Enhancement of Film Lubrication by Tailored Surface Wettability

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Limited lubricant supply (LLS) is currently an inspired strategy in tribology to provide on-demand lubricant for energy saving and environment concerns. This presentation delivers how tailored surface wettability can make efficient use of lubricant for tribo-contacts under LLS. It was revealed that wettability steps, fabricated at the two sides of an oleophilic contact track by oleophobic layers, could augment lubricant replenishment on the track. Modification of contact track by some friction modifiers, which leads to some levels of lubricant dewetting, was also demonstrated to enrich lubricant supply.

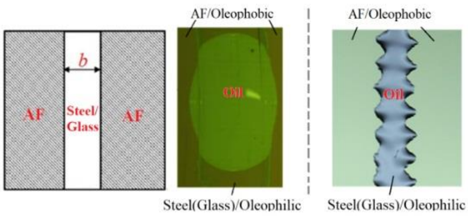
Keywords: Limited lubricant supply, wettability pattern, dewetting, lubricant replenishment, film lubrication

1. Introduction

Excessive supply of lubricant to moving parts of machines, such as rolling bearings, leads to increase in friction as well as environment problems, and there is an emerging trend of limited lubricant supply (LLS) in tribology design of machine elements[1]. However this does not mean direct reduction of oil dosage given the risk of lubrication failure due to oil starvation. Thus approaches to facilitate as much as possible use of lubricant are crucial to optimal LLS. Several wettability patterns are introduced in this study and have proven as useful tools to improve oil supply and film lubrication under LLS.

2. Experimental apparatus and specimens

Optical interference tribometres were used for measurement of film thickness in slider-on-disc/ball-on-disc contact[2], and a UMT, for friction measurement. A fluoroalkylsilane material, which is usually available for oleophobic anti-fingerprint (AF) coating, was used to fabricate wettability step. Figure 1 illustrates the oleophilic lubrication track with side wettability step (straight line boundary ASA-1 & zigzag boundary CT-1). In the tests wettability of the contact track was also tuned by stearic-acid, and some level of autophobic dewetting can be realized[3].



(a) ASA-1 (b) CT-1

Figure 1: Fabricated oleophilic lubrication track with side wettability step

3. Results and Discussions

UMT tests for a steel ball loaded against ASA-1 and original steel plates showed that the treated surface presents much lower friction than the untreated one as shown in figure 2. Furthermore, average steady-state *COF* measured at different reciprocating frequencies revealed that the side wettability step changed friction evidently in the mixed lubrication regime. Optical interferograms, also included in figure 2, exhibit more oil supply when wettability step presents. Moreover figure 1 shows that wettability steps can pin oil to the central track due to unbalanced interface force.

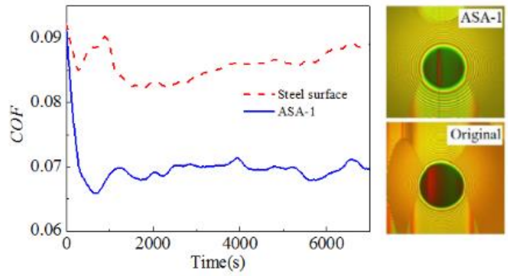


Figure 2: *COF* for a steel ball (9.5mm in diameter) loaded against treated and untreated steel plates, PAO4, 10 N, 0.5 µL, sliding frequency = 8 Hz.

Slider-on-disc tests revealed that PAO10 with stearic acid could present higher film thickness under LLS. The autophobic dewetting by adsorption of stearic acid generates discrete oil droplets on the contact track. The droplets can produce load capacity in the inlet earlier than continuous oil layers, allowing for a longer distance for pressure building. In addition it was also observed that the oil droplets have some opportunities to promote lubricant accumulation at the central inlet region, where no oil starvation exists.

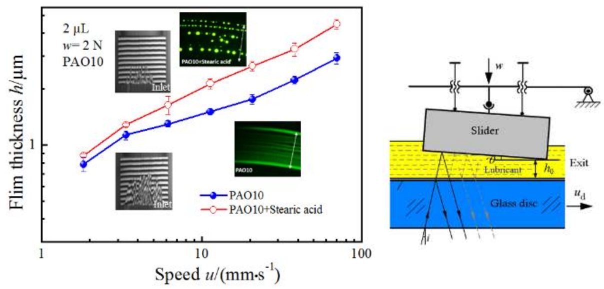


Figure 3: Film thickness in slider-on-disc contact for PAO10 with/without stearic acid, slider size: 4mm×4mm, slider inclination: $\theta=5.89\times10^{-4}$

4. References

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