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

Mesoscale approach to understand tribological behavior of lubricants

Sophia Berkani,[1,2] Sophie Loehle,[1] Miriam Chebre,[1] Akira Miyamoto,[2]

N. Hatakeyama [2], K. Okushi [2], Y. Obara [2], S. Asakura [2], K. Araki [2], M. Tanno [2]

1 TOTAL MARKETING SERVICES – CReS Solaize, France

2 New Industry Creation Hatchery Center – Tohoku University, Japan)

TOTAL
COMMITTED TO BETTER ENERGY

TOHOKU UNIVERSITY

東北大学未来科学技術共同研究センター
New Industry Creation Hatchery Center

Outline

I. Context

II. Principle of mesoscale simulator

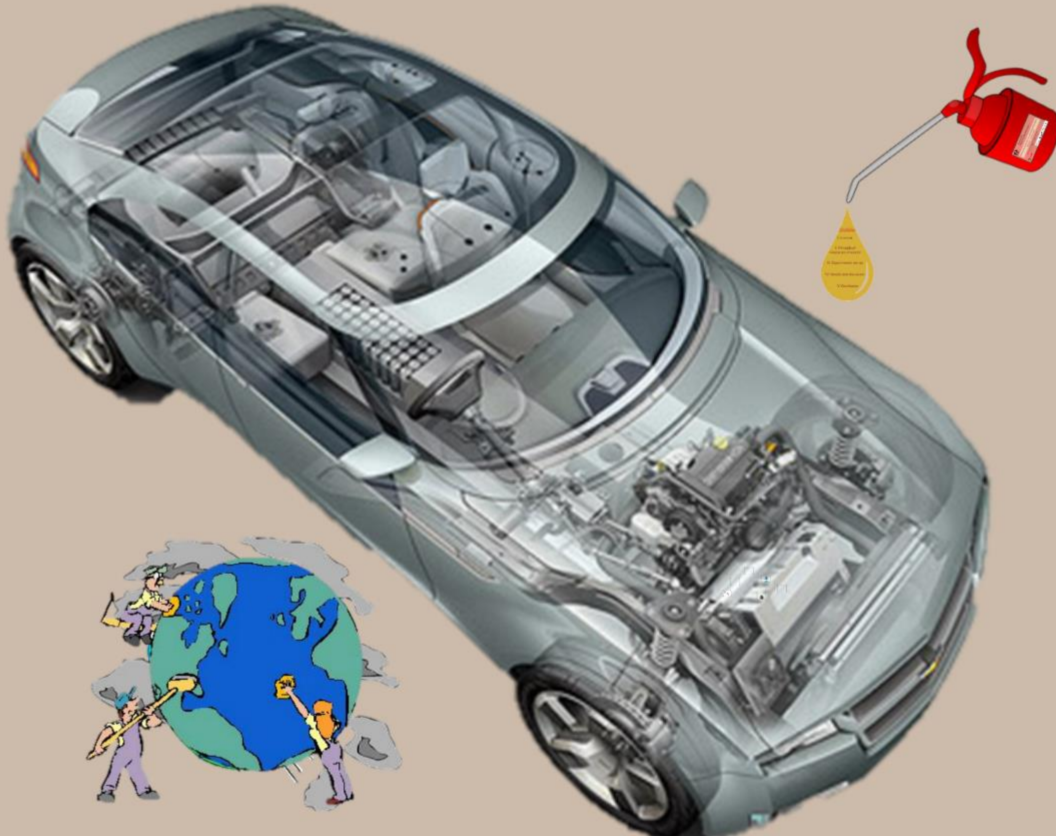
III. Experimental set-up

IV. Results and discussion

V. Conclusion & Perpectives

I. Context

Lubrication of internal Combustion engine (ICE)

