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THE EFFECT OF ADDITIVE CHEMICAL STRUCTURE ON THE TRIBOFILMS DERIVED FROM VARYING MOLYBDNEUM-SULFUR CHEMISTRIES

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1. INTRODUCTION

Inorganic friction modifiers are critical components in lubricant formulations. These additives reduce friction in the boundary regime where extensive surface asperity contact occurs. Lubricant-soluble friction modifiers are able to deposit on contact surfaces *in-situ* to provide localized low-friction performance where it is needed [1].

The most commonly employed friction-reducing species employed in automotive applications is molybdenum disulfide (MoS_2), which is formed from the decomposition of the ubiquitous additive; molybdenum dialkyldithiocarbamate (MoDTC). The mechanism of MoDTC activation and characterization of the resulting tribofilm have been the subject of extensive study. However, MoS_2 can be formed from a much wider range of molybdenum-sulfur chemistries and can be formed both as the result of molybdenum-sulfur cluster decomposition and by multi-molecular reactions [2]. In this work, a structure-activity relationship approach has been taken to understand the nature of the tribofilms formed from three different types of molybdenum-sulfur inorganic friction modifiers, MoDTC, a molybdenum trimer and an organic molybdate species.

2. EXPERIMENTAL

The three additives (MoDTC, molybdenum trimer and organic molybdate) were subjected to tribological testing in reciprocating contact to compare their friction performance in both model oils and fully formulated systems. Friction testing was performed on a Cameron Plint TE77 pin-on-plate tribometer using AISI 52100 bearing steel pins and plates. A range of tribological conditions and lambda ratios were tested. Base oil tests were used as a control. The resulting tribofilms were then chemically characterized with Raman spectroscopy and transmission electron microscopy (TEM) [3]. Mechanical properties and relative durabilities of the films were determined using Atomic Force Microscopy (AFM) in Lateral Force Microscopy (LFM) contact mode by rubbing the resulting MoS_2 tribofilms until a rise in localized friction was observed.

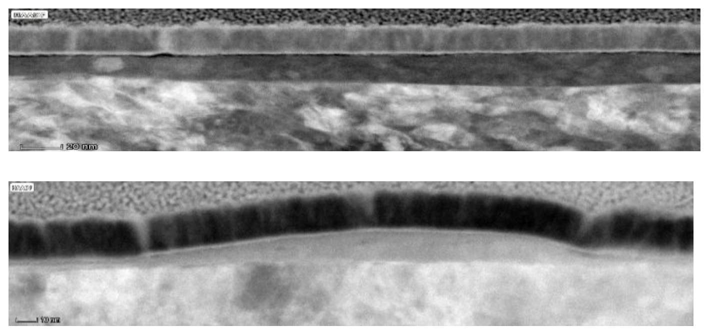

Fig.1 Transmission Electron Micrographs of molybdenum trimer (top) and MoDTC dimer (bottom) tribofilms

3. RESULTS AND DISCUSSION

The dimer and trimer Mo-base oil monoblends showed comparable friction performance despite the trimeric additive forming a thicker MoS_2 layer than the dimer, and there being a lower concentration of molybdenum in the dimeric monoblend. This suggests that the friction performance is not determined by the tribofilm thickness, or the amount of molybdenum available in the blend, but by the crystallinity, purity and orientation of the MoS_2 film formed.

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