Identification of lubrication regime on textured surfaces by multi-scale decomposition

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1. Introduction

This paper focuses on the analysis of surfaces resulting from thickness reduction performed by an experimental drawing process [1]. During reduction, the lubricant is pressurized and may escape from their initial cavities and supply the neighbouring ones. The nature of the lubrication regime is thus changed locally and may vary from boundary to hydrodynamic.

As classical tribological parameters such as the arithmetic roughness or developed profile length don't allow clear identification of regions where different phenomena occurred, the method based on roughness peaks curvature estimation recently developed in [2] is applied.

2. Experiments

Fig. 1a shows the experimental testing device for aluminium strips drawing and the pockets pattern created on the strips.

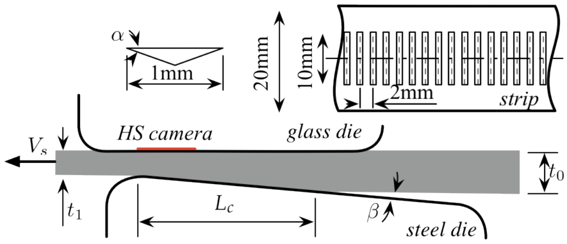

Fig.1 Illustration of the experimental device and the lubricant pockets pattern on the strip upper surface [1].

Four sets of experiments have been carried out with two exit speeds V_s and two lubricant viscosities. Prior testing the pockets are filled with lubricant which behaviour will be observed during drawing by means of a high speed video camera. These videos will be analysed in conjunction to the multi-scale decomposition of the curvature radius of surfaces peaks

3. Peaks curvature radius multi-scale decomposition

The drawn specimens are measured by means of Vertical Scanning Interferometry, giving surfaces topography which area is 8×2mm^2. The curvature radius is assumed to be scale dependent [2] and to follow the scaling law $r_c = r_{c0} l_x^{\Delta}$, where r_c is the curvature radius, r_{c0} is an unscaled radius, l_x a scale gauge and Δ is the fractal dimension. Fig. 2 shows an example of multi-scale decomposition of the curvature radius of peaks related to a given surface, along with its topography and 2D profile extracted in its middle. Thanks to the multi-scale decomposition the identification of the different regions of the profile, which is not clear if only the 2D or 3D profiles are considered, is made easier: regions labelled (a) with high curvature radius correspond to severe contact, regions (b) for which the roughness has changed and that belong to the pockets, regions (c) that also belong to the pockets and were no contact occurred, and region (d) that have belonged to the pockets and that came into contact with the tool.

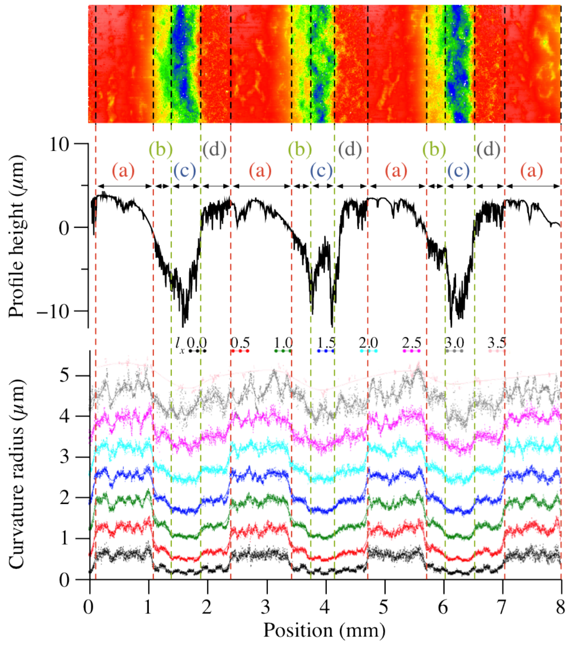

Fig.2 Multi-scale decomposition of the peaks curvature radius for a given surface.

4. Summary

The multi-scale decomposition of peaks curvature radius is applied to drawn surfaces to identify the different regions of involved in the contact. The analysis of all the surfaces obtained in all testing conditions will be extended to the relationship between the lubricant escape and the lubrication regime.

5. References

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[2] Bigerelle, M., Nianga J.M., Najjar D., Iost A., Hubert C. and Kubiak K.J., "Roughness signature of tribological contact calculated by a new method of peaks curvature radius estimation on fractal surfaces", Tribology International, 2013 (in press).