IMR TOHOKU UNIVERSITY
Institute for Materials Research,Tohoku University

AIMR

Eleventh International Conference on Flow Dynamics
Global / Local Innovations for Next Generation Automobiles
2014.10.09

Development of Novel Hydrogen Storage Materials

Li Guanqiao

Orimo Laboratory

www.hydrogen.imr.tohoku.ac.jp

Institute for Materials Research /
WPI Advanced Institute for Materials Research,
Tohoku University

Demand for compact hydrogen storage materials

Spread applications of fuel cell

Transportations…

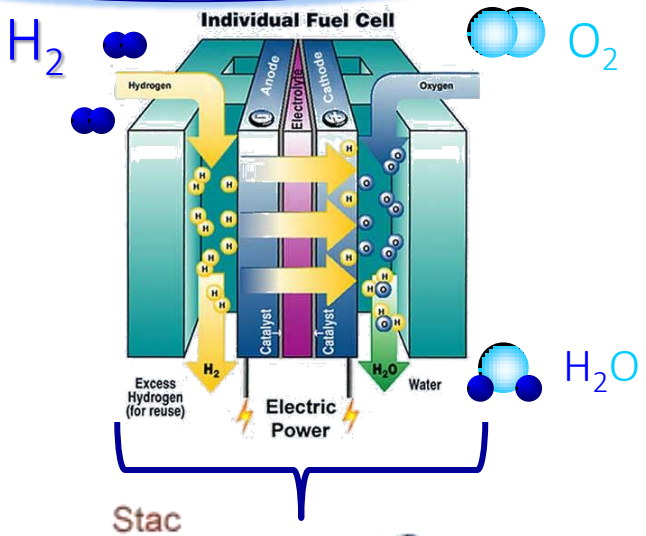
http://www2.toyota.co.jp/

http://www.yamaha-motor.co.jp/

Home used fuel cell station…

http://www.ene-farm.info/about/index.html

Hydrogen as the fuel…



Stac

http://www.jari.co.jp/

Compact storage materials are necessary !

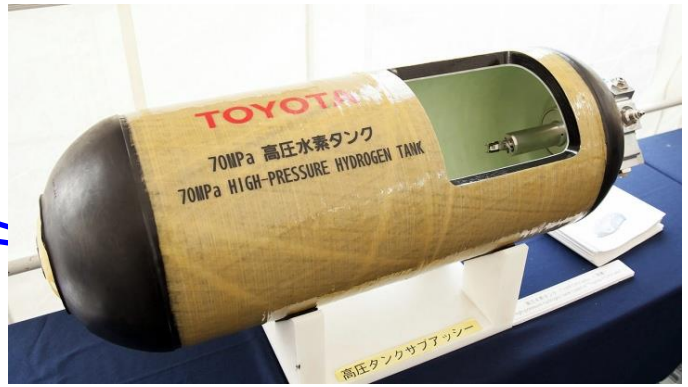
Hydrogen storage containers in automobiles

