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Max Marian, Stephan Tremmel, Sandro Wartzack

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Microtextured Surfaces in Higher Loaded Rolling-Sliding EHL Line-Contacts

Max Marian [1, a*], Stephan Tremmel [1, b], Sandro Wartzack [1, c]

[1] Engineering Design, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Martensstraße 9, 91058 Erlangen, Germany

[a] marian@mfk.fau.de, [b] tremmel@mfk.fau.de, [c] wartzack@mfk.fau.de

* Corresponding author

Abstract

Due to scarce resources coupled with increasing mobility requirements, resource-efficient machine and motor elements are vital. Therefore, surfaces in lubricated tribological contacts can be microtextured, enabling improved lubricating conditions and friction behavior. While this has already been shown for lower loaded contacts, the effects for higher loaded, application-oriented EHL contacts are topic of basic research. Therefore, geometrically defined microtextures are adapted to the tribological system of the tappet/camshaft contact in the valve train of combustion engines as a demonstrator. The tribological performance in respect to lubricating conditions, friction and wear behavior is analyzed on single cam/tappet component test-rigs. EHL simulation is used as 'numerical zoom' into a section of the contact area contributing to better understanding of effects and observed phenomena.

Keywords:

Surface Texture, Friction, Wear, Elastohydrodynamic Lubrication

Introduction

Dwindling resources, rising environmental awareness and stricter statutory requirements combined with rising mobility requirements, growing demands for increasing power density and reliability of technical systems lead to the necessity of more efficient machine elements and engine components. Therefore, tribological contacts with low frictional losses are essential. This can be achieved through further development of materials, lubricants and their additives as well as the optimization of component surfaces ("surface engineering"). Particularly in the area of boundary lubrication or mixed lubrication, where no sufficient lubricating film for completely separating the surfaces can be generated, e. g. in highly dynamic operating conditions or in start/stop operations, surface characteristics have a significant influence on tribological behavior.

Surface modification can be realized by tribological coatings, for example amorphous carbon coatings [1, 2], or by directly influencing the surface topography in a stochastic way through manufacturing processes, e. g. milling, grinding, polishing or honing [3]. Discrete microtextures applied on component surfaces may also contribute to influence the lubricating conditions and thus friction and wear behavior. Therefore, methods like cutting and forming are established. For the former, machining methods such as micro-turning [4] or micro-milling [5] are used. Furthermore, thermal, chemical or electrochemical processes can be used for moving or removing material. By way of example, micro laser beam machining (µLBM) [6], direct laser interference patterning (DLIP) [7], micro electrical discharge machining (µEDM) [8], micro electrochemical machining (µECM) [9] and LIGA (lithography, electroplating and molding) [10] are mentioned at this point. In terms of forming processes, micro-rolling [11] and micro-coining [12] are stated exemplarily.

For lower loaded, hydrodynamic sliding contacts positive effects on friction and wear induced by microtextured surfaces were already shown within numerous numerical [13-21] and experimental studies. Latter range from fundamental model tests [22-24] to specified applications, such as mechanical seals [25, 26], thrust bearings with parallel surfaces or disc-on-disc-tribometers [27, 28], radial plain bearings [29, 30] and piston/ring-contacts or oscillating tribometers (SRV) [31-34]. In some cases, microtextured surfaces have already reached industrial application, see [35]. The benefits of modifying the surface topography result from the interplay of several effects [36, 37]. First, in the area of full-film lubrication, microtextures may