THE EFFECT OF HYDROGEN CONCENTRATION ON SURFACE-INITIATED DAMAGE IN ROLLING CONTACTS

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ABSTRACT
Rolling element bearings are known to be susceptible to hydrogen embrittlement, a phenomenon where the mechanical properties of materials are reduced drastically [1]. In rolling element bearings, hydrogen has been found to reduce the rolling contact fatigue life by an order of magnitude [2], [3]. Hydrogen is known to promote the formation of white etching cracks, leading to premature failure caused by sub-surface induced macro pitting [4]. While most studies so far focus on sub-surface-initiated fatigue, the effects on wear, and surface damage at different hydrogen concentrations are commonly overlooked. The present study investigates the influence of hydrogen concentration on surface-initiated damage in rolling contacts.

Self-mated 100Cr6 bearing steel was tested in pure rolling conditions using a micropitting rig and lubricated with a PAO. Surface topography analysis was performed using 3D optical profilometry and SEM before and after tribotesting. Hydrogen was introduced into the samples by electrochemical pre-charging using different charging currents and durations before tribotesting. The hydrogen concentration and trapping behaviour were measured by thermal desorption mass spectrometry.

The average coefficient of friction after running in was found to be similar for samples with and without hydrogen pre-charging (Fig. 1a). This indicates that similar tribological stresses exist between the surfaces with and without hydrogen pre-charging. However, when comparing the surfaces before tribotesting (Fig. 1b) and after tribotesting for the sample without hydrogen charging (Fig. 1c) and with hydrogen charging (Fig. 1d), it becomes evident that the hydrogen pre-charged sample undergoes more severe wear. Similar observations were made using 3D optical profilometry, where larger surface waviness was measured on the hydrogen pre-charged samples, as well as increased surface roughness. In summary, it has been found that hydrogen affects the wear severity in a rolling contact, and not only the fatigue life of the 100Cr6 bearing steel.

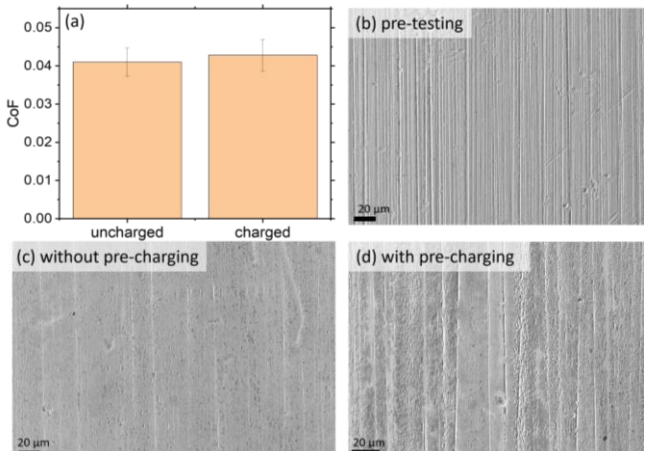

Fig.1 (a) Average CoF after running in for samples with and without hydrogen pre-charging. (b) Sample surface before tribotesting. (c) Sample surface of an uncharged sample after tribotesting. (d) Sample surface of a charged sample after tribotesting.

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