Extracting More Value from Tribofilm Image Analysis

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INTRODUCTION

A main function of an engine oil or lubricant is to form protective films (also called tribofilms) that reduce friction and wear of moving parts. It also cools the engine by transferring the heat to other parts. Tribofilms are formed through the chemical bonding of additives in the oil with the metal engine surfaces. Stronger and thicker tribofilms are likely to give better wear protection by preventing metal-to-metal contact. Analysis of tribofilm thickness is therefore crucial to the development of engine oil formulations that exhibit enhanced wear protection because engine oil formulations are becoming thinner (lower viscosity) to provide increased fuel economy. The wear protection of a lubricant can be investigated at the vehicle level, in an engine test, or in a laboratory bench test using a tribometer. Tribometers offer custom, timely, cost-effective and rapid screening options to investigate and compare lubricants for wear protection. The mini-traction machine 3D spacer layer imaging (MTM 3D-SLIM) instrument manufactured by PCS Instruments is one such tribometer that is used for wear investigation. The test involves rubbing two surfaces together in the presence of a lubricant and then analysing the tribofilm image. The tribology-based test methods available to the lubricants community generate many wear images that need further analysis to determine tribofilm thickness. These traditional methods of tribofilm thickness analysis have limitations due to the sampling locations, the inability to extract the tribofilm region automatically and the lack of a quantitative metric to characterize tribofilm uniformity. This presentation features the development of a toolkit to derive more value out of tribofilm images from MTM SLIM experiments by automated extraction of the tribofilm region to generate thickness distribution, identification of salient image features such as tribofilm uniformity, minimum thickness, dominant tribofilm thickness, and arithmetric tribofilm operations for lubricant differentiation. Extracting more value out of tribofilm images is crucial to optimizing lubricant formulations and hardware development for surface protection. The details provided by the developed toolkit in this work will enable screening of lubricant chemistries with enhanced tribofilm attributes and surface protection in internal combustion engines and other applications that share similar additive chemistry.

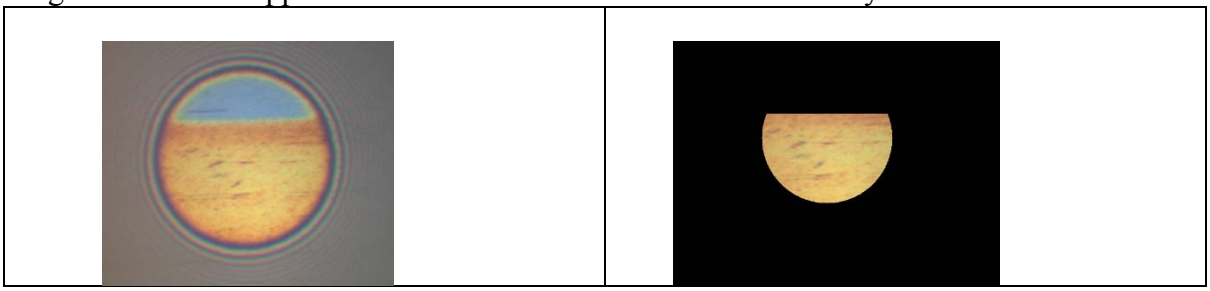

FIGURE (a) Image obtained from an MTM 3D-SLIM experiment. (b) The tribofilm region of interest.

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