In-situ experimental investigation of real contact area of sliding contacts at the asperity scale

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Real contact area remains one of the unsolved phenomena in Tribology. Although there are several established theoretical models, experimental validation and relevant data is still lacking in literature, particularly for dynamic contacts that include relative motion of contacting surfaces. In this study we investigated the evolution of real contact area of steel multi-asperity contacts during sliding under different contact conditions. The value of real contact area was determined via optical observation of the whole contact, where microscopy images with submicron resolution of the contact were taken during sliding in real time and then graphically processed.
Keywords (from 3 to 5 max): real contact area, steel, experimental, sliding

1. Introduction

Although real contact area is an important aspect of tribological contact behavior, it is not fully understood yet. Many attempts have been made to establish theoretical models, starting with the Greenwood Williamson model in the 60s and continuing with the more recent, advanced models [1]. However, there is a lack of experimental, particularly in-situ, studies, that would provide relevant insight into contact behavior on the asperity scale. Most such studies were conducted on static contacts, and only a few were performed on contacts with relative motion where the entire contact area, rather than a part of the surface or single asperities, was taken into account [2]. Nevertheless, the true micro-asperities were not entirely captured due to limited resolution of the device.

This work presents an experimental approach to the investigation of real contact area in dynamic contacts, where whole steel multi-asperity contacts with different roughness were observed during sliding at different normal loads and roughness values with in-situ sub-micron resolution analyses.

2. Methods

An in-house custom-built test rig based on optical observation of contact was used to investigate the evolution of real contact area during sliding. The samples used were manufactured from 1.0737 steel with different R_a surface roughness: 0.1, 0.6 and 1 µm. Sliding tests were conducted dry at two constant normal loads (contact pressure equivalent to 0.6- and 1-times material yield strength), constant sliding speed of 0.5 mm/s and total sliding distance of 5 mm. A smooth sapphire disc was used as the transparent counter-body to allow for contact observation. Friction data and images of the contact were obtained in-situ through a microscope (Nikon LV150) and graphically processed [3] to determine the real contact area values.

3. Results and discussion

Results show an increase of real contact area during sliding due to asperity deformation. Both surface roughness and load had a notable effect on the evolution and the stabilized value of real contact area obtained after the initial sliding stage.

The real contact area values obtained along the whole sliding distance were significantly smaller than the nominal contact area, particularly at higher roughness, namely around 15 %.

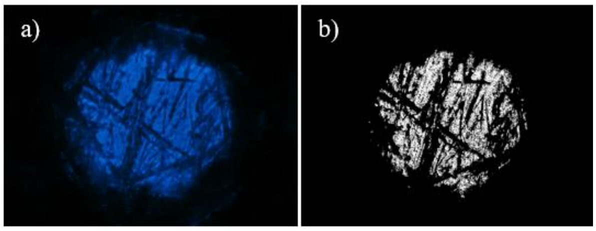

Figure 1: (a) Raw microscope sample image; (b) processed real contact area image.

4. References

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