

APPLICATION OF SURFACE ANALYTICAL TECHNIQUES (HRAES, XPS) FOR OPTIMIZING A TRIBOLOGICAL SYSTEM FOR ZERO-WEAR AND LONG LIFE

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1 Introduction

In the field of tribology the surfaces, metallic surfaces as well as surfaces of coatings, are the most important part¹. Most failures originate at the surface, either by wear, fatigue or corrosion². High Resolution Auger Electron Spectroscopy (HRAES) was applied to our tribology studies with the aim to optimize a tribological system for zero wear and long life. Our first task was characterization of wear scars in order to obtain detailed information regarding their chemical composition at fretting wear^{3,4}.

2 Experimental

The subject of HRAES studies was a steel flat sample, AISI 52100 (DIN 100Cr6) bearing steel of chemical composition: Fe, 1.0 wt.% C, 0.55 wt.% Si, 0.35 wt.% Mn and 1.5wt.% Cr. The dry fretting test was performed at 100 μm amplitude, $F_N = 100\text{ N}$, $f = 50\text{ Hz}$ and $t = 60$ minutes. The HRAES apparatus used in this study was a VG-Scientifics Microlab 310-F spectrometer, equipped with a sector spherical analyzer, a field emission electron gun providing a spot of 10 nm at a current of 1nA. This low dimensional spot enables the performance of high resolution Scanning Auger Microscopy (SAM) across the surface. In addition, a secondary electron detector enables Scanning Electron Microscopy (SEM). XPS enables a chemical analysis of conductive materials, semiconductors and insulators.

3 Results

SEM image of the wear scars created in dry fretting after 360 minutes at 100 μm amplitude on a steel plate is shown in Figure 1.

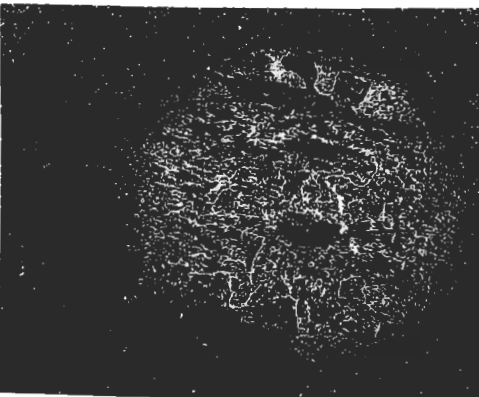


Fig.1: SEM image of wear scars created in dry fretting test, M30, Jeol JSM-35

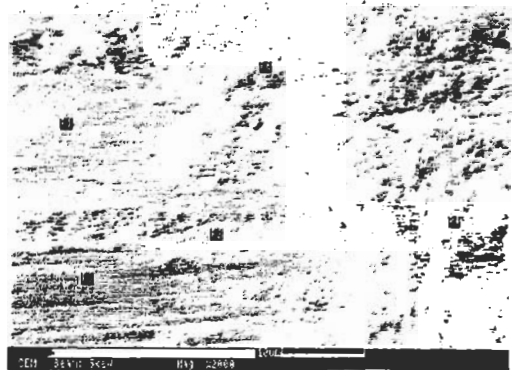


Fig.2: SEM image of an interface of white layer and wear scars, Microlab 310 F

SEM image of an interface of *white layer* and wear scars is shown in figure 2. Auger spectra measured in the points P₁, P₂, P₃, P₄, P₅ and P₆ are shown in figure 3.

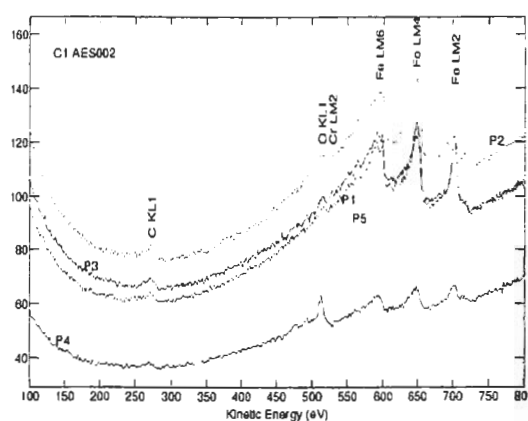


Fig.3: AES spectra measured in points P₁, P₂, P₃, P₄, P₅ and P₆

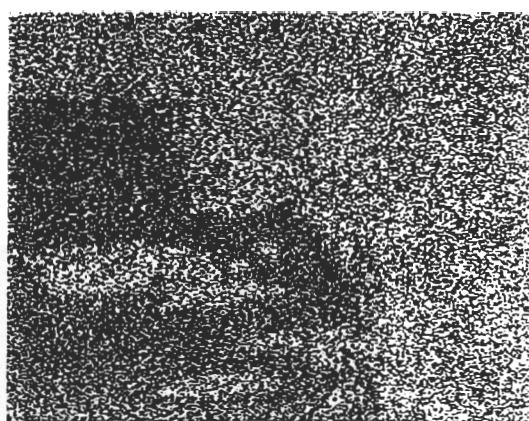


Fig.4: SAM image of oxygen distribution within the interface shown in Fig.2

From these Auger spectra it was estimated that the wear scars are about 1 μm thick porous oxide layer most probably Fe_3O_4 (P₄, P₅ and P₆); AES spectra of white layers taken in P₁ and P₃ show Fe and Cr while AES spectra taken in P₂ shows Cr and O, suppose it is a thin layer of Cr_2O_3 . The distribution of oxygen within the interface is shown in figure 4 where SAM image for O is presented. Note that this image show the interface presented in figure 2.

4 Conclusion

The HRAES results of dry fretting showed that on the areas of so called *white layers* the flat and oscillating samples were during the experiment in close contact and this prevent the oxidation at elevated temperatures. From the thermodynamic data of oxide formation and the thickness of the oxide layer it is possible to estimate the temperature during the fretting test, which is the subject of our next paper.

5 References

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