MTM2 3D SLIM Option

Principle

The 3D spacer layer imaging (3D-SLIM) option uses optical interferometry to measure sub-micron additive films on the specimens as they form during the test. To make the measurement the steel test ball is loaded against a glass disc coated with a chromium and silica layer. The contact is illuminated by a white light source directed down a microscope and through the glass disc.

Part of the light is reflected from the chrome layer on the disc and part travels through the silica layer and any additive film and is reflected back from the steel ball. The recombining light paths form an interference image which is focused onto the imager of a high resolution RGB camera. The camera image is captured by a digital frame grabber and can be analysed by the control software to determine a film thickness map of the contact.

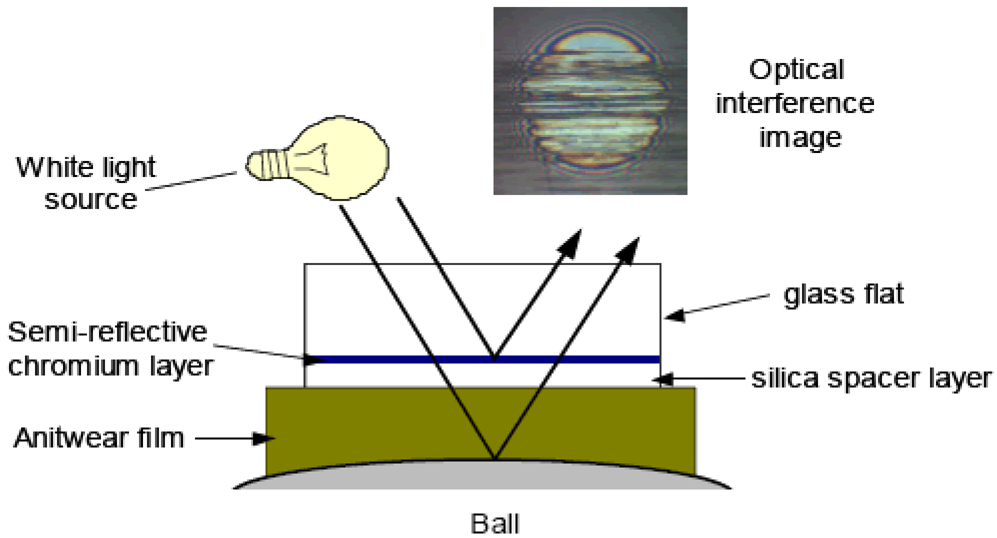

Figure 1:Optical interference technique used on the MTM2

To perform the test the steel ball is loaded against the steel disc and run under mixed sliding/rolling conditions for a fixed duration. Periodically throughout the test, the ball is stopped, loaded in reverse against the glass disc and a film thickness map of the complete contact area is taken. This allows film thickness measurements to be taken of any reaction films as they form. When used in tandem with the friction measurement, this provides a full, real time picture of both the chemical and physical effects of the films formed in the contact.

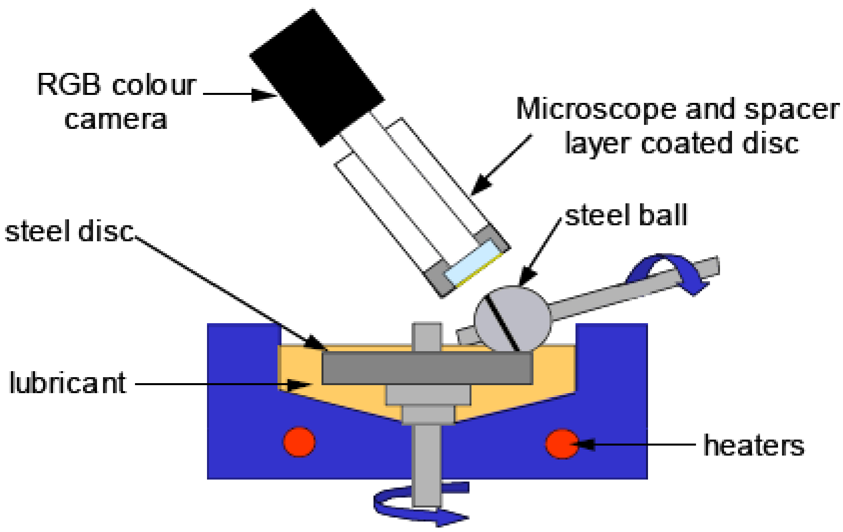

Figure 2: Step 1 – The test ball is run against a steel disc for a pre–defined time

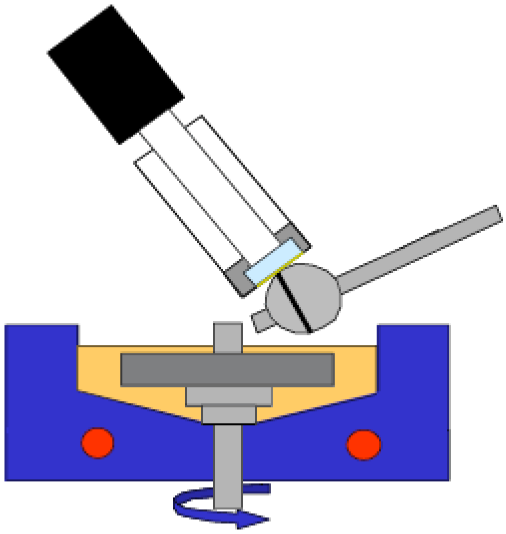

Figure 3: Step 2 – After a pre–defined time, the test Ball is reverse loaded against a coated glass disc and an image is taken The ball is then lowered and the test continues.

