Formation of MoS_2 flakes from molybdenum dithiocarbamate-based molecules in a severe lubricated contact: toward a better understanding

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1. Introduction

Nowadays, there is a strong need to reduce gas consumption of passenger cars as well as emissions. The reduction of friction losses in internal combustion engines is a way to achieve this. Moreover, Holmberg. *et al.* [1] have estimated global friction losses in cars to be about 33% with 11.5% for the engine. A way for reducing such losses in severe contacts is to use a fully formulated lubricant containing friction modifier additives such as Molybdenum dialkyl Dithiocarbamate (MoDTC). A tribochemical reaction of MoDTC molecule in steel/steel contact is known to occur under boundary lubrication conditions and allows the generation of MoS_2 flakes responsible for friction reduction. An important research work has been previously devoted to the study of MoDTC friction reduction capabilities [2-3].

Figure 1: MoDTC molecule – x could be either O and S. R are alkyl groups

But the tribo-chemical pathway from the MoDTC molecule to the generation of MoS_2 flakes instead of MoO_xS_y needs to be further investigated. The aim of this study is so to provide a better understanding of the MoS_2 generation mechanism from the MoDTC molecule in steel/steel contact.

In order to study the decomposition of this additive within steel/steel contact, different MoDTC-based molecules have been synthetized controlling O/S ratio (X atoms on figure 1 could be either O or S), oxidation state of molybdenum as well as alkyl chain types (R groups). Conducting investigations with such well-controlled synthetic molecules is very important as it is not the case in classical studies found in the literature where ill-defined commercial MoDTCs are commonly used.

2. Materials and methods:

Tribotests are conducted using steel ball and flat samples (AISI52100). Base oil (PAO4) blended or not with two different MoDTC-based molecules are used as lubricants. Tribotests are performed on a reciprocating tribometer with a ball-on-flat configuration (boundary lubrication). The influence of various contact parameters such as temperature (20°C and 100°C) and Hertzian max pressure (0.64 GPa to 1.4 GPa) is studied. Optical microscopy is used to estimate the wear on both ball and flat samples. Raman and XPS spectroscopies are carried out to characterize the physico-chemical compositions of generated tribofilms.

3. Results and discussion:

All results are discussed for a better understanding of tribochemical decomposition of MoDTC based molecule in steel/steel contacts working under boundary lubrication conditions.

4. References:

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[3] Khaemba, D.N., Neville, A., Morina, A., New insights on the decomposition mechanism of Molybdenum DialkyldiThioCarbamate (MoDTC): A Raman spectroscopic study, RSC Advances, 6 (45), pp. 38637-38646, 2016.

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