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Microcharacterization of Tribo Layers on Al–Steel

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In order to improve the efficiency of internal combustion engines, profound understanding of the tribological problems in the piston ring assembly is crucial. Relentless efforts have been made by the tribologists over the past one decade in understanding the tribological interaction in steel on steel counter-face materials in dry and lubrication conditions. These efforts were mostly limited in characterizing tribo-layers through surface characterization techniques [1]. Quite a few have reported about the microsturctural aspects of tribolayer and sub-surface deformed regions in the tribo-contacts [2]. In this research an effort has been made to understand the microstructural and chemical aspects of tribolayer and subsurface deformed regions formed during Pin-on-disc (ball-on-disc) sliding wear test. The experiments were conducted on 6061 Aluminium (ball)-E52100 Steel (disc) tribopairs in dry and in the presence of novel lubricants such as Basil oil and Fully formulated oil. Microstructural changes in the tribopairs were characterized by conventional, analytical, and high-resolution TEM (transmission electron microscopy). TEM cross section specimens were prepared using a FIB (focused ion beam). The specimens were studied with a Zeiss Libra 200EF, a 200 kV instrument equipped with an in-column imaging energy filter of the Omega type. STEM images taken from the Al ball revealed the presence of continuous deformed sublayer in all testing conditions Fig (1). The depth of deformed layer in dry condirtion is much larger than the lubricated conditions. Also STEM studies showed discontinuous tribo-layer formed on Al ball only in fully formulated lubricant condition Fig (1). Further ESI (electron spectroscopic imaging) and EELS (electron energy-loss spectrometry) results showed the presence of Ca and oxygen in tribo-layer region (Figure3 and 4). This results shows that Al has a tendency to react with lubricant and form a stable tribo-layer and this confirms that fully formulated lubricant could be considered as a potential wear modifier for this tribopair.

References:

[1] B. J. Taylor and T.S. Eyre, *Tribology In.* April (1979) 79
[2] C. Chen, *Engineering Tribology*, Dec (2008) 571
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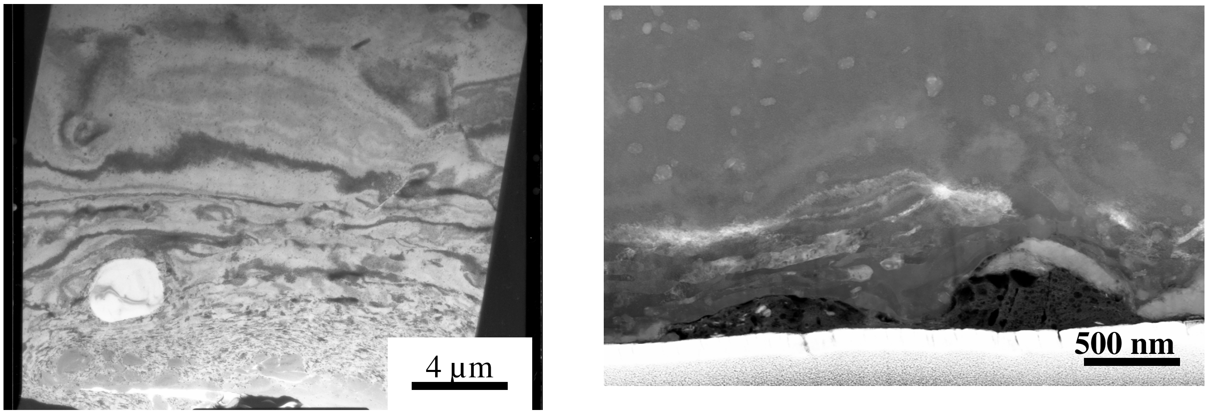

Figure (1): TEM images shows a) Sub-surface deformation in dry condition, b) subsurface deformation along with tribolayer formation in fully formulated lubricant

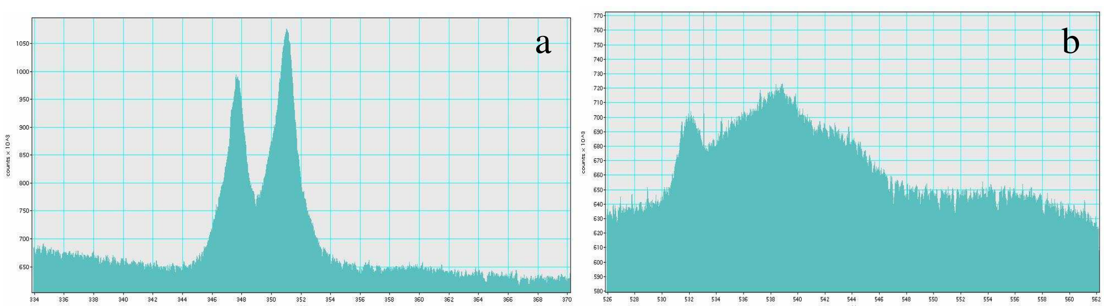

Figure 2: EELS spectrum showing a) Ca and b) Oxygen edges

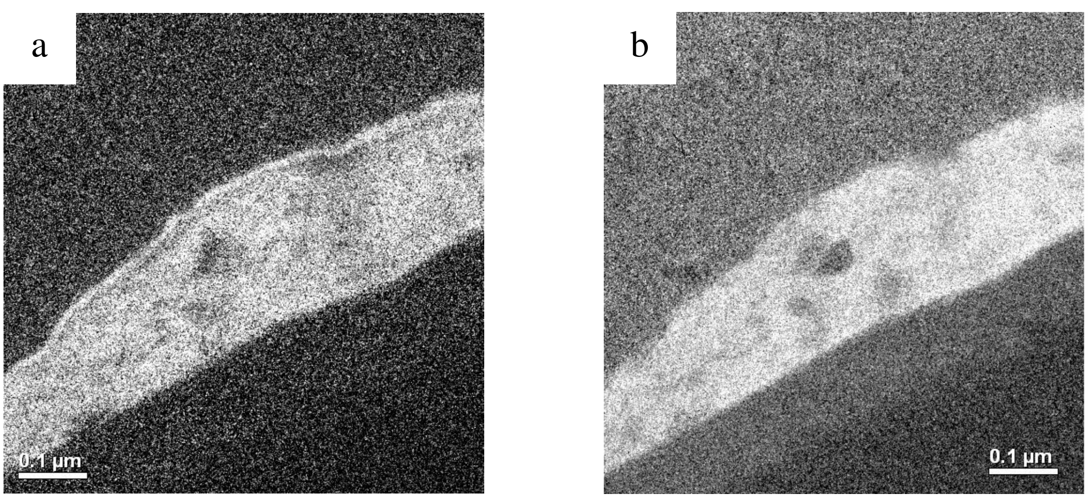

Figure 3: ESI mapping revealed presence of a) Ca and b) Oxygen

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