Analysis

Once the test is completed the images are analysed using a stand alone analysis program. This can be done on the PC connected to the MTM2 or the images can be moved to another PC. The analysis program matches colours in the image to the calibration data supplied with the instrument to determine the film thickness at every point in the image up to a maximum film thickness of about 250nm. This allows the user to generate a complete film thickness map of the contact area or point and line measurements of a specific area of interest. The analysis program writes out the film thickness data as a text file which can be loaded into the supplied visualisation package or into a spreadsheet or other viewing software.

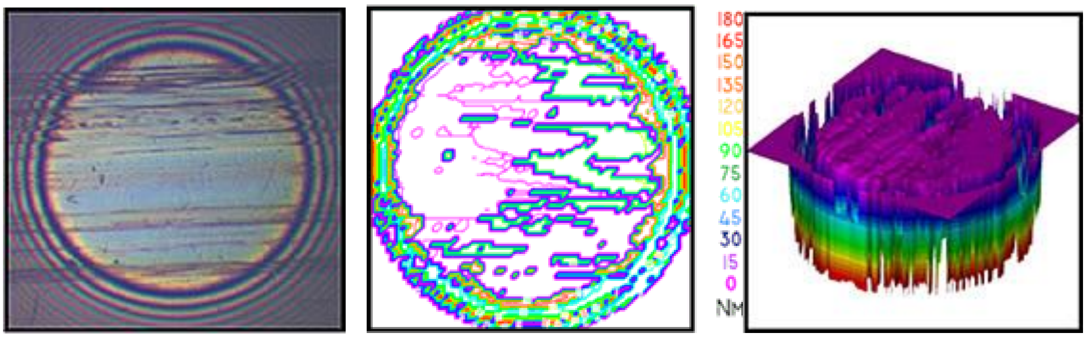

Figure 4:Image taken during test, 2D Contour Map, 3D Surface Map

Applications

Two recent trends in engine oil formulation are a progressive reduction in phosphorus concentration and an increase in dispersant concentration. Both of these trends make it more difficult to generate and retain effective antiwear films on lubricated surfaces.

The MTM2 has been shown as a suitable test method for monitoring antiwear film thickness during rolling/sliding and to explore how various factors, including operating temperature, antiwear additive type and concentration, and the presence of dispersant, influence both the formation and removal of the tribofilms formed by the antiwear additive zinc dialkyldithiophosphate (ZDDP).

1 'The study of zinc dialkyldithiophosphate anti-wear film formation and removal process. Part I: Experimental', Fujita, H., Glovnea R.P. and Spikes, H.A., Tribology Transactions Volume 48, pp 558-566, (2005)

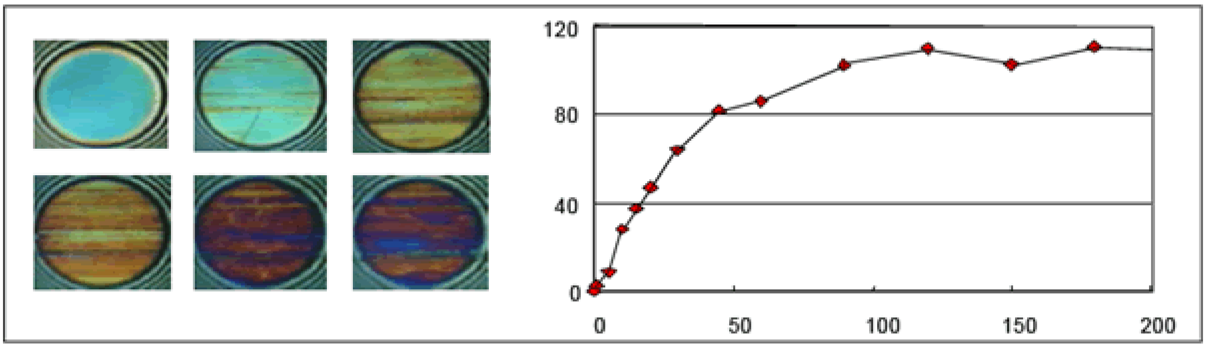

Figure 5: Images (from top left to right) from 0, 5, 20, 30, 90 and 120 minutes running of a fully formulated oil with ZDDP and resulting graph showing ZDDP reaction film thickness (in nm) against time