Application of high-throughput screening approach for accelerated lubricant formulation with improved tribochemical performance.

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The search for new formulated products that exhibit improved performance on characteristics of interest is traditionally conducted via trial and error studies and guided by expert knowledge. In the context of a growing demand to develop high-efficiency multi-functional products, and to explore an increasing number of combinations of raw materials, we developed a high throughput screening tribology method allowing automated blending and testing of an extensive number of samples. Applied to friction reduction, benefits in terms of synergy discovery, lubricant formulation fine tuning and performance robustness have been obtained.

Keywords: tribology, lubricant formulation, high-throughput experiments

1. Introduction

In response to environmental challenges, a wide variety of new technologies are developed by car manufacturers, ranging from mild hybrid, to full electric vehicles, thereby giving rise to new requirements for lubricants. The resulting tribological domain that must be covered, combined with an increased variability of raw materials leads to an intractable formulation problem with traditional experimental methods. In order to address such complex formulation optimization, high throughput testing have been applied in many industrial fields such as healthcare, [1], paints and inks [2] or new alloys discovery [3]. We propose in this study to adopt a similar approach to study synergistic additive-additive interactions for improved friction reduction and wear protection. This presentation will demonstrate some capabilities of coupling automated blending, tribotests and end-of-test analysis in a single workflow and the impact of large dataset analysis on the understanding of some tribochemical processes.

2. Methods

The automated formulation and testing platform (Accelerated Tribology "AcT") used for this study includes a dosing system and a robotized ball-on-three-pins tribometer. The test method has been developed to focus on the friction drop kinetic due to molybdenum based friction modifier activation (fig 1). Post-test characterization of the surfaces are carried out in batch mode with Raman spectroscopy and interferometric measurements. In addition to advanced machine learning based methods, results are reviewed with a data vizualisation software

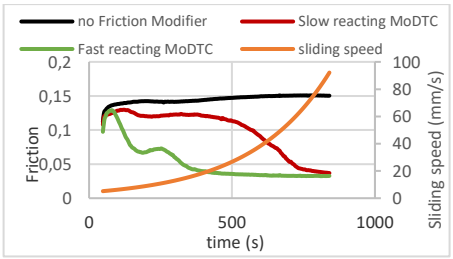

Figure 1. Friction curves on a ball on three pins tribometer at 80°C for three 0W-8 lubricants.

3. Discussion

Activation of Mo based friction modifiers is a complex tribochemical process leading the formation of low friction MoS_2 tribofilms at asperity contacts [4,5]. Tribofilm growth and surface coverage is leading to low friction at the macro scale [7] and seems to be highly dependent on the formulation and reaction kinetic. Processing on the AcT plateform of more than 400 tests with a large variety of compositions allows identification of formulations with robust and ultrafast kinetics as well as some with anti-synergic performance. Some results will be discussed and related to real life performance or tribochemical mechanisms.

4. References

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