injection molding

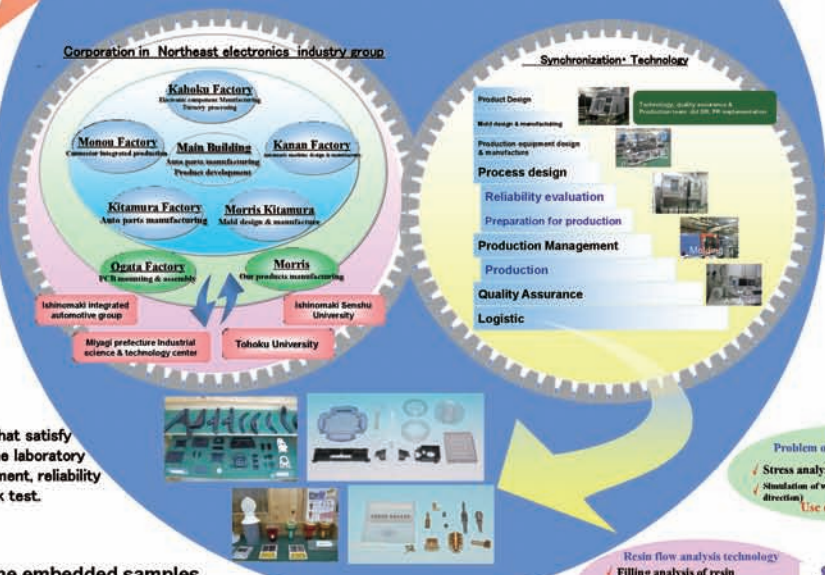
- Set 3D CAD, the optimum conditions using flow analysis.
- Realization of the secondary processing less devised mold structure based on the product shape.



Environmental Products
Union technology of secondary batteries & solar

Even if cut off the power supply, it will start the production of electric power itself by any cases.

Simultaneous engineering
synchronization technology



Quality & reliability evaluation

For reliability and performance ensure that satisfy our customers, we have carried out in the laboratory with a variety of test and analysis equipment, reliability testing on a regular basis, the benchmark test.

Analysis & failure analysis

We observe cross section of the embedded samples.

The main holding facility

Molding machine, processing machine, measuring instrument

1 Small molding machine (7～10t)
2 Injection molding machine (45～180t)
3 Injection molding machine (220～350t)
4 Injection molding machine (450～550t)
5 Vertical injection molding machine (20～40t)
6 NC electrical discharge machine
7 Wire electrical discharge machine
8 Vertical machining center
9 Machining center
10 CNC automatic lathe
11 Three- dimensional measuring device
12 Image measurement system
13 Measuring instrument shape and Contour surface roughness

Test & analysis equipment

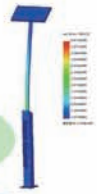
14 Thermostatic bath
15 Tank constant tempter & humidity
16 TCR tank
17 Pressure cooker
18 Thermal shock testing machine
19 strength test equipment (Pull, Compression, Bending, peel test)
20 Soldering test equipment
21 DC regulated power supply
22 Solder bath
23 Electron Microscope
24 Atomic absorption spectrophotometer
25 X-ray fluorescence film thickness meter

Software

26 3D CAD (SolidWorks)
27 3-D CAD/CAM system (CAM-TOOL, CADCEU)
28 2D/3D CAD system (2001PLUS)
29 Resin flow analysis software (3D TIMON)
30 Optical simulation software (Zemax)
31 Analysis simulation software (Femtet)

Proposal of solutions

We propose quickly to our customer about the best solution of customer's use condition.



Problem of stress relationship
- Stress analysis of the pole section
- Simulation of wind load (wind speed, wind direction)

Use of stress simulator

Resin flow analysis technology
- Filling analysis of resin
- Holding pressure cooling analysis, mold cooling analysis
- Warp shrinkage deformation analysis

Use of injection molding CAE

Optical design & analysis technology
- LED model analysis
- Analysis of the light guide plate

Use of optical analysis CAE

Customer

To everyone in the company

We aim to improve the technical capabilities for the future with local companies.

◆A focus on the manufacture of electronic components & automotive parts production through integrated with community- based.

◆We run in QCD speed from product design to mold equipment.
◆Accumulation of our technology satisfy customers expectation.

Human resources education


The executive staff training


The executive staff training


In- house training


Presentation in a company

In a Development Early Stage the Proposal of the Die-Casting Form which Considered Quality Cost by Original Casting Technology

IWAKI DIECAST Co., Ltd.

MEXT | TOHOKU ECONOMIC FEDERATION | Tohoku University | 宮城県 | 七十七銀行 | ICR

Semi-solid Die-cast Process

Outline of Manufacturing process

How to cast after making melted hot water half-solidification(slurry), comparing with casting from perfect melted hot water, it is little stickiness, it becomes a detailed and uniform organization, the product which called for high resisting pressure, high intensity and high toughness is possible.

Slurry

Casting

Processing

Section

Throw in

Knife cutting of slurry

Comparison of solidification structure

MIM (Metal Injection Molding)

Outline of Manufacturing process

MIM is finished after fabricating a metal particulate powder by injection machine, degreasing and sintering, post-processing accept necessity.

Injection machine

Thermoplasticity binders | Metal particulate powder

↓

Mix and knead

↓

Fabrication

↓

Remove binder

↓

Sintering

↓

Sizing

↓

Post-processing

↓

Product

Continuous sintering furnace

Headquarters・Factory
51-2 Yamazaki, Washiashi, Yamamoto
Watari, Miyagi, Japan 〒989-2204
***TEL* +81-223-37-3322**
FAX +81-223-37-3720
E-MAIL info@iwakidc.co.jp

IWAKI DIECAST

Main Facilities Machinery

The Best our Ability to Construct Factory Line; Pursuing Automation, Energy Saving and User-Friendly

The production line of Iwaki always holds the latest level of a time, the result of original now-how and joint research with an apparatus equipment maker is employed everywhere.
At a casting process, a supervising system and a multifunction robot which foreknows and prevents failure and poor product beforehand are introduced, the production line is automated mostly. And, the utility tunnel which stored the automatic hot water distribution system of an encapsulated type, home generation of electricity facilities for energy saving, compressor or conveyer is prepared.
Furthemore, a factory function is raised even to the highest level, it still continues making an effort to investigation of factory full automation that aims at high quality, high efficiency, low cost, the stable product supply, and realization of comfortable work environment.

Processing Factory

Mold Automated Warehousing

Impregnating Apparatus

Die-Cast Machine

Automation

Main Facilities Machinery

IWAKI DIECAST

Die-cast Model design Proposal System

Outline of Manufacturing Process of Mold and Die-Cast Products

The biggest problem of technology that supports modern high-mix low-volume production system is how to supply confirmed high accuracy molds on a timely manner, and construct a high efficient production system at low cost.
IWAKI designs casting with brand-new technology as a pure-play company focused on die-cast manufacturing. After we hear customer's request, we offer design of casting which can use easily. You'll be satisfied with both quality and cost phases.

Die-cast Model design Proposal System

High-Speed Machining Center

Mold Factory

Color anodized

Kyowa Aluminum Industry Corporation

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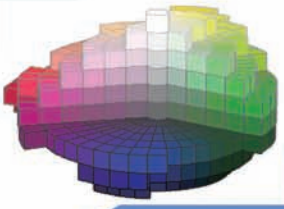
Color anodized

We reproduce wide range of color
Provides the color from your request
Our color reproduction is using proprietary technology



Hard anodized color

We can do hard anodized color
We can balance a vivid decoration and advanced durability

Alumite treatment

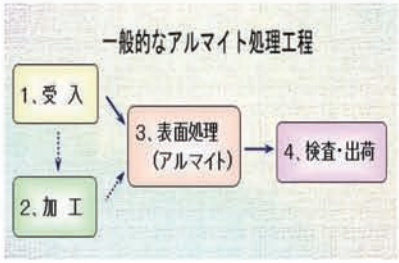
Color ・Hard anodized

Manual line

Normal anodized tank×1 tank
4,000(W)×900(L)×800(H)
Hard anodized tank×1 tank
1,200(W)×900(L)×850(H

Automatic line

Normal anodized tank×4 tank
2,200(W)×900(L)×1,150(H)
Hard anodized tank×1 tank
2,200(W)×900(L)×1,150(H



Greeting from The President

Since 1988, we have been aiming to improve the quality of surface treatment of aluminum products.

Even towards the 22 century, Aluminum is a necessary material to spend a good life for the comfortable environment for us.

We'll continue to challenge to the new generation.

We believed that we provide to our customers as soon as possible, and to serve the community for our future.

The President
Kouzo Inoue

Plating Business

Toho Plating corporation

MEXT TOHOKU ECONOMIC FEDERATION Tohoku University 宮城県 七十七銀行 ICR

Toward Tomorrow

Manufacturing technology in Japan, we have been sweeping all over the world by the management and capacity development prowess. A key foundation technology is industrial surface treatment technology.

Current production in Japan has relocated overseas, " plating industry" in the country in the future must continue on the path of future high-precision and high-quality.

We'll make an effort to improving the technical capabilities, quality of power and environmental power for our future " manufacturing"

Surface treatment processing type list

Plating classification	Plating method	Plating bathtub	
Chemical conversion coating	Fully automatic equipment	chromium chemicol conversion coating (trivalent)	
	Manually operate equipment	zinc phosphate coating.	
		copper oxide coating	
		coating on other materials such as Fe, Cu, SUS, etc.	
Zinc plating	Fully automatic equipment (static)	zincate bath (10,000 litres)	
		colored chromate (trivalent)	
		black chromate (trivalent)	
	Manually operate equipment (rotation)	2 bathtubs	zincate bath (1,680 litres)/ colored chromate (trivalent)
			black chromate (trivalent)
			zincate bath (750 litres)/ topcoat
Tin-zinc alloy plating	Semi-automatic equipment (static)	neutral bath (1,400 litres)/ colored chromate (trivalent)	
	Fully automatic equipment (rotation)	neutral bath (4,600 litres)/ colored chromate (trivalent)	
	Manually operate equipment (rotation)	neutral bath (3,100 litres)/ colored chromate (trivalent)	
Zinc-nickel alloy plating	Fully automatic equipment (static)	zincate bath (6,600 litres)/ colored chromate (trivalent)	
	Manually operate equipment (rotation)	zincate bath (1,300 litres)/ colored chromate (trivalent)	
Zinc-steel alloy plating	Manually operate equipment (static & rotation)	zincate bath (500 litres)/ colored chromate (trivalent)	
Hard chromic plating	Manually operate equipment	3 bathtubs	fluoride bath: 1,300 litres x 1bathtub
			1,200 litres x 2bathtubs
			beef bath: 1,300 litres x 1 bathtub
Electroless nickel plating	Manually operate equipment	4 bathtubs	electroless nickel bath: 100 litres x 2 bathtubs
			200 litres x 2 bathtubs
		electroless nickel composite plating (Ni-P-PTFE, Ni-P-B)	
Tin plating	Manually operate equipment (rotation)	luster acidity bath: 200 litres	
		sensglous acidity bath: 200 litres	
		dull luster acidity bath: 200 litres	
Decoration chrome plating	Manually operate equipment	copper-nickel-chrome, W nickel-chrome	
Passivation film coating	Fully automatic equipment	nitric acid bath: 250 litres	
	Manually operate equipment	nitric acid bath: 87 litres	
Alunite coating	Manually operate equipment	oxalic acid bath: 1,000 litres (hard plating)	
		sulfuric acid bath(hard plating, soft plating, coloring	
Painting	Fully automatic equipment	4 bathtubs	teflon coating x 3 bathtubs, solvent painting x 1 bathtub
	Manually operate equipment	teflon coating, common painting (solvent, waterborne)	
		cationic electrodeposition painting (black)	
Polishing	Buffing lathe		
	Semiautomatic short blast equipment		
Others		copper strike bath, nickel strike bath, copper pyrophosphate bath, etc.	

Company Info

Name of company

Toho plating corporation

Address

31-2 Nishigaokaaza Ooaza Murata Shibata-gun Miyagi prefecture

TEL.0224(83)5557

FAX.0224(83)2786

E-mail

toho@soleil.ocn.ne.jp

President

Hiroo Shimada

Capital Stock

20 Million

Business info

Surface processing industry (Electricity plating, painting)

Employee

60 people

To form a technology

Our company get "ISO 9001:2008" and "ISO140012004".

We bring a system which is international standards with an Emphasis on quality management.

Our manufacture products that require high precision, such as sensors and automotive fuel supply system, high corrosion resistance, high durability. It can respond to large-lot mass production from small-lot short-term delivery.

In addition, we have taken a system that can reflect the know-how of development to mass production management place a dedicated department for newly developed products.

From Yamagata, we aim to technological innovation of noise filter coil

UENO CO., LTD.

http://www.uenokk.co.jp/

MEXT　TOHOKU ECONOMIC FEDERATION　Tohoku University　宮城県　77 七十七銀行　ICR

What's Noise filter coil?

To prevent a malfunction of electrical products, electric components, which is cut the noise intrusion from power line, is included into the electricity most of the products.

Toroidal type
Common mode choke coil

We have been producing Toroidal coil by hand!

Ueno Coil

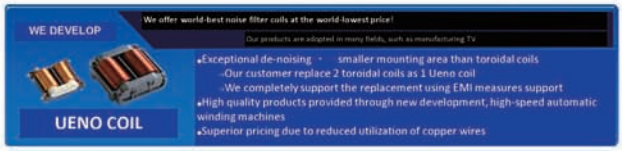
Revolutionize the world of noise filter coil

We developed new coil

Ueno Coil horizontal type
◆Suitable for thin products◆

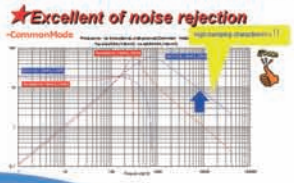
Ueno Coil vertical type
◆Reduce the footprint of a circuit board◆

Lineup of the 3-phase coil for a high tension current!



Merit of Ueno Coil

★Excellent of noise rejection



Winding time is just 10 seconds!!

Winding in 10 seconds by the high-speed automatic winding.
We did the man-hour reduction of about 90% compared with the Toroidal.

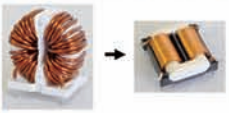
Winding directly to the closed magnetic circuit core

This is a new method that winding directly to closed magnetic circuit core!
Inductance improved about 20 % compared with open magnetic circuit core!

No short layers!

Tension of the coil is law at the time of the winding.
There are no short layers because of the single- phase winding.

From Toroidal to Ueno Coil



Company Overview

Name	UENO CO., LTD.
Name of Representative	President and Representative Director: Ryuichi Ueno
Date of Establishment	January 1982
Capital	412.7 million yen
Sales	37 million yen (May 2011)
Business Content	Design and manufacturing of noise filter coils, smoothing choke coils
Production Sales	Production volume (monthly production): 8,000,000 units

★ Major Awards ★

Nikkei Manufacturing Award [Nikkei BP special award](2008年)
Tohoku New Business Award(2009年)
Selected as 300 companies manufacturing small & midium sized enterprises a healthy 2009(2009年)
Manufacturing Nippon Grand Tohoku Bureau of Economy, Trade & industry director Award(2009年)
Ministry of Education Award Science & Technology award [Technology sector](2010年)
Ymagata Prefectural Industrial Award(2011年)

Ueno's challenge " Toroidal coil automatic winding machine"

We have developed an automated production system of the Troidal coil of the one and only in the world, and has been producing 20 million or more in total in Mikawa plant in Yamagata prefecture.

Compared with hand made, characteristics are more stable such as air conditioning. It is used in a variety of areas.

Attention !

Application of Ueno coil to the electronic vehicles

- Charger・Power feeding equipment
- DC-DC converter
- Inverter
- Defogger

Application such as Normal mode choke coil

- Car navigation・Audio
- Wiper
- Power window

Ueno coil is also used solar power.

To all of the companies

~We provide a coil fitted in your products!

Ueno CO., Ltd. develop and provide the noise-filter coils that are coping with customers' needs by powerful staff members, materials, facilities, such as simple anechoic chamber, and domestic plants of speedy trials.

Contact info: 0235-64-2351 Ueno production manager Watanabe
E-mail : info@uenokk.co.jp Home page : http://www.uenokk.co.jp/

We'll make Zinc alloy, Aluminum, Die-cast prototype, Casting parts machining of 500g or less!

Corporation Horio Factory

MEXT | TOHOKU ECONOMIC FEDERATION | Tohoku University | 宮城県 | 七十七銀行 | ICR

3Keystones to make LOWER COST basis in industrial operation

Mold / High-Tech / Casting / Automation

1 Mold Technique - Accuracy Keystone

The Mold has Rich-Functions in a Compact Body!
That Helps Usability.

- Compact Mold can be carried by one hand. To make Molds are Low Cost & Quick Turn
- By Discerning Mold, Accomplished Over 1 Million Shots Mold Life.
- By Using a Mold Multiple way, can Produce Various Kind of Products.
- By Coating Mold oils of friction lessh, Making High-Quality Products and Long-Life Mold.
- Creating Standard Mold Die Set which fits to a Die-Cast Machine's Cassette Base.
- Equipped Mold Release Spray Function

real size

Easy-to-Use ! Multiple Function

- Able to Carry by One Hand
- Low Cost
- Quick Turn
- Mold life : over 1 Million shots

2 Die-Cast Technique - Casting Keystone

The Technique of No Burr in Parting !
That Helps 'Must-be' Quality.

- Accomplished Mass-Produce by 5t Compact Die-Cast Machine, Not large machinery
- High-Shot Produce by 5t Die-Cast Machine
- Accomplished High-Quality Parts Production by Creating Processing Conditions Standard
- Simplified Mold Description by Cassette System that can be replaced by Whole Set
- By In-House Products, Making Low-Cost / Double the Life of Wearing Parts of Die-Cast Machine
- Nozzle-Touch Mold Injection Prevents Drip-offs
- Equipped In-House Eject Mechanism to Die-Cast Machine (Zinc Materials)
- Purchasing Zinc Materials by Direct Deal, Not from Trading Companies

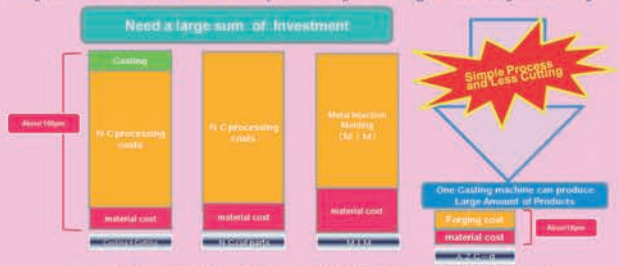
3 Automation - Self-Manufacture Keystone

Responsive Technique; Clued-up Attention to Improve !
That Helps Quick Turn.

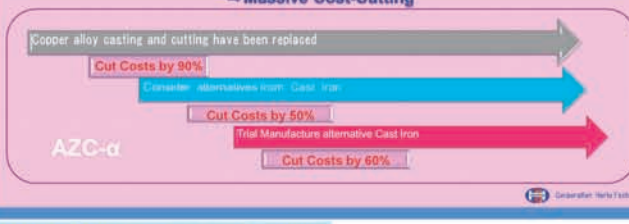
- Automatized Hand-Processing Operation Line
- Combined Full & Semi-Automatic Screw Cutting Equipment not for one use, but for versatile
- Automatized Check Device for visual-aspect Check
- Automatized Finishing Bore

Birth of High-Intensity Die-Cast Zinc Alloy !

If your materials would be improved by our High-Intensity Zinc Ally ...

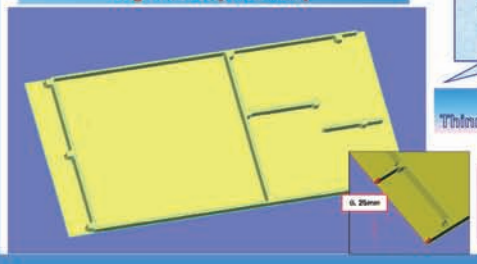


Alternate Current materials to Expensive High-Intensity one
⇒Massive Cost-Cutting



Challenge of Hot Chamber Die-Cast !