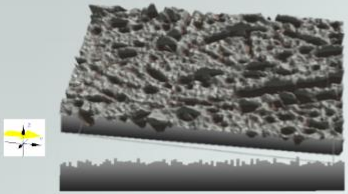


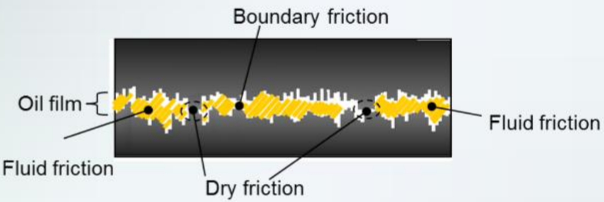
II. Principle of mesoscale simulator

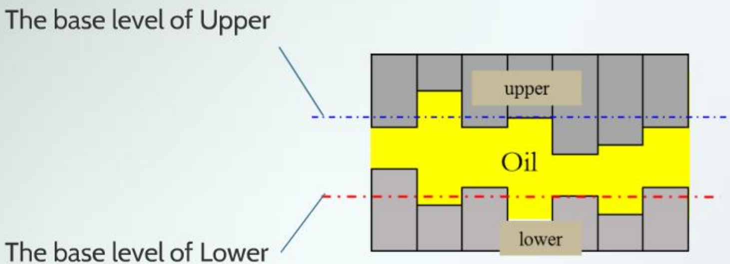
Meso-scale simulation: Simulation method

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

The surface is discretized into meshes

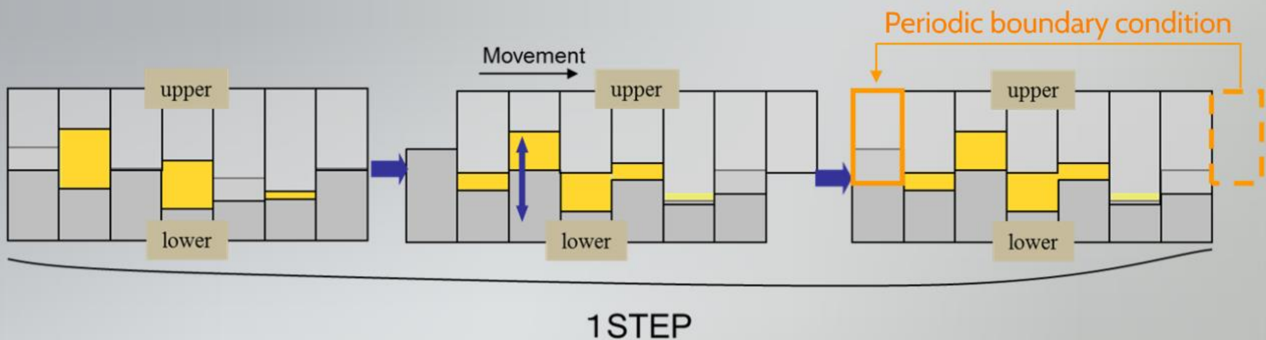






II. Principle of mesoscale simulator

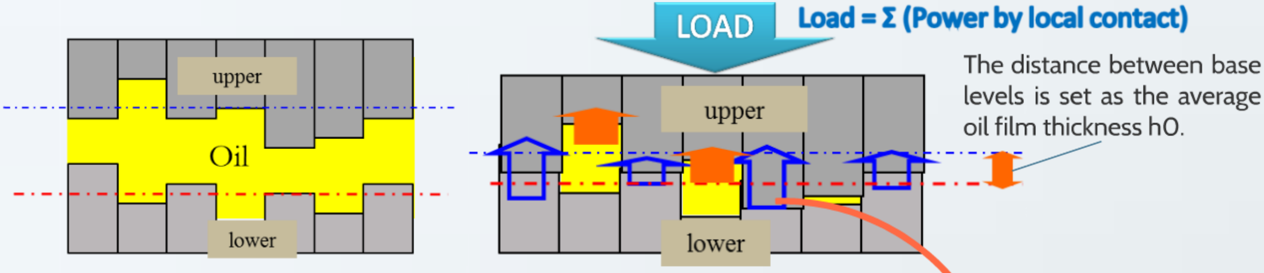
Meso-scale simulation: Simulation method



Meshes outside of the system after movement
=> placed in the vacant side of the surface.

