Influence of lubricant additives and SRR in tribofilm generation

M. MEHEUX[1], C. MINFRAY[2], F. VILLE[3], Th. LE MOGNE[2], A. A. LUBRECHT[3], J. M. MARTIN[2] and H. P. LIEURADE[1]
[1] CETIM, SENLIS, [2] LTDS, ECL, Ecully, [3] LaMCoS, INSA de Lyon, Villeurbanne.

Subject:

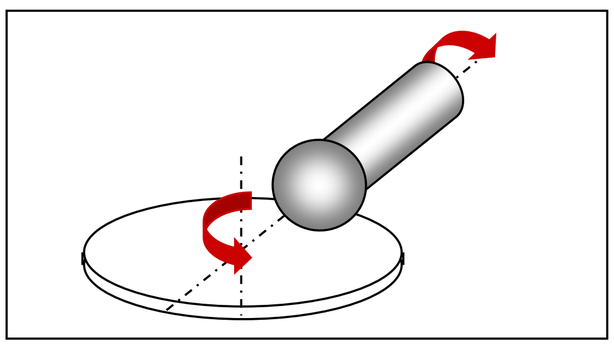
The reaction pathways of lubricant additives under various sliding conditions as well as the tribofilm properties and morphology have become an important subjects of research.

- AFM and spacer layer imaging methods combined with the rolling-sliding Mini Traction Machine (MTM) have shown that lubricants containing calcium detergent form tribofilms at 50% Slide-to-Roll Ratio (SRR)[a]. Recently, the combination of MTM and Auger Electron Spectroscopy (AES) depth profiles has produced similar results with a formulated oil containing five additives, including a calcium detergent [b]. The authors have also shown that tribofilms can be formed at much lower SRR. These tribofilms increase the friction coefficient compared with the pure base oil value. The rate of friction coefficient increase augments with the SRR.

- The work presented here compares the results of 5h tests performed with base oil (BO) and the formulated lubricant (formulated lubricant, FL) in terms of friction coefficient, topography and chemical composition for various SRR. The influence of SRR and the presence of additives are investigated.

[a] TOPOLOVEC-MIKLOZIC K. et al. Film Forming and Friction Properties of Overbased Calcium Sulphonate Detergents. Tribology Letters , 2008, 29, pp. 33–44
[b] MEHEUX M. et al. Influence of slide-to-roll ratio on tribofilm generation. Proceedings of the Institution of Mechanical Engineers, Part J: Journal of Engineering Tribology, to be published

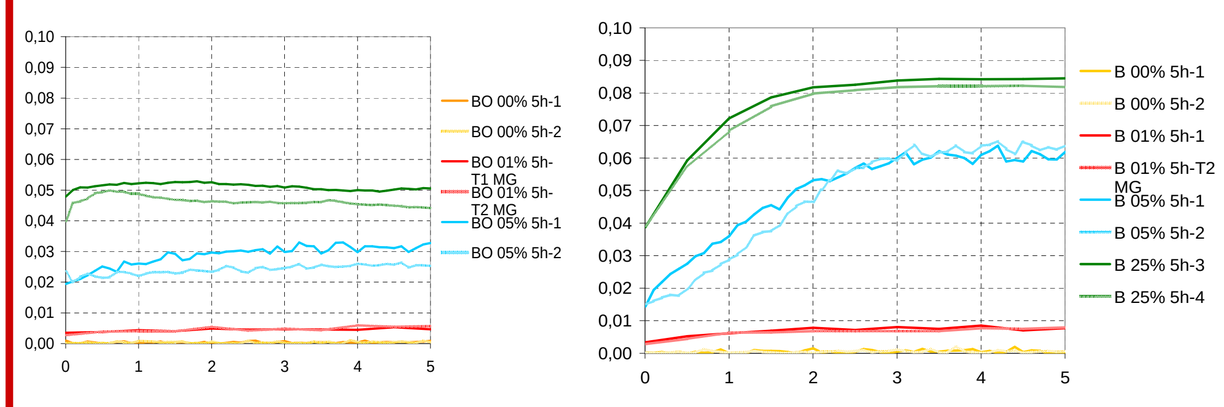
Mini Traction Machine



SRR** <1, 1, 5 and 25%
Mean Speed= 100 mm/s;
Temperature = 80°C;
Max Hertz Pressure= 890 MPa;
Minimum film thickness= 11nm