Suggesting Thin-Wall Molding by High-Intensity Zinc Alloy



Ultra Thin-Wall test piece (Challenge making chassis of Smartphone)

Complete! Thinness of case; 0.25mm

Aluminum / Magnesium ⇒0.4mm

High-Intensity Zinc Alloy⇒0.25mm

Contributing to Thinner Wall of Mobile devices like Smartphone

High-Intensity Zinc alloy A Z C-α Efficiency

Comparing with ZDC-2, about **Double Strength**

Composition and performance of AZC-α

1.Chemical composition(%)

Material name	Al	Cu	Mg	Cd	Pb	Fe	Sn	Si	Mn	Mech metal	Zn
AZC-α	7.85-8.55	3.00-3.30	0.03-0.06	≦0.002	≦0.003	≦0.075	≦0.001	–	–	0.02-0.07	Residue

2.Physical properties

Material name	Density kg/m³	Conductivity %IACS	Coefficient of thermal expansion ×10⁻⁶/℃	Solidification temperature range/℃	Thermal conductivity W/m·k	Specific heat J/kg·k	Liquidity 630℃ (mm)	Poisson's ratio	Specific gravity	Remarks
AZC-α	6300	28	23	385-390	115	435	280	0.286	6.3	

3.Mechanical properties

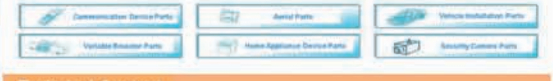
Material name	Tensile strength (MPa)	Breadth (%)	Longitudinal modulus elasticity (Gpa)	Charpy impact (J/cm²)	Fatigue strength (1×10⁴ times MPa)	Hardness (HB)	Pull 0.2% proof stress (Mpa)	Elongation % at break (%)	Potential difference (mV)	Remarks
AZC-α	340	3	90	100-120	100		300	–	–	

Low Cost Manufacturing Comes True by Zinc Die-Cast Parts Casting

Points

- Proposing Engineering to Customers to Derive Better benefit from Manufacturing of New Part at Low Cost
- Supplying Optical Pickup Parts 30% Market Share of Global
- Own-Design Auto Fabrication Technology, Possible to Manufacture
- Own-Design Mold, Possible to Manufacture

Zinc Die-Cast Parts ((Example of Application)

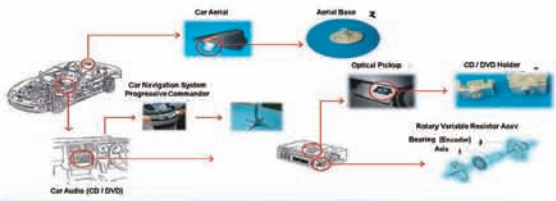


Technical Content

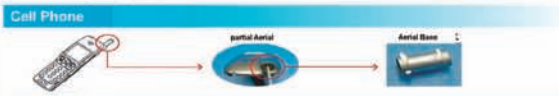
Products which were Created from Encounter with our Customers

Product Line : Optical Pickup Parts (DVD, Blu-ray) , Aerial Parts, Home Appliance Parts, Communication Device Parts, Industrial Device Parts

Vehicle installation



Cell Phone



By Zinc Die-Cast
Making Low-Cost Manufacturing Comes True

- Low-Cost Manufactured Mold Multiple Functioned Compact body Can be Carried by One Hand
- Attain Customer Satisfaction Auto Fabrication Technology
- High-Shot Produce by 5t Die-Cast Machine

〒987－1103 21-2 Takachiyaichi Kitamura Ishinomaki-shi Miyagi prefecture
Corporation Horio Factory
tel0225－73－2488 fax0225－73－3271
e－mail: info@horioss.co.jp

Corporation Horio Factory

Challenge to The State - of -The Art Image Processing & Next Generation Vehicles

Tohto C-tech Corporation

http://www.tctec.co.jp

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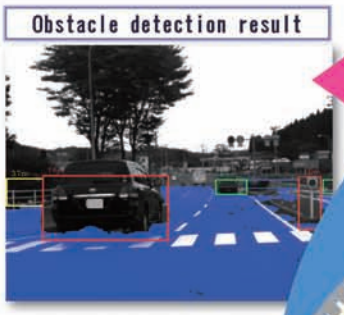
— Obstacle detection on the road —

3-D measurement by stereo camera

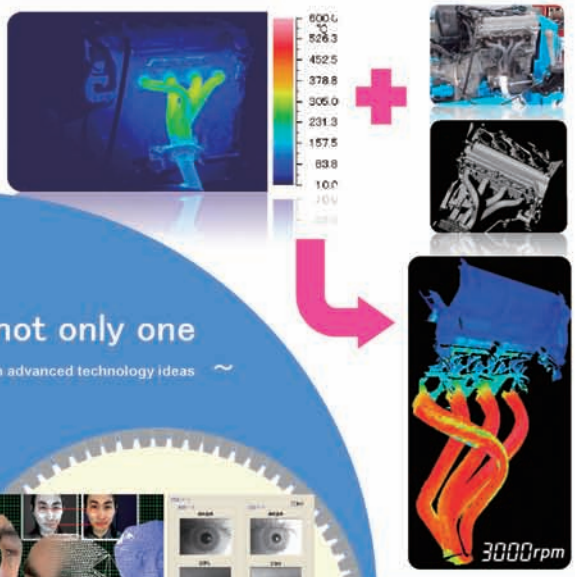
This system detects obstacles on the road such as vehicle and people. Processing three-dimensional measurement from stereo images, it detects the road surface. If there are some objects higher than road surface, these are detected as obstacles.



— 3dimensional heat measurements —

「3dimensional measurement」×「Temperature distribution measurement」

This system can synthesize thermal image and three dimensional data to process three-dimensional temperature distribution data. Using this system, you can detect accurate relationship between spacial position and temperature. For example, You can apply this system to heat test or product evaluation of thermal design.



Point of view is not only one

～ We will help you to solve problems with advanced technology ideas ～

Toto C-tec

System development in the middle of society

AUDIO, smart phone
etc…→Bluetooth／USB／BUS

- Power window／Sliding door
- Auto air conditioner
- keyless entry
- Push engine start

▼Technology component

- Power supply/ Mechanical device control
  System power control, motor control, such as D/D converter control
- Various IC control
  LCD control IC control, Backlight control(FL,LED) etc….
- Model based development
  MATLAB/Simulink, Auto coding／Auto test

—Automotive embedded software development —

Car navigation, body control system ECU

C-tec kun

—Business Area—

Image processing Solution	Embedded system solution	Parallel & speed-up solution
Problem-solving (algorithm Review)	MATLAB/Simulink Model-Based Development	Porting
Prototype development & joint research		Consulting
System development	Software Outsourcing	Software outsourcing

To every customers

～Have you troubled by the image processing system ？～

We're utilizing the state-of- the- art image matching technology with guidance from Tohoku University Professor Takafumi Aoki. Using synthesize of some of image information with different nature such as X-ray, infrared, advanced three-dimensional measurement, we achieve defect inspection system, the abnormal temperature measurement and so on.

Venture Capital for Innovation in Tohoku

Tohoku Innovation Capital Corporation (TICC)

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■ Company Information

- Company's name Tohoku Innovation Capital Corporation ("TICC")
- Address 1-1-1 Honcho Aoba-ku Sendai-shi Azur SENDAI F16
  <Tohoku Uni. Office> 6-6-40-407 Aoba aza Aramaki Aoba-ku Sendai-shi (inside the T-Biz)
- Business Investment and management support to venture companies, and management of the venture capital funds
- Establishment October 2003
- Paid up Capital 70 million yen
- Number of staff 9 people
- Board members
  President Ko Kumagai (ex President, Nikko Capital)
  Executive Vice President Kazuyuki Igarashi (ex JAFCO)
  Managing Director Hideo Hirama(ex SII, ex Sendai Cluster)
  Director Shiro Takahashi (ex Representative, Sony Sendai technology center)
  Auditor Akio Nishizawa (Professor, Toyo Uni.)
  Supreme Advisor Shoichi Noguchi (Professor emeritus, Tohoku Uni.)
  Advisor Yasutaka Iguchi (President, Miyagi Organization for Industry Promotion)
  Tomoya Shiraishi (ex JAFCO, Representative Director of Social Investment Partners)

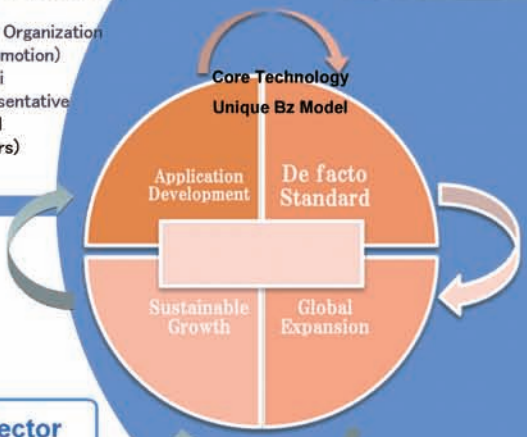
■Funds under management

・Tohoku Incubation Fund
Established March 25, 2004
Fund total 31.8 billion yen

・Tohoku Growth Fund
Established August 31, 2006
Fund total 35.8billion yen

・TICC University Alliance fund
Established June 22, 2007
Fund total 10.11billion yen

Support growing companies seeking global expansion based on the core technology



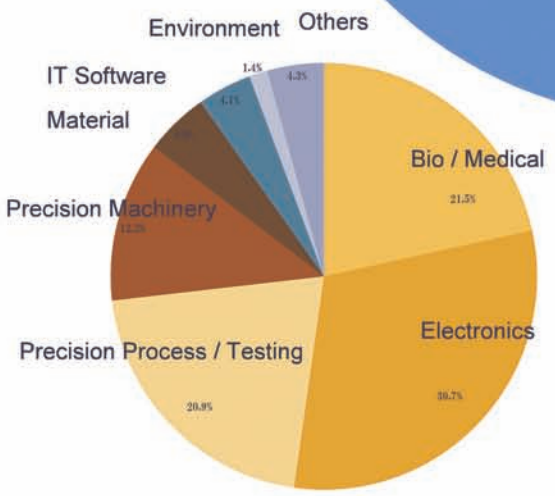
Growing Businesses

- Leading edge technology based on universities/research institutes
- Unique business model
- Application development with high added value to potential demands in various industries
- Adoption by global leading companies aiming to be de facto standard
- International expansion
- Sustainable high growth with profitability

Financial/management support

TICC
- Risk capital
- Business development
- Management support
- International expansion

■Portfolio by Sector



■Building a global network

- It is important for expansion into emerging markets in East Asia.
- In order to support the overseas expansion of investment companies, TICC is conjunction with research and development institution with overseas.
- First of all, signed with MOU with following two institutions

◆(Taiwan) Industrial Technology Research Institute(ITRI)

◆(Korea) Korea Technology Venture Foundation(KTVF)

Vigorous and Creative Industry Development

Miyagi Industry Association

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Association Profile

☆ Name : Miyagi Industry Association

☆ Address : c/o ITIM, 2-2 Akedori, Izumi, Sendai, Miyagi, JAPAN

☆ Establishment : December, 1986

☆ Chairman : Yuki Takebuchi (Corporate Consultant of Tokyo Electron Miyagi Limited)

☆ Membership : 418 - Regular member : 352
- Supporting/Special : 66

Purpose of Establishment

For Miyagi people who engage in industry and its related work

by promoting exchange and improvement beyond their business, size of organizations and arias,

Aiming to;
- Reinforce the Management Base
- Advance their Technology
- Open up a New Market

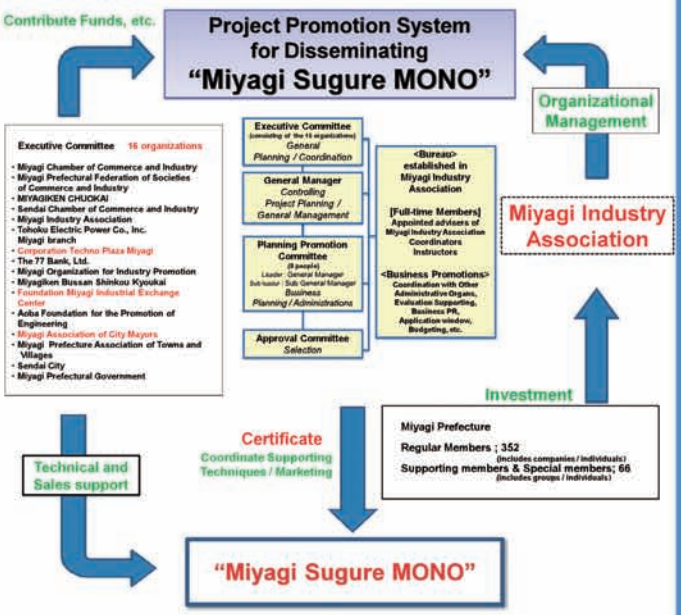
We contribute to healthy developments of vigorous and creative industries of our prefecture.

Business Promotion System

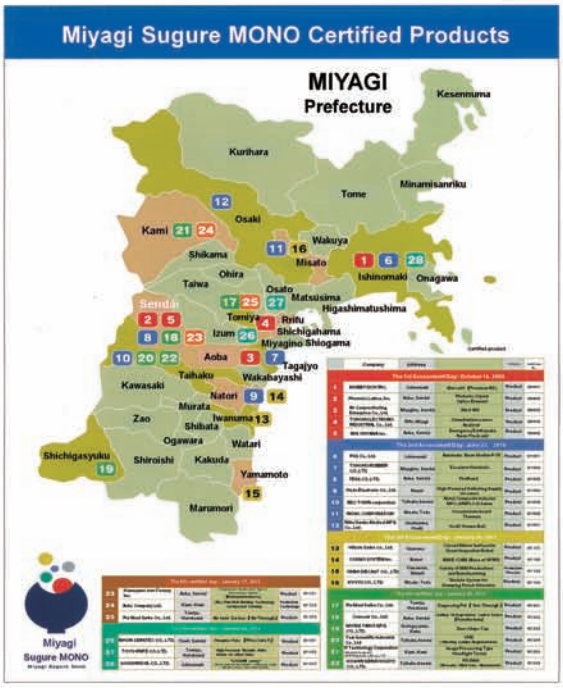
We Support Aggressive Challenges — Miyagi Industry Association

Miyagi Industry Association aims to contribute to industrial vitalization in the prefecture. We give help to improve business performances of affiliate companies through the various projects, by moving with the times accurately, challenge to solute social problem boldly.

[Accepting Consignments of the Industry Association] Business Promotion System



Miyagi Sugure MONO Certified Products



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c/o ITIM, 2-2 Akedori, Izumi, Sendai, Miyagi, Japan 〒981-3206
TEL:+81-22-777-9891 FAX:+81-22-772-0528

Contributing to the filed of Automotive Electronics with Optical Technology

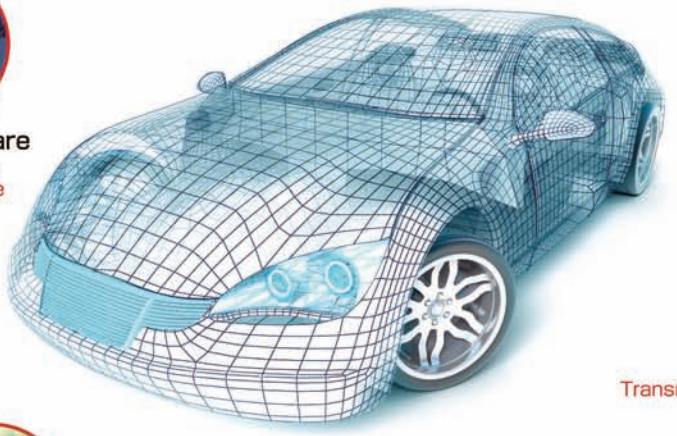
HAMAMATSU PHOTONICS K.K.

MEXT TOHOKU ECONOMIC FEDERATION Tohoku University 宮城県 七十七銀行 ICR

Hamamatsu Photonics' Automotive Solutions

We contribute to safety, comfort, and energy-saving driving for vehicle drivers using our forefront optical technology.

Sense the Glare
Si Photodiode
Photo IC Diode



Sense the Sun
Si Photodiode
Sun Sensor Assembly

Sense the Music
Transmitter Photo IC/ Receiver Photo IC

Sense the Rain
Si Photodiode
Infrared LED

Sense the Distance
APD,
Image Sensor for Distance Measurement
Pulsed Laser Diode

Sense the Corner
APD, Si PIN Photodiode
Image Sensor for Distance Measurement
Infrared LED, Pulsed Laser Diode

Sense the Angle
Photo IC, Encoder Module
MEMS Mirror

Products for Manufacturing Processes

Hamamatsu Photonics has a line of products which support manufacturing.
Please feel free to contact us for more details.

- Surface Reforming
- Thickness Measurement
- UV Coating
- UV Gluing
- Laser Welding
- Spectrophotometry
- Electrostatic removal
- Nondestructive Inspection
- Micro/Minute Pin Hole Detection
- Imaging Measurement

HAMAMATSU
PHOTON IS OUR BUSINESS

HAMAMATSU PHOTONICS K.K.

Established	September 29, 1953
Capital	34,928 Million Yen (As of end of Dec., 2012)
Number of Employees	3,045 (as of end of Sep., 2012)
Main Product Lines	Photomultiplier Tubes, Imaging Devices, Light Sources, Opto-Semiconductors, Imaging and Analyzing Systems
Domestic Center	Headquarters, Main Factory, MitsueFactory, Shingai Factory, Toyooka Factory, Tenno Glass Works, Joko Factory, Miyakoda Factory, Central Research Laboratory, Tsukuba Research Laboratory, Industries Development Laboratory, Tokyo Branch Office, Sendai Sales Office Tsukuba Sales Office, Tokyo Sales Office, Chubu Sales Office, Osaka Sales Office, Nishinihon Sales Office
Global subsidiaries	America, Germany, France, UK, Sweden, Italy, China

www.hamamatsu.com

Create the Future of an Affluent Society

~Contribution for people and companies by solid production techniques~

MIYAGIKASEI Co., Ltd.

MEXT | TOHOKU ECONOMIC FEDERATION | Tohoku University | 宮城県 | 七十七銀行 | ICR

Company Profile

◆Corporate Information

Name	MIYAGIKASEI Co., Ltd.
Address	15-4, Kitazawahankinzawa, Ichihasama, Kurihara, Miyagi
CEO	Akihiko Oyama
Establishment	April, 1987
Capital	¥20 million
Number of Employees	40
Certification	ISO9001 & ISO14001
Government Approvals	Ordinary Construction Business License chartered by Governor of Miyagi Prefecture (O-19) , The 18067th item

◆Business Summary

Main Business Activities; FRP (fiber-reinforced plastic) production and sales

- Auto components and other FRPs sales and production (bumpers, bodies, truck air deflectors, campers, cover panels, portable toilets, vessels, playground equipment, etc.)
- Construction material rent & sales (portable toilets, shower houses, houses, and event supplies)
- Construction works (lining, sealing, insulation, etc.)

◆Primary Customers

Automobiles

ICL, Mitsuoka Motor Co., Ltd., Lotas, First Custom, FATRASTYLING Inc., KLC

Constructions

House builders and construction machineries

◆Group Company

HAIPURA KASEI Co., Ltd.

8-92-5 Murasakino, Kitakami, Iwate

Corporate Identity

We aim to contribute to society and people through high-value productions and high-quality services.

We always think about better production and service delivery to develop our ability and personality.

Main Factory Profile

Gross Area	6,800㎡
- Molding factory area	671㎡
- Assembling factory area	205㎡
- Finishing factory area	197㎡
- Resting &warehouse area	197㎡
- Office area	113㎡

FRP Molding Technique

FRP Molding Method

① Hand lay up molding
Paste fiberglass and resin into mold by hand

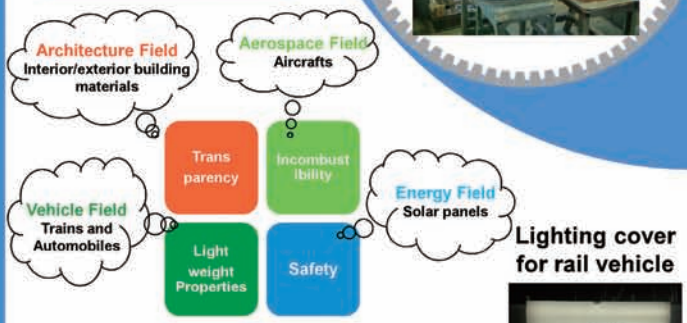
② Spray up molding
Spray fiberglass and resin by spray molding machine

③ Light RTM molding
Set fiberglass in an uneven mold, and inject resin into.

④ Infusion molding
Set fiberglass in a mold, and inject resin into by vacuum drawing

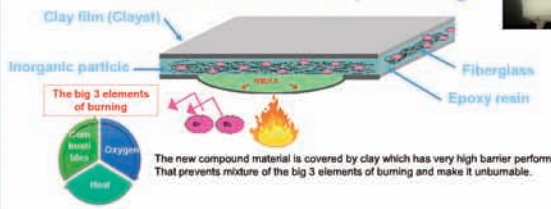
Working on New Techniques

The development of EXVIEW



Lighting cover for rail vehicle

Mechanism of fireproofing



The new compound material is covered by clay which has very high barrier performance on the surface. That prevents mixture of the big 3 elements of burning and make it unburnable.

Mitsuoka Motor Co., Ltd. 'Viewt'

FRP Front face, Bonnet, and Trunk

Message for corporate customers

~As your partner company, we create the future by new ideas &challenges~

We always think what we could do for our customers and society.

By the productions and manufactures, we aim to contribute to society.

Contact

TEL +81-(0)228-52-3931 FAX+81-(0)228-52-3933

E-mail : info@miyagi-kasei.co.jp URL : http://www.miyagi-kasei.co.jp/

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

We provide the Best Solution with the Highest Technology

Daisho Denshi Co., LTD

MEXT　TOHOKU ECONOMIC FEDERATION　Tohoku University　宮城県　七十七銀行　ICR

PROFILE

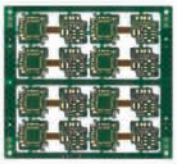
◇Company Name : Daisho Denshi Co., LTD
◇Address : 2-16-5 Denenchofu, Ota-ward, Tokyo
◇Date of Foundation : 12 September, 1968
◇Paid in Capital : ¥731milion
◇CEO : Naotoshi Shinozaki
◇Main Products : Printed board design and manufacturing;
- Planning for pattern, various simulation
- BGA board, CSP board, COB board, FC-BGA board
- Build up multilayer board, Cavity board
- BVH / IVH multilayer board　・Laser Metal Mask
- Magic Resin Career　・Various tester jigs
- Component assembly

◇Annual Revenue : ¥18,700milion
(2014 financial results as of March, 2015)
◇Main Customers :
- Mitsubishi Electronic Corporation
- Murata Manufacturing Co., Ltd
- Sony Corporation
- Panasonic Corporation
- FUJITSU LIMITED
- CANON Inc.　etc.

NETWORK

Total Support System

We satisfy customer's needs on flexible manufacturing, from research development, design, production to assemblage for printed boards.

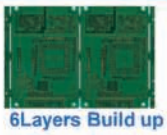


4Layers Flexible-Rigid Build up

TOYOTA

CAMERA MODULE

BLUE TOOTH



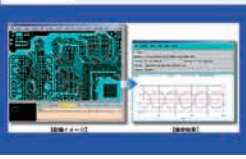
6Layers Build up

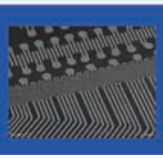
4Layers

ENGINE CONTROL PARTS

We have accumulated manufacturing technologies, experiences, know-how and networks since the foundation. Utilizing these abilities, we have created total support systems such as manufacturing, pattern planning, simulation, manufacture of tool for production, package support tool, development of inspection tools, parts package, construction for unit, assessment for reliability and so on.

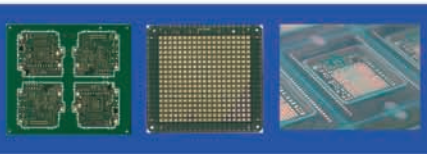
We swiftly and flexibly meet the diversified needs of the customers, not only for total support, but also for each process.