II. Principle of mesoscale simulator

Meso-scale simulation: Simulation method



1. Determination of the oil film thickness

2. Determination of contact part and non-contact part

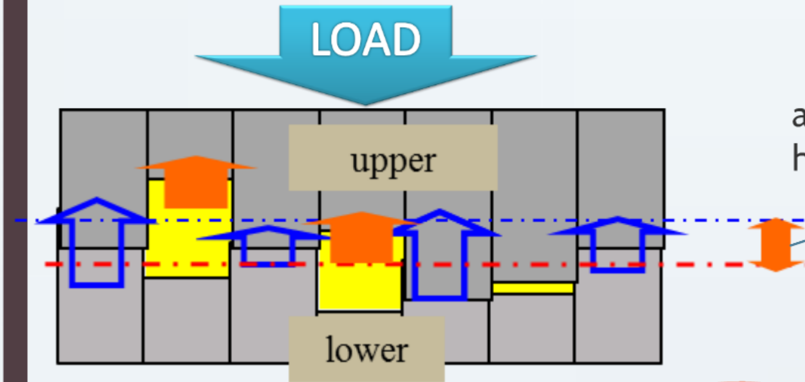
->Two surfaces have overlapped

=> 3. Distortion of a part is determined

4. Oil film reaction force is determined.

II. Principle of mesoscale simulator

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



average oil film thickness h0.

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

$h_{k,l}$: *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

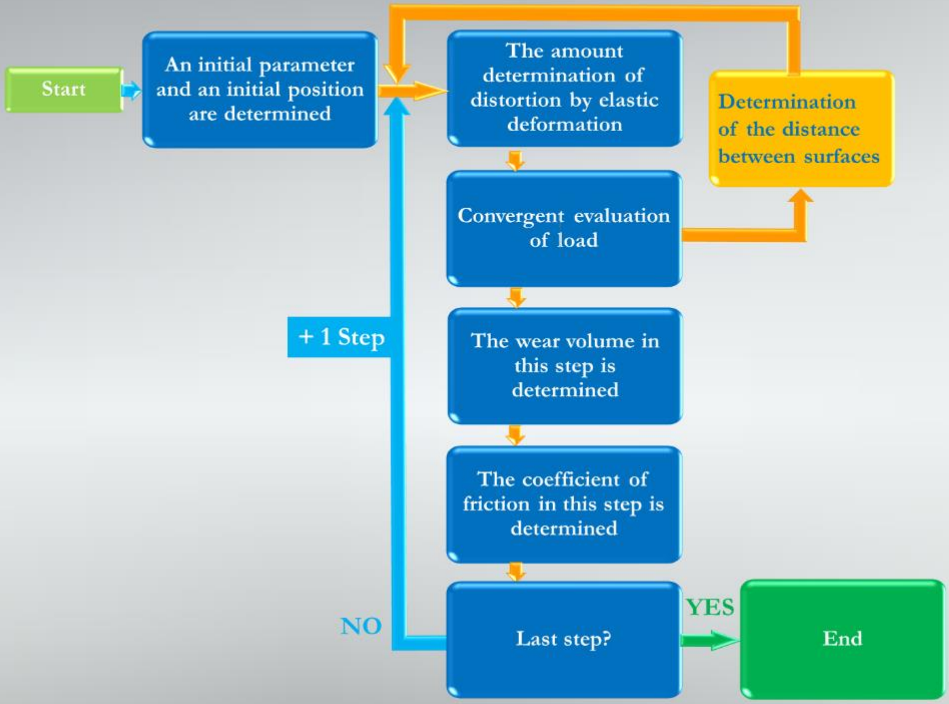
Boundary friction:

