Tribological performance of surface-lubricant systems for automotive transmissions [Abstract]

Tribological performance of surface-lubricant systems for automotive transmissions

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1. Introduction

There is an increasing demand on the conjunctions of automotive transmission systems to transfer the power from the power unit in a more efficient manor, while reducing weight and wear [1-2]. Furthermore, other developments within the drivetrain to improve vehicle efficiency such as powertrain downsizing must be balanced against retaining the output required by the consumer. Thin hard coating materials, such as Diamond-Like-Carbon (DLC), is used to achieve the required performance. However, the application of a coating on the contacting interfaces has a significant effect on the surface-lubricant system.

The contact conditions at the conjunction of the meshing spur gears within transmissions are subjected to high contact pressure, shear rates, sliding velocities and elevated bulk lubricant and material temperatures resulting in a mixed elastrohydrodynamic regime of lubrication. This regime results in the contacting load being carried by a combination of the interacting asperities and lubricants hydrodynamic response together. The harsh conditions created at the conjunction of the conjoining gear teeth faces can be sustained due to the activation of lubricant additive packages, which are employed to protect the surfaces against unwanted phenomena, such a wear or increased friction. Lubricant additives within the lubricant perform a number of roles. Common lubricant additives added within fully formulated transmission oils can be categorised into friction modifiers, anti-wear, extreme pressure additives as well as antifoaming agents, corrosion inhibitors, dispersants and detergents. These lubricant additives improve the performance by forming a tribo-film at the surface. This tribo-film can reduce friction and wear within the contact extending component life and improving efficiency. This interaction of the lubricant and the surface is defined by the surface-lubricant combination and a change to either can have a significant effect on the tribological performance of the contact. The physio-chemical and bulk rheological behaviour of the lubricant, mechanical and topographical variations in the surfaces results in a system subject to continual change. This research investigates the nanoscale surface topography of DLC in comparison to steel under both dry and lubricated conditions.

2. Methodology

Surface-lubricant systems designed for the harsh contact conditions at the transmission gear interface are investigated through the use of representative tribometry to activate the tribofilm of the fully formulated lubricant. AFM lateral force microscopy is used to characterise nanoscale boundary friction of the surface-lubricant system. A DLC coating is compared to a ground and super finished steel surface topography.

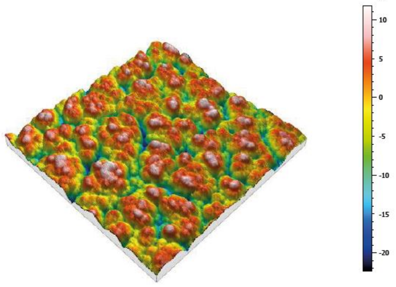

Figure 1: Surface topography of DLC coating using AFM

3. Conclusion

The nanoscale boundary friction coefficient of DLC coatings are investigated through the use of representative tribometry and AFM lateral force microscopy. The coefficient of interfacial boundary shear strength is compared to ground and highly finished steel surfaces under dry and lubricated conditions. A significant difference is observed in the coefficient of boundary shear strength of the two compared surface topographies.

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