Reducing friction using micro-textured machine elements - An advanced simulation approach for the optimization of textured surfaces in cam-tappet contacts

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In order to achieve the goals set by the European Union in the context of the energy transition, the development of increasingly efficient technical systems has become more and more important in recent years, in addition to renewable power generation. In many cases, improving tribological contacts can help to reduce friction losses and thus increase the overall efficiency of the whole system. In addition to the use of tribological coatings, system friction can also be reduced under certain contact conditions by selective texturing of the contacting bodies. At this point, the choice of the texture geometry and its arrangement is of decisive importance, since unfavorable texture patterns can also lead to an increase in friction in the worst case. As the experimental determination of a suitable texture for different applications is typically associated with a very high effort, numerical approaches for the texture optimization have gained increasing importance in recent years. In most cases, however, the contacts for texture selection are modeled in a simplified way, since a detailed description of the complex physical relationships entails a high computational effort and numerical problems. In previous work, an application-oriented EHL-simulation approach was developed specifically for the cam-tappet contact in the valve train of internal combustion engines to describe the time-dependent contact as realistic as possible. In addition to the influence of the surface roughness and the realistic loading conditions, the edge effects that occur on the sides of the cam are considered. Within the scope of this work the developed simulation approach is expanded to describe the effect of surface textures within the contact and determine an optimal texture pattern for the considered cam-tappet contact. Based on a randomized test plan, important influencing factors are determined to describe the contact conditions for the different texture patterns, such as the minimum lubricant film height or the average solid friction. The texture patterns are then optimized with respect to these target figures. The simulation largely confirms the results of other research work and shows that comparatively wide and flat texture patterns lead to the best friction properties for the selected load case. The work also critically questions the extent to which the considerably increased computational effort of the presented simulation model can be justified by a more detailed description of the contact conditions and also compares the optimum texture patterns depending on the selected simulation model.

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