Effect of surface roughness of Polyamide 66 against carbon steel S45C on wear properties

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In order to reduce the weight and quietness of mechanical systems, there is a trend to replace mechanical parts made of metals to polymers. However, polymers have lower mechanical properties and heat resistance than metals, and tend to cause creep and stress relaxation. Furthermore, polymers exhibit viscoelasticity, which induce a significant effect on friction and wear characteristics, therefore it is important to understand the phenomena at the friction surface when polymers are used for tribomaterials. In this study, we report the effect of surface roughness of polymer and metal surface on tribological properties under grease lubrication.

Keywords : Polymer; PA66; Steel; Surface roughness; Worn surface

1. Introduction

Reducing a weight of automobiles is one of the key technologies to improve their fuel economy. Therefore, replacement of machine component materials from metals to polymers has been promoted. For example, applying polymer materials to automobiles has achieved a weight reduction up to 40% compared to conventional systems. To date, replacement of non-sliding parts has much progressed. The application for polymers to sliding parts is strongly expected for the further weight reduction. In order to improve these properties, applying surface roughness is one of the effective solutions [1]. Santner and Czichos performed the sliding test of polymer against steel. They demonstrated that the friction and wear properties of polymers improve by applying the appropriate roughness to steel surfaces [2]. However, the detailed wear mechanism associated with the surface roughness has yet to be clarified. In this study, we investigated the effect of surface roughness on tribological properties.

2. Methods

Sliding tests were carried out by using reciprocating tribotester with cylinder-on-disk setup. We used S45C cylinders with surface roughness Ra of 0.01, 0.10 and 0.50 µm and PA66 disks with surface roughness Ra of 0.1, 0.6, 0.6 and 1.0 µm. A barium complex grease was used as a lubricant.

3. Discussion

Figure 1 shows the effect of surface roughness on friction coefficient of each sample combination. The steel surface roughness Ra 0.01 µm showed the lowest friction coefficients. Figure 2 shows SEM images of worn surfaces of the polymers. The worn surfaces are classified into three modes: grooves parallel to the sliding direction (Fig. 2(a)), lateral ripple perpendicular to the sliding direction (Fig. 2 (b)), and wear debris on the wear scars (Fig. 2(c)).
Effect of surface roughness on friction and wear behavior and the wear mechanism of polymer surface will be discussed.

4. References

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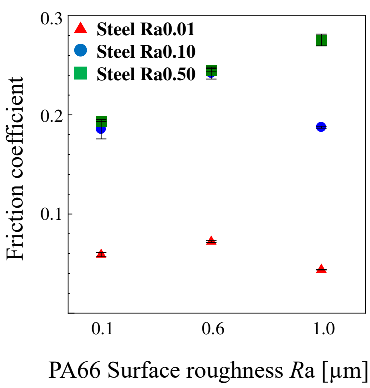
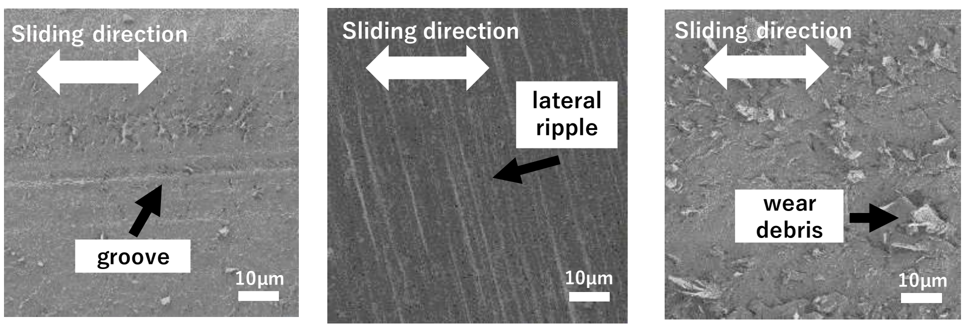


Fig. 1 Friction coefficient of PA66 vs. steel at a load of 300 N



(a) S45C *Ra* 0.1 µm vs. PA66 *Ra* 0.6 µm at a load of 300 N

(b) S45C *Ra* 0.01 µm vs. PA66 *Ra* 1.0 µm at a load of 300 N

(c) S45C *Ra* 0.01 µm vs. PA66 *Ra* 0.1 µm at a load of 300 N

Fig. 2 SEM images of worn PA66 surface