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PROPOSAL OF DEVELOPMENT GUIDLINE FOR LOW FRICTIONAL MATERIAL IN OIL LUBRICATION WITH HIGH PERMITTIVITY MATERIAL

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ABSTRACT

In the tribological field of engineering, low friction materials have been developed to increase power efficiency. Especially, oil lubrication is very important because oil lubricant technique is widely used in wide spread engineering fields.

Recently, because of advance of optical and electrical measuring technology on oil lubricants and materials in material properties, importance of permittivity on friction in oil lubrication is started to be indicated. In this study, we prepared different DLC films, whose permittivity is from 3.5 to 4.8 F/m, and compared friction coefficient. As results, friction coefficient decreases from 0.10 to 0.08 as permittivity increase from 3.5 to 4.8 F/m. In addition, we compared friction coefficient of two different materials which have different permittivity. As permittivity increases from 4 to 100 F/m, friction coefficient decreases from 0.13 to 0.05.

Keywords: permittivity, friction, oil lubrication.

INTRODUCTION

In the tribological field of engineering, low friction materials have been developed to increase power efficiency. Especially, oil lubrication is very important because oil lubricant technique is widely used in wide spread engineering fields. It is well known that lubrication conditions are divided into three mode, boundary lubrication, mixed lubrication and hydrodynamic lubrication. In the view point of reducing friction in boundary lubrication, using high viscos oil can be one solution. However, engineers tend to use low viscos oil for reducing friction loss in hydrodynamic lubrication. On the basis of this background new method to reduce friction in boundary condition without oil property control is required.

Some researches show that Diamon-like Carbon (DLC) film consisting of nitrogen, called CNx, has high oiliness. Moreover, importance of permittivity on friction in oil lubrication is started to be indicated because of advance of optical and electrical measuring techniques (Nishimura *et al*., 2016) on oil lubricants and solid films in material properties (Nishimura *et al*., 2017). On the other hand, the quantitative comparison between permittivity and friction properties has not been conducted.

In this study, we prepared some different materials which have different permittivity. And then, frictional properties depending on permittivity are shown.

EXPERIMENTAL METHOD

In this study, we prepared two different DLC films, which consisted of hydrogen and nitrogen. Permittivity of the films were 3.5 and 4.8 F/m, respectively, which were measured by reflection spectroscopy. In addition, we prepared two different ceramics materials, SiO_2 and TiO_2, whose permittivity were 4 and 100 F/m.

Frictional properties of the films were clarified by a pin-on-disk type friction tester. SUJ2 ball which radius was 4 mm was used as counter material. Test was conducted in room temperature. The sliding speed and normal load were 15.7 mm/s and 0.3 N, respectively. PAO4 oil is used in all friction tests.

RESULTS AND CONCLUSIONS

The results of friction tests with DLC films and ceramics are shown in Figure 1 and Figure 2, respectively. As results, friction coefficient decreases from 0.10 to 0.08 as permittivity increase from 3.5 to 4.8 F/m in the case of DLC films. In the case of ceramics, as permittivity increases from 4 to 100 F/m, friction coefficient decreases from 0.13 to 0.05. Because surface roughness of each films and ceramics does not show difference, the surface morphology seems not to affect friction results. From the results, the new guideline that higher primitive materials can show low friction with oil lubricants is indicated.

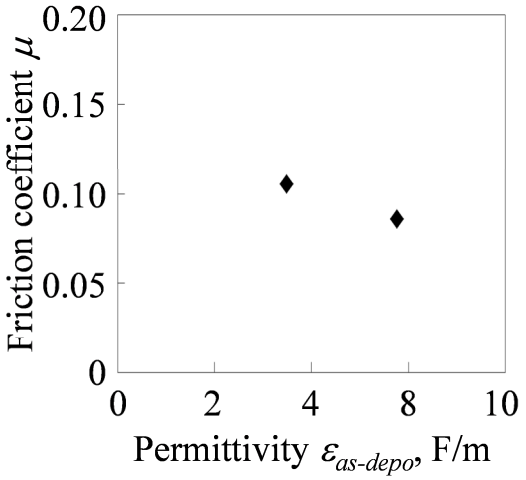

Fig. 1 - Friction coefficient of DLC films with different permittivity

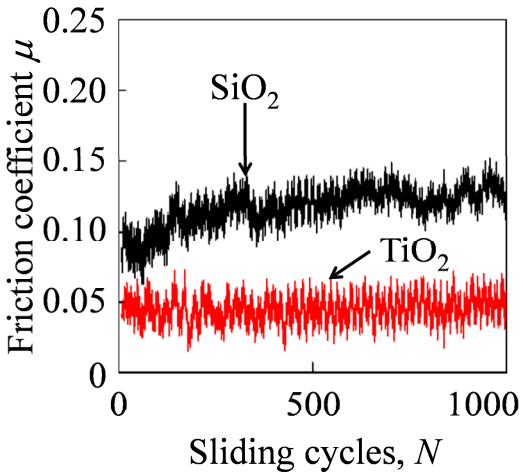

Fig. 2 - Friction coefficient of different ceramics materials

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