THE FORMATION AND WEAR RESISTANCE OF TRIBOFILMS DERIVED FROM ANTI-WEAR ADDITIVES USING IN-SITU AFM OBSERVATION

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ABSTRACT

Reduction of friction and wear by lubrication is necessary to improve the efficiency and prolong the lifespan of industrial machinery. In order to improve the tribological performance of industrial machineries, lubricant oils are optimized by mixing many kinds of additives. Lubricant additives have an important role to improve the performance of industrial machineries. In the boundary and mixed lubrication regimes, many kinds of chemical reactions occur, so it is important to understand the lubrication mechanism and turn into the appropriate lubricants design by using some useful evaluation technologies.

The in-situ AFM methods is considered to be one of the most useful techniques for understanding the forming process of the tribofilms in lubricants. Gosvami et al. studied the formation process of ZDDP-derived tribofilms in lubricating oil using AFM [1, 2]. Furthermore, AFM can be used to investigate the mechanical characteristics of tribo-surface, such as the hardness. The nano-scratch method of AFM is known as an evaluation technique for this purpose [3].

However, while numerous studies on additives have been conducted, the formation process of tribofilms has not been elucidated especially in the case of additive-combined oil. Additive-combined oil may occasionally exhibit unexpected lubrication effects. Such unexpected lubrication effects can significantly impact the performance and lifespan of products in industrial machinery. The chemical interaction between lubricant additives causes wear; however, the mechanism is not completely understood in detail. Therefore, the lubrication effects of additive-combined oil should be understood to develop appropriate lubricants for different applications.

In this study, we investigated the growth process and wear resistance of the tribofilms in lubricants with additive oils containing anti-wear additives, friction modifiers, rust inhibitors using in-situ AFM. Nano-scratch test was conducted using AFM to clarify the wear resistance of the tribofilms derived from additives. Based on the results, we compared the differences in the formation process and wear resistance of the tribofilms depending on the combination of additives. These results indicated that the usefulness of nano-scale scratch test using in-situ AFM for revealing the mechanical properties of tribofilms, thus indicating their potential as a laboratory evaluation technique.

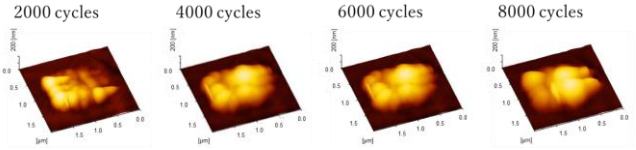

Fig.1 In-situ AFM observation of tribofilm formation

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