Main Office : TEL.03-3722-2151
Iwate Plant : TEL.0191-63-5111
http://www.daisho-denshi.co.jp

DAISHO DENSHI



Using electric vehicle COMS

Car Sharing system

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

TOYOTA TSUSHO CORPORATION
Green Mobility Business Development Dept.
81-3-4306-3174

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Excellent ideas to use eco-friendly Micro EV,"COMS"

EV Sharing
@ Community, Condominium, Workplace, Tourist area etc....

Selling points of COMS sharing system

●Remaining battery level and cruising range estimation

Display battery level & cruising range

Select "Station" ⇒ "Departure time" ⇒choose "Vehicle"

Display battery level and possible travel mileage

＊State-of-charge (SOC) is calculated by information from COMS and accumulated charging data.
＊Cruising range is calculated by remaining battery level.

Driving route search

Plot your "destination"

Route Search ⇒Battery consumption calculation

Possible to reach destination　**Unable**

Display "Estimated time of travel" and "Distance"　**Display "NG"**

＊Calculated by accumulated driving data and slope/grade information on map and driver's past driving characteristic.

State-of-charge projection after drive & estimated battery charging time display

SOC projection after drive

Calculate battery charging time & recharge level

＊Estimated SOC at the .time of car return is calculated by accumulated driving data and actual current battery level.
＊Estimated battery charging time and recharge level are calculated by accumulated charging data and CAN information from COMS.

Inflection line matching algorithm

～Advanced defect detection technique for painting on mirror surface by image processing～

×3PROJECTS By Three projects corporation

MEXT　TOHOKU ECONOMIC FEDERATION　Tohoku University　宮城県　77 七十七銀行　ICR

Company profile

Address：〒981-3212　15-22 4 cho-me, cho-meigaoka Izumiku Sendai, Miyagi
Established ：　March 3, 1987
Capital stock ：　10million yen
Employee ：　31 people（March,2012）
Office ：　Headquarters（Cho-meigaoka Izumi-ku）
　　Furukawa branch（Nakazato Hurukawa Osaki Miyagi）
Business info　：1. Embedded Systems
　　2. Measurement & test system development
　　3. Operational systems development
　　4. Image processing system development
　　5. digital / analog circuit design
　　6. Research & development

東北で初　ナショナルインスツルメンツ社 アライアンスパートナー（東北初）
LabVIEW認定開発者5名（東北最大規模、国内トップクラス）

※April ,2013
・1　NI certified instructor
・5　certified LabVIEW developer
・3 certified　LabVIEW associate developer

NATIONAL INSTRUMENTS Alliance MEMBER

"2010 Strategic Technology Infrastructure Support Sophisticated Business"
Adoption Projects
" Commercialization and development of image processing embedded software for enhancing visual for industrial robot"

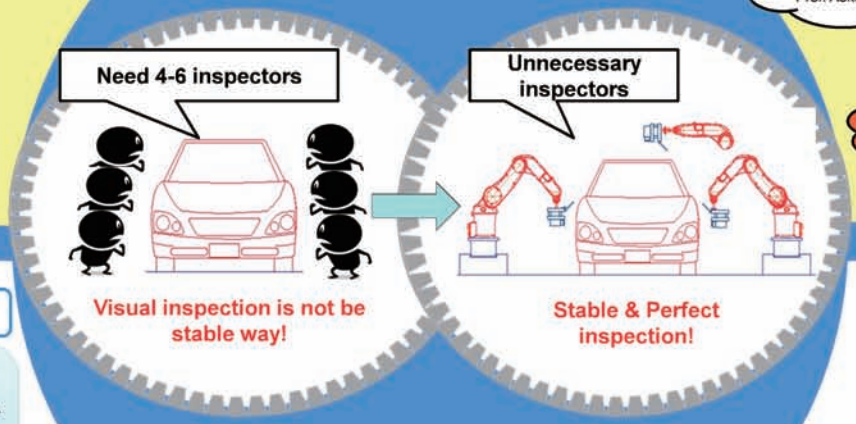
One of the project development result "Inflection line matching method"
※ As "surface inspection method and surface inspection device". The patented in January 2013.
（Patented :Number 5182833 ）

【Joint research group】(Alphabetical order)
Hikichi Seiko Corporation
Miyagi Prefectural Industrial Technology Center

【Adviser】
Tohoku University Grad school of Information Science & Technology.
Prof. Aoki

industry-academia-government – collaboration

Automatic defect inspection



■Prevent defect outflow
■Save inspection cost

Summary of Inflection line matching method

・Algorithm to highlight irregular part of the interval and the direction of the curve in the image.

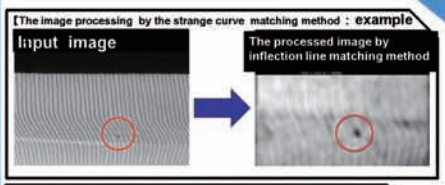
< Applications >
⇒Using slit of the organic EL lightning to imprint slit on the test object to take in image.

※１のサンプル画像

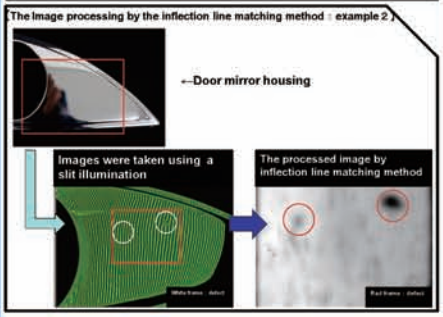
① 検査対象物

対象物	表面状態 ゆず※1	微細痕や汚れ※2	鏡面	艶有り	艶なし
塗装（メタリック含）	×	×	○	○	×
メッキ	−	×	○	−	−
金属加工	−	×	○	−	−

【The image processing by the strange curve matching method：example】



【The image processing by the inflection line matching method：example 2】



【Applications】

・Surface defect inspection of the exterior and interior automotive products

・Surface defect inspection of plating painted

・Surface defect inspection of metal processed goods

・Surface defect inspection of plastic products

・Surface defect inspection of resin processed products

Etc…Applicable to defect inspection with respect to the surface that has the property of specular reflection to the light.

② 欠陥、及び検査対象物の形状

表面状態	欠陥 線キズ	汚れ ゴミ	ゆるやかな凹凸	鋭利な凹凸（ブツ含）	検査対象物の形状 平面	ゆるやかな曲面	きつい曲面	カド	複雑な曲面
ゆず※1	×	×	×	×	×	×	×	×	×
微細痕や汚れ※2	×	−	×	×	×	×	×	×	×
鏡面	△	○	○	○	○	○	△	×	△
艶有り	△	○	○	○	○	○	△	×	△
艶なし	×	×	×	×	×	×	×	×	×

※1 欠陥とまでは見なされない程度のゆず肌（塗装表面の粗さ（ラウンド））のうち、比較的きついもの。
※2 表面を研磨した時につく研磨痕のきついもの（光を回折させ虹色に見える線キズなど）や、表面光沢を失わせる汚れが、検査面全面に付いているもの。

By three projects corporation
〒981-3212　15-22　Chomeigaoka Izumi-ku Sendai
TEL:022-342-7077／FAX:022-342-7079
http://www.x3pro.co.jp/
E-Mail:sales@x3pro.co.jp

×3PROJECTS　NATIONAL INSTRUMENTS Alliance MEMBER

We provide "New familiar Hybrid"

My Car Plaza Eco Custom Division Corporation

http://www.e-rhs.com/

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Hybrid Cars Evolution to " Ultimate Eco-Car"

RHYBRID Prius α (ZVW41)


TMS2011 at Venue

LPG + Electricity + Gasoline

The evolution to the " ultimate eco-car" by the RHYBRID of the motor hybrid car is synonymous with eco- friendly cars.

The exhibitors participating in RHYBRID Priusα in 2011 Tokyo Motor Show. It was a celebration of next- generation vehicles. Many visitors had to experience abroad to see.

Active in the Nationwide "not a dream" as the vehicle realistic

RHYBRID, so called Bi-fuel LPG remodeling is a technique that can be practiced right now.
The economic efficiency and excellent environmental performance, a lot of attention from taxi operators around the country, especially in Tokyo metropolitan area, there are more than 700 taxi vehicle active currently.
As a car running daily basis, there is a running truck record of more than 400,000 km after remodeling.
There is also a truck record of introduction as official vehicles of municipal and commercial vehicles.

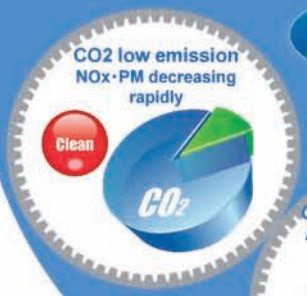
Adoption in local government, is due to the strong focus on LPG in case of emergency in the earthquake earlier.

Use of fuel as the "LPG"

Realistic Ecocustom=" Real HYBRID system "

RHYBRID®

Innovative Custom for Eco



Non-stop Evolution


RHYBRID Hiace(TRH224 renewal)


RHYBRID Camry(AVV50 Renewal)


RHYBRID Professional box(NCP51 renewal)

Prius series is the flagship model in our company, in order to respond to various needs, we'll continue to expand its corresponding model.
We don't think a technology that requires million people, but at present, it is in the process of evolution of automotive technology, we believe that technology that connects to the next generation.
Know-how and retrofit technology that we have is immediately transferable to bi-fuel of the LNG and CNG.
Now, it is a next generation energy issues such as Payload and infrastructure, challenge of widespread use, but when the conditions are in place, it is a technology that can immediately respond.

Aim for Higher Goals


RHYBRIDCROWN(AWS210 renewal)

The technology and the structure of "Automobiles", especially "engines" develop firmly and more highly day by day. For example, the latest crown hybrid. It has the new style 2.5L engine "Next generation D-4S" which is concentrated Toyota's high and advanced technology. We materialized the gasoline × LPG dual fuel reduction by analyzing the vehicle characteristic and the esoteric control system. Immediately, we received construction projects and we are promoting the mass production system.

As "Automobiles" are developing, we are also aiming our technology and system's progress. This challenge has just begun. We keep on challenging with the aim of future heights.

RHYBRID仕様車 設計・開発・加工・販売
My Car Plaza
http://www.e-rhs.com/
My Car Plaza Eco custom Division Corporation
〒028-3161 4-23-1 Kuronuma Ishidoriyacho Hanamaki Iwate
TEL:0198-45-2700　FAX:0198-45-6579
e-mail:info@e-rhs.com

Ministry of Education, Culture, Sports, Science and Technology
Area innovation strategy support program next generation car Miyagi area

Auto industry support through technology seeds

AKITA Industrial Technology Center

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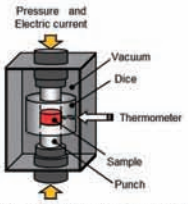
Super hard tool materials of resources strategic type

We've tackled development of hard tool materials have high hardness and high crack length. As a result, it was found that Tungsten carbide(WC) raw material of the hard metal becomes densification adding SiC. Therefore, we become able to make WC-based cemented without addicting cobalt(Co).

A prototype of burnishing reamer collaborating with companies

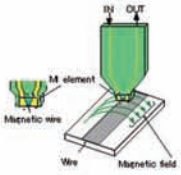


Development method of hard tool materials

A high frequency magnetic detection element

We developed MI probe measurable electric current of the wiring contactlessly from direct current to high frequency with high sensitivity. Covering all frequency band and having flat frequency characteristics, that implements 10 micron spatial resolution. This one can evaluate EMC of the whole vehicle body. Application as high frequency noise sensor, high bandwidth magnetic field sensor, and rotation sensor are capable also. So, the structures are simple and the manufacturing cost can suppress.

The measurement example by developed MI effect type magnetic probe



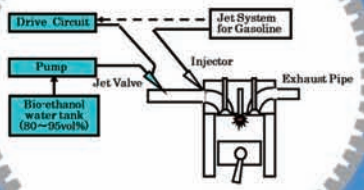
MI probe

Development and proof experiments of Dual-Fuel Vehicle

We took running tests in Solar sports line of Oogata-village.

As a result, we finished proof experiment safely without engine trouble.

It was equipped with a bio-ethanol tank in addition to the gasoline tank.



To a minimum remodeling of around engine!

DFV is the automobile can use two fuel both gasoline and bio-ethanol water coincidently. The vehicle runs by providing the two fuel from the two fuel supply systems to the engine. Accordingly, reducing carbon dioxide could be expected.

A prototype has flexibility.

The example can make simultaneous trials using two color resins.

The Rapid Prototyping technology don't need metal mold, and you can get prototype in a short time. It can raise capability to develop new products. In addition, you are able to shape prototype from three-dimensional data(STL) gained by three-dimensional CAD or 3D scanner, and the feel of shaping model and function can be evaluate.

Prototyping by digital engineering

Autoclave

The carbon fiber reinforced plastic(CFRP) has merits like lightness, high strength, high rigidity, high corrosion resistance. It is the next-generation material which expanding a substitute from conventional metal material rapidly as structure material of automobile parts. Our center aim to expand industrial utilization, by maintenance of facilities and developing technology seeds.

Composite Center

For companies

It becomes high function and low cost of automobile parts and others by the locally laser quenching technique, which is our center's technology seeds. Also, we design an improvement in productivity for automobile factories by the hardness test gripper technique for industrial robots. In this wise, we support automobile industry with seeds of technology of design, processing, and measurement based on materials engineering, mechanical engineering, and electrical and electronic engineering. For more information or any question, please contact the contact address below.

Akita Industrial Technology Center Technological innovation department
TEL +81-(0)18−862−3420 FAX +81-(0)18−865−3949 http://www.rdc.pref.akita.jp/

Highly recommended!

"LNG-DDF"

Main figure in the shale gas revolution

Hana Engineering Japan Co., Ltd.

http://www.hanaeng-japan.com

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Retreat from nuclear power and the shale gas revolution

After the Great East Japan Earthquake, the extreme begun to retreat from nuclear power worldwide. Then, simultaneously the times changed not to rely on petroleum energy. That is the fuel revolution by developing of fuel gas mining technology, representative USA. The new hybrid system of motor and gas not to rely on gasoline protect the global environment, with a thermal power station makes retreat from nuclear possible, and the fuel battery car instead of electric cars.

When Japan is waved by retreat from nuclear, the shale gas revolution is in progress in the world. It advances to retreat from nuclear and protect people's life that Japan make fuel revolution as a member of the shale gas revolution.

Nowadays, if the motor hybrid based on gasoline car increase fuel efficiency 40% compared with gasoline car, development of gas hybrid by the shale gas revolution can increase fuel efficiency 30% furthermore.

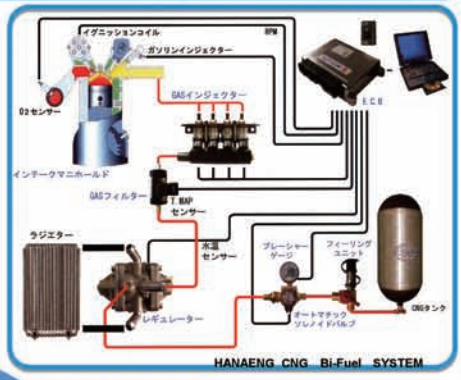
Therefore, almost hazardous wastes will be restrained, and many high environmentally cars exist in the world.

The lowering of price of automobile fuel by the shale gas revolution, automobile fuel efficiency will be able to be halved. So the spread reducing hazardous waste from cars, we can leave the precious legacy beautiful earth to offspring.

The secondary fuel system not rely on gasoline oil when earthquake

Bi-Fuel

Bi-Fuel is hybrid of gasoline and gas, when warming-up operation it uses gasoline, a few minutes later it switches to gas automatically. When the Great East Japan Earthquake gas stations ware filled of crowd, Bi-Fuel car ware able to supply at vacant gas station. Fuel efficiency rise 30 to 35%, and CO2 are cut down above 20%, Nox, PM etc. are able to reduce 50 to 70%. It uses gas: LPG, CNG.



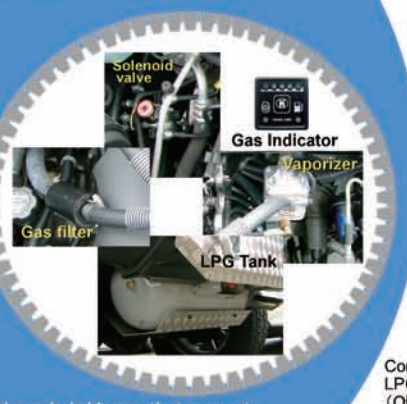
HANAENG CNG Bi-Fuel SYSTEM

LPG・CNG gas hybrid system

We provide next generation car.

Restraining hazardous exhaust materials, CO2 decrease and fuel efficiency increase.

Gas hybrid system, the most practical, becomes the leading role of the shale gas revolution.



We provide the most practical gas hybrid cars that convert petroleum fuel car into high environmentally car as the primacy of post-oil fuel in automobile world, solving retreat from nuclear power in Japan, not being late for the shale gas revolution only once in a century or two centuries in the world.

CNG Bi-Fuel Gas Injection System

It can utilize almost gas, such as LNG, HHO.

Japanese taxies choose Prius Hybrid instead of gas powered vehicles.

For several years, Japanese taxi companies have replaced Toyota Prius with LPG auto gas car. And simultaneously, the number of taxi company convert Prius into gas hybrid boosted. Used Bi-Fuel system are occupied almost 100% by our company made.

Company profile

Company name
Hana Engineering Japan Co., Ltd.
Paid in capital 10,000,000yen
Founded October 2009 established May 2011
President Kazuhiko Kami
Head Office Tsurugaoka2-12-3,Izumi-Ku, Sendai, Miyagi, 981-3109Japan
East Japan Sales Department
HANA JAPAN first building 2F
3-1-43 Haranomachi, Miyagino, Sendai
983-0841,Japan
West Japan Sales Department
Haruhiyaketa67-2Kiyosu-shi, Aichi-ken 452-0962Japan
System hybrid department
HANA JAPAN first building 3F
Haramachi3-1-43,Miyagino-Ku, Sendai
Information center
HANA JAPAN first building3F Haramachi3-1-43,Miyagino-Ku, Sendai

Products and sales items

Gas hybrid system in general
- LPG Bi-Fuel system
- CNG Bi-Fuel system
- LPG-CNG Bi-Fuel system

Correspondence gas: LPG,CNG,LNG,HHO, oxyhydrogen (OHMASA-GAS) biogas in general
- Plan, Design, Product; Limousine, Adapted vehicles
- The ability test strength and stiffness of cars in general
- Operations authorized by Ministry of Land, Infrastructure and Transport and related ministries

Sales department building, view from National Route 45

The gas hybrid car's the range per one fuel filling is 10 times as long as electric car. It can reduce CO2 20 to 22% compared with gasoline, reducing hazardous wastes 60 to 90% such as Co, HC, Nox, PM, Sox, fuel efficiency can increase 30 to 40%(compared with gasoline car).

※Though "hybrid" means to have plural motor in one car, "Bi-Fuel" means the system combusts dual fuel by switching alternately, we express all of those "hybrid" to understand by general public.

Hana Engineering Japan Co.,Ltd.
East Japan Sales Department 3-1-43 Haranomachi, Miyagino, Sendai 983-0841,Japan
TEL +81-(0)50-1208-5862(representative) FAX +81-(0)22-776-5072
E-mail: hanaeng_japan@ybb.ne.jp
http://www.hanaeng-japan.com

After the Great East Japan Earthquake, the world began breaking with nuclear power generation. One only accident takes life and the health of innumerable people, and it makes towns into the death. Spread of electric car increases electrical energy consumption by 10%, it puts on the brakes retreat from nuclear. It is not enough that wealthy families install solar power system. A nominal that we are supplied from electric cars when a natural disaster, but cars are not able to at the important time. Besides, the batteries retain only several hours. Solar power system responds the case of a power failure due to a disaster, any days or any weeks. Though the problem of thermal power generations is only fire, nuclear reactor convert a hometown into dead town. Almost all regions have the possibility. The tragedy of FUKUSHIMA is not another person's problem. We contribute to retreat from nuclear with making cars using clean energy liquefied natural gas (LNG). Gas cars and electric cars. Electric cars sound smart, but we hope you to find out there are dreadful power supply source behind them. Although the nuke has called safety and reasonable, the Nuke accident of the Great East Japan Earthquake caused a great illluck, and its amount of damage is as tens or hundreds times as the cost when it was built. Now Japanese government seems to force people to pay that , we are convinced the importance of gas hybrid, because we must choose a choice to protect our offspring .

To provide our customers with the added value different from the other companies based on innovate material

NEC TOKIN corporation

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Company overview

Company's name: NEC TOKIN corporation

Capital stock: 34.2 billion yen

Sales figures: 41.3 billion yen (2012)

Number of employees: Consolidated 6,014 (Domestic 1,298 international 4,716)

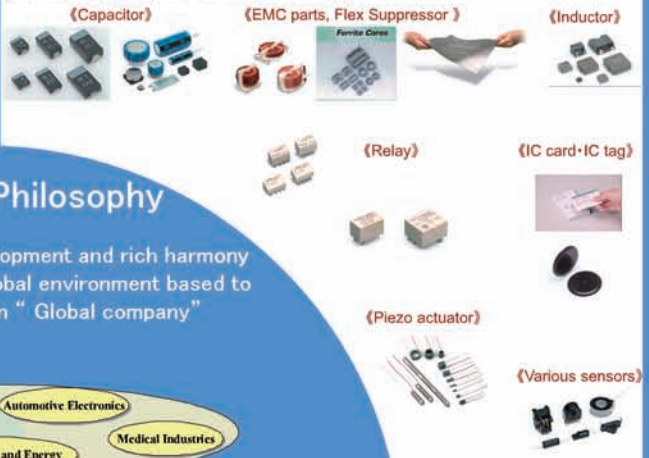
Production plants: 7 (Domestic 3, International 4)

As of March 31,2013

Factories and Products

Main product

Tantalum capacitors, Electric double-layer capacitors, EMI suppressing components, Flex Suppressor (noise suppression sheets), Power inductors, Signal Relays, Power relays, IC cards and IC tags, Piezoelectric devices, Sensors (Temperature, vibration, infrared).



