Microscopic Mild Wear in the Boundary Lubrication regime

R. Bosman and D.J. Schipper

Phone +31-(0)53-4892476, e-mail R.Bosman@ctw.utwente.nl
University of Twente, Faculty of Engineering Technology,
Laboratory for Surface Technology and Tribology, P.O. Box 217, NL 7500 AE Enschede

Introduction

Many applications run in the boundary lubrication regime e.g: cam-followers, piston liner combinations and transmissions. Wear prediction in this regime is complex due to the multi-physical nature of the problem.

Figure 1: A CVT transmission normally operating in the boundary lubrication regime.

The boundary lubrication regime is characterised as: “A lubricated contact where the load is carried by the asperities rather than by the lubricant”. In this regime there are three types of defence against metal-metal contact, as illustrated in Fig. 2.

- Physical adsorbed layer
- Chemical adsorbed layer
- Chemical reaction layer

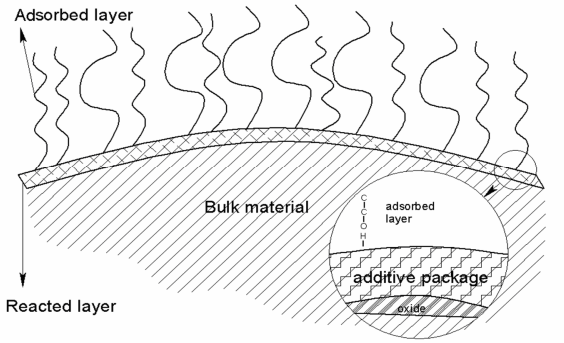

Figure 2: Schematic build-up of surface layer.

The first two layers are assumed to fail thermally and the latter mechanically.

Mild Wear

To protect the metallic surface, constant renewal of the surface layer is needed. As long as the removal and growth are in balance mild wear occurs. The reaction layer is build up from bulk material and additives. Bulk material is needed to rebuild the surface layer and removal of bulk material takes place through a chemical reaction. These layers are very thin: in the range of tens of nm, see Fig. 3, and thus low wear rates occur in the mild wear regime.

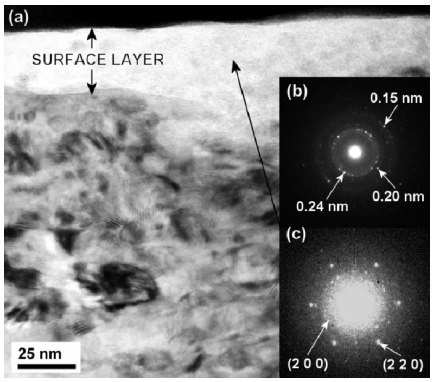

Figure 3: TEM image of the chemical reacted layer on a steel substrate lubricated with ZDDP[1].

Objective

The objective of the project is to predict the effect wear will have on the surface on roughness level (nm). This will be done by combining the different physical and chemical phenomena on the surface in a multi-physics model.

References:

[1] Evans R.D. et al., 2005, Transmission Electron Microscopy of Boundary-Lubricated Bearing Surfaces. Part 2: Mineral Oil Lubricant with Sulphide and Phosphorus Containing Gear Oil Additives, Tribology Transactions volume 48, 299-307.