# INHIBITION OF CONFINEMENT-INDUCED SOLIDIFICATION OF MINERAL OIL-BASED LUBRICANTS

**K. Tamura [a*], K. Sunahara [a], H. Tatsumi [a], Y. Takashima [a], M. Mizukami [b], K. Kurihara [c]**
*kazushi.tamura@idemitsu.com
[a] Lubricants Research Laboratory, Idemitsu Kosan Co., Ltd.,
24-4, Anesakikaigan, Ichihara, Japan
[b] Institute of Multidisciplinary Research for Advanced Materials, Tohoku University,
2-1-1, Katahira, Aoba-ku, Sendai, Japan
[c] New Industry Creation Hatchery Center, Tohoku University,
2-1-1, Katahira, Aoba-ku, Sendai, Japan

## KEYWORDS
***Friction; Lubricant additives; NanoTribology; Surface force***

## ABSTRACT
Reducing energy consumption is a perpetual challenge for human society. Friction is a major source of energy loss to be reduced; it has been reported to consume 20% of total energy in the world [1]. Oil-based lubricants have significantly contributed to reduce friction in human society. In transportation sector, which accounts for almost one third of total energy, these oils lubricate the engines and transmissions of transportation vehicles. In industrial sector, to which another one third of total energy is attributed, oil-based lubricants are also widely used in many types of industrial machineries such as turbines, hydraulics and compressors. The main components of these lubricants are mineral oils derived from petroleum refining. Friction-reducing function of these oils are not only based on the hydrodynamic surface-separating force governed by their viscosity, but also exhibited when this hydrodynamic force is no longer capable to carry load. The latter behavior, so-called boundary lubrication, highly depends on the chemistry of lubricant oils. For example, some surfactants are widely known to reduce friction. However, the mechanisms of boundary lubrication have been not fully understood.

In this study, we investigated the effects of the surfactant chemicals commonly used as friction modifier (FM) and dispersant additives on the mechanical properties of the interfacially confined mineral oils by using a surface force apparatus. Resonance shear measurements (RSM) [2] revealed that spatial confinement induced solidification of the mineral oil at ~10 nm surface separation. Addition of a glycerol mono-oleate FM into the oil strongly inhibited this solidification. The polyisobutenyl succinimide dispersants were also found to deliver such inhibitory effects on confinement-induced solidification. Polar group chemistry of the dispersants was critical to this inhibitory effects of the dispersants. The hard-wall thickness was not significantly different between inhibitory and non-inhibitory dispersants. As with RSM, macroscopic friction measurements showed that these solidification inhibitors reduced metal-to-metal friction. These results suggest that inhibition of confinement-induced solidification plays a dominant role in boundary lubrication performances of surfactant additives.

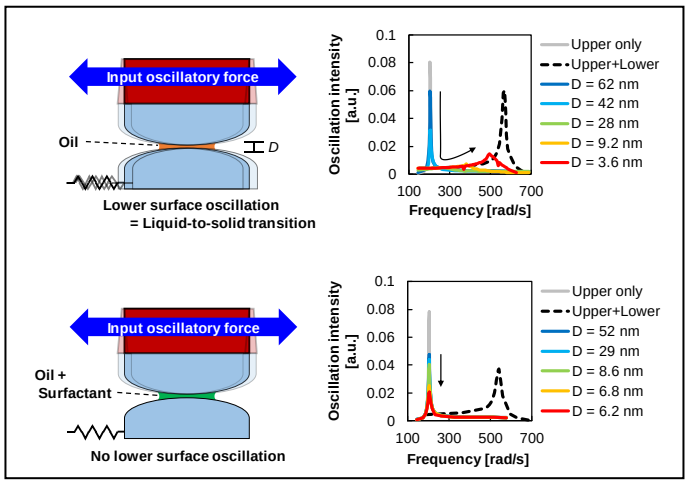


Fig.1 Schematic representation (left) and data (right) of RSM of confined lubricants. While mineral oils solidified under nano-confinement (upper), surfactant-containing oils did not (lower).

## REFERENCES
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