Corporate Philosophy

We contribute to the development and rich harmony between people and the global environment based to the material innovation " Global company"

Main Markets

Digital Consumer Electronics | Automotive Electronics | Industrial Equipment | Environment and Energy | Medical Industries

Main Products

Capacitors
- Tantalum capacitors
- Electric double-layer capacitors
- Proadlizer

EMC Electro-Magnetic Components
- AC line filters, Flex Suppressor
- Power inductors, Transformers
- Magnets, Metals

Electro-Mechanical Devices
- Power relays
- Signal relays

NFS
- Near field communication

Access Devices
- IC cards and tags

Piezoelectric Devices
- Piezoelectric materials
- Piezoelectric actuators
- Piezoelectric transducers

Sensors
- Thermal sensors
- Electric current sensors
- HD haptics ・FFB

Core Technologies

Capacitors' Materials: Tantalum | Conductive polymers | Active carbon

Magnetic Materials: Ferrite | Magnets | Metals

Ceramics: Piezoelectric materials

Expansion into Car electronics market

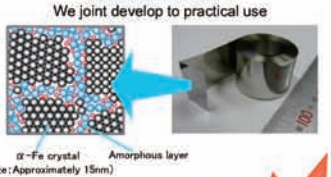
~To HEV core device the latest from various electrical parts , we'll propose a variety of solution~

Next generation vehicles for latest items

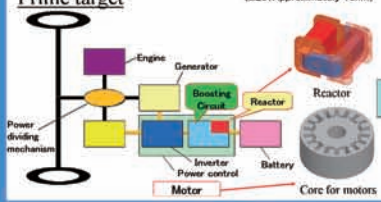
Nano crystalline soft magnetic material

What's Nano crystalline magnetic material ?

High saturation magnetic flux density &
Ultra Low Electric power loss **Nano Cristal**
Found by Prof. Akihiro Makino,
TOHOKU UNIVERSITY
We joint develop to practical use



Prime target



The contribution to the Creation of next-generation vehicles And highly efficient technology development in the Northeast

Towards a leading manufacturer of next generation

Ricoh Industry corporation Tohoku plant

MEXT TOHOKU ECONOMIC FEDERATION Tohoku University 宮城県 77 七十七銀行 ICR

About Ricoh Industry

■With the aim of manufacturing to provide new value creation to customers

April 2013, offering integrated part of Ricoh Co., Ltd. Production Division (Tohoku Ricoh, Ricoh Printing Systems, Ricoh Uni-techno) and series production company of three domestic, the company responsible for the domestic production of the Ricoh Group, was established as a production company.

The new company, to mobilize the power of each company so far, and not only with the product, with the aim to advanced manufacturing company that has a technology development capabilities for the next generation of new key parts, such as a new business area, the Ricoh Group to become the company's core to bolster the manufacturing of power, we will continue to strive.

《 Tohoku plant picture 》

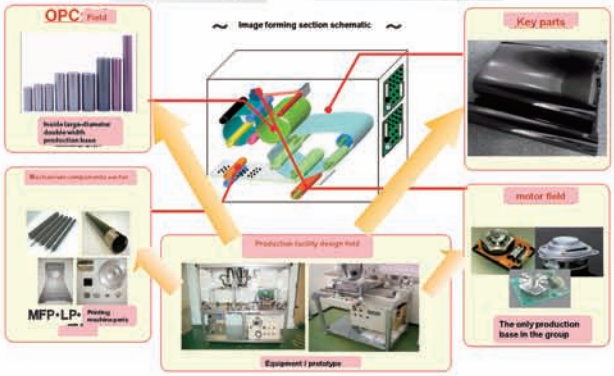
《 Ricoh brand message 》

RICOH
imagine. change.

In bringing together of imagination, we create change. We will continue to provide new value to our customers in the future.

Production items

《 printing machine》 《 copier 》



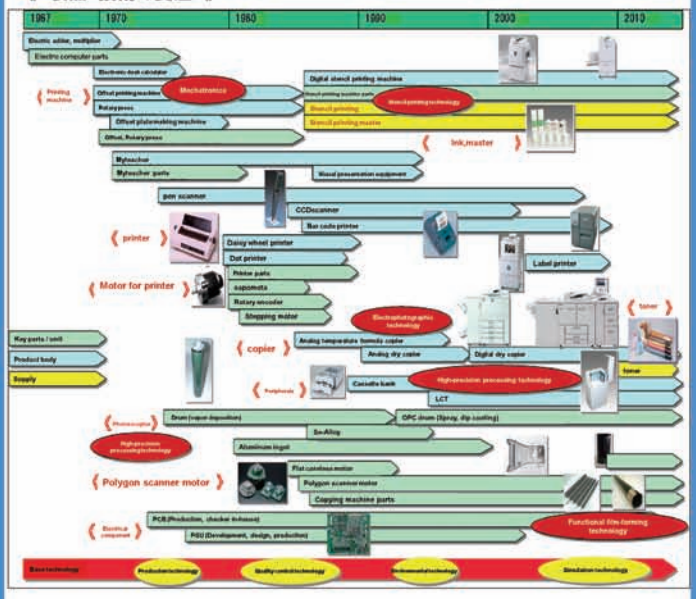
From the main body of product to parts, functions necessary for crafting gather in a northeastern establishment and I perform the action that is the concurrent that did the cooperation with the design thickly routinely, and go ahead through method of construction development, the facilities development concurrently and realize a quick mass production shift, the achievement of QCDSE, production capacity maximization.

Changes in technology (technology that has been polished)

■Production technologies that are the backbone

We always challenge the highest technology development. And, at Tohoku plant, take good care of a forward posture to go one step ahead, a new action through the production of OA apparatus connection product, main parts.

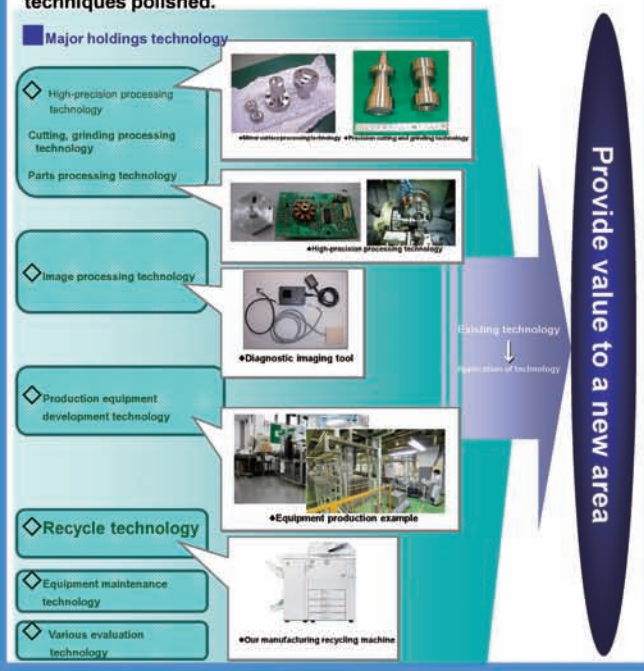
《 製品・技術の変遷 》



Aiming to create new value

■ We will continue to a new value provided to customers.

As a production function companies, not only to contribute to Ricoh group so far, and cultivate it until now from the past, we will make a new value provided to our clients on the base of the techniques polished.



Searches for five senses functional sensing

Miura sensor institute corporation

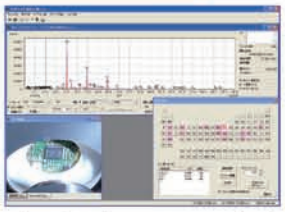
MEXT　TOHOKU ECONOMIC FEDERATION　Tohoku University　宮城県　七十七銀行　ICR

Non-contact type harmful elements detecting device

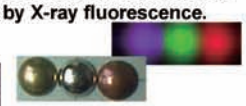
Denbee Series

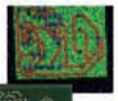
The measured immediately in a non-contact harmful elements

The inspection of RoHS Directive REACH



We can analyze the elements contained in the sample by X-ray fluorescence.





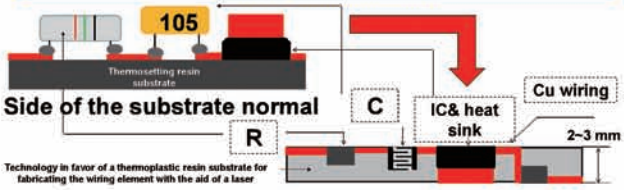
small

Take it everywhere

Elemental mapping

Evaluation of the sample with a diameter of 300mm!

Method included any value electric element embedded substrate manufacturing apparatus of environment-friendly



【 Feature 】

Side of the substrate to be prepared by the action

- Wiring need only the substrate thickness, the apparatus for manufacturing electrical and electronic devices.
  (Device that included fabricated embedded on the spot to the substrate wiring and parts)
- Standard values and can be formed on the spot element of the non-standard value
- Raw materials and thermoplastic resin substrate recycling
- Conductive transfer rate Cu wiring possible of the plating film equivalent
- The expensive vacuum apparatus is all-free!

:Plastic (Nihon kogyo shuppan April,2013)

Collaboration with Prof. Katsuhiko Suzuki from Sendai National College of Technology

Embedding apparatus laser assisted particle jet

ルリフィ

Loulifee

3 感覚 フィードバック システム

株式会社ミウラセンサー研究所

Magnet sensor RTD

attached to the measuring unit

A magnet built into the sensor part, putting on and taking off of the sensor and the measured object is excellent simple, workability.

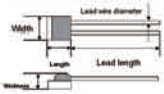
Plastic coating thermocouple line

It is superior for use in places like around the water, trash.

M 222 platinum resistance temperature detector

A temperature range is wide and is superior in long-term stability, compatibility, accuracy.

It is high-performance at only 2mm



素子サイズ (mm)				
Length	Width	Thickness	Lead length	Lead φ
2.3±0.15	2.1±0.2	0.9+0.3/−0.2	10±1	0.2±0.02

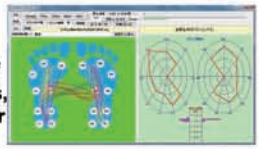
Name	M 222 platinum resistance temperature detector	
Nominal resistance	100Ω (when 0℃)	
Tolerance	German industry standard DIN EN 60751, class A	
Manufacturing standard	German industry standard DIN EN 60751 (IEC 751)	
Temperature range	Class A: − 50 ℃ ～ + 300℃	
Temperature coefficient of resistance	TCR = 3850 ppm/K	
Output wires	Platinum clad nickel wire	
	Connection methods: welding, welding, brazing	
Prolonged stability	Resistance value drift of 500 ℃ 1000 hours after the 0.04 percent maximum(※1)	
Vibration resistance	withstand 40G acceleration in the 10 ~ 2000Hz. (※2)	
Impact resistance	withstand 100G acceleration in half sine wave of 8ms. (※2)	
Use conditions	Available only dry environment.	
Insulation resistance	20℃: 100 MΩ over ; 500℃: 2 MΩ over	
Self-heating	0.4 K/mW at 0℃	
Response time	Underwater measurements (v = 0.4 m/s):	t0.5 = 0.05 s t0.9 = 0.15 s
	Air measurements(v = 2 m/s):	t0.5 = 3.0 s t0.9 = 10.0 s
Measured current	100 W: 0.3 ～ 1.0 mA 500 W: 0.1 ～ 0.7 mA 1000 W: 0.1 bis 0.3 mA (Please consider the self-heating)	

※1 (Guaranteed range of class A is 300 ℃ ~ 50 ℃. It is the tolerance of the Class B in the case of 500 ℃ ~ 500 ℃.

※2 will change by the mounting structure of the sensor

Temperature sensor

Look measured by a variety of sensors, such as the movement of the head, hands and feet, and eyes, listen, and can be feedback to their own feeling.



3 sensory feedback system

To everyone in the company

～ Make the research and prototyping and development of measurement equipment ～

We are a research-based company. We perform the construction of the optical measurement system by the materials tester by the request from a semiconductor, the machine materials maker and a university, the research institute request, device production.

〒981-3203 1－40　2 Cho-me Takamori Izumi-ku Sendai, Miyagi 21st Century Plaza Research Center 207 room
TEL : 022-374-3207　FAX : 022-772-0640
E-mail : office@miura-sensor.jp　HP : http://www.miura-sensor.jp

KTECH
K Technology Corporation

Electronic Devices
from Planning, Design, Manufacturing, Evaluation, to Services
K Technology Corporation

MEXT　TOHOKU ECONOMIC FEDERATION　Tohoku University　宮城県　七十七銀行　ICR

Core value &DMS concept

KTECHのコアバリュー
DMSコンセプト

お客様の課題をあらゆる面で解決する
ソリューション企業をめざして

Development & Design
開発・設計

- Design service which surpass a simple mass production design from a development stage including product concept and prototype launch.

Manufacturing
製造

- Not only a production by commissioning, we also offer production service which involve the high reliability evaluation technology and the production technical assistance.

Service & Solution
サービス・ソリューション

- It is the solution service which offers not only after service but also solution service that provides added value such as material procurement cost-reduction, productization and new business marketing.

We provide a solution in accord with the needs of the customers.

We are design and fabrication company to support your manufacturing.

To the needs of the customer, we cope with the form that general and partial of great variety.

企画・構想 → 設計・試作 → 部品購買 → 信頼性評価 → 設備開発 → SMT実装 → Assy組立 → 出　荷 → サービス

Core technique of the in-vehicle business

Development and design of products
- IMAGE PROCESSING /display technology/digital technology
- cabinet design/ packing design /Printed wiring board design

The quality system
- ISO/TS16949 A quality control system cultivated it with an in-vehicle apparatus product

facilities
- Including evaluation facilities, necessary facilities for securing of quality of the in-vehicle product are enriched.

Designers according to the product area

Core technology

We have skills and experiences of wide product area and various product categories.

research project
- Bond magnet applied technology
- Supersonic wave skin sectional evaluation
- Spatial Imaging applied technology

Company Profile

Company name　K Technology Corporation
Established　April, 2005
Paid in capital　100 million yen

Net sales　¥9.8billion (2013 result)

Employees　558 (As of Oct 1, 2014)
Office　Head Office 325 Ganbara, Kami-machi, Kami-gun, Miyagi, Japan
Tokyo Sales Office 6th Floor, Nikko Gotanda Bldg, 2-29-5 Nishigotanda, Shinagawa- ku, Tokyo
Facilities area Site 187,313 m²
Building 34,027m²
Business contents　Design, trial manufacture, production and services of electronic devices.
The public certification　ISO/TS16949、ISO14001 ISO13485 certification

To companies

～Please tell me the company's problem.～

We suggest differentiation and increasing competitiveness with other companies, by adding wide manufactural service from development to service "DMS(Development & Design, Manufacturing, Service & Solution) " has.

KTECH
K Technology Corporation

＜Head Office＞
325 Ganbara, Kami-machi, Kami-gun, Miyagi,Japan
TEL:+81-(0)229-64-1111　FAX:+81-(0)229-63-5652
URL:http://www.k-technology.co.jp/

＜Tokyo Sales Office＞
6th Floor, Nikko Gotanda Bldg,29-5 Nishigotanda 2-chome,Shinagawa-ku, Tokyo
TEL:+81-(0)3-6431-9067　FAX:+81-(0)3-6431-9068
Email:info@k-technology.co.jp

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

We propose an image inspection system of world-class

Inspec Inc.

http://www.inspec21.com/

MEXT　TOHOKU ECONOMIC FEDERATION　Tohoku University　宮城県　七十七銀行　ICR

■Company Information

Trade Name	Inspec corporation
Securities Code	6656
Listed Market	Market of the High-Growth and Emerging Stocks
Headquarters	Kakunodate, Semboku, Akita
Establishment	January, 1984
Capital	1,274 Million yen
Number of Employee	45 (As of April,2012)
Business Lineup	Development and production, the sale of the optical appearance tester of a semiconductor and the IT-related device and maintenance service.

【Headquarters】

Famous cherry blossom in Kakunodate

■Image processing technology

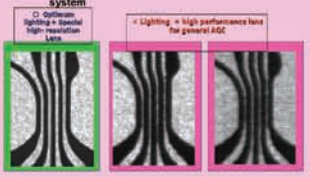
Imaging technology(camera, lens and lighting system)

17000 pixel CCD line camera

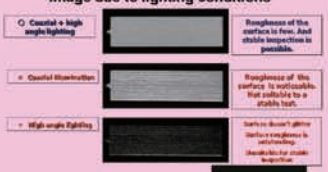
Dedicated lens

Lighting configuration example I

☆ The example of optimal imaging optical system



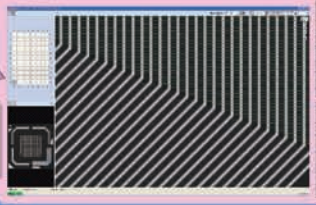
☆ Different of the captured image due to lighting conditions



Inspection algorithm (example)

☆Length measurement algorithm (most stable for the highly precise inspection of the minute pattern)

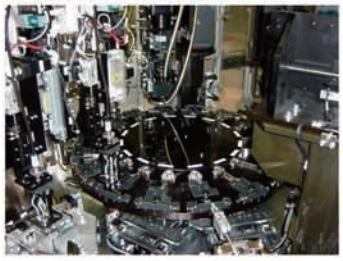
All the pattern and the space make length measurement !



We hold all the elemental technology of the appearance tester

■Mecharonics

☆ Rotation index transport cases



☆ Straight transport index cases

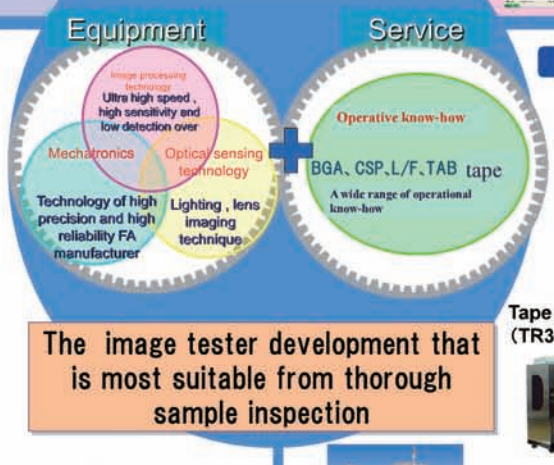
☆ Bamp AOI

☆ Examination for exact dimensions screening equipment

Parts supply from parts feeder
The inspection classification of sub-micron accuracy in digital gauge
High-speed processing by the cam drive
Inspection tact: 2 seconds / 1

Jeffrey tray deck to deck Jeffrey tray three-dimensional two-dimensional bump + front and back

Composite inspection sorter
Inspection tact: 2 seconds / 1



The image tester development that is most suitable from thorough sample inspection

Product (element crystal technology)

Substrate AOI (SX3300)

Substrate AOI (SX1000)

Tape inspection equipment (TR3000)

BGA・CSP inspection equipment
LED mold frame inspection equipment

To all of companies

How about being considered about possibility such as the collective inspection in the state that stood in line to an examination for all quantity and the tray with the image in the in-line?
If you have a problem with examination for image, please talk to us.

【Contact】Inspec corporation　sales department　Michiaki Tomioka
TEL : (direct)0187−52−3073　FAX : 0187−54−3195
E−mail : mtomioka@inspec21.com

Supported by high technology business that value

Altech Corporation

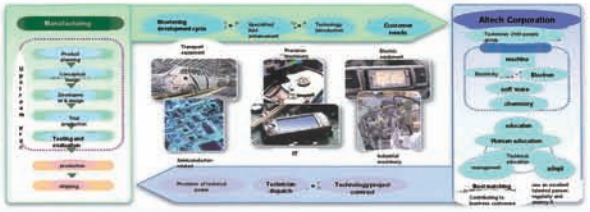
MEXT TOHOKU ECONOMIC FEDERATION Tohoku University 宮城県 七十七銀行 ICR

Altech Corporation

■Company Info
☐Establishment: January, 1971
☐Address: 3-7-13 Nagamachi Taihaku-ku Sendai, Miyagi (Main building: 2-3-5 Minatomirai Nishi-ku Yokohama, Kanagawa Queens Tower C 18F)
☐Listing Classification : First section of the Tokyo Stock Exchange (code: 4641)
☐President: Soichi Ushijima
☐Capital stock: 2.3 billion 47 million yen (December,2012)
☐Employee: Consolidated 2,565／Single consolidated 2,283 (December, 2012)
☐Business contents: Trust business of the technical project (development, design, prototyping, manufacturing, evaluation)・Dispatch business of the engineer
☐Business partner: machine, electric equipment, precision equipment market, stock listing, excellent company including information processing, the communication, approximately 700 companies
☐We can cope with the receiving a contract items such as a machine tool, the examination device from software having company factory and a trust section.
＊Number of location: 19 offices nationwide

Technology area's data of Altech Corporation

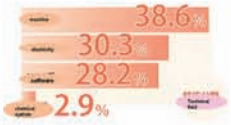
Business model



Industry client configuration

A person is the future–Next Technology Frontier

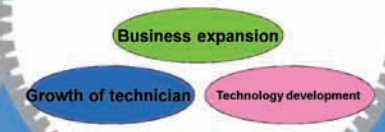
Performance of 45 anniversary



Group Company

Management philosophy

Heart to Heart



One push !

Participation in next-generation vehicles Miyagi area

We offer a ready-to human resources development

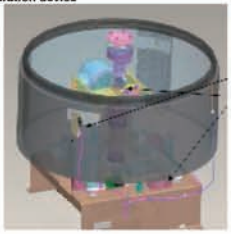
Avoiding development risk

It is most suitable in the short-term and long-term projects

Manufacturing sites that play a role in the manufacturing sector of Altech Corporation.

・Order example of test equipment

1. Cell separation equipment, centrifuge
Design of a centrifugal separation unit equipped with by a cell separation device



Unite dimension
Body : φ500 × Depth 300
Length 500 x side 500x over height 600
Centrifugal force 700G

Realization of new product development and new technology development

To all of companies

～To advance the development, the challenge of securing human resources, to training! Please consult the risk of development.～

■We aim to provide a technique that is community-based.

■Offer of technology and know-how through manufacturing.

The goal of "technology-oriented company," We aim to meet precise and quick to your needs a "manufacturing".

