The effect of dimple shape on friction in lubricated reciprocating motion

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The experiment was conducted in starved lubricated conformal contact in reciprocating motion using an Optimol SRV5 tribotester. Different types of oil pockets were created using ytterbium fiber laser on disc surface of 42CrMo4 steel. For lubrication a L-AN-46 oil was used in volume of 1 drop (approximately 0.04 ml). In all tests dimple parameters such as pit-area ratio and oil pocket depth were selected arbitrary, on the basis of literature review. Only the oil pockets shapes were different. It was found that the dimple shape can affect the friction coefficient.
Keywords: tribology, friction, laser texturing, reciprocating motion

1. Introduction

Surface texturing is one of methods of reducing friction under lubricated sliding. Creation of different surface structures was widely used to decrease friction, especially in combustion engines, where internal cylinder surface were plateau honed. Such approach was also made for hydraulic cylinders, where low friction is essential for effective work. Laser texturing is the common technique [1, 2, 3].

2. Methods

Tests were performed in reciprocating motion and the frictional pair consists of two discs of 42CrMo4 steel with hardness of 44 ± 2 HRC. Contact surfaces of samples and counter-samples were lapped to achieve roughness parameter *Ra* of 0.14±0.02 µm before laser texturing. Texturing parameters for laser engraver SpeedMarker 300, produced by Trotec® and equipped with ytterbium pulsed fiber laser of 20 W power, were set to obtain 8-10 µm depth with possibly small outflow around single dimple.
Tests were carried out an Optimol SRV5 tribotester produced by Optimol Instruments Prüftechnik GmbH – Germany. Test parameters were the same for all tested friction pairs: the normal load was 50 N, the oscillation frequency was 20 Hz and the stroke was 3 mm. The duration of each test was set to 12500 cycles. One drop of L-AN-46 oil was supplied to the inlet side of the contact zone to obtain starved lubrication conditions, lubricant was not added during test. Test were conducted in temperature of 30°±0,2°C. Different dimples were tested, with circular, triangular and sandglass shapes (Figure 1).

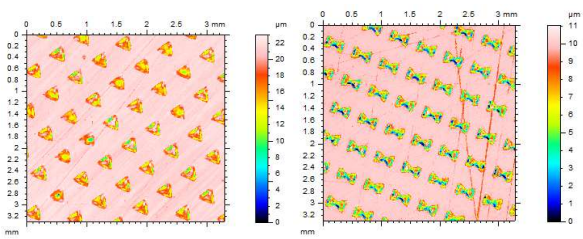

Figure 1: Isometric views of triangular and sandglass shapes of dimples.

3. Results

Surface texturing affects the friction coefficient during bidirectional sliding. In Figure 2 correlation of the friction coefficient to displacement is shown. Measurements were made with time intervals of 40 µs. This graph helped to show that specific textures can work differently depending on sliding direction. Surface texturing led to a decrease in the coefficient of friction.

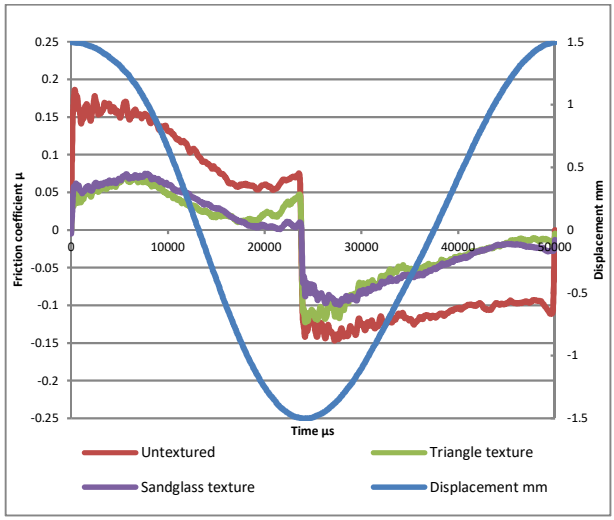

Figure 2: Friction coefficient and displacement versus time obtained from high resolution analysis.

4. References

[1] I. Etsion; State of the art in laser surface texturing, ASME Journal of Tribology 125 (2005) 248–53.

[2] C. Gachot, A.Rosenkranz, S.M.Hsu, H.L.Costa; A critical assessment of surface texturing for friction and wear improvement. Wear372-373(2017)21–41

[3] A. Rosenkranz, P. G. Grützmacher, C. Gachot, H. L. Costa, Surface Texturing in Machine Elements - A Critical Discussion for Rolling and Sliding Contacts, *Adv. Eng. Mater.* 2019, 1900194