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

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

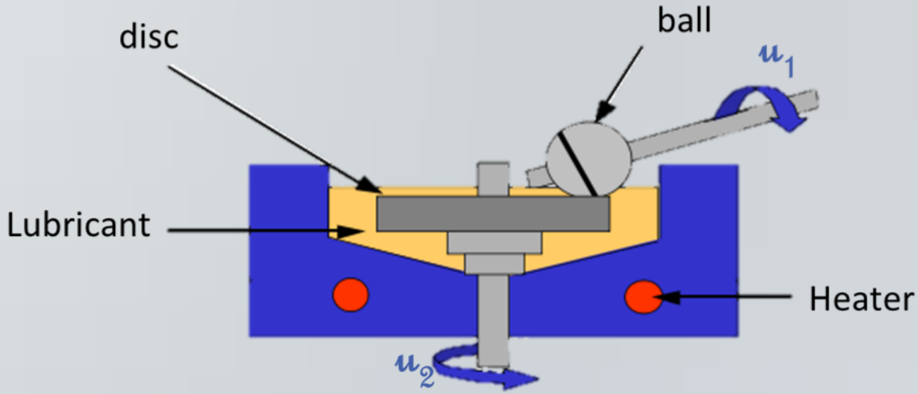
Tribological condition

Conditions

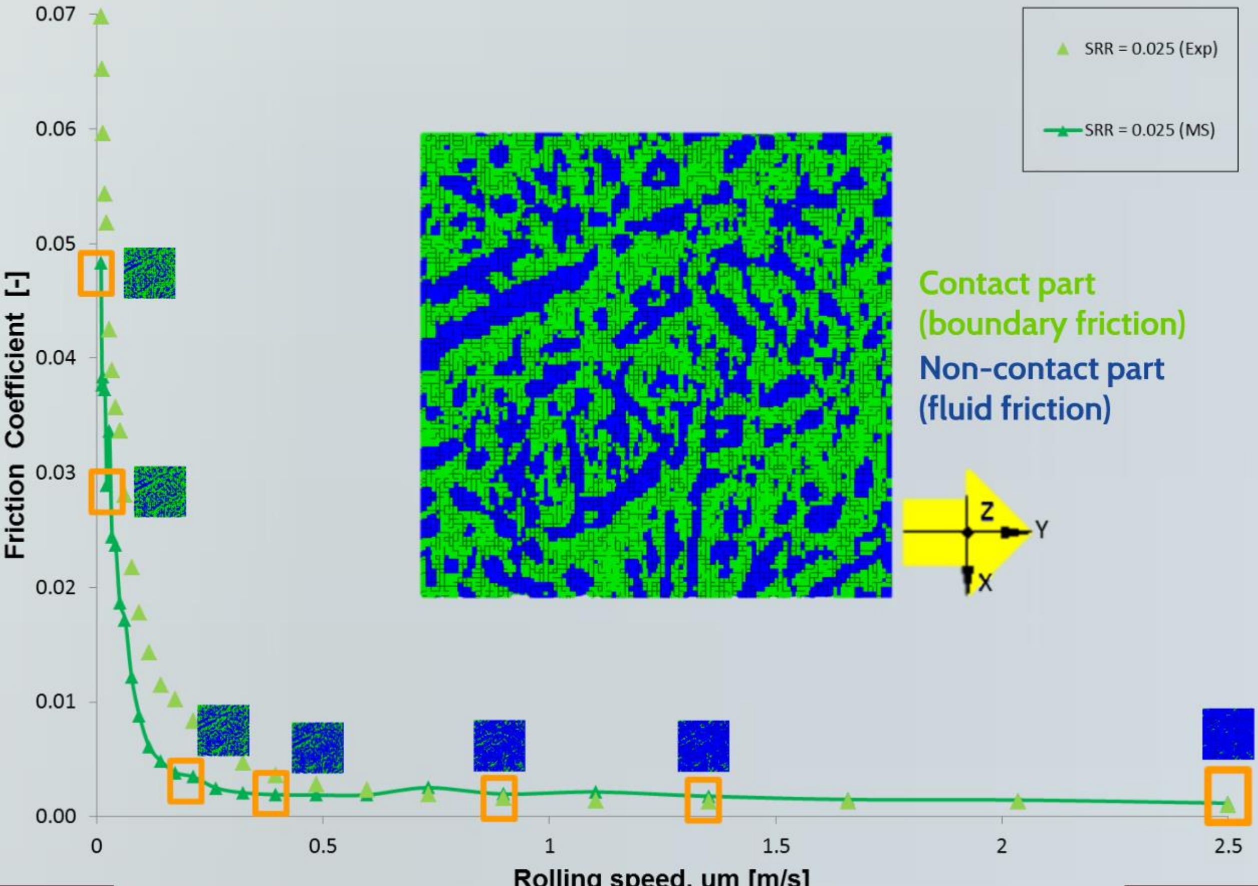
Contact:	Steel/steel AISI 52100
Temperature:	100°C
Oil:	Base oil group III
Normal load:	10 N
Rolling speed:	2500 -> 10 mm/s
SRR:	0.025 to 0.5

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.*