MG corporation

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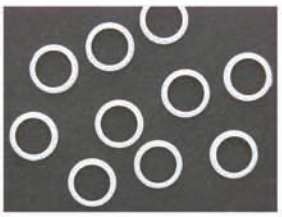
Engineering plastic modeling

Filter device
Multiple insert molding
(Assembly process omission adhesion improvement)



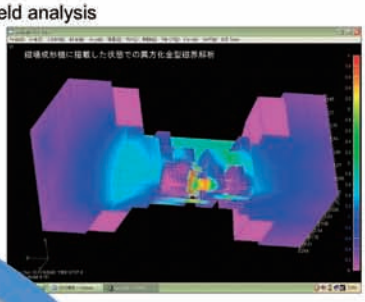
Battery parts
Thin-wall molding and ultra-high cycle molding

Automotive panel unit
- From the mold production, integrated production to molding and assembly
- Decorative processing technology, such as laser processing

Various connector

Forming & plastic magnetized

- Two-color molding and engineering plastics
- Integral molding technologies, including the shaft parts
- The magnet design and design technology magnetized by magnetic field analysis



Plastic magnet various

We aim "technology-driven company"

Technology
All the employees regard a technique as important

Search
Continuing searching for the always most suitable technique

Customer
We offer an appropriate technique Become the company pleased with by a visitor

MG corporation
〒981-0134
6－1－8 Shirakasidai Rifu
Miyagigun Miyagi
Tel: +81-(0)22-356-5571
Fax: +81-22-356-5508

JAB CM035　ASR REGISTERED FIRM ISO9001, ISO14001
We have ISO9001、ISO14001

MG Group Worldwide Network

Product Development

We perform various research and development as well as processing of plastic.

Solar dimming street light signboard

- The power generation by solar, signs will direct the emission of dimming program when it is night.
- It can be chosen dimming pattern that matches the installation scene, and increase the catch of the eye to the sign.
- It turns on even at the time of a blackout, and the charge of the cell-phone is a signboard with the publicity possible, too.

To all of companies

It aims to develop products that make use of advanced injection molding technology, responsible for the rich life of the future.

株式会社エムジー MG Co.,Ltd.

URL : http://www.mg-japan.co.jp/

"Complete Support" for Miyagi Industry

Miyagi Organization for Industry Promotion

MEXT | TOHOKU ECONOMIC FEDERATION | Tohoku University | 宮城県 | 77 七十七銀行 | ICR

Support of Industry- Academia Collaboration

Discovery → Research → Development → Commercialization → Industrialization

Miyagi Reconstruction Park

Discovery Matching

- Coordinate → The Challenge support Fund
- coordinate → Support for Public Project Proposals
- Complementary research
- coordinate → Project Creation Research Groups
- coordinate → Industry-Academia-Government Collaboration Fare

Support for Development of New Technology, Support for New Business Development

Management Entity Support

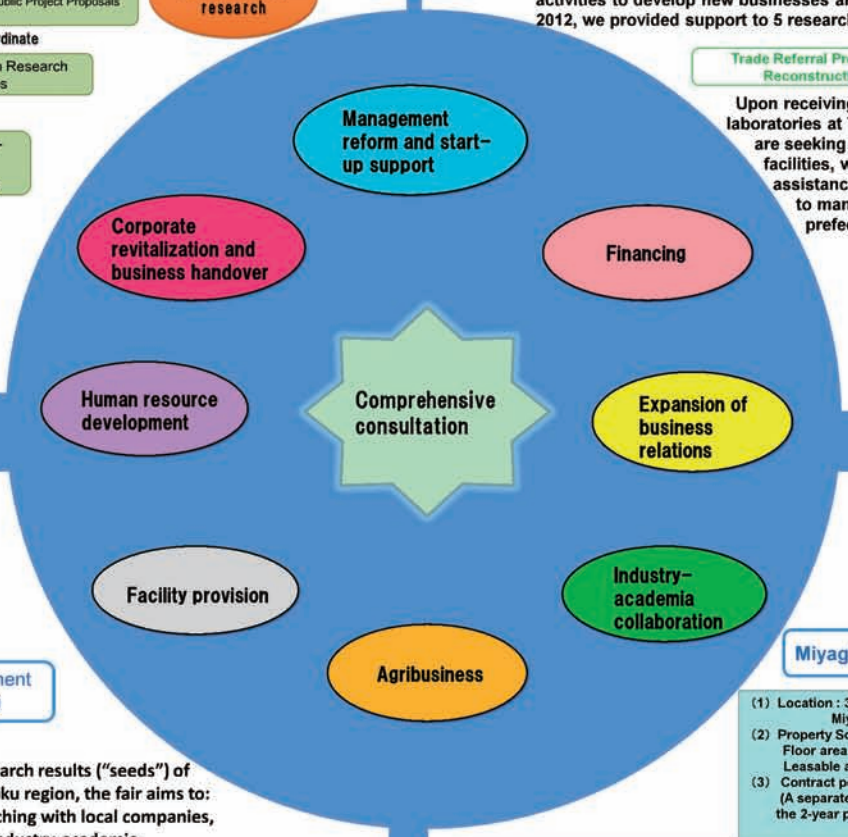
Miyagi Organization for Industry Promotion offers management entity support for competitive funds such as Supporting Industry (Assistance Project for Strategic Advancement of Fundamental Technology). In FY 2012, we offered this service for 6 projects, including ongoing projects.

Project Creation Research Group

We financially support small and medium-sized businesses and researchers who form research groups and conduct research activities to develop new businesses and technologies. In FY 2012, we provided support to 5 research groups.

Trade Referral Project(Service) for Reconstructing Business

Upon receiving requests from various laboratories at Tohoku University which are seeking help with restoring their facilities, we offer them various assistance such as referring them to manufacturers within the prefecture.



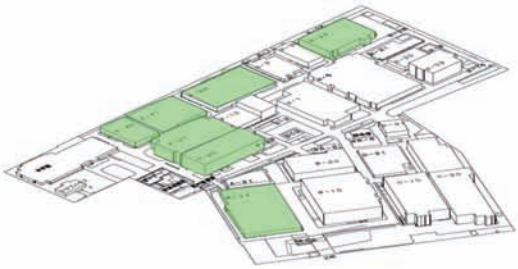
Industry-Academia-Government Collaboration Fair Miyagi

Through the presentation of research results ("seeds") of academic institutions in the Tohoku region, the fair aims to: provide a place for business matching with local companies, encourage exchange within the industry-academia-government community, start new research projects, and create new business ventures. The last fair took place on January 17, 2013 at the Sendai International Center, together with the Tohoku University Innovation Fair and the Miyagi Industrial Association Industry-Academia-Government Exchange Forum.

Miyagi Reconstruction Park

(1) Location : 3-4-1 Sakuragi , Tagajo-shi, Miyagi
(2) Property Scale : 7 buildings
Floor area : 32,602 square meters
Leasable area : 24,245 square meters
(3) Contract period : 2 years
(A separate agreement is needed after the 2-year period is over)

Facilities are leased to disaster-affected businesses and groups in order to help the manufacturing industry within the Tohoku region recover from the Great East Japan Earthquake Disaster as well as encourage the creation and development of new industries.



Analysis/evaluation, investigation, and analysis technology for next-generation automobiles

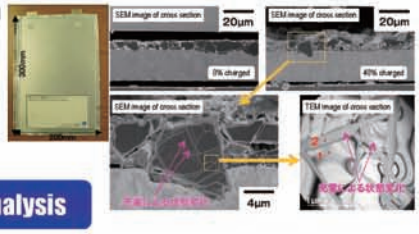
JFE Techno-Research Corporation (Tohoku Branch)

A trusted company for analysis, evaluation, investigation, and examination of materials

MEXT | TOHOKU ECONOMIC FEDERATION | Tohoku University | 宮城県 | 七十七銀行 | ICR

Next-generation battery materials evaluation

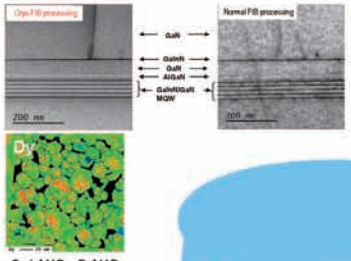
- Prototype of lithium ion cell (Dry room support)
- Charge/discharge performance evaluation
- Battery material evaluation
- Dismantled investigation
- Failure analysis



Microstructure analysis

- Evaluation and analysis of power devices and thermoelectric element modules
- Sample processing for microscopy
- Analysis of rare earth magnets
- Failure analysis of electronic components

Electron microscope, ARM200F installed in dedicated laboratory



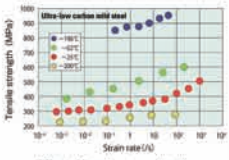
GrainMAP + DyMAP

Characterization of materials

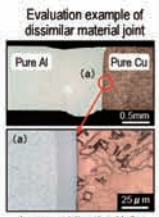
- Strength, high-speed deformation, fatigue, fracture characterization
- Damage analysis
- Corrosion test, anti-corrosion technology
- Weldability, welded joint evaluation (Laser welding technology)
- Magnetic characterization
- Steel material prototypes for testing

Fracture toughness test

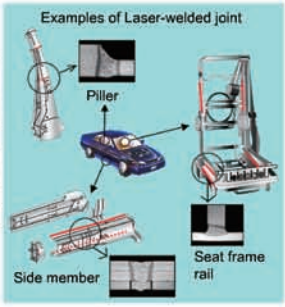
Constant load creep test facility



Effect of strain rate and testing temperature on tensile strength



Laser welding for Al-Cu dissimilar material joints [Joint strength: 80 MPa]

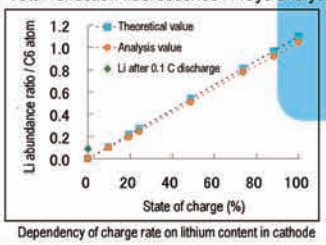


Your Best Partner for *"Monodzukuri"*

JFE Techno-Research Corporation is ……
A trusted company for analysis, evaluation, investigation, and examination of materials.

Trace analysis, other chemical analyses

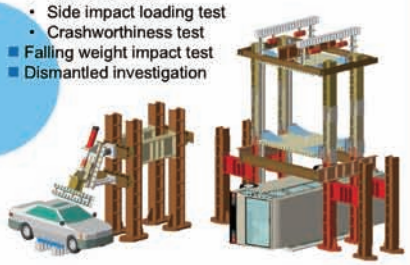
- Trace analysis, analysis of very small amounts of halogen, sulfur
- Mapping analysis by laser ablation
- Total reflection fluorescence X-rays analysis



Dependency of charge rate on lithium content in cathode

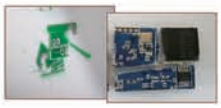
Structural performance evaluation, dismantling investigation

- Collision performance test
  - Roof crush test
  - Side impact loading test
  - Crashworthiness test
- Falling weight impact test
- Dismantled investigation



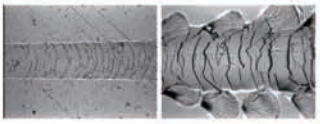
Environmental analysis

- Bad smell analysis (room air pollution) investigation
- Analysis of environmentally hazardous substances (RoHS, REACH, VOC, etc.)



Coating evaluation

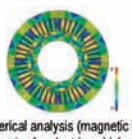
- Evaluation of coating properties of surface-treated materials,
  - Gravel meter testing
  - Coating film investigation
  - Film thickness measurement
  - Surface roughness measurement
  - Hardness measurement
- Corrosion resistance evaluation, accelerated corrosion test
  - Gas corrosion examination
  - Salt spray test



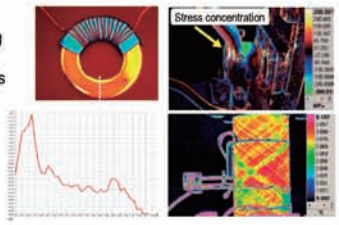
Observation of anodizing film of aluminum (section observation without vapor deposition)

Nondestructive testing /numerical analysis

- Thermal analysis of magnetic material and stress distribution measurement by infrared camera
- Defect detection and film thickness distribution measurement by imaging spectrometer (*ImSpector*)
- Stress analysis by numerical analysis
- Dry ultrasonic measurement



Numerical analysis (magnetic induction) of motor for electric vehicles



Stress distribution measurement by infrared camera, heat analysis

Contact

JFE Techno-Research Corporation
Tohoku Branch, Tokyo Office
3rd Floor, Higashi-Nibancho Square Building
4-1-25, Ichibancho, Aoba-Ku, Sendai-City,
Miyagi-Pref., 980-0811, Japan
TEL: 022-211-8280 FAX: 022-211-8281
http://www.jfe-tec.co.jp

We Support Regional Manufacturing Companies

The 77 Bank, Ltd.

MEXT　TOHOKU ECONOMIC FEDERATION　Tohoku University　宮城県　77七十七銀行　ICR

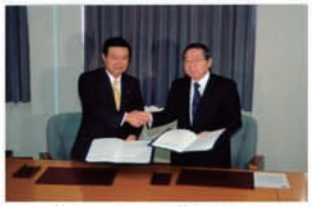
Joint Effort between Industry, Academia, Government and Finance

～ Walking together with Tohoku University, a National University Corporation～

The 77 Bank, Ltd. concluded an agreement on collaborations and linkages with Tohoku University in January, 2007

We support regional manufactures' technology and new product development challenges;

- Conducting individual consultations; Tech-support consultations for each company
- Tohoku University Laboratory Tour; Experience-based project, visit the laboratories directly



Conclusion of Cooperation Agreement with Tohoku University (January, 2007)

"Tohoku University Lab Tour2" (November,2013)

"Tohoku University Lab Tour3" (November,2014)

Tohoku University Laboratory Tour (November, 2014)

Message for Corporate Customers

~ We support "Manufacturing Companies" by offering financial and information providing services through collaboration between industry, educational institutions and government ~

Fulfilling the function of Consulting & Finance Intermediation

We have been certified as one of "Support Institutions for Business Innovation, etc." based on "Act for Facilitating New Business Activities of Small and Medium-sized Enterprises" (Certified on November 5, 2012)

As a Support Institution for SMEs, we do;

Financial affairs, Support developing business plans, Start-up incubation, Support business succession, Providing consultations for M&A, business matching, etc., Analyzing business conditions, and taking finely-tuned supports for each company on the basis of its business plan development

Support for the Business Innovation is available at all 77Banks*

*Only at the offices which offer business loan services

Message for Corporate Customers

~ Please feel free to contact us regarding;
- Inquiries for "Subsidies for Manufacturing" and "Grants to start a business"
- Application supports for various subsidies ~

Cooperate Profile

Head Office; 3-3-20 Chuo, Aoba-ku, Sendai

Date of Establishment; December 9, 1878

Capital Stock; 24.6 billion yen

Number of Employee; 2,791

Number of Establishments; 141
136 of Head Office & Branches and 5 of Local Offices
(As of March 31, 2015)

The 77 Bank, Ltd., Regional development section, Regional development division
3-3-20 Chuo, Aoba-ku, Sendai, Miyagi 980-8777, Japan
TEL : +81-22-211-9804　FAX : +81-22-267-5303
E-mail : chisin@77bank.co.jp

Efforts to the automotive industry promotion in Akita

Akita Prefecture Department of Industry and Labor
The Akita Center To Implement Vigorous Enterprises

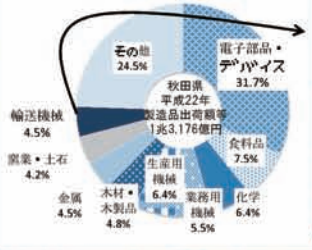
MEXT　TOHOKU ECONOMIC FEDERATION　Tohoku University　宮城県　七十七銀行　ICR

Development of Akita automotive industry promotion plan

Akita is known as an eminent agriculture prefecture, but also the integration of the electronic device industry has progressed in the manufacturing sector, we have set the automotive industry as a pillar of a new industry and establish the directionality of the action.

1. The situation of the Akita manufacturing

Industry Composition of Akita manufacturing (Manufactured goods shipments, etc.)



Attractive car company in Akita

- ○Keep about 50 percent of a share in the semiconductor field of the Toyota group.
- ○Development and production with the power supply unit of the hybrid car
- ○The sulfuric acid parent water factory of the separator nonwoven fabric for nickel hydroids batteries only in Japan
- ○Manufacture O ring for overseas makers diesels over 30 years
- ○Top share in the field of a door switch sensor
- ○Top share in the field of the car navigation embedded software

◆The leading industry of Akita is electronic device industry. Percentage is more than 30%. (The Industry composition of national electronic device industry are 6%)
◆The industry composition of transport machinery industry, Akita in less than 5% to the 19% across the country, we think that the industry has large growth potential.

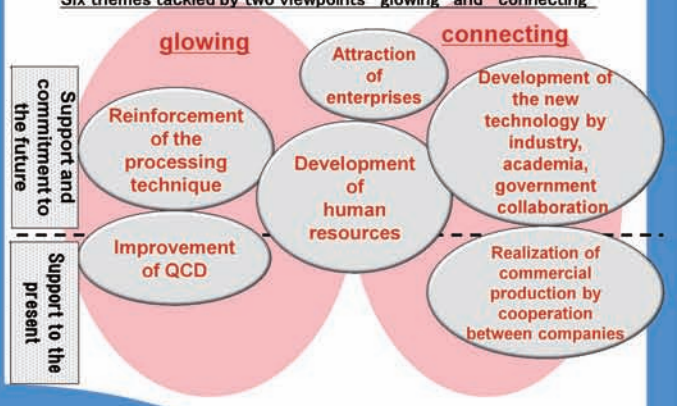
Access to a main factory

2. Figure to aim at of the plan

- ◆Improvement of QCD
- ◆Development of human resources
- ◆Reinforcement of the processing technique
- ◆Realization of commercial production by cooperation between companies
- ◆Development of the new technology by industry, academia, government collaboration
- ◆ Attraction of enterprises

Focusing on six above, All Akita Prefecture aims to become indispensable to car manufacturing in TOHOKU

Six themes tackled by two viewpoints "glowing" and "connecting"



Akita Prefecture aims to become indispensable to car manufacturing in TOHOKU!

3. Main action in the plan

(1) Support efforts to improve productivity improvement and production site(Improvement of QCD)

We carry out the guidance by the process improvement adviser intensively and improve the shop floor corresponding to a price reduction, the mass production required for the auto industry.
◆from October,2012

(2) Offered Akita automotive academy (Development of human resources)

We are training up the core talented person who can lead problem-solving of quality assurance, price reduction and mass production..
◆from August,2012(12-part series)
◆19 people 16 companies participated

(3) Seminars "Akita automobile human resource development training"

Guidance of the 2013 training course

Training Course

1. The cost management
2. QC Circle and small group activities
3. Process improvement
4. Auto parts required performance
5. Management
6. VE・VA
7. Quality management
8. Processing technique

We hold a seminar to train human resources technical capabilities, production capacity and power management required for auto industry.

Permanent exhibition of the AQUA decomposed model

- ○ 1st floor exhibition room exhibition place Akita Industrial Technology Center (4-11 Sanuki,Arayamachi,AkitaCity,Akita)
- ○ Exhibition parts Toyota AQUA (S grade) all parts (about 1,000 points)
- ○ There is no limit to limit visitors.
- ○ Contact the attendance procedures Akita Industrial Technology Center Technology Innovation Unit. Please visit. (TEL018-862-3420)

Everyone is welcome

This exhibition is a permanent exhibition of AQUA decomposition model for the first time in the whole country.
Since we are also part loan for everyone in the company in Tohoku, Please visit.

Akita Prefecture Department of Industrial and Labor
Industrial Development Promotion Division Transportation industry group
3-1-1 Sanno, Akita City, Akita010-8570, Japan
TEL+81-18-860-2242 FAX +81-18-860-3887 E-mail induprom@pref.akita.lg.jp

Strategic Regional Innovation Support Program by MEXT "Next Generation Automobiles / Miyagi Area"

Next generation hydrogen production process can realize Hydrogen Energy Society

Renaissance Energy Research corporation

MEXT | TOHOKU ECONOMIC FEDERATION | Tohoku University | 宮城県 | 七十七銀行 | ICR

Technology 1: Heat resistant γ- alumina

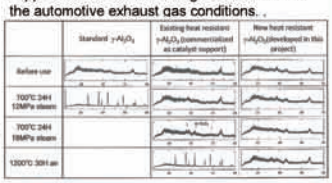
Development of new carrier with a large surface area in the automotive exhaust gas condition

Improved heat resistance of γ-alumina

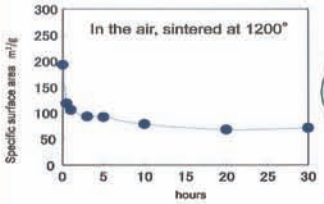
- γ-Al2O3 has a large surface, but unstable at high temperature
- γ-Al2O3 change to α-Al2O3 easily, and surface area is extremely reduced at high temperatures & humidified atmosphere.

Sintering characteristics of γ-Al2O3

We succeeded in development of new catalyst support which maintain a large surface area in the automotive exhaust gas conditions. .



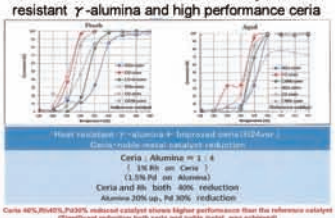
Stability of newly developed heat resistant γ-Al2O3 was significantly improved compared to the existing heat resistant γ-Al2O3.



