ACHIEVING SUPERLUBRICITY WITH FULLY-FORMULATED ENGINE LUBRICANTS

Dean B. Clarke [a*], Eduardo Tomanik[b], Dinesh Bansal [a], Paulo V. de Morais [b], Margareth Carvalho [c]
*dean.clarke@infineum.com
[a] Infineum USA
1900 E. Linden Ave. Linden, NJ 07036 USA
[b] MAHLE Metal Leve S.A.,
Rodovia Anhanguera, sentido interior - capital, km 49,7, 13.210-877 Jundiaí, Brazil
[c] Infineum Brasil Ltda
Rua Praia da Ribeira, 1 - 20560-001, Rio de Janeiro – RJ, Brasil

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ABSTRACT
Structural Superlubricity is the state in which two contacting surfaces slide with no resistance within measurement error (< 0.01 CoF). Real-world superlubricity aims to achieve significant friction reduction (≤ 0.04 CoF) of fully-formulated engine lubricants between real engine parts or in actual engines. Kano (1) reported a friction coefficient as low as 0.02 with actual engine parts (ta-C on steel). The lubricant he used was a binary blend of Glycerol Mono-oleate ester in PAO; this lubricant did not contain ZDDP, Anti-oxidants, or metal detergent, dispersant, or other components required for a fully-formulated oil.

This paper demonstrates the achievement of real-world superlubricity conditions between a coated piston ring and a cylinder liner in reciprocating motion. The noteworthy part of the attaining a 0.035 CoF was achieving it with a fully-formulated SAE 0W-20 engine oil. Furthermore, improvements in wear protection were found with this oil while using DLC-coated parts from the crankcase.

Surface coatings on the rings tested included CrN and Hydrogen-free DLC. Cylinder liner materials included both regular honed Gray Cast Iron and Coated bore with a Mirror-Like Finish. Elemental mapping, surface morphology, and chemical species on the surfaces were characterization by SEM-EDS, XPS, SIMS, and STEM. An example STEM image of a tribofilm cross section is shown in the Figure below.

Effects of Molybdenum chemistry and organic friction modifiers for friction reduction are discussed.

REFERENCES
[1] Kano, M., "Diamond-Like Carbon Coating Applied to Automotive Engine Components," Tribology Online,, 9, 3, 2014, 135-142..

Figure 1. STEM Image of Tribofilm formed on an iron surface.