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ANALYSIS OF WEAR MECHANISMS AND MICROSTRUCTURE MODIFICATIONS OF THRUST BALL BEARING UNDER FRETTING CONTACT AND GREASE LUBRICATION

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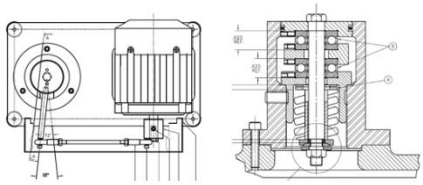
Wear; rolling contact; experiments in tribology, microstructure

ABSTRACT
This work focuses on the microstructural evolution of thrust ball bearing subjected to fretting loads according to ASTM D4170 with grease lubrication. The aim of the works realized on surface and subsurface is to correlate the wear mechanisms and microstructural evolutions of the 100Cr6 rolling steel base material. Multi-scale analysis of fretting wear mechanisms was carried out through morphological and SEM observations. Subsurface plastic behaviors and microstructure modifications were investigated using EBSD technic with mechanical properties evaluation by nanoindentation and residual stress measurements. This study made it possible to define a scenario linking microstructural evolution, mechanical properties, and wear mechanisms.

1. Introduction

The previous study[1] focused on the characterization of the properties of different greases to prevent fretting wear in thrust ball bearings considering the stress conditions but without characterizing the nature and extent of damage on sub-surface. This work proposes a scenario of damage to thrust ball bearings according to the test conditions and the nature of 3 lubricants.

Fig.1 Schematic and position of the thrust ball bearings of the test bench

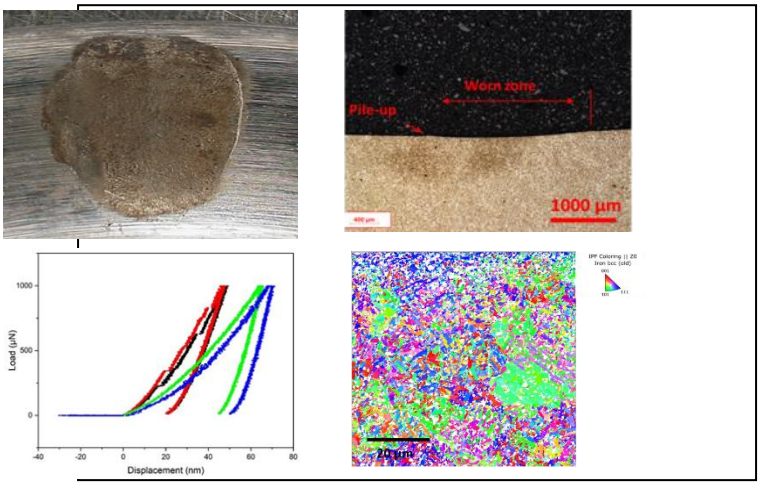


2 Multiscale analysis method

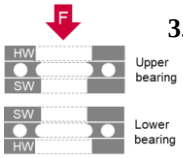
To complete the campaign tests, morphological and SEM observations of fretting facies, sub-layer, and near-surface metallographic analyses and EBSD analyses were made. In addition, nanoindentation and residual stress measurements were made to evaluate mechanical properties.

2. 3 Main results and discussions

In this conditions a significant difference of tribological behavior between the 3 greases was reported. The ASTM D4170 standard uses only weight measurement to quantify the



effect of greases. In this analysis, the tests performed on the fretting bench made it possible to carry out analyses of wear marks by fretting at different scales. Observations with both the microscope and the SEM on the surface show cracks and plastic deformation. Metallographic and EBSD analysis on sectional view show different evolution of the near-surface microstructure in relation to grease type. This microstructure modification in sublayer may be caused by dislocation concentration which result in a significant change of surface crystal orientation in relation with maximal tangential stress. Since the depth of this stress depend on friction coefficient, grease type plays certainly an important role in this damage mechanism. Nanoindentation measurements show significant increases of surfaces hardness in wear scar.



3. Conclusions

Sever wear of bearing ring is related to hardening of a very thin layer, great changes of crystal orientation and microcracks. Main wear mechanism should be removal of strongly plastic deformed, near amorphous material by tangential stress near surface. That is why the "good" grease causes less wear by lower tangential stress in deep depth.

4. References

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