Time-dependent change of the specific surface area of the heat resistant γ-alumina

Application to reforming catalysts for hydrogen production is promising

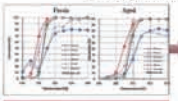
The noble metal and ceria reduction by heat-resistant γ-alumina and high performance ceria



Ceria 40%,Rh40%,Pd30% reduced catalyst shows higher performance than the reference catalyst (Significant reduction both ceria and noble metal was achieved)

Technology 2:High performance ceria

Effect of improved ceria①

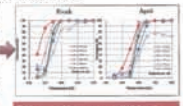


TWC result of improved ceria (H23ver.) (reference catalyst composition)

Ceria : Alumina = 1 : 2
1% Rh on Ceria
2.5% Pd on Alumina

Aged catalyst shows higher performance than the reference catalyst

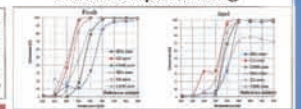
Effective of improved ceria②



TWC result of improved ceria (H24ver.) (reference catalyst composition)

Ceria : Alumina = 1 : 2
1% Rh on Ceria
2.5% Pd on Alumina

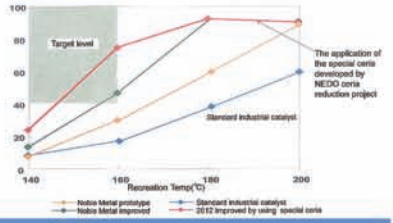
Fresh, Aged catalysts show higher performance than the reference catalyst



Heat resistant γ-alumina + Improved ceria (H24ver.)
Ceria-noble metal catalyst reduction
Ceria : Alumina = 1 : 4
(1% Rh on Ceria)
(1.5% Pd on Alumina)
Ceria and Rh both 40% reduction
Alumina 20% up, Pd 30% reduction

Ceria 40%,Rh40%,Pd30% reduced catalyst shows higher performance than the reference catalyst (Significant reduction both ceria and noble metal was achieved)

Application to new high- performance CO shift catalyst



The hydrogen production related technique which RER holds

Seeds technologies cultivated by Tohoku University and RER

- Heat resistant γ-Alimina (Technology 1)
- High performance ceria (Technology 2)
- Catalyst performance prediction software

By prevention of sintering
・Precious metal reduction
・Ni catalyst performance improvement

The high performance CO shift catalyst developed by the application of high-performance Ceria

Improve efficiency of the catalyst development and process development

Oil / Natural gas → Desulfurization: Removal of sulfur → Steam reforming: $C_mH_n + H_2O \rightarrow H_2 + CO, CO_2$ Produce hydrogen by reacting steam and hydrocarbon → CO Shift: $CO + H_2O \rightarrow H_2 + CO_2$ Reduction of CO in the reformed gas → Purification process

Purification process
- Chemical absorption method (remove CO2)
- Selective oxidation (remove CO)
- PSA (adsorption)

→ Ammonia, Methanol / PEFC / Hydrogen station

Complete desulfurization — Extra high performance desulfurization: Desulfuriize to the level of PPb

Low S/C possible — High performance Ru catalyst

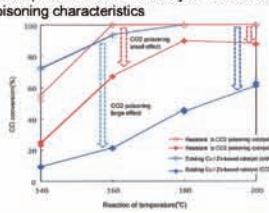
High SV possible — Catalyst without CO2 poisoning (Technology 3)

CO conversion rate improvement

Energy saving of CO2 removal — CO2 selective membrane (Technology 4)

Technology 3:CO shift catalyst with reduced CO2 poisoning characteristics

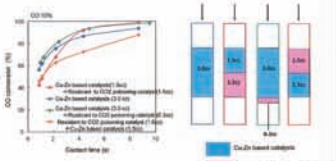
Development of CO shift catalyst with reduced CO2 poisoning characteristics



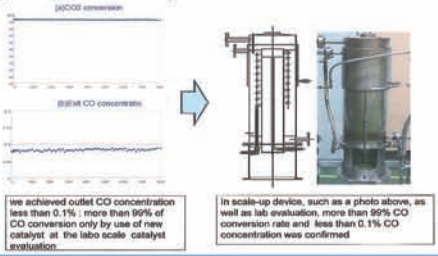
Conventional Cu-Zn based CO shift catalysts were found to be poisoned to large extent by CO2. CO2 formation is inevitable in CO shift reaction. So large amounts of catalyst was used in CO shift process.

Effect of newly developed CO shift catalyst

CO conversion rate is largely improved by using Cu-Zn based catalyst(in up stream) and newly developed catalyst with reduced CO2 poison characteristics together in downstream.



The CO reduction effect of heat exchange isothermal CO shift reactor and newly developed CO shift catalyst

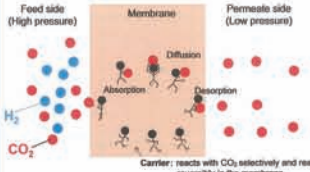


we achieved outlet CO concentration less than 0.1% ; more than 99% of CO conversion only by use of new catalyst at the labo scale catalyst evaluation

In scale-up device, such as a photo above, as well as lab evaluation, more than 99% CO conversion rate and less than 0.1% CO concentration was confirmed

Technology 4:CO2 selective membrane

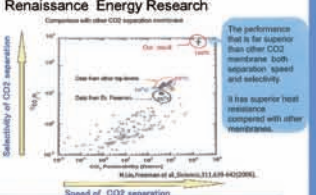
CO2 Selective Membrane



Energy of CO2 absorption to carrier covers that of CO2 desorption

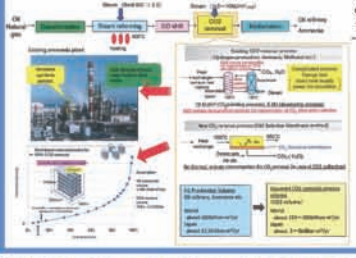
No energy consumption

Superiority of CO2 separation membrane Renaissance Energy Research



•Our CO2 Selective Membrane shows by far the best performance on both Selectivity and Permeability.

Application to Hydrogen Production w/ Reforming System



Joint venture with Sumitomo Corporation, Sumitomo chemical and Renaissance Energy Research was established to promote commercialization of CO2 membrane

2012年10月16日 日経新聞 朝刊

Renaissance Energy research can provide with one-stop service various functions required for the catalyst research, development and commercialization.

(Catalyst prototype, performance evaluation, Catalyst mass production, Pilot testing, Demonstration test, Feasibility study)

Contact : TEL : 06-6228-3111 FAX : 06-6228-3113 Email : information@r-energy.com

株式会社 岩沼精工

We can deal with mass production press process, precision machine process, mold planning, production, labor saving machine planning, processing, assembling, and so on.

IWANUMA SEIKO Co,.LTD

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Company Profile

NAME: IWANUMA SEIKO Co,.LTD
CEO: KOUJI CHIBA
ADDRESS: 305-3,Omatsubara Shimonogo Iwanuma,Miyagi
TEL: +81-(0)223-29-2121
FAX: +81-(0)223-29-2122
URL: http://www.iwanuma-sk.co.jp/
E-MAIL: info@iwanuma-sk.co.jp
MAIN BUSINESS: ・Mass production press
・Tool product
・Sample product
・Planning and manufacturing for production facilities
・Planning and manufacturing for mold(metal)
Paid in capital: 10,000,000 Yen
Date of foundation: April 1974
Certification: ISO9001、ISO14001
Main Customer:
・SONY Co.,LTD
・FUJITSU Co.,LTD
・SII Micro Parts Co.,LTD
・Keihin Co.,LTD
・IHI Co.,LTD
etc.

Mass production press and planning and manufacturing the metal mold

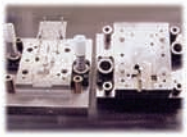
They correspond to mass production press using press processing machine(25t-110t).

★Secondary battery for the tab

★Primary battery for tanshi

★Speaker grill for the mobile phone

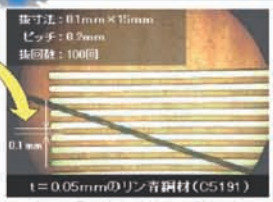
★Planning, processing and cutting-in of metal mold



We contribute to reducing the weight and down size for medical device by Light press mold and equipment technique fusion

★Slit press machine

★Example of slit process to phosphor bronze



Technology Fusion

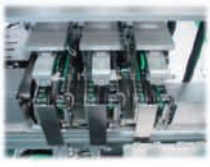
Equipment for labor saving

We contribute to the energy control by our technique

★Unloader
Tact 8 sec/1sheet 200sec/
Magazine (25sheet)

★Equipment

★Magazine part



This machine can admit the semi-conductor which is from a reflow furnace to the magazine

Sample processing and precision machine processing

Cost, Down
Suggestion sample of precision

Laser processing, Wire discharge processing
Machining Center, Processing equipment for CNC lathe

★Minute process finishing

★Three dimensions process

★Reflective road sign and metal parts for caulking the ball

After combined

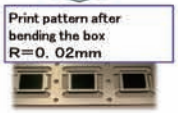
Machine for developing the new product (Support Projects)

★Press process machine development for miniature pattern precoated metal strip

★ Metal mold unit for place revision

Print pattern
R=0. 08 mm

Print pattern after bending the box
R=0. 02mm



★Developing a minute process machine (minute cutting＋minute discharging)

Process for discharging whole

φ20μm×200μm
(Super hardwood)

The precision of locating for whole with steps by front and back discharging process

Less than 1 μm

・Promote 5 themes for innovation with cooperation among industry, government and universities
・Develop and produce for original products by support project

High thermal conductivity silicon nitride substrate, heat sink material

Japan Fine Ceramics Co., Ltd.
URL http://www.japan-fc.co.jp

MEXT TOHOKU ECONOMIC FEDERATION Tohoku University 宮城県 七十七銀行 ICR

Introducing Japan Fine Ceramics (JFC)

We challenge the possibility in an original technique about metal, new material fine ceramics next to the plastic as a 100% investment company of JGC Corporation.

We made use of the electrical characteristics of the various efforts actively to manufacture and sell technology development, and application development, to meet the various needs of various cutting-edge industries.

Introduction of Fine Ceramics Product

In electronic materials Division of JFC, structure materials Division, it produces various ceramics products depending on a use.

Introduction of Electronic Materials Division products :

We produced "The high-grade alumina board" which a dielectric loss is minute small and bends it in the high frequency band, and has high strength, "The microwave dielectric board" which can plan the downsizing of the circuit, "Ceraflextime -A" which is used as turning ceramics, "Ceraflextime -8Y" superior in oxygen ion conductivity"The high heat conduction silicon nitride board" which strength was high, and raised thermal conductivity, "The film integrated circuit substrate" which we attached a film by the PVD method on these boards, and formed a circuit.

Introduction of structural material Division products :

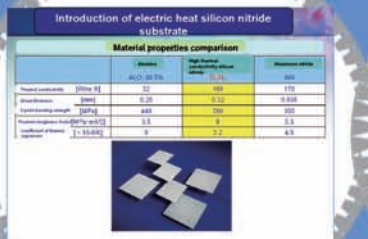
We have been produced by our original (silicon carbide, silicon nitride, alumina, Zirconia) engineering ceramic material with excellent characteristics heat resistance, wear resistance, corrosion resistance. In addition, composite materials "AMC" of metals and ceramics with (lightweight high rigidity, vibration damping) excellent properties not in the ceramic material and metal conventional materials are also produced, and to be able to meet the diverse needs of our customers are.

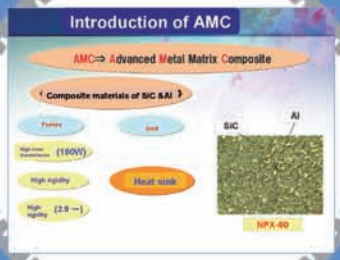
We are daily challenge and aim to material that is always better.

Introduction of high heat dissipation insulating substrate heat sink material

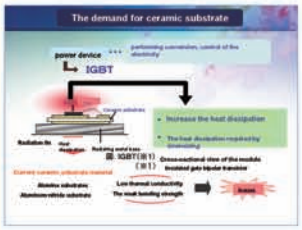
High thermal conductivity silicon nitride substrate

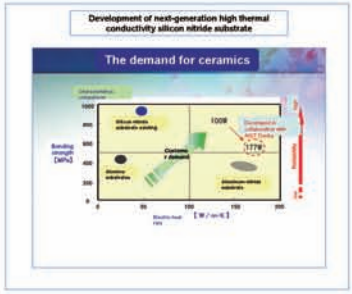
AMC (Advaced Metal Matrix Composites)





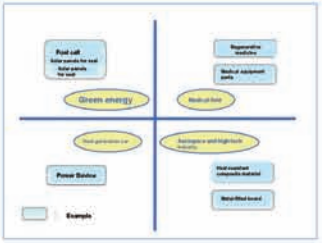
Needs of high heat radiation insulation board, heat sink materials





Technical Skill And Creation !

JFC's challenge field



To all of universities and companies

~why don't you begin an action for the next generation with us?~

Our company focus on material development.

We believe that we would like to supply the products with high originality that can be to the world from Tohoku to join forces with you.

日本ファインセラミックス株式会社
JAPAN FINE CERAMICS CO., LTD.

Engineering Department Product Development Department
Chief Shin Sato
TEL:022-378-7825 FAX:022-377-4161
Email:satousin@japan-fc.co.jp

" Iwate Center of Development for the Novel Human- and Eco-friendly Vehicles "
Regional Innovation Strategy Promotion Project

Iwate University, Iwate Prefectural University, Ichinoseki National College of Technology,
Iwate Industrial Research Institute, The Bank of Iwate, Ltd.. Kita-Nippon Bank, Ltd., and Iwate prefecture

Iwate Industry Promotion Center (General Coordination Agency)
2-4-26, Kita-Iioka, Morioka Iwate 0200857 Japan tel: +81-(0)19-631-3825 fax: +81-(0)19-631-3830
email: mobility@joho-iwate.or.jp URL: http://www.joho-iwate.or.jp/mobility/index.html

Metallic casting @Iwate University
High-strength metal casting automotive parts for next-generation vehicles
Applying for … cylinder liner, brake disc etc.

Insert mold @Iwate University
Simpler process of Insert molding with fine metal parts.
Applying for … automotive connector etc.

ICT/Software @Iwate Prefectural University
- Development of Plug-and-Play on board sensor system with Radio on Demand technology. Applying for Road to Vehicle / Vehicle to Vehicle info service.

- Development of Wake on Demand communication system.

- Development of Wireless charging system for onboard devices

Promote research & development

"Showcase car" project
Iwate Showcase car visualizes all automotive researches & automotive technologies made in Iwate. Through the Showcase car, fostering the relationships between researchers, engineers, industries and customers, to promote open-innovation for next generation vehicles.

"Matching project" industry needs and academia seeds
Create partnerships of regional industry and academia through matching between industry needs and academia seeds in manufacturing , technology area, and promote finding joint solutions.

Supporting Student Formula EV Team "SIFT"
Supporting "SIFT" (Students of Iwate Formula Japan Team, cooperation of students with two universities and one national collage of technology in Iwate) for participating "Student Formula Japan"

Establishment of knowledge networks

Project Vision
-Realizing the reconstruction
from the disaster of Great East Japan Earthquake-

Along with further advancing technologies for auto industry ever accumulated in Iwate such as materials/metal working, electronic devices, information and communication, etc., we will promote commercialization of projects through cooperation with industry, academia, local authorities and banks, and cultivation of professional engineers, to realize the persistent innovative region with prospective activities for vehicle innovation.

Develop human resources

@ Iwate University
Development of engineers with practical skill and engineering knowledge, focusing material/machining and general automobile engineering.

@ Ichinoseki National Collage of Technology
Development of engineers for next-generation automobile industries, focusing material design, vehicle design, and specific EV engineering

@ Iwate Prefectural University
Development of engineers who have specialized knowledge both in manufacturing and software for the creation of next-generation vehicle innovation

Sharing of research facilities and equipments

@ Iwate University
Introduce and promote common utility of cast system and modeling system

@ Iwate Prefectural University
Introduce and promote common utility of equipments at i-MOS, Iwate Monodukuri and Software Integration Technology Center

@ Iwate Industrial Research Institute
Introduce and promote common utility of research equipments for the creation of next-generation of vehicle innovation

岩手大学 IWATE UNIVERSITY　岩手県立大学　一関工業高等専門学校　岩手県工業技術センター　岩手銀行　北日本銀行　岩手県

Reinvention of Our Eco-Friendly Molding Factory

Plamoul Seiko Co., Ltd.
http://www.plamoul-seiko.co.jp/index.html

MEXT　TOHOKU ECONOMIC FEDERATION　Tohoku University　宮城県　七十七銀行　ICR

Company Profile

Head Office 4-3-5 Takanomori, Tomiya, Kurokawa, Miyagi
981-3351, Japan TEL +81-22-348-1250 FAX +81-22-348-1244

Established October 1983
Capital Found 50 million yen
Number of Employees 37

Production Item Ultrafine Mold (for mold injection)
Molding precision electronic components (connectors, etc.)

Gas Through Gas Vent Ejector Pin
Air Through Vent Adjustment for Parts
Revo Sprue Star-Shaped Sprue
Revo Gate 3Plates Pin gate

Head Office

China Factory
Guangdong Province,
Dongguan City Changan Zhenjiang Shell Illage path Shinminami third Industrial Zone

China Factory

The Important thing in Molding is …

Immobilize Condition at Low pressure

* Low Pressure Molding can … *

- Resource Saving
  Saving power & Materials
- Productivity Growth
  Enhance capacity utilization
  Reduction of maintenance manhours
- Quality improvement
  Barr, gas burring, warp, deformation

Don't you have any Quality Problems with Gas / Air Inclusion which occur in Molding ?
Why don't you use GasThrough and AirThrough that will Solve your problems!!

Corporate Identity

Plamoul Seiko Creates No.1

Enterprise Reliability that based on

Developing Human Resources with a Vision

Quality Goal

The Products which made by the Mold should be All Good

Innovating Mold Structure which can Low Pressure Molding

Development Product Introduction

Certified to Miyagi Superior Products in succession for two years

Self-Developed Products
Production cycle time reduction
Improve liquidity at the molding
Production efficiency improvement
using the mold structure

2012

Degassing Pin 『 Gas Through 』

Gas Through pulling out the gas from the tip of the core pins and ejector pin

2013

Air vent device 『 Air Through 』

Air Through Development of air vent devices in dreams

Revo Gate
Can Prevent Convex凸 of 3 plates' pin gate

Revo Sprue
Allows for shorter Cool down time of sprue.

Head Office

China Factory

Council for Improvement Task of Self-Developed Products

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

Frontier company of magnetic power transmission

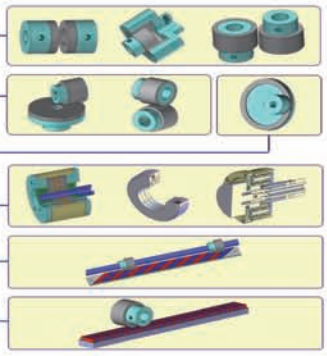
Prospine Co., Ltd.

117 Azashinsenkarita Tsugihashi Matsuyama Osaki-city, Miyagi-pref. 987-1305
TEL: 0229-55-3375 FAX : 0229-55-4350
http://www.prospine.jp

MEXT | TOHOKU ECONOMIC FEDERATION | Tohoku University | 宮城県 | 七十七銀行 | ICR

Product variety and advantages

Standard goods: Coupler, Miter
Customized goods: Gear, Clutch & Brake, Linear slider, Rack & Pinion



Power transmission through wall
Torque limiter function
Easy attaching and detaching
Large tolerance for declination and eccentricity

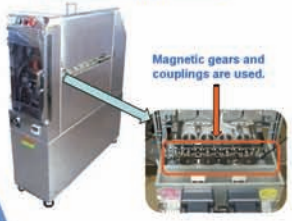
Applications

Belt conveyor for clean room use
Ex. Semiconductor, LCD and food-producing process etc.

Tension control for fiber-producing process

Bread kneader

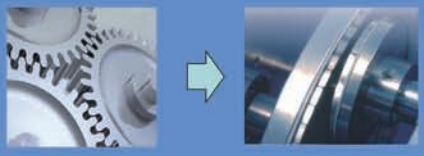
Clean roller



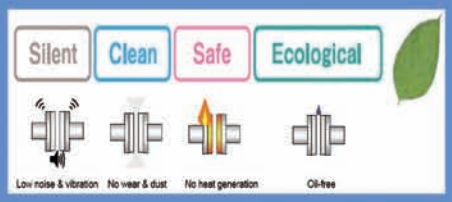
Magnetic gears and couplings are used.

Other applications
-Robot
-Mixer
-Others

Prospine offers



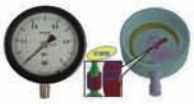
non-contact power transmission mechanism.



Expansion of applications

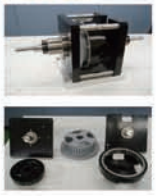
Pressure gauge

This mechanism decreases mechanical vibration and avoids the wear of mechanical gears.



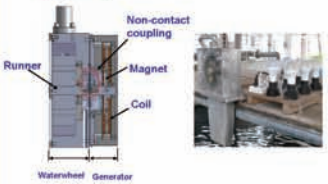
Magnetic gear

Gear ratio is one to five and the power transmission efficiency is more than 96%.



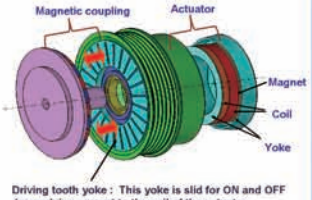
Small hydropower generation

A waterwheel and a generator are separated by magnetic coupler. Field test has been performed.



Magnetic clutch

Magnetic non-contact clutch adding the on/off function to Prospine coupling.
Instant current flows only at the moment of ON-OFF changing to realize energy saving clutch.



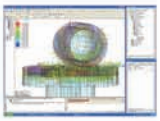
Driving tooth yoke : This yoke is slid for ON and OFF by applying current to the coil of the actuator.

Attention

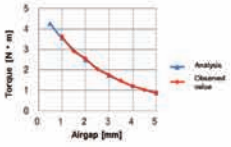
Magnetic field analysis simulation

Cooperation with Industrial Technology Institute, Miyagi Prefectural Government

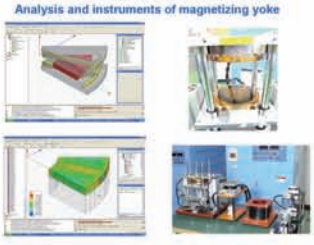
Example of magnetic field analysis for magnetic miter



Analysis of magnetic torque coupling shows the correlation over 90%.

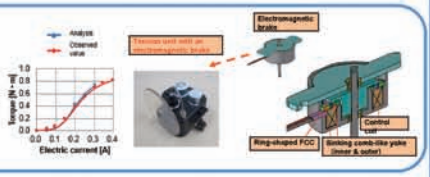


Analysis and instruments of magnetizing yoke



Topics

Established the world's first magnetic field analysis simulation technique for the brake unit using hysteresis material !



Co-development with customers

We design and provide custom-made products according to your specifications.
Sales contact: http://www.prospine.jp Kiyotaka Ikeda or Shigehisa Sato

Our Key word is Speed!
We aim for competitive manufacture
KYOYU CO.,LTD.