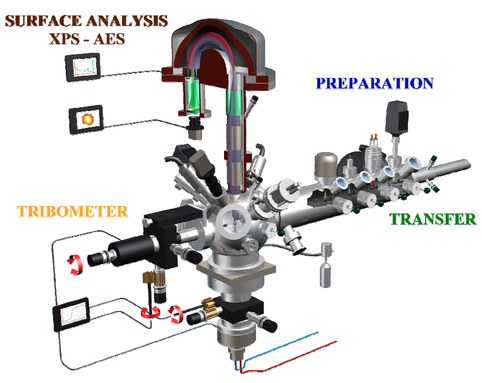
λ=0.95; 5h

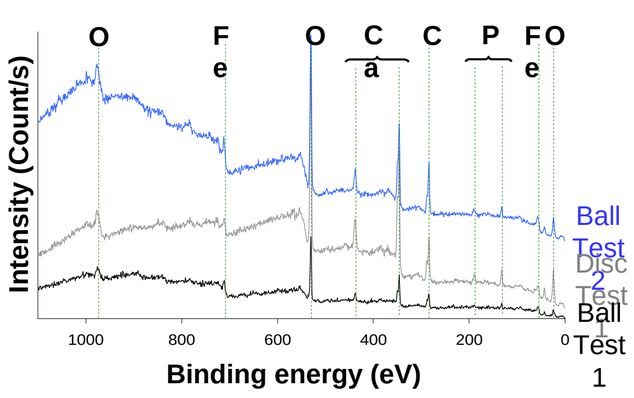
Friction Coefficient as a function of time



Friction coefficient increases when additives are present in the base oil Friction coefficient increases when SRR augments

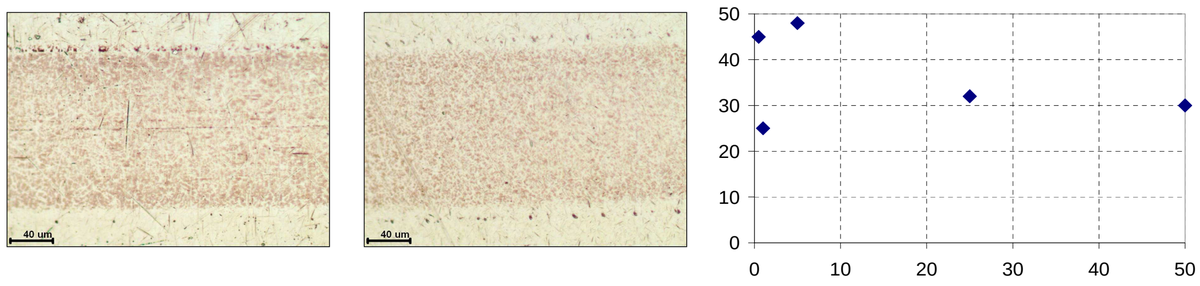
Ex situ surface analyses





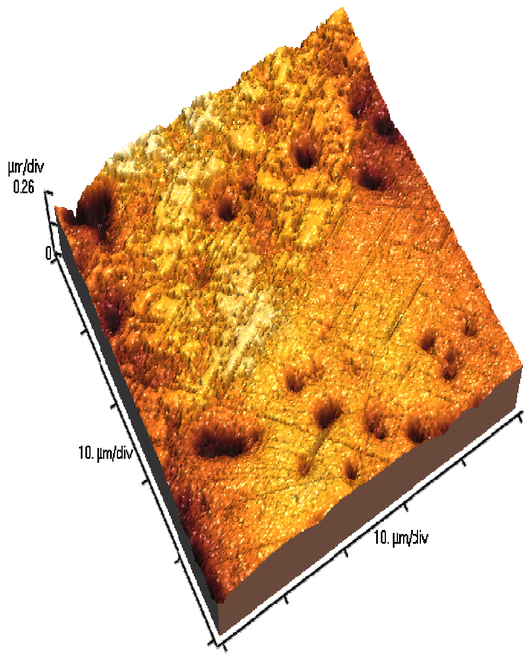
The same chemical components are detected in the rolling track on :
Two balls from 2 different tests
A pair ball and disc from the same test

Results



Tribofilm is formed in the rolling track, even at very low SRR

AFM* topography Contact Mode



Roughness inside the wear track= Roughness outside

Tribofilm (25%, FL)

Thickness ≈ 30 nm

Conclusion

The tribofilm:

- is generated only in the rolling track.
- forms even at very low SRR.
- increases friction coefficient but does not modify surface roughness.
- chemical composition is identical on both ball and disc in contact during an MTM test.
- chemical composition is identical at all SRR.

Friction coefficient increases when SRR augments.
Film thickness evaluated by AFM and AES depth profiling are similar.
It seems that the film thickness reaches a maximum at 5% SRR.

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Mathilde.Meheux@insa-lyon.fr
LaMCoS, Université de Lyon, CNRS, INSA-Lyon UMR5259, 18-20 rue des Sciences - F69621 Villeurbanne Cedex
Laboratoire de Mécanique des Contacts et des Structures