Toyota FCV — Fuel Cell Vehicle

http://green.autoblog.com

http://www.greencarreports.com

Pressed hydrogen gas tank:
70 MPa H_2 = 700 km



http://www.autoevolution.com

Already best performance in gas tanks

But…

Main types of hydrogen storage materials

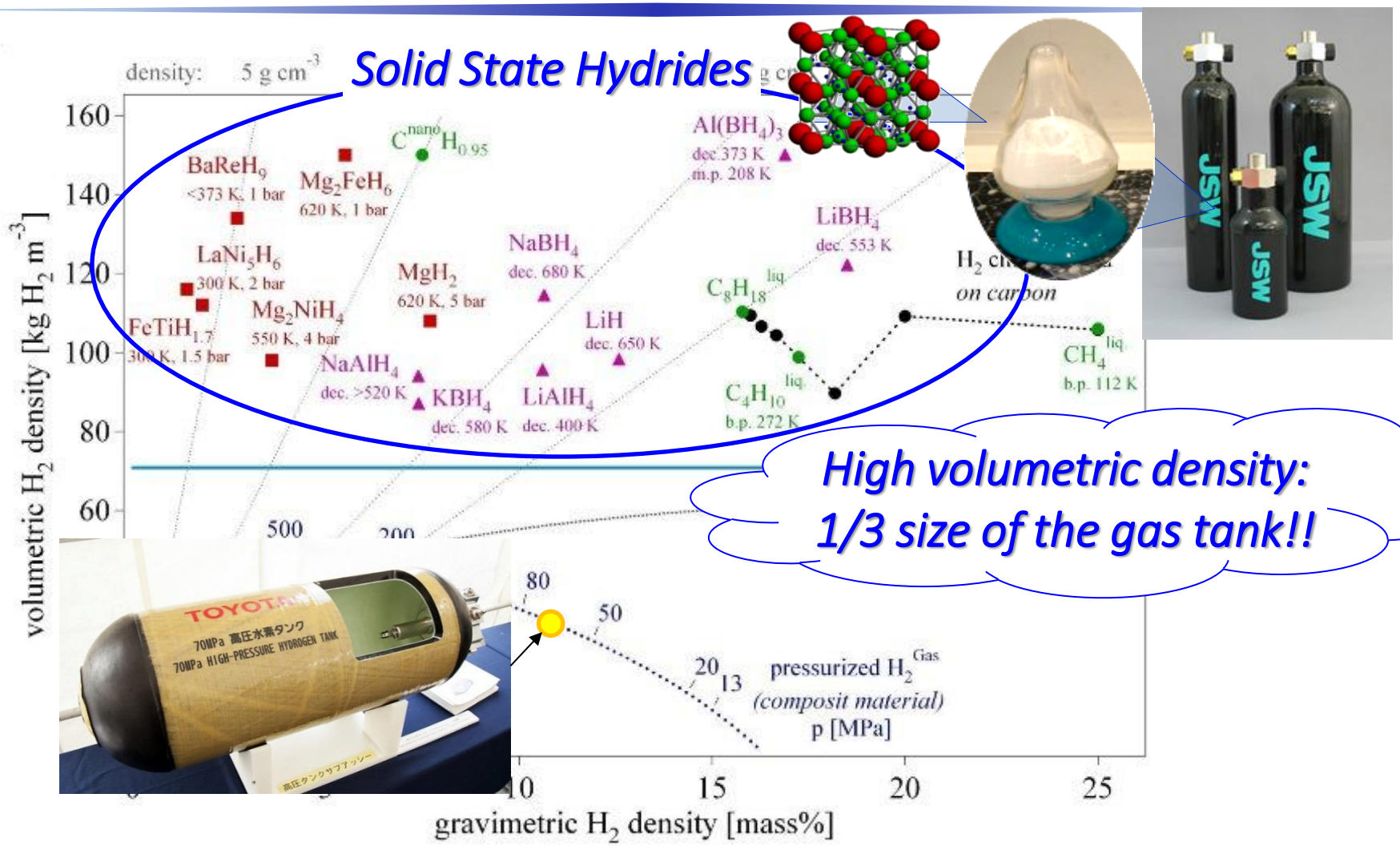


Figure: A. Zuttel, *Mater. Today*, 6, 24 (2003).

Main types of hydrogen storage materials

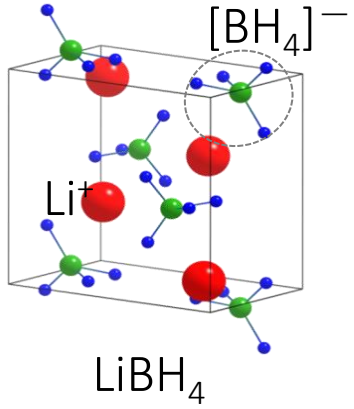
Hydrogen tank

X Low hydrogen density

✓Room temperature

✓Fast charging speed

Solid State Hydrides



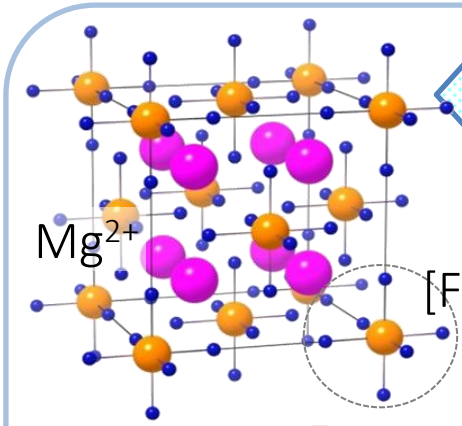
✓High hydrogen density

Subject!!

