Assessment of Friction and Wear Properties of Porous Polyimide Film

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While numerous studies are currently being conducted to increase surface wear resistance of the mechanical components, we have conducted research on improving the wear resistance by controlling the surface stiffness through internal structure design. A porous polyimide film, which provided pores inside the polyimide film, was prepared to assess the friction and wear properties. As a result, friction and wear properties were enhanced compared to an as-prepared polyimide film. It is expected to aid in increasing the lifetime of the mechanical components by controlling the surface stiffness of the polyimide film.

Keywords: micro-tribotester, tribology, polyimide, friction

1. Introduction

When using mechanical equipment, it is essential for machine design and manufacturing to increase the life of the equipment by reducing friction and wear of the components. Thus, research on various strategies including surface treatment, structure design and functional coatings have been actively conducted to achieve low friction and increase the wear resistance [1,2]. In this study, we have examined the friction and wear properties of porous polyimide film with different porosities. Such structural design is expected to aid in increasing the lifetime of the mechanical parts significantly.

2. Methods

The bulb solution was simply synthesized by adding a pre-prepared ODA-NMP solution and PMDA. Porous polyimide film was synthesized in a bulb solution by means of inductive phase separation (NIPS). The porosity of the porous polyimide film was calculated with the following equation:

$$\text{Porosity (\%)} = 1 - w/(d \times A \times \rho) \times 100 \text{ (\%)}$$

where w is the weight of the film, d is the thickness of the film, A is the area of the film, and ρ is the density of the polyimide. Figure 1 present the as-prepared polyimide film and the porous polyimide film utilized in this study. Followed by polyimide synthesis, mechanical durability was assessed by comparing the friction and wear characteristics of as-prepared polyimide film and the porous polyimide film. Constant load was applied using custom-built reciprocate type of a micro-scale tribotester.

Using the various solubility of the polyimide precursor solution and the surface tension of the solution, polyimide film with different porous structure could be prepared. Figure 1 present the as-prepared polyimide film and the porous polyimide film utilized in this study. The friction and wear tests revealed that the wear of as-prepared polyimide film was clearly observed, while wear of porous polyimide film was not observed. Thus, it is noted that the polyimide film with porous structure aid in enhancing mechanical durability against repetitive sliding.

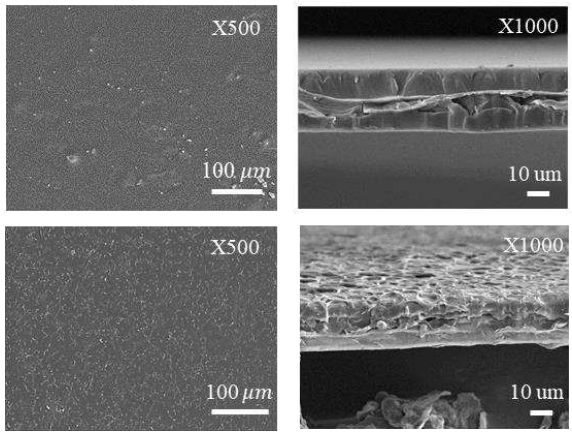

Figure 1: Scanning electron microscope images of surface (left) and cross-section (right) of the polyimide film (upper) and porous polyimide film (bottom), respectively.

3. Discussion

The internal pore structure of porous polyimide film was varied to control the stiffness of the film. It is expected that enhanced friction/wear characteristics of the porous polyimide film could be achieved from the effective distribution of the contact pressure. The experimental results revealed that almost no wear could be observed with an optimized amount of porosity of the polyimide film. Such stiffness control of the polyimide film can contribute in increasing the lifetime of various mechanical components.

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4. References

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