Tribological Characteristics of Polymer-based Composite Materials

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Silicone-based polymers are used in various fields. However, silicone-based polymers generate large friction forces during the sliding motion due to the high adhesion characteristics of silicone-based polymers. Therefore, it is necessary to reduce the friction force of silicone-based polymers. In this study, the surface, mechanical and tribological properties of polymer-ceramic composite materials according to the mixing ratio of ceramic particles were evaluated. In addition, the friction characteristics in lubrication conditions have been significantly improved compared to the dry conditions, and the variation in friction characteristics has been shown differently depending on the types of lubricants.

Keywords : Ceramic, Friction, Lubrication, Polymer, Wear

1. Introduction

Silicone-based polymers have high transparency, flexibility and biocompatibility. Silicone-based polymers are used as water repellents, antifoams, medical lenses and flexible substrates in various fields [1]. Recently, the role of silicone-based polymers as electrode substrates is increasing for developing flexible devices due to their superior durability and flexibility [2]. However, due to the high friction characteristics of silicone-based polymers, there is a limit to application to actual products. Therefore, there is a need for research to improve the friction characteristics of silicon-based polymers.

2. Experimental methods

In this study, silicone-based polymers were mixed with micro-sized glass particles to improve the friction characteristics. Polymer-ceramic composite specimens mixed in different ratios were prepared. The surface properties of polymer-ceramic composite specimens were evaluated through water-droplet contact angle measurement and adhesion tests. As shown in Figure 1, the mechanical properties and tribological characteristics of composite specimens were evaluated using an indentation tester and a reciprocating-typed tribotester, respectively [3]. In addition, the change in the friction characteristics of the silicone-based polymer according to the viscosity of the lubricant was analyzed.

3. Results

The elastic modulus of polymer-ceramic composite specimens increased in proportion to the content of ceramic particles, and the friction coefficient was reduced by 70% compared to the bare polymer. As the added amount of ceramic particles was decreased, the wear rate increased. However, the wear rate in the case of high content of ceramic particles was similar to that of bare polymer. The friction coefficients in the water and oil lubrication conditions were much lower than that of the dry condition. The surface damage of silicone-based polymer in oil-lubricants was significantly less than those in dry and water lubrication conditions.

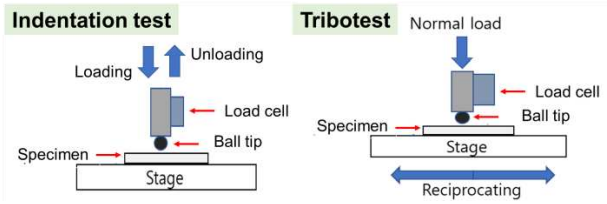

Figure 1: Schematic designs of an indentation tester and a reciprocating-typed tribotester

4. Conclusions

It was analyzed that the mechanical properties and friction coefficients were different depending on the mixing ratio of the polymer-ceramic composite, while the surface properties were similar. It was confirmed that the wear shape and the amount of wear formed on the surface of the polymer-ceramic composite specimens were changed according to the ratio of the added ceramic particles. In addition, the friction coefficient in the lubrication condition was significantly reduced compared to that in the dry condition, and the variation in friction characteristics was different depending on the types of lubricants. The results of this study will be used as basic data for research on the surface protection of silicon-based polymers in the fields of medical and flexible devices.

5. Acknowledgment

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6. References

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