INFLUENCE OF SMALL ELECTRIC POTENTIALS ON THE PERFORMANCE OF ROLLING-SLIDING LUBRICATED CONTACTS

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KEYWORDS
Mixed Lubrication; Wear; Tribofilms and 3rd bodies, Electric Vehicles (EVs)

ABSTRACT
In engineering applications that employ electric machines, such as EVs and wind turbines, there is a risk that unexpected electric voltages may be present in tribological contacts of rotating components, such as bearings and gears. Discharge of high electric currents is well known to promote specific forms of damage in lubricated rolling-sliding contacts, such as those between bearing rolling elements and rings or between meshing gear teeth. Most previous work in this area has employed relatively thick EHL films and high voltages to study electric discharge damage. However, what is less understood is how relatively small voltages and currents (in the range of mA) affect the tribological performance of contacts operating in mixed regime.

This work explores surface damage and tribofilm formation under such small voltages and the mixed lubrication regime. This is done using bearing steel specimens and a suitably modified ball-on-disc tribometer equipped with the Spacer Layer Imaging Method (SLIM). The setup is modified to apply a controlled DC voltage across the contact in a two-electrode setup as shown in Fig.1. Resistor R1 controls the maximum current in the circuit, and R2 controls the maximum open circuit potential across the contact.

The setup has been used to study the effects of several factors including surface roughness, voltage and current magnitude, polarity, and lubricant composition. The results indicate that even small electric potentials and current (10mA) can promote surface wear under mixed lubrication as shown in Fig.2, but the effect is heavily dependent on voltage polarity. The SLIM observations indicate that the electric potentials affect tribofilm build-up (Fig 3) and this is at least in part responsible for the observed wear behavior. The talk will discuss these and other results in terms of the parallel effects of tribofilm growth, counterface roughness evolution, and local electric discharge on observed surface damage.

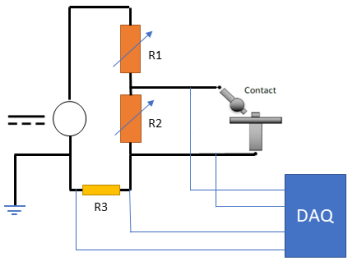

Fig.1 Schematic of the electric circuit used in this study with the ball-on-disc tribometer.

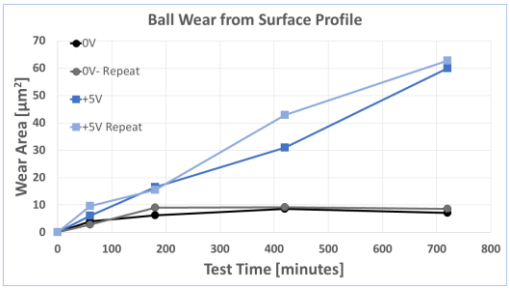

Fig.2 The effect of electric potential on measured wear (1 GPa, 50% SRR, PAO + ZDDP (0.1 wt% P), ʌ 0.6, Ra $_{composite}$ 20 nm)

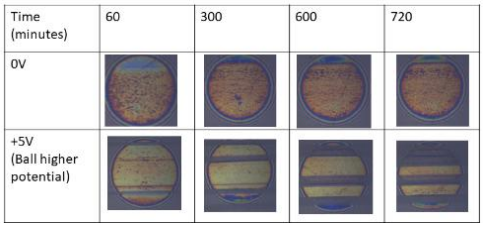

Fig.3 SLIM images of the ball track during the test (1 GPa, 50% SRR, PAO + ZDDP (0.1 wt% P), ʌ 0.6, Ra $_{composite}$ 20 nm)