X High dehydriding temperature

X Sluggish kinetics

Improve dehydriding property by combining hydrides

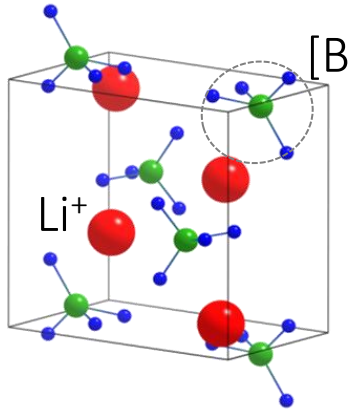


Cubic $Fm\bar{3}m$
a = 6.44 Å

Transition metal based complex hydride

- Destabilization
- New compound

Borohydride



Orthorhombic *Pnma*
a : 7.173 Å, *b* : 4.434 Å, *c* : 6.798 Å

- **Synthesis of $xLiBH_4 + (1–x)Mg_2FeH_6$**

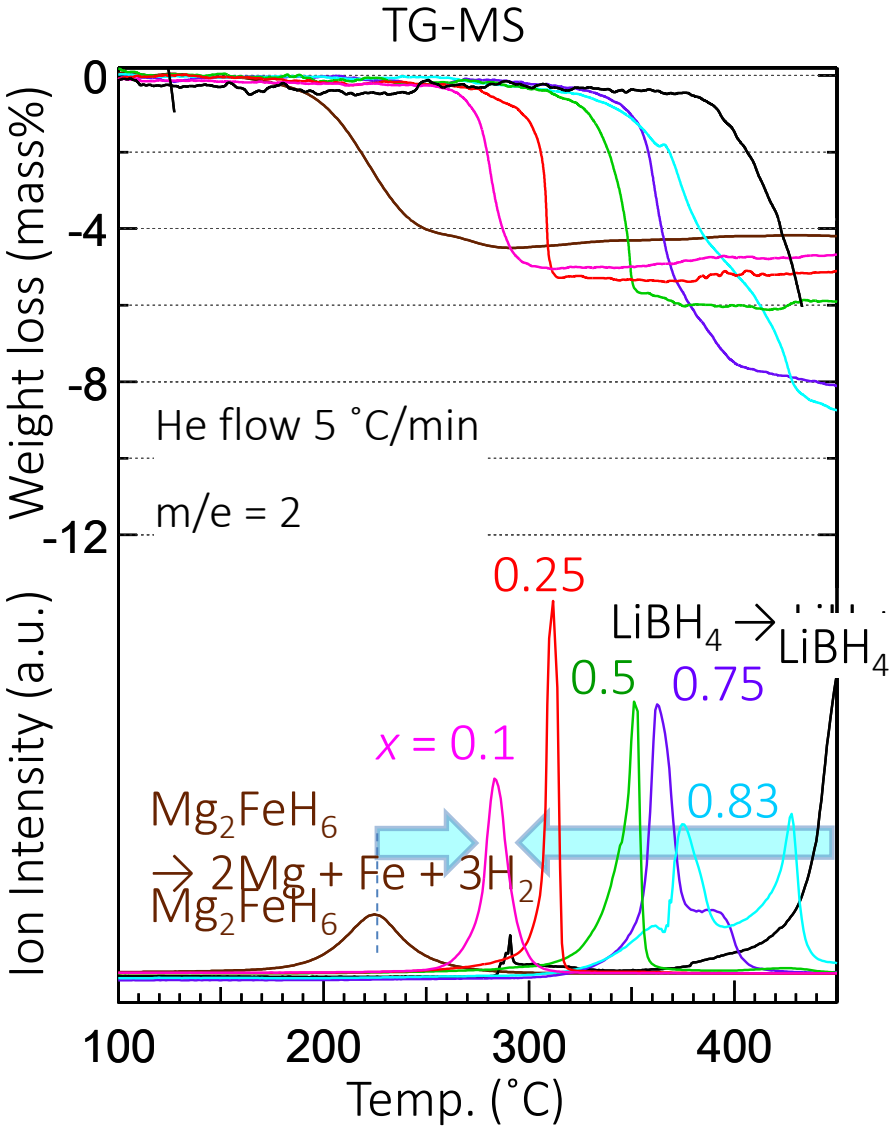
  Ball Milling: x = 0.1 ~ 0.83, 5 h, 0.1 MPa Ar

- **Dehydriding property characterization**

  Thermogravimetry-Mass Spectrometry (TG-MS)

  In-situ Synchrotron Radiation X-ray Diffraction (SR-XRD)

