Micro-contact Parameters and Specific Dissipated Friction Power during Self-mating Reciprocating Sliding Wear Tests of a Martensitic Steel

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1. Introduction

Non-conforming rough contacts are one of the classic examples in tribology. Many machinery elements like gears, bearings rely on such contacts. Today's economic and ecological directives on machinery design claim longer service life with reduced production cost. Following this directives it is necessary to further reduce friction and wear rate with an increased robustness of tribosystems in general. Currently a wide range of processes is used as counter measures to minimize wear by modifying the properties of near-surface material (e.g. case hardening) and/or applying a hard surface layer [1]. The stress distribution underneath the surface of sliding contacts is a parameter being characteristic for each tribosystem. Beside other factors these contribute to the formation of wear particles, which then can either leave the contact spot immediately or interact with the contacting bodies as third body. The mutual influence towards the formation and the stress distribution is difficult to quantify e.g. due to the unknown mechanical properties. Regarding the size of wear particles and, therefore, the origin of the formation, the surface topographies, near surface properties and micro-contact stresses are essential. In order to at least estimate the stresses underneath the contact different micro-contact models are available. As an input either real or arbitrary surfaces can be used. Either way, with that surface height data micro-contact parameters like the micro-contact area, the number of micro-contacts, the contact pressure etc. can be estimated by means of the statistical Greenwood Williamson (GW) model [2, 3] or the version, optimized for numerical calculations, of the elastic half-space concept [4]. Tribologists might use both models as well as many others.
Considering both, the huge amount of influencing factors of wear tests and the complexity of numerical calculations, it is difficult to model every aspect of the wear test and synchronize both. Mostly this can only be done for certain aspects and idealized test cases. In doing so wear tests must then meet certain requirements, regarding the signal processing, sample treatment and analyzing methods to maintain a database allows for reliable calculations. Then numerical results can be compared and validated among each other and reflected on the measured wear quantities. In the following an attempt is presented in which for a start only elastic material behavior is considered regarding the numerical calculations. The superior aim of this project is to compare different manufacturing methods as to the materials relation between the dissipated friction power, the wear behavior and the microstructural alterations. Here wear tests and corresponding numerical analyses are presented in order to gain a first quantitative approximation of how much energy is dissipated per contact area under boundary lubricated ultra-mild sliding wear conditions.

2. Material and Method

A wear test series was performed with standard case hardened martensitic steel with a milled surface topography. Due to the manufacturing parameters like axial feed and cutting velocity, a specific periodical surface topography is achieved, which has a distinct influence on the wear behavior. A superior aim is to compare different manufacturing methods concerning the wear behavior and microstructural alterations. In this study wear tests and corresponding numerical analysis are conducted.

3. Discussion

The presented wear tests with machined and carburized steel brought about no wear. Whether there is no wear loss or whether it is under the current detection limit of 0.0001 g after 2mio cycles (< 20 nm/h) is not clear right now. Nevertheless the contact area is changed by the dissipation of friction power. Although a lubricant is present the milled surface topography is too rough to allow fluid film lubrication. Thus by to high pressure peaks at the summits boundary lubrication can be expected. The changes of the contact area can be assumed of being brought about mechanically by (cyclic) deformation and the use of strictly mechanical analyses of the contact situation by numerical contact models appears legitimated.

4. References

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