MEXT　TOHOKU ECONOMIC FEDERATION　Tohoku University　宮城県　77 七十七銀行　ICR

Company profile

【Company name】KYOYU CO.,LTD.
【Established】May,1980 【Paid in capital】88,880,000 yen
【No. of employees】92(As of July, 2015)
【President】Tokumi Hatanaka
【Scope of business】Precise mechanical component
The design and assembly for automatic machines
【Certification】ISO9001・ISO14001・EN9100

Tackles by local relationship

～Collaboration between Designer and Artisan and Manufacture company～

The luxurious aluminum material shaped "S" Sendai s initial are coated with Tamamushi lacquerware which has vivid colour and lustre. (Our company take charge of cutting.)

※The photo is a replica.

≪Production Design≫
The Interior Designer lives in Sendai
Mr. Kouichirou Kimura

Aerospace business

"Combustion test apparatus specimen"

Materials : SUS・Cupper alloy
Electron beam welding(by cooperative company)
(Consent to photograph:JAXA Kakuda Space Center)
Furthermore, we deliver precise cutting products to engine makers and equipment makers.

・3D-CAD
(Installing CATIA V5)

EN 9100 BUREAU VERITAS Certification

・The international standard EN9100

KYOYU

We challenge high extra value industry, with the core technology we experienced electrical devise business.
We are skillful in hard-to-cut material and precise cutting, so manufacture products which can respond needed by customer, with the production of many kinds in small quantities.
Our slogan is "The key word is speed", Therefore, we aim to shorten delivery time.

Automobile business

"Divided punch part of stamping die"
Materials and Thickness:SPC440・t=1.0
Die condition:10process progressive die
・The first product cost is 90% or less than conventional die and mold. (For ability to change process method)
・The running cost is 50% or less than conventional die and mold.
・Using holder and blade edges materials are properly usable. (Proper materials can be used each other.)
・Blade edge can be exchanged by only removing stopper.

In 2006-2007,we succeeded development and practical applications of low cost and excellent durability stamping used die and punch, helped by Strategic generic technology advancement support project (supporting industries).
This product was accredited as third "MONO excellent Miyagi ".

Before

After

(Consent to photograph:Toyota Motor East Japan, Inc.)

Controlling whole factory by production management system

Core Technology

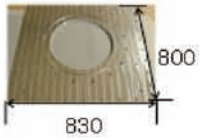
Home Information Appliances

From design to product die and mold and auto machine, based on a precise cutting technique. We are capable of being made consistent from machine processing to evaluation with 3D CAD with original Data-base.

"Product testing device "

Semiconductor manufacturing apparatus related business

"Semiconductor manufacturing apparatus "
Materials: A5052
Thickness: 25mm



"Proof of hard-to-cut material Large-sized processing parts"

・compound machine with 5 spindles type vertical lathe function
Processing size (MAX) φ2,000×1,440mm
・CAM Simulator
・Three-dimensional measuring machine X1,600×Y3,000×Z1,200mm
・We have ultrasonic washing apparatus.

Medical devices business

It is in development that no burrs minimization of in hard-to-cut material inserting optical components using ultrasonic vibrations, utilizing "JST revival promotion program, aligned with Tohoku University.(2012-2014)
As a processing method, we aim at cutting costs by multiple and shortening LT.

KYOYU CO.,LTD.
149-1,Shinnawashiroe, Sekine, Misato-machi,Toda-gun, Miyagi-Pref.987-0006,JAPAN
TEL:+81-229-34-2329(represent) FAX:+81-229-34-1965
URL [illegible] E-Mail info@kyoyu.jp

Embossed carrier tape and electronic component manufacturing

OKURA OKURA Industry Co., Ltd.

http://www.okurainc.co.jp

MEXT TOHOKU ECONOMIC FEDERATION Tohoku University 宮城県 77 七十七銀行 ICR

Embossed Carrier Tape deep drawing

Optimum various molded method, supported by production facilities in depth product variant-diaphragm. In addition, it supports the shape to prevent telescoping product of deep drawing.

•Shape:insertion site (20mm×22mm) deepest part(21.6mm)
•Material: A-PET (W=32mm t=0.5mm)
•Use: On-board electronics parts

• Shape:insertion site (14mm×15mm) deepest part(18.3mm)
• Material: PS (W=24mm t=0.5mm)
•Use: On-board electronics parts

• Shape:insertion site (10mm×19mm) deepest part(17.8mm)
【antiskid eqquiped】
• Material : PS (W=32mm t=0.5mm)
•Use: On-board electronics parts

Achieve a low-cost fast delivery to mass production carrier tape design, mold design and manufacture by house production facilities (line 140 in Japan and China). It also available in taping process, the final step further.

Electronic component manufacturing

Design and development - mold making - prototype - mass production - secondary processing - Packaging - Shipping We are equipped the integrated production system up.

Actual
[Integrated production of narrow-pitch micro connector

Housing unit
Precision plastic mold
Design and manufacture
processing-Terminal part
Precision press dies
Design and manufacture
processing-Assembly
(housing + terminal)

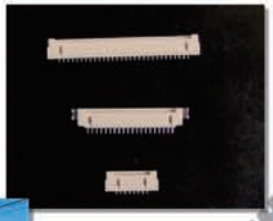
The embossed packing the finished product

Dispatch

Special shape embossed molding technology Precision molding technology

Embossed Carrier Tape

Narrow pitch micro connector



OKURA INDUSTRY Co., Ltd.

大倉工業(蘇州)電子有限公司

大倉電機(東莞)有限公司

Film sheet slit

Sheet slitter equipment

Including the carrier tape sheet, and cut with high precision a variety of synthetic resin / paper film and sheet. In addition to the sale of the sheet slit goods, to cope with the slitting of bringing material.

The achievement to low cost and short delivery date processing with company design, production facilities

Embossed Carrier Tape Manufacturing equipment

【 Company design facilities 】

Center hole drilling and Inline image inspection apparatus

Traverse (spiral) Winding device

Slit products

(PS, PET Sheets)
※Carrier tape
W = 8~72mm
T = 0.3~0.5mm

(Paper sheet)
W = 100mm
T = 0.1mm

(Urethane foam)
W = 60mm
T = 1.5mm

HeadOffice 〒985-0854
46-3 Niidanishi, Tagajo, Miyagi, Japan 985-0854
TEL:+81-22-368-5836
FAX:+81-22-368-5508

Matsushima Factory
131-107 Uchihibiki, Kawakudari, Higashimatsushima, Miyagi, Japan 981-0304
TEL:+81-225-87-4330
FAX:+81-225-87-4001

Naruse Factory
131-107 Uchihibiki, Kawakudari, Higashimatsushima, Miyagi, Japan 981-0304
TEL:+81-225-86-1681
FAX:+81-225-87-4641

大倉工業(蘇州)電子有限公司
中国江蘇省蘇州市高新区何山路399号
TEL:+86-(0)512-6807-5876
FAX:+86-(0)512-6807-5873

大倉電機(東莞)有限公司
中国廣東省東莞長安烏沙江貝村新南路第三工業區
TEL:+81-(0)769-8509-1910
FAX:+81-(0)769-8509-1920

SME Innovate in Next-Generation Automobiles

ASTER Co., Ltd.

http://www.ast-aster.com

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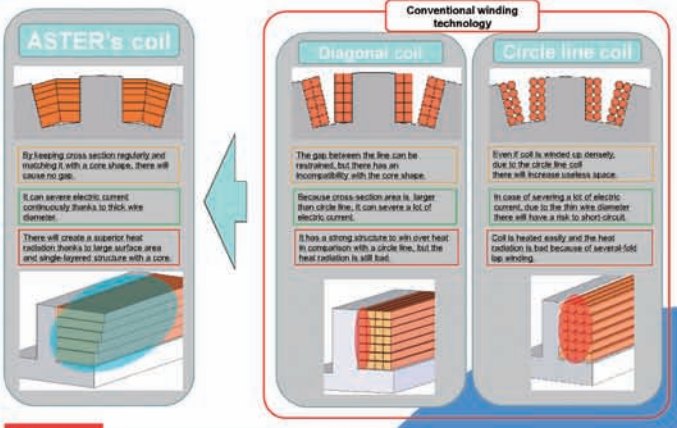
Development of the high efficiency motor (super motor)



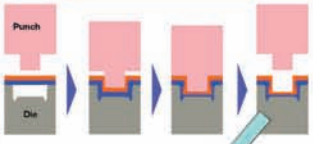
Performance

We can achieve a good balance between the compact and high power by improving space factor, heat radiation and voltage resistance.

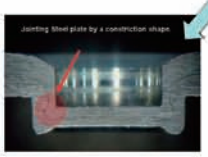
Productivity

We can product high efficiency motor with short process by using slot-in method.

Development of swage joint device for car steel plate

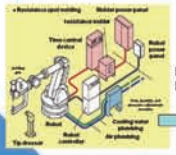


By flowing the steel plate to the die side by a punch, it can be jointed mechanically. So it is easy to joint various different kind of metal such as high-tension steel plate, stainless steel, copper, aluminum with low cost and energy conservation.



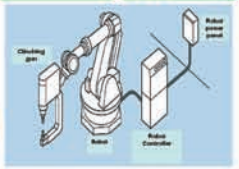
Point

① High endurance strength to dynamic load.
② Jointing more than three pieces is possible.
③ Jointing multiple points simultaneous with 1 shot is possible.
④ Board thickness is available from minimum 0.2mm to maximum 4.0mm.

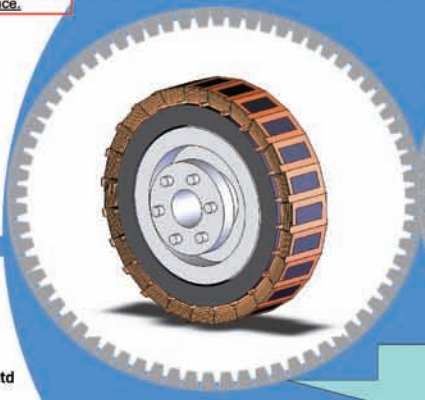


From an existing spot welding line to swage joint line

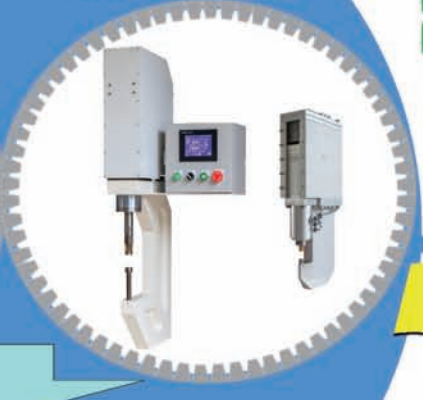
power consumption 1/3 | line scale 1/3 | retention costs 1/3 | environment's anti- pollution



Power train section



Body section



We propose to next generation automobiles in full scale

Company profile

- Company name ASTER Co., Ltd
- Established January 2010
- Paid in capital 5,000,000 yen
- Employees 70 persons
- President Takenori Hongo
- Business description
  - Car-related parts production
  - Production and sale of the industrial equipment device
  - Production and sale of LED lighting equipment
  - Production of beauty equipment
- Certification ISO 9001
- Ministry of Economy, Trade and Industry SME advanced manufacturing certification 2 times (in 2012 and 2013)

- Number of patent applications 5 applications (including one application of international patent)
- Number of design registration 1 registration

LED light

Desk lighting Spoon Light series
Fluorescent tube lighting EnaBlight series
High-intensity lighting (25W～1000W) Takumi series

We are developing above 3 series according to application. Regarding Takumi series, wide range of needs for custom-made from factory lighting to shipboard lighting are available.

Contact Mail furuyayt@ast-aster.com
Tel 0182-24-1377 (rep.) Fax 0182-24-0611

Now is made for the future

Automotive Components and Systems

Perfecting the Art of Electronics

ALPS

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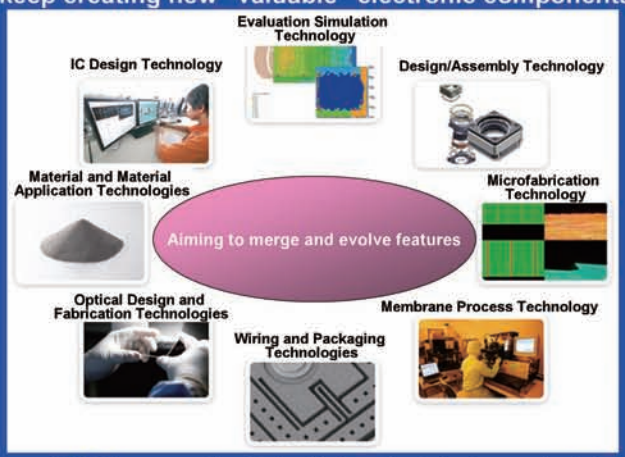
Business Fields

Human Machine Interface (HMI) Products

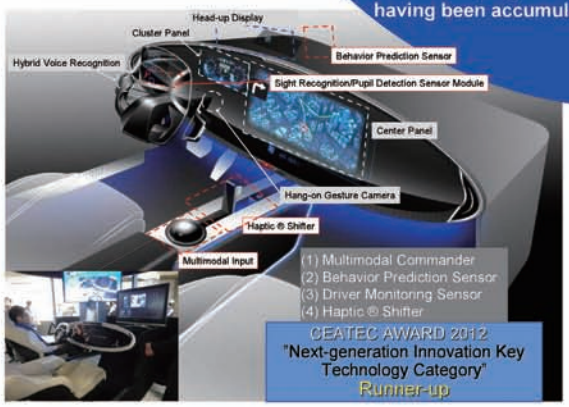
immersion
TouchSense™ Technology Licensed by Immersion Corporation

Evolving and merging unique technologies to keep creating new "valuable" electronic components



ALPS keeps creating "valuable" products that are unrivaled in the industry by merging "process technology" and "material technology" that support functional devices as well as uniquely evolved "mechatronics technologies" having been accumulated for many years.

With newly proposed "value" merging advanced technologies with proven functional devices, ALPS' "Next Generation Premium CockPit" won the Runner-up at CEATEC JAPAN 2012.



Next Generation Premium Cockpit

Vehicle Interior Interface Products

Head Office: 1-7, Yukigaya-otsukamachi, Ota-ku, Tokyo, 145-8501 Japan
Furukawa Plant: 6-3-36, Furukawanakazato, Osaki-city, Miyagi-pref 989-6181 Japan
Phone: +81 229-23-5111 Contact: Masami Terakubo, Business Planning Department
http://www.alps.com

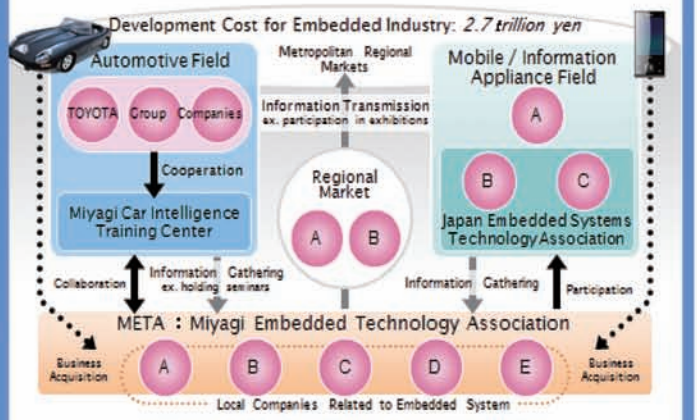
Perfecting the Art of Electronics
ALPS

Efforts for Embedded Industrial Promotion of Miyagi Prefecture

META: Miyagi Embedded Technology Association

MEXT　TOHOKU ECONOMIC FEDERATION　Tohoku University　宮城県　七十七銀行　ICR

① META: Miyagi Embedded Technology Association



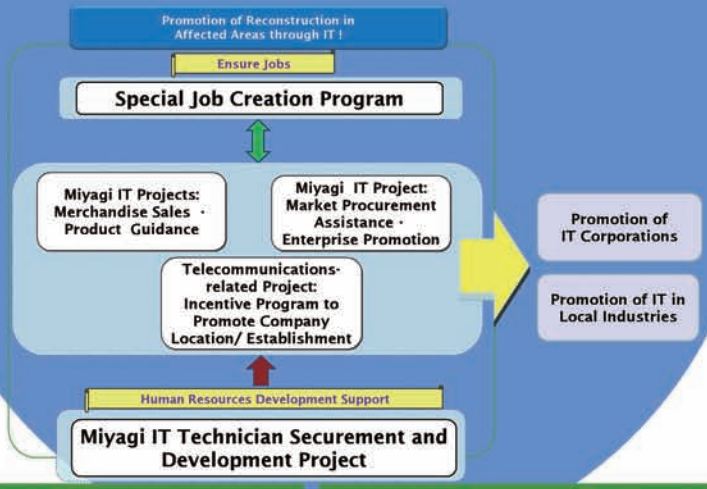
② Technical Show & Exhibition Support

ET2012 TOHOKU Pavilion Display For 7 Consecutive Years

At the Yokohama Embedded Technology Exhibition we have exhibited the "TOHOKU Pavilion" in cooperation with numerous embedded technology-related companies and organizations in the Tohoku (northeast Japan) region.
8 companies participated from the Miyagi Embedded Technology Association and we have made presentations for 7 consecutive years. Approximately 5,851 visitors have come to the pavilion.

One-Stop Service by Miyagi Prefecture's Information Industries Promotion Division

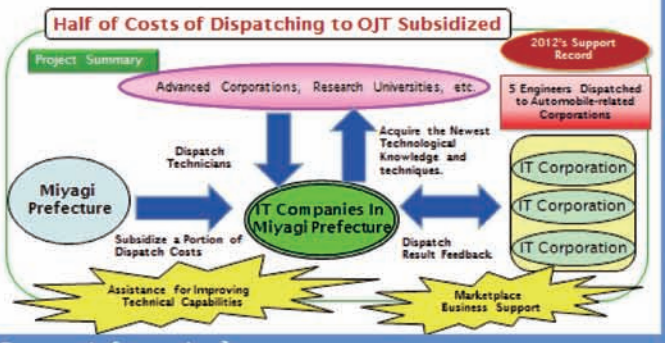
"Towards Recovery! Never Give Up Miyagi!



③ Dispatch OJT Support Project

We support the dispatching of technicians to universities and advanced corporations (Ex. Automobile-related corporations, Tohoku University) to have them acquire the newest techniques and technical knowledge .

Can Supply a Maximum of 2 million Yen per Business



④ Human Resource Development Support

Cultivating Miyagi IT technicians for careers in the prospective high-growth industries of advanced electronics and automobiles

1. Enterprise support in developing human resources: Training at the Industrial Technology Institute, Miyagi Prefectural Government

1) Primary Level: Trainees learn basic technical skills necessary for the development of new employees
2) Intermediate Level: Trainees learn technical skills for business solutions
3) Embedded System Technical Seminar: Contents of seminar include the latest information required by companies.

2. Developing practical, advanced human resources: Miyagi Embedded Technology Association (META)

1) Hold human resource development seminars for those entering the auto industry and other fields.
2) Hold "Kumikomi-Tekijuku" practical exercise course via satellite to support Miyagi development of "System Architect" embedded software development
3) Hold "co-design implementation exercises" (Kansai Cooperation) for implementation and design reinforcement of technicians corresponding to the fusion of hardware &software

3. Miyagi Car Intelligent Human Resources Development Center

Develop the next generation automobile industry workforce by fostering comprehension and skills in hardware , automobiles, electronics market dynamics and IT electronics, marketplace dynamics, IT and more

4. Local Human Resources Development (Special Job Creation Program)

Human resource development in diverse fields -software, embedded tech., animation, mobile, etc.

【Contact Information】
META : Miyagi Embedded Technology Association
(Organizer : NEC Software Tohoku, LTD.)
1-10-23, Ichibancho, Aoba-ku, Sendai, Miyagi 980-0811
TEL: 022-215-5653　Fax: 022-215-5665
Email: kumikyo@kumikyo-miyagi.org

Information Industries Promotion Division
Miyagi Prefectural Government
Miyagi Prefectural Government Office (3F government office)
3-8-1, Honcho, Aoba-ku, Sendai, Miyagi 980-8570
TEL: 022-211-2479　Fax: 022-211-2496
http://www.pref.miyagi.jp/soshiki/jyoho-i/

Pursuing the Ultimate Cross-media Advertising

ADOX
Digital Image Creations

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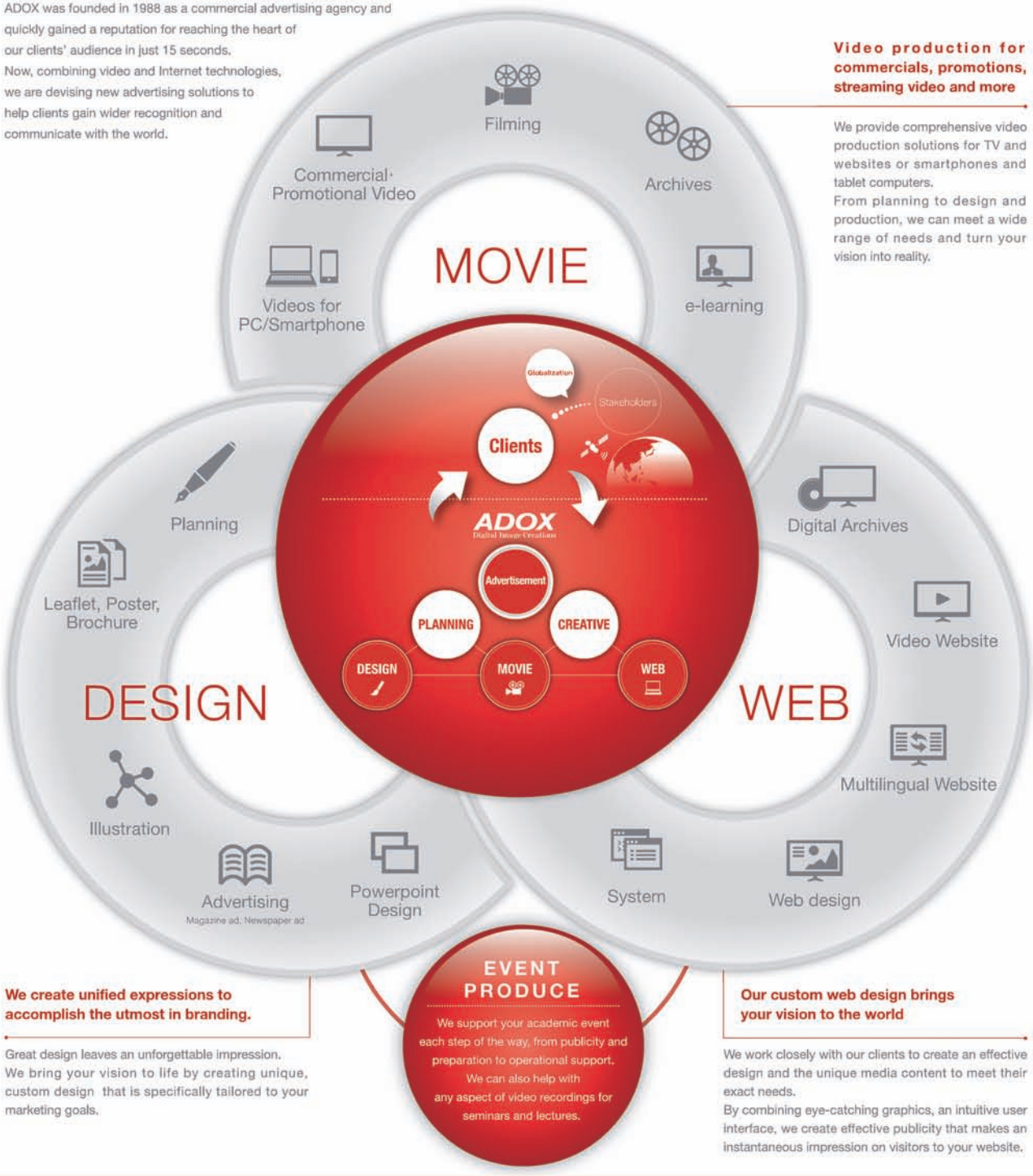
ADOX was founded in 1988 as a commercial advertising agency and quickly gained a reputation for reaching the heart of our clients' audience in just 15 seconds.
Now, combining video and Internet technologies, we are devising new advertising solutions to help clients gain wider recognition and communicate with the world.



