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A New Surface of Three Dimensional Comb-tooth-shaped Texture to Enhance Oil Replenishment

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Effective oil replenishment to the lubrication track of a running bearing is crucial to its sustainable operation. This paper presents a new surface which can provide wettability gradient to enrich the replenishment. The surface consists of two arrays of periodic 3 dimensional comb-tooth-shaped pattern (3d-CTG) on both sides of the lubrication track. Unidirectional oil flow towards the lubrication track can be generated, thereby escalating oil replenishment to the lubrication track. The effects of the newly devised surface pattern on lubrication are experimentally evaluated under the conditions of limited lubricant supply.

Keywords: Laser surface texture, Limited lubricant supply, Comb-tooth-shaped pattern; Lubricant replenishment; Friction coefficient

1. Introduction

The best bearing lubrication scenario is probably for a bearing to run safely and efficiently with "just enough" lubricant. The oversupply of lubricant is not only a waste, but also it can be detrimental, such as an excessive viscous friction may bring the operation of a whole micro-mechanical systems on halt [1]. Moving liquid droplets in desired directions can be facilitated by the unbalanced interfacial forces attributable to the wettability gradient of a surface and the net force created at the boundary between regions of different surface energies. This study proposes a surface pattern characterized by anisotropic wettability and topographic features to channel oil to the lubrication track to improve bearing lubrication.

2. Experiments

2.1. Surface pattern design and parameters

The proposed surface pattern, 3d-CTG, as schematically depicted in Figure 1, comprises two arrays of wedge-shaped micro-grooves located symmetrically on the two sides of a longitudinal central lubrication track.

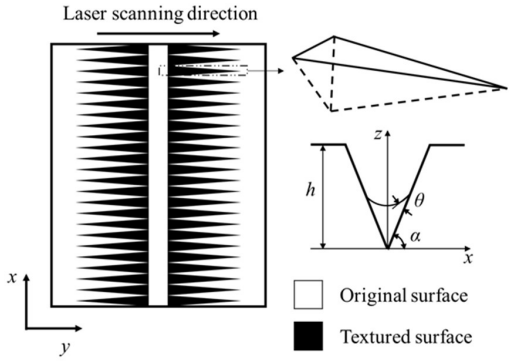

Figure 1: Textured surface with V-groove arrays.

The depth of the grooves varied from 0.2 μm at the tip to 2.5 μm at the wide end. The width of the wide end was 150 μm, and the length of the groove was 1000 μm, wherein a sharp apex angle of 8.6° was produced.

2.2. Specimen samples

The contact angles of a tiny oil droplet on different locations of the surface were determined to obtain the wettability of the micro-patterned surfaces. The effect of the comb-tooth-shaped patterns on oil replenishment was evaluated on the basis of the lubricating film thickness and friction tests.

2.3. Results

Figure 2 shows the spreading of a PAO4 oil droplet on the left comb-tooth array. The droplet was deposited on the middle of the patterned area, and the motion of the droplet profile was recorded in 60 s. It depicts that the droplet moved further towards the wide end of the comb-tooth, which is deeper than the tooth tip. The one with the comb-tooth-shaped pattern demonstrated steadily low values of COF curve, whilst that with no texture maintained consistently high COFs.

Figure 2: Oil droplet movement on the comb-like surface.

3. Discussion

The devised pattern is characterized by the synergistic effects of the geometrical structure and the micro-profile variation on the wettability gradient. The directional oil flow for replenishment can be readily facilitated. A proper design of the groove length, micro surface roughness and the density of the grooves would optimize the lubricant spreading behavior. The application of the newly devised comb-tooth-shaped pattern in enhancing the lubrication under conditions of limited lubricant supply is demonstrated by its substantial lubrication film formation and friction reduction capability.

4. References

[1] S. K. Sinha, N. Satyanarayana and S. C. Lim, Nano-tribology and Materials in MEMS, Springer, Heidelberg, Berlin, (2013).