Dehydriding property of xLiBH$_4$ + (1–x)Mg$_2$FeH$_6$



x = 0.1, 0.25, 0.5

- **One–step** Reaction
- Dehydriding Temperature T_d

  $Mg_2FeH_6 < T_d < LiBH_4$
- T_d increase with x

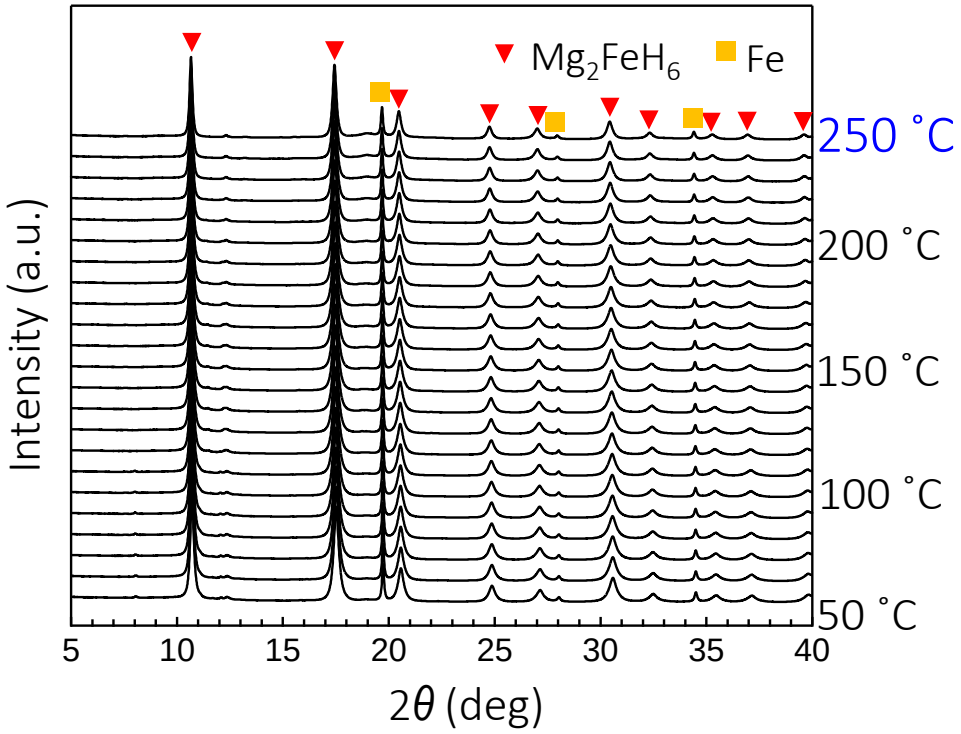
x = 0.75, 0.83

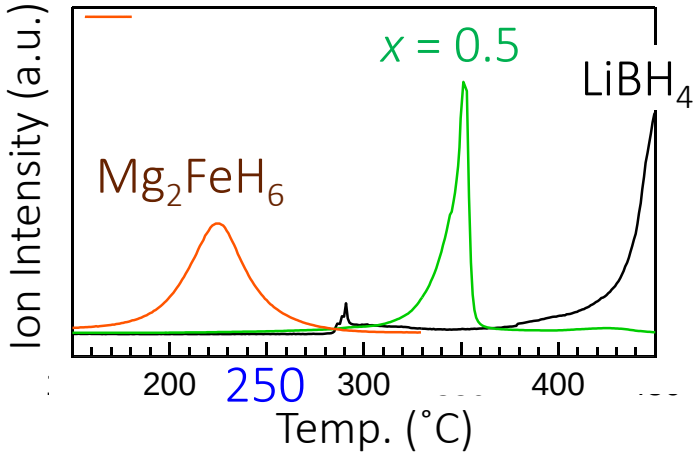
- Multi-step Reaction
- $T_d < LiBH_4$

1. Simultaneously dehydriding of $LiBH_4$ and Mg_2FeH_6
2. Decreased T_d of $LiBH_4$

In-situ SR-XRD of $LiBH_4 + Mg_2FeH_6$ ($x = 0.5$)

(BM01B at ESRF, λ: 0.693862 Å, 5 ˚C /min)

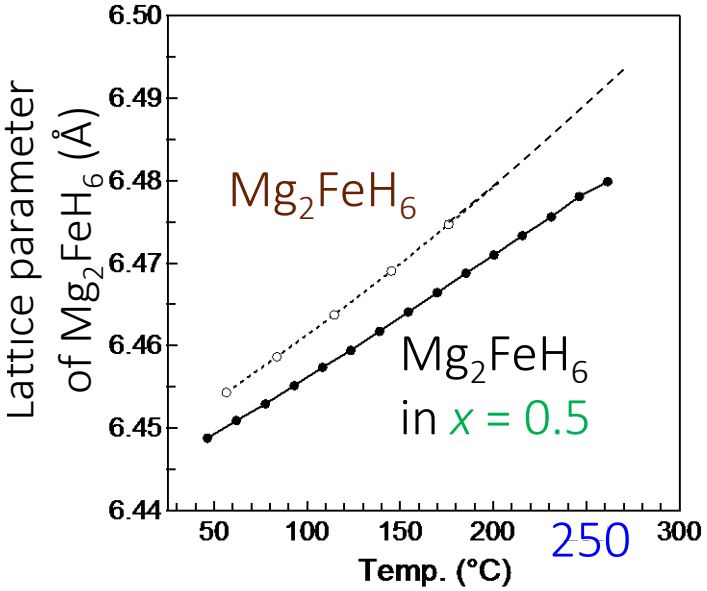




Different Lattice Expansion

⇩

Possibility of
Mixed Complex Anions



Orimo lab 2014

Thank you