THE EFFECT OF MOLECULAR STRUCTURE ON FLOW IN AN ELASTOHYDRODYNAMIC CONTACT

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ABSTRACT
In non-conformal engineering contacts under high-pressure and high-shear, the rheological response of a thin film of lubricant may reveal non-Newtonian characteristics. Assumptions of a linear velocity profile and spatial homogeneity may be invalid [1]. An inaccurate description of the flow limits our understanding of lubricant behaviour, affecting our ability to theorize novel ways of controlling friction. The rheological behaviour will be dependent on the chemical makeup of the lubricant itself. It is therefore critical to gain an understanding of the rheology at a molecular level, considering the chemical structure of the lubricant.

In previous research, local through-thickness velocity profiles have been determined using molecular phosphorescence imaging velocimetry (mPIV) [2]. The technique exposes a lubricant doped with phosphorescence dye to a short laser pulse creating a tagged phosphorescence column. The spatiotemporal evolution of the phosphorescence emission is then captured using an intensified charge-coupled device. The experimental intensity distribution is simulated against an iterative numerical reconstructive scheme to determine the flow profile. The technique can predict shear localisation in elastohydrodynamic contacts to identify non-Newtonian phenomena such as shear banding. In the past, testing has been limited to high shear rates at slide to roll ratios above 50%. Therefore the resolution of the technique has been modified to test a broader range of conditions and limit any effect of shear heating on rheological measurements.

In this work rheological measurements of traction fluids under confinement are presented using mPIV. Comparisons will be made between different chemical structures of base stocks and their subsequent rheological response in high-shear environments.The effect of pressure on through-thickness velocity profiles will be investigated. Finally the frictional response is analysed as an overall goal to improve efficiency of mechanical systems.

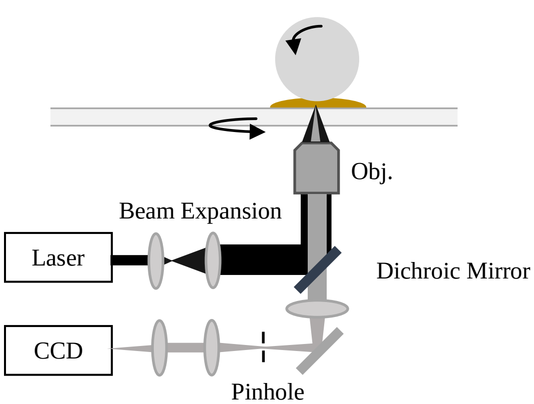

Figure 1- Schematic of mPIV technique

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