Effects of Surface Ridges on EHL Films under Impact Loading

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1. Introduction

The understanding of squeeze EHL phenomena is an important subject to improve the performance, durability and function of machinery. The surface roughness seems to play an important role for squeeze EHL. The purpose of this study is to make clear the basic effect of the surface roughness on impact EHL phenomena.

2. Experiment and numerical methods

The experimental apparatus used in this study is basically the same as that in the previous work [1]. A 25.4 mm diameter steel ball with ridges produced artificially impacts an oil lubricated glass disc. The impact load was applied by pushing the ball with a piezo-actuator. The initial central impact gap between smooth surfaces was set at 1.41μm. The film thickness was measured using the optical interferometry technique. The experiments were numerically simulated based on the isothermal Newtonian analysis [1, 2].

3. Results

Figure 1 shows the load curve. The interferogram obtained for the rough surface and the load curve shown in Fig. 1 is shown in Fig. 2 together with the enlarged view. In Fig. 3, the corresponding film profile along y=0 is compared with the smooth surface result. The film thickness at the valley of the ridges is roughly similar to that of the smooth surface. As seen from Fig. 2, the horse-shoe shaped constriction is formed at each bump near the contact rim. Consequently, the film thickness at the ridge becomes larger (see the film profile at y = 0.184mm in Fig. 3).

Figure 4 shows the relation between the smooth surface central film thickness and the loading speed. The experimental results agree well with the numerical results. That is, as the loading speed increases, the central film thickness increases and levels off.

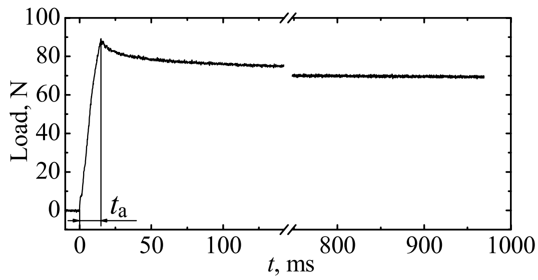
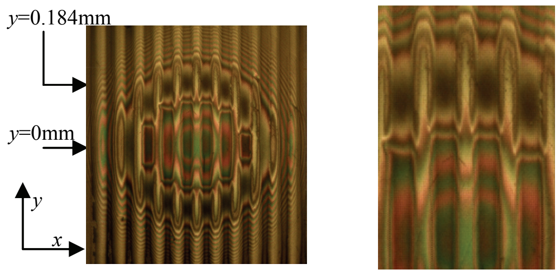


Fig. 1 Load curve



(a) Oil entrapment (b) Enlarged view

Fig. 2 Interferograms (t_a=15ms, t=969ms)

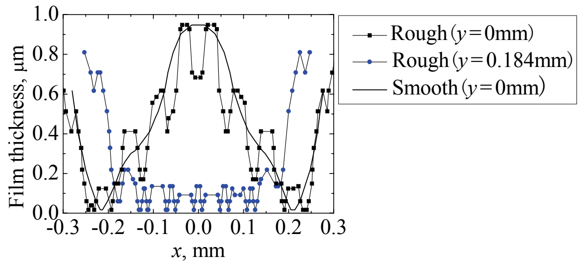


Fig. 3 Comparison of film profile between smooth and rough surfaces

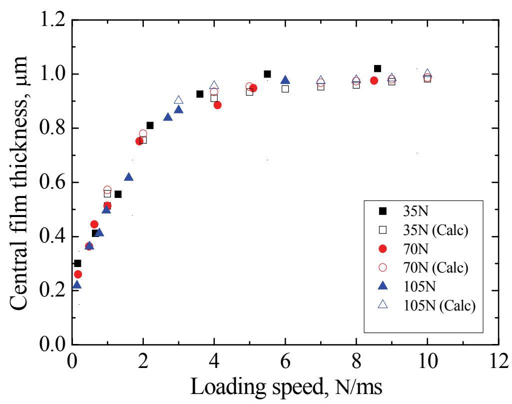


Fig. 4 Effect of loading speed on central film thickness

4. References

[1] Kaneta, M., Nishikawa, H., Mizui, M., and Guo, F., "Impact Elastohydrodynamics in Point Contacts", Proc. IMechE., 225, J, J.Eng. Tribol., 1-12.

[2] Kaneta, M., Guo, F., and Wang, J., "Impact Micro-Elastohydrodynamics in Point Contacts", ASME J. Tribol., 133, 2011, 031503, 1-9.