ADDITIVE - SURFACE INTERACTION IN BOUNDARY LUBRICATION: A COMBINATORIAL APPROACH

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INTRODUCTION
During the interaction of a lubricant additive with the rubbing surfaces of a tribological system in the boundary lubrication regime, a large number of parameters are involved. Apart from the lubricant and the additive chemistry the most important are contact pressure, relative velocity and temperature. Until now it has been very time consuming to produce tribostressed samples for a wide range of conditions and to analyse them by surface analytical techniques as XPS. A combinatorial approach could rationalise this process and greatly reduce the time needed for screening new lubricant additives. In this work some of the problems in the imaging and small area XPS surface analysis of samples containing a whole parameter library are studied.

EXPERIMENTAL
Tribological samples were produced in a ball on disc setup. Diisopropylzincdithiophosphate (ZnDTP) dissolved in decane was used as a lubricant / additive system. A combination of imaging and small Area XPS was used to analyse the sample. In a first step the wear scar was identified with imaging XPS (Figure 1) and small area XPS was applied to get the full spectroscopic information.

Figure 1: Imaging XPS of a tribostressed sample. Small Area XPS is performed in the areas of interest.

STABILITY OF TRIBOFILMS
Imaging XPS of tribological samples (Fig. 1) with the required high resolution may take several hours per element, thus the stability of both the additive and the tribofilms under UHV and X-ray irradiation are important issues. The pure compound (ZnDTP, pressed to pellets) showed changes attributed to degradation phenomena in both the carbon (Fig. 2) and oxygen signals: the FWHM increased and the ratio between the two contributions to the C1s signal decreased.

![Figure 2: Change of FWHM of the C1s signal and corresponding decrease in the ratio showing the X-ray degradation of pure ZnDTP](image)

The tribofilms formed in the tribological tests were found to be stable during the time of analysis (Fig. 3). This allows to perform both imaging and small area XPS where several hours of X-ray irradiation are needed to achieve a reasonable energy resolution and signal to noise ratio.

![Figure 3: O1s region of a tribostressed sample after 0 h and 24 h of X-ray irradiation.](image)

TRIBOLOGICAL LIBRARIES
Tribological libraries were generated with a tribometer capable to freely program load, radius and rotational velocity. Friction coefficient and wear rate were mapped onto the respective tribological parameters. The library was probed with imaging XPS to determine different tribological areas and subsequently analysed with small area XPS. Detailed analysis of tribological libraries produced following the combinatorial approach will be presented.