Molecular-Scale Structure and Friction Properties of Organic Modifiers over the Metal-Lubricating oil Interface

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Friction modifiers are used to reduce friction and wear. Especially, in boundary lubrication where relatively moving solids are in partial contact with each other, the monolayer formed by the modifier on the solid surface plays an important role in reducing friction. In order to achieve further reduction of friction in the future, it is necessary to clarify the structure of the adsorbed molecular layer which is optimum for reducing friction. In recent years, development of high-performance organic modifiers has been actively advanced. Long et al. reported that ascorbic acid palmitate (AP), a vitamin C derivative, is effective in suppressing friction and wear. In this study, in order to clarify the structure of the adsorbed molecular layer of AP, we obtained the friction properties and cross-sectional imaging with molecular resolution using AFM. Hexadecane was used as the base oil, and oil-soluble lauryl alcohol (LAlc) was mixed with hexadecane to improve the solubility of AP. AP was used as the organic modifier. Iron film sputtered on silicon wafers was used as the model metal surface. The friction properties for three kinds of lubricants, hexadecane, hexadecane + LAlc, and hexadecane + LAlc + AP were evaluated using a colloid probe AFM (Shimadzu, SPM-9700HT) (Fig. 1 (a)). Subsequently, cross-sectional imaging of the lubricating oils was conducted using a frequency-modulation AFM (Shimadzu, SPM-8100FM) (Fig. 1 (b)). The friction coefficient was slightly decreased by adding LAlc to hexadecane, and was significantly lower by adding LAlc + AP. In the case of adding LAlc + AP, the adsorption layer that was not observed with hexadecane alone was confirmed by AFM imaging.

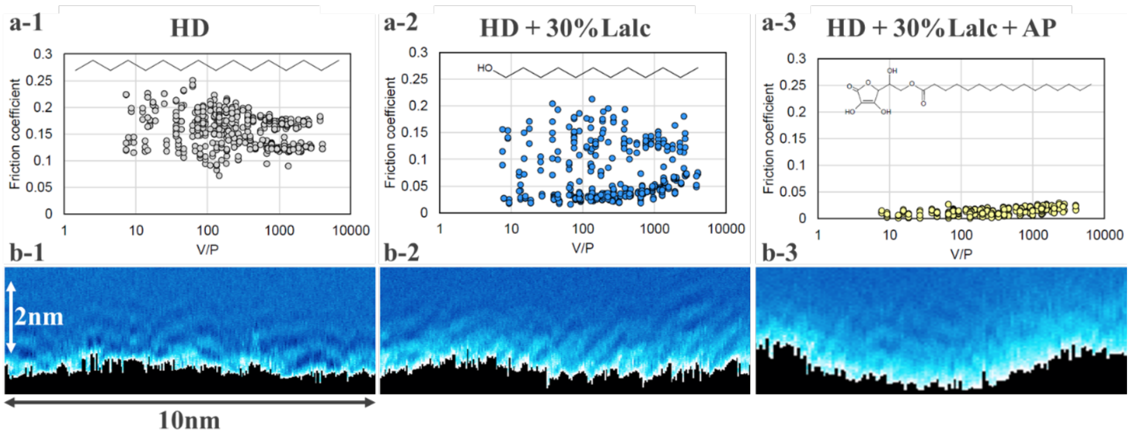

Figure 1. Friction coefficient (a) and cross-sectional images (b) of hexadecane (1), hexadecane + LAlc (2), and hexadecane + LAlc + AP (3).

Reference

[1] Y. Long, et al., Lubricants, **10**, 253 (2022).