Topographical Model Selection in Tribology

S. Tchoundjeu[1,2*], M. Bigerelle[3], F. Robbe-Valloire[1], T. DA SILVA[1], F. Jarnias[2]

[1)] Laboratoire d'Ingénierie des Systèmes Mécaniques et des Matériaux, SupMeca, 93407 Saint-Ouen, France.
[2)] Total Supply Marketing, Centre de recherche de Solaize, 69360 Solaize, France.
[3)] Laboratoire de Thermique, des Ecoulements, de Mécanique et Matériaux en Mise en Forme, 59313 Valenciennes, France.

[*]Corresponding author for stephane.tchoundjeu@supmeca.fr

1. Introduction

A major problem met in tribology consists in finding the effect of qualitative phenomena on a quantitative evolution of a tribological system. For examples, what is the effect of different environments on surface damages? In this paper, a multi scale methodology is proposed to model and to characterize the effect of 2 lubricants on surface morphology evolution during its first hours (running-in stage). This evolution is characterized by the evolution of standardized roughness parameters given in ISO 25 178.

2. Materials and experiments

Two steels samples were mounted on a twin-disc tribometer for the test of each lubricants A and B during 42 hours. Each test is interrupted in several sequences and replicas of the surface were done and 3D topographies are measured by an interferometer. Test and operating conditions are more detailed in a previous paper [***1***].

3. The best 3D Roughness parameter

From all these replicas measures, the multi scale methodology is. The S_{r2} (percentage limits of the inferior core roughness surface) evaluated at the scale around 100 µm with high pass filter is the best global roughness parameters (Fig.1).

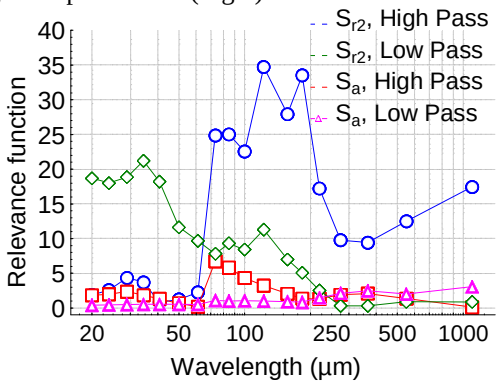

Figure.1 Relevance of Sr2 and Sa versus the scale for low and high pass filtering.

The Sr2 decreases for both lubricants (Fig.2, left) meaning that valleys becomes more and more pronounced during time, and the lubricant B increases rapidly these valleys. Our methodology shows that the best difference of wear due to lubricant is also modelled by S_{r2} but evaluated at the scale of 40 µm with a low pass filter (Fig.2, right). The lubricant A does not introduce localized damage (small pits) compare to lubricant B.

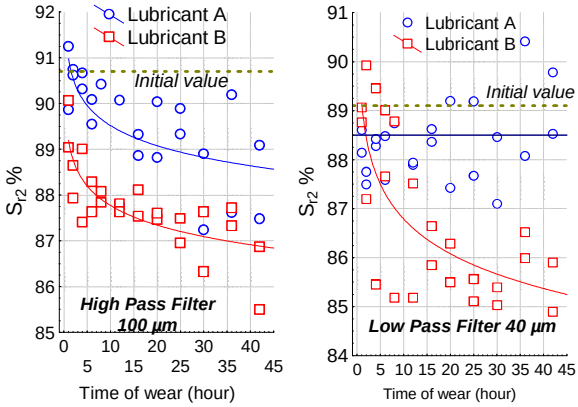

Figure 2. Evolution of the S_{r2} roughness parameters versus the wear time.

4. Effect of lubricant during wear

The same methodology is applied with 2D roughness parameters: the regularity of the surface (Fig.3, left) drastically decreases like the fractal dimension (Fig.3, right) for Lubricant B but these parameters slowly decreases for lubricant A to finally reach the same values after 40 hours.

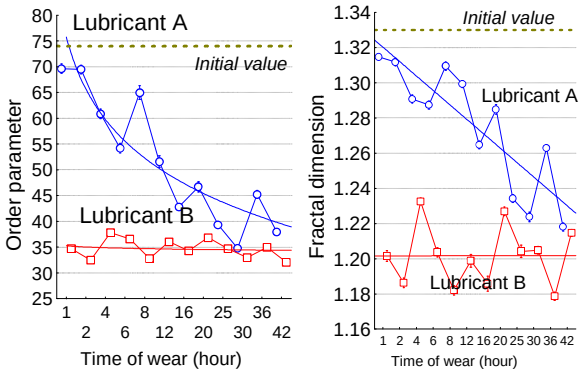

Figure 3. Evolution of the Order (left) and Fractal dimension (right) during wear

5. Summary

These selection models show that lubricant A leads to preserve better integrity of surface during wear that lubricant B. Surface are rapidly damaged (form removal, pits creation) with lubricant B and lubricant A leads to the same results but with higher delays.

6. Bibliographie

[1] S. Tchoundjeu, T. Da Silva Botelho, F. Jarnias, F. Robbe Valloire, "Caractérisation d'écaillage en phase de rodage sur tribomètre de type bi-disque," *Proceeding of JIFT*, 9-11 Mai 2012.