# Real time $MoS_2$ formation and friction performance

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## 1. Introduction

The development of modern engines and transmission technologies has been highly credited towards the innovation of lubricant additives chemistry and lubricant formulation. Engine oil lubricants, along with the mixtures of various additives extends the life of the moving parts operating under different conditions, while enhancing vehicle operational characteristics. However, an increasing demand for improved fuel efficiency and more reliable automotive engines has seen a number of approaches made to further improve the tribological performance in automotive engine parts. Lubricant additives are also known to have a detrimental effect towards the environmental concern and hence, recent legislation demands the development of environmentally friendly lubricant additives in order to meet the very strict emission requirements. Lubricant additives operating in the boundary lubrication regime are exposed to severe working conditions, such as low speeds and high Hertzian pressures, where the asperities of the sliding surfaces come in contact with each other. Hence, the wear and friction are determined by the properties of the surface materials and the lubricant films formed at their common interfaces.

Generally, *ex-situ* techniques and analysis are currently applied for the understanding of the surface technique analysis. Although this method provides useful information, they tend to neglect the development of many possible tribochemical reactions occurring at any point during the experiment. Hence, direct observation of the moving contact or *In-situ* approaches offer the potential to greatly enhance our understanding on the evolution of tribofilms between contacting interfaces. The importance of *in-situ* applications has been recently highlighted by Sawyer & Wahl [1], and a focus on the need for in-situ studies of the tribochemical process has been emphasized. Therefore a combination of ex-situ and in-situ studies provides a thorough insight towards a better understanding of the many possible tribochemical reactions.

## 2. Methodology

A convenient Pin on Disc bench tribometer has been designed and built for the purpose of undertaking *in-situ* measurement, along with other parameters such as friction and wear. A basic configuration of the contact between the samples has been highlighted on *Figure 1*, where the focus of the Raman lasers are focused on the wear track of the sample discs during i*n-situ* measurements. Lubricant additives of

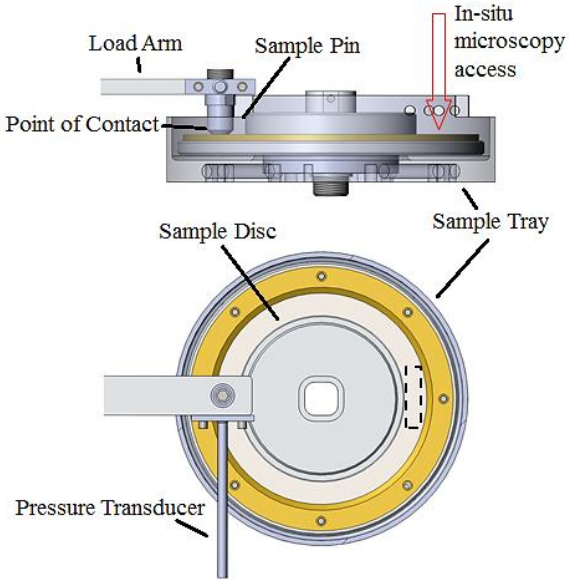


*Figure 1: Lateral and Upper view of the sample contact configuration with the microscope access*

MoDTC has been characterized under various conditions of load, speed, time and temperature for steel on steel contact. Experiments were conducted for various lubricant additives, and analyzed in-situ and ex-situ, utilizing the surface technique of Raman spectroscopy to properly characterize the tribofilm formed.

## 3. Summary

Raman microscopy is a well-known surface analysis technique for determining the molecular structures of a material surface. The application of the Raman technique provides a great insight towards the *ex-situ* understanding of the '*intact*' tribofilm, and also fulfilling the challenges set for its application towards understanding *in-situ* tribochemical reactions. This paper will discuss the kinetics of the tribofilm formation for well-known lubricant additives and MoDTC with friction, and also understand the effect of *ex-situ* and *in-situ* analysis.

## 4. References

[1] Sawyer, W.G., Wahl, K.J., "Accessing Inaccessible Interfaces: In Situ Approaches to Materials Tribology", MRS Bulletin, Vol. 33, Issue. 12, 2008.