Video production for commercials, promotions, streaming video and more

We provide comprehensive video production solutions for TV and websites or smartphones and tablet computers.
From planning to design and production, we can meet a wide range of needs and turn your vision into reality.

We create unified expressions to accomplish the utmost in branding.

Great design leaves an unforgettable impression.
We bring your vision to life by creating unique, custom design that is specifically tailored to your marketing goals.

EVENT PRODUCE

We support your academic event each step of the way, from publicity and preparation to operational support.
We can also help with any aspect of video recordings for seminars and lectures.

Our custom web design brings your vision to the world

We work closely with our clients to create an effective design and the unique media content to meet their exact needs.
By combining eye-catching graphics, an intuitive user interface, we create effective publicity that makes an instantaneous impression on visitors to your website.

≪ Contact us ≫
ADOX Co., Ltd. | SENDAI: Aioi Nissei Dowa Insurance Sendai Ichiban-cho bldg, 2-8-10 Ichiban-cho, Aoba-ku, Sendai, 980-0811, JAPAN
TOKYO: F&F Royal Bldg, 2-4-6 Kanda-Awajicho, Chiyoda-ku, Tokyo, 101-0063, JAPAN
☎ +81-22-261-9481
WEB SITE http://www.adox.co.jp MOVIE SITE http://cue-tv.net/

Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

Recycle spent Organic Solvents & Alcohols by Distilling
Contribution to Resource Circulation Society

MITSUMARU Chemical Corporation
http://3maru.co.jp/mitsumarukagaku.htm

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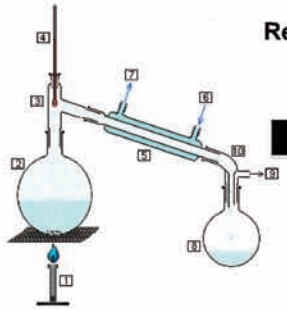
What is Distilling? Here's an Experimental Model ...

What is Distilling ....?

It is a coagulation separation technology of two or more components having mutually different boiling points by fixing after vaporing of mixture organic solvents or alcohols.

Experimental Model



1 : Heat source
2 : Distilling compounds
3 & 4: Heat control
5, 6 & 7: Cooling system
8 : Purified substance receptacle
9 &10 : Vacuum unit

Required Qualities of Distillate

1, Distillation separation purity
2, Moisture content
3, Contamination elements
4, Cost of recycling
5, Comply with Great variety / Small amount
6, Others

Plant Apparatus & Key Technology

Plant Apparatus

1, 5 distillation equipment 21kl/day
2, 6 batch-wise rectification equipment 67kl/day

Key Technology & Features

1, Distillation technology from low to high boiling point solvents; 40 – 250℃
2, Recycle technology to high purity distillation with free-contamination
3, High-tech chemical analyzes & quality assurance system of GC-MAS, ICP, gas chromatograph etc.
4, Handling variety of solvents & alcohols
5, Shipment from small quantity;18l can; to tanker

"Various Chemical Analyzer "

Commodity Recycle Materials & Market

1, Toluene / Hydrocarbon system solvent
2, Methanol / IPA
3, Acetic etheracetic ether
4, Acetone / MEK / cyclohexanone
5, N-methylpyrrolidone / pyridine / DMF
6, GP thinner
7, Others; Having development function

Market1; Li-ion battery solvent
Market2; Pharmaceutical / Chemical reaction solvent
Market3; Miscellaneous paint solvents
Market4; Miscellaneous cleaning solvents
Market5; Magnetic recording tape solvents
Market6; Others

Realization of Resource Circulation Society

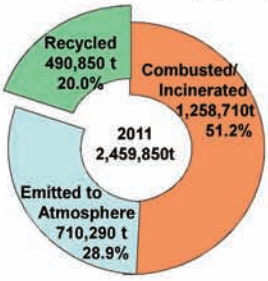
Contribution to Vast Majority of CO_2 Reduction & Resources Circulation

Application Development of Existing Technology

Biomedicine Reagents Production & Commissioned Analyses

Resource Circulation & CO_2 Reduction comparison chart

Annual usage and Effluent disposal
Adapted from Japan Solvent Recycling Industry Association



Annual usage : 25million tons (approx.)
50% of effluent: Incinerated
30% of effluent: Emitted to Atmosphere
20% of effluent: Recycled

CO_2; Evolution & Reduction

Amount of CO_2 emission per kg of process liquid

Amount of CO_2 emission from combustion system

1, Imported crude oil to Japan from Middle East; During tanker shipping (0.1Kg CO_2)
2, Crude refining in Japan; During refining (2.0 ~8.0Kg CO_2)
3, Combustion of spent solvents; Thermal recycling (3.0Kg CO_2)
4, Crude oil – Combustion Total amount of CO_2 emission (5.0~ 11.0Kg CO_2)

Total amount of CO_2 emission of oil combustion system; 10 - 22Kg

Amount of CO_2 emission of distillation system

Total amount of CO_2 emission during distillation
0.1 - 1.0Kg CO_2

→ Effective way to Reduce CO_2

Example of Domain-shift Business Evolution Utilizing Solvents-Handling Technology

1; Domain-Shift Utilizing Handling Solvents, Treating Poisonous / Deleterious Substances, Analyses Feature, and Skilled Pharmaceutical Preparations
Production and distribution of non-clinical reagents collaborated with clinical reagent to domestic & overseas markets

2; Commissioned Biologic Analyses utilized ICP spectroscopy
Biological analyses commissioned by research institutes and Universities

3; Others

Products of Non-clinical in vitro diagnostic

ICP-OES Analyzed Concentration of Trace Metal in biological sample

	Ca	Cu	Fe	Mg	Zn
Sample-1	89.6	1.0	20.7	15.3	2.4
Sample-2	146.0	1.8	59.9	23.6	3.9
Sample-3	234.5	2.8	320.4	25.8	21.7

(unit: mg / l)

Entrusted Analyses (Example)

Multi-Kind and Small-Quantity Automotive Aluminum Forging

ALTEX ALTEX CO., LTD.

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Metal Mold Casting (Gravity)
Sendai Headquarters Factory


9 Crucible Furnaces


Molds for Quantity Production


Metal Mold Maintenance Testing


Setting Core to Metal Mold


Pouring Molten Aluminum


Product Finishing

Sand Mold Casting
Yamagata Obanazawa Factory


2 Crucible Furnaces


Resin Mold Maintenance Testing


Sand Mold Casting


Setting CO_2 core to Sand Mold


Pouring Molten Aluminum


Product Finishing

Production of Shell Core

Production of CO_2 Core

Cast Aluminum

Making Best Effort to inherit
'Craftsmanship' that we value.
Going back to the original once again.

Intake Pipe

Transmission Case

You'll be satisfied with the products we provide.

Materialize

Good Quality, Low Cost, and Quick Delivery

Company Profile

Corporate Name
ALTEX
ALTEX CO., LTD.

Sendai HQ Factory
57-4 Shin Minaminaganuma
Shimonogo Iwanuma
Miyagi JAPAN 989-2421
TEL : 0223-24-5411
FAX : 0223-24-4777

Obanazawa Factory
326-7 Minamiura Harada Obanazawa
Yamagata JAPAN 999-4335
TEL : 0237-28-3121
FAX : 0237-28-2254

Established	Capital	Payroll Number
July, 1983	10 million yen	50

Obtained ISO 9001 : 2008

Main Products
Intake pipes
Intake manifolds
Thermostat cases
Covers / Cases
Truck diesel engine components
Aluminum prototype parts

Major Facility & Apparatus

- Molding Machine: F-1, FD-3
- Mold Casting Machine: 500×500×300h-1000×1000×600h
- Shotblast: IMR-600, table shot (φ1400)
- CNC BARINDER: 400F
- Permeation Apparatus M-100P
- Shell Core Casting Machine: VS-660, SG68, NUS440, SMK430
- CAD System HyperM-DrafVer3.0, CADmeister, MYpac
- Analyses Software: JSCAST
- Brinell Hardness Testing Apparatus: NBH-3

Solutions for Automobiles and Auto Components

Engineer Science Co., Ltd.

URL : http://www.tes-ltd.co.jp

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Automobile-related Solutions

- Automobile carrier
- Plastic molded plane production control system
- ABS machine tool / Interlocking movement control
- Air back assembling, Quality evaluation system
- Small electric car (Battery evaluation)
- Bumper painting system of administration
- The automobile body painting / Electric characteristic
- Latex pushing out line equipment for development
- X-ray tester / Laser marking
- Battery module assembling production line
- Brakes production line / Measurement control
- Semiconductor evaluation equipment
- Engine machine stand number reading
- Infrastructure facilities monitoring system

Core Technology of Engineer Science

◇Speedy suggestion & specification
- ·Offering variety of solutions & know-hows
- ·Suggesting with being on the customers' stand

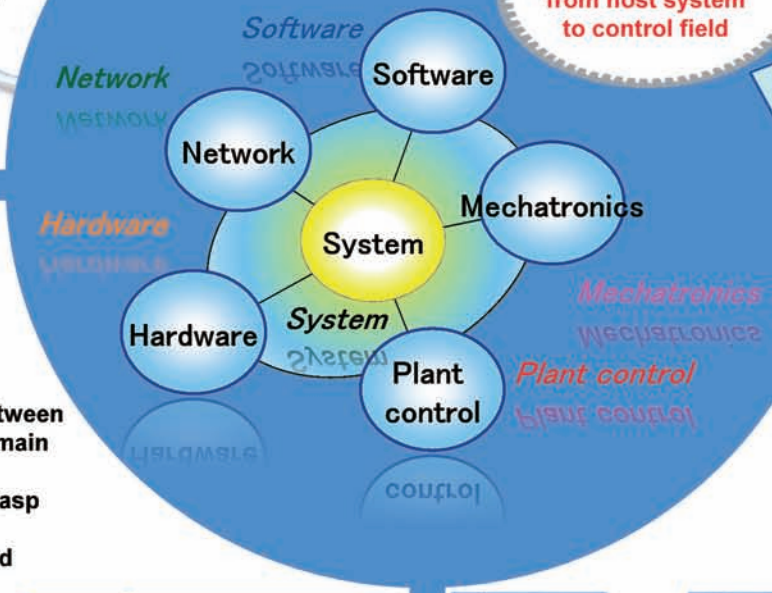
◇Machine design / Manufacture

◇PLC / Instrumentation
- ·Technology modifying Equipment old to new
- ·Machine control (Various motor & sensors)
- ·Analog measurement

◇PC / Communication technology
- ·SCADA (Graphic, Animation, and Trendy graph)
- ·Making database of manufacture history
- ·Peripheral equipment device cooperation (Two-dimensional cord, RFID)

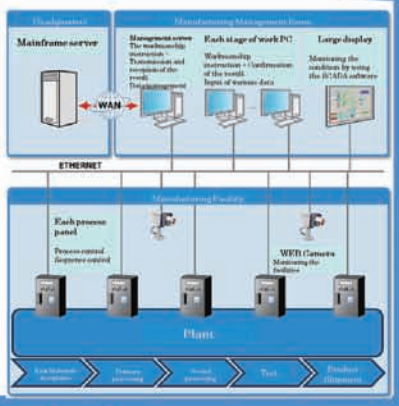
Core Technology

We prove total support from host system to control field



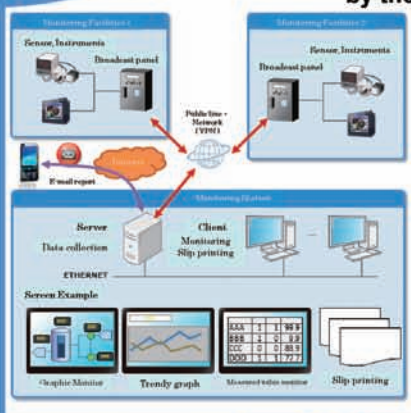
FA System
(Factory Automation)

Removing interface between computer system and main production equipment makes it possible to grasp the whole production virtually in real time and to collect the results. And it also can improve production efficiency by developing production schedule automatically, and that achieves reduction of loss rate and cost significantly.



Facility Monitoring System

To realize monitoring multiple facility sites, measure facility signals by Programmable Controllers etc. and establishing the system by the computers which can process and interpret data. The introduction of the system improves immediate response to monitor trouble; notify you mobile text messages / voice call; and stable operation management for the facility.




株式会社 エンジニア・サイエンス
5-18-7 Yamatomachi, Wakabayashi, Sendai, Miyagi, Japan 984-0042
TEL +81-22-782-3307／FAX: +81-22-782-3304


Strategic Regional Innovation Support Program by MEXT, Next Generation Automobiles / Miyagi Area

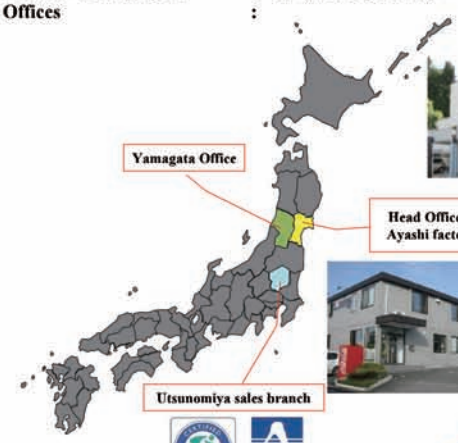
Designing & Manufacturing Service of Electronic Equipment & Desk Robot

COSMOSWEB Co., Ltd

MEXT TOHOKU ECONOMIC FEDERATION Tohoku University 宮城県 七十七銀行 ICR

Company Profile

Trade name	:	COSMOSWEB Co., Ltd
Head office	:	5-4-1 Kuryu, Aoba-ku, Sendai-shi , Miyagi-ken 989-3122 Japan
Establishment	:	Nov. 1989
Capital	:	60 million yen
President	:	Naoyuki Yoshimura
Number of Employees	:	46 (as of Apr. 2015)
Offices	:	



ISO 9001 JAB CM009
JQA-QMA14006
Head office &Ayashi factory

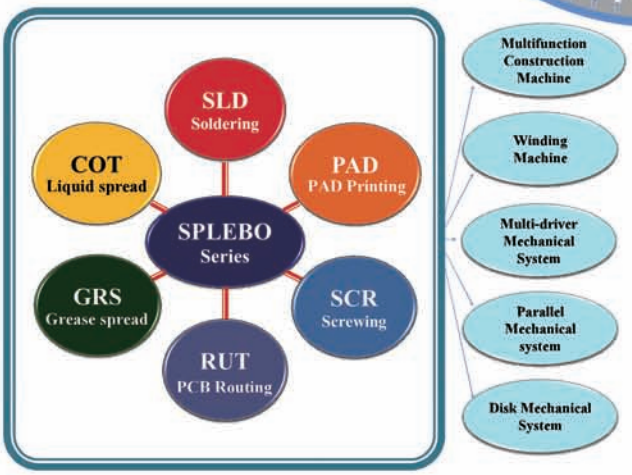
Business Contents

We Help to Make it Possible.

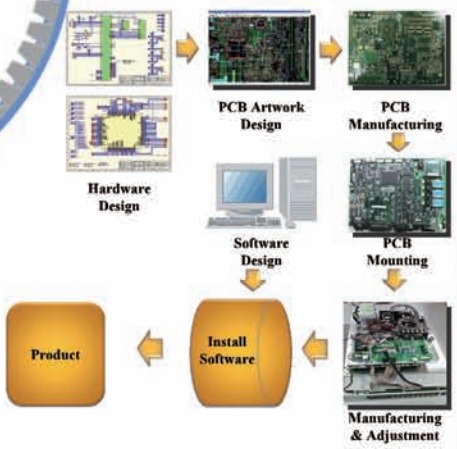
Even if society changes,
Even if the times change,
Our passion and dedication
for production are eternal.

To further evolutions -
Change But not Change.

Desk Robot Technology



Core Technology



Contact us

COSMOSWEB Co.,Ltd
5-4-1 kuryu , Aoba-ku , Sendai-shi , Miyagi-ken Japan
Tel : +81-22-302-8520 Fax : +81-22-392-0270
URL: http://www.cosmosweb.com
Email: cosmosweb.inquiry@cosmosweb.com

Contribution to technology with attention to environment and people

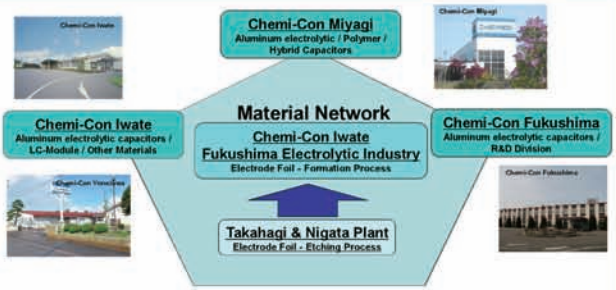
Nippon Chemi-Con Corporation

MEXT　TOHOKU ECONOMIC FEDERATION　Tohoku University　宮城県　七十七銀行　ICR

Company Overview

Company Name : Nippon Chemi-Con Corporation
Our Origin is Miyagi Prefecture!
Date Founded : August, 1931
Head Office : 5-6-4 Osaki, Shinagawa-ku, Tokyo, Japan
Capital : ¥21.5 billon
Net Sales : ¥123.3 billion (FY2014)
Number of Employees : Consolidated 6,981 (March,2015)
Business Content : Manufacturing and Sales of
aluminum electrolytic capacitors,
other various capacitors(Polymer, EDLC, MLCC, Film),
various electro-mechanical devices and parts,
circuit devices, materials for capacitors etc.
International Certification : TS16949 / ISO9001 …

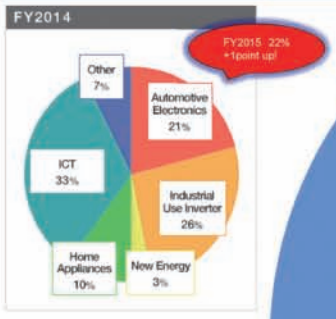
Domestic Value Chain of Aluminum Electrolytic Capacitors



Overseas Assembly Plants
- United Chemi-Con (USA)
- Samyoung Electronics (Korea)
- Taiwan Chemi-Con (R.O.China)
- Chemi-Con (Wuxi) (P.R.China)
- Chemi-Con (Malaysia)
- P.T. Indonesia Chemi-Con

Other Dmestic Plants
- Chemi-Con Iwate (Coil Engineering Dept.)
- Chemi-Con Yamagata (MLCC, Film Caps, Varistor)
- Chemi-Con Nagaoka (EDLC Module, Battery Charger , Camera Module)
- Marcon Denso (Automotive Parts)

Sales by Market (Aluminum Electrolytic Capacitors)

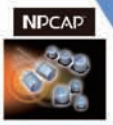


NIPPON CHEMI-CON

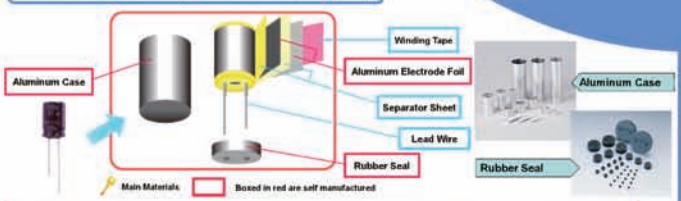
We're
"The Capacitor Company"
Best of the best for Passive Components

Smoothing Solution
Storage Solution
Best Solution & True Innovation
Noise Solution
Sensing Solution

Aluminum Electrolytic Capacitors



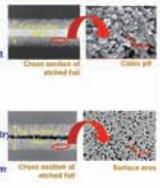
Basic Structure (Radial Lead Type)



Surface Processing Techniques of Electrode Foils (Etching)

AC Etching Process
◆For low voltage capacitors (under 100V)
◆Pit geometry: Cube geometry
◆Features: Continuously produces a cubic pit of about 0.1 to 0.5 μm, which enables increase of effective surface area

DC Etching Process
◆For mid to high voltage capacitors (160V and above)
◆Pit geometry: circular cylindrical (tunnel-like) geometry
◆Features: Produces a circular cylindrical pit with dia of about 1 to 2 μm standing upright against the foil to take advantage in producing thick oxide film



The surface area of the etched foil is about **200 times larger** than those of a plain foil

Our Proposal for Automotive Use

Sensing Solution

Noise Solution

Storage Solution