ABSTRACT

Friction is usually treated as a two-body problem, in which the two counter faces move against each other and a “magical” parameter – the friction coefficient – comes into being. Not so. At some scale, from atomically-thin surface films to microns-thick chunks of wear debris, third bodies play an important role in friction. Third bodies are usually born in the sliding contact and often grow up to be wear debris. They might come about because the tribologist intentionally lubricated one or both counter faces, or they might arise unintentionally, e.g., from reactions with atmospheric gases. Either way, they play an important role in friction and wear, a role often overlooked in studies reported in the literature.

For nearly 20 years, we have demonstrated that third bodies contribute to the effectiveness of many coatings and surface treatments in dry sliding contact [1-9]. Our studies have traditionally used ex situ surface analytical techniques to examine wear scars, allowing us to infer the physical and chemical basis for improved tribological behaviour. Unfortunately, tribological behaviour isn’t a simple “property” of the materials; tribology has no equivalents of “thermodynamic laws” to predict magnitudes of friction and wear or “strength or fracture criteria” to predict failure modes. Classical tribology, however, has traditionally focused on contact area, friction and wear (particle detachment). From these, tribologists are expected to piece together explanations for friction, wear and failure behaviour. While this approach might be possible for a few ideal cases, e.g., abrasion of ideal plastic metals, it cannot be done for practical tribocouples that are designed to last "forever”.

A more realistic approach is based on third body contributions to friction and wear. This approach examines the sequence of processes that take place at a moving interface: surface deformation and particle detachment (via classical modes), third-body formation and circulation (particle morphology and flow within contact zone) and particle ejection (the “traditional” wear particle). Third body studies have generally emphasized the kinematics and mechanics, the “where” and “how” of velocity accommodation. Our ex situ third-body studies have focused on “what” third bodies are produced during sliding in concentrated contacts and “how” they form. We have relied on surface analytical techniques (AES, XPS, Raman, IR, XRD, SEM, TEM, EDX and interferometry/profilometry) to identify composition, structure and thickness of films (1-1000 nm) and particles (0.1-100 microns).

This talk will describe recent studies using a new tribometer that lets us focus directly on the contact itself. This in situ Raman tribometer allows us (1) to watch third bodies form, break up and move in and out of the contact and (2) to chemically analyse the sliding interface using micro-Raman spectroscopy. Three studies will be presented: one on friction and interface chemistry of B2O3+C coatings in moist air; a second on effects of moisture on the transfer film and friction of a Pb-alloyed MoSx coating; and a third on the effects of moisture and contact pressure on transfer film formation and friction stability of a DLC coating.

REFERENCES