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1. Introduction

The tribological behaviour of gear teeth contacts in high performance transmissions is viewed as a lubricant-surface system. Physio- chemical and bulk rheological behaviour of the lubricant and mechanical and topographical variations of adjacent surfaces means that the frictional performance of the system as a whole is subject to continual change. Therefore, a detailed experimental methodology is required to accurately measure and characterise lubricant-surface system evolution and determine the frictional characteristics. A multitude of analysis techniques are used. The paper presents analysis of a high performance lubricant-surface system for multi-scale frictional performance, wear and chemical interactions.

High performance transmission systems are subjected to extreme contact pressures, shear rates and generated temperatures. Dry sump lubrication is employed with lubricant scavenging from the sump into galleries and fed through directed oil jets, directed at meshing teeth pairs. Therefore, the lubrication environment comprises oil jet flow in an air-oil mist transmission sump. This approach has led to significant efficiency savings and reduced emissions primarily through reduced windage and pumping losses. However, these system level changes can have an adverse effect on the tribological performance. One problem is lubricant foaming, increased lubricant void fraction and reduced contact inlet viscosity. Collapse of a coherent lubricant film can occur, putting a greater demand upon the lubricant surface active additives [1]. It is crucial to understand the fundamental parameters in lubricant-surface system for an optimal application-oriented bespoke solution. The teeth pair contacts in high performance transmissions are subject to mixed Elastohydrodynamic regime of Lubrication (EHL), with non-Newtonian lubricant shear at high contact loads and sliding velocities [2]. Using benchtop tribometry and chemical analysis have proved to be effective methods for characterising component-level frictional performance [3].

2. Methodology

Representative pin-on-disc tribometry is used to characterise the micro-scale frictional performance of the system and activate lubricant additives to form a tribo-film. The surfaces are then characterised using an atomic force microscope (AFM) in lateral force mode (LFM) and x-ray photoelectron spectroscopy (XPS) as well as optical interferometry to investigate the evolving changes to contacting surfaces. At a single asperity level the pressure coefficient of boundary shear strength of the formed tribo-film is characterised using AFM in LFM. Chemical analysis is performed for evaluation of chemisorbed tribo-films using XPS. Comparison of the wear scars on the contacting surfaces before and after the formation and retention of a tribo-film is performed to determine changes asperity level mechanical surface properties.

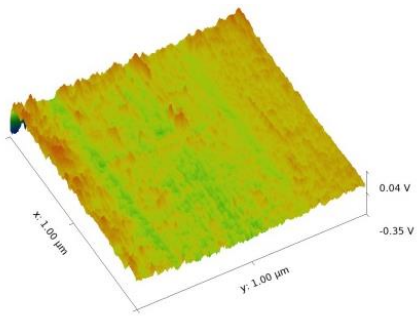

Figure 1 - Lateral force microscopy image from within wear scar of the surface.

Use of an analytical contact mechanics model for asperity interactions provides improved understanding of the complex lubricant-surface system interactions. In particular, the aim is to enhance understanding of the relations between contact conditions, tribo-film formation, retention and wear. Good correlation between literature, theory and experimental results are observed.

3. Reference

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