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Development of PTFE Bonded Films for Sampling Mechanisms in Space Exploration

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In many cases of sample return missions in space exploration, use of MoS_2 solid lubricants is refused because of difficulty to distinguish wear debris and samples from soils. Therefore, development of new solid lubricants, which can be distinguished from soil and/or which make little wear debris, is required. In this study, PTFE was focused because it was artificial polymeric material and it had generally low friction coefficient and little wear debris. Several PTFE bonded films with different binders and additives were evaluated in a vacuum.

Keywords: PTFE, bonded film, Sample Return, PAI, PI

1. Introduction

Sample return missions from explored place such as comets, asteroids, and satellites of planets are increasing. Their missions must need mechanical components with sliding parts. In many cases of the missions, use of MoS_2 as solid lubricants is refused because of difficulty to distinguish between wear debris and samples from soils. Therefore, development of new solid lubricants, which can be distinguished from soil and/or which make less wear debris, is required. In this study, polytetrafluoroethylene (PTFE) was focused because it was artificial polymeric material and it generally had low friction coefficient and little wear debris. Tribological properties of several PTFE bonded films with different binders and additives were evaluated in a vacuum. The effect of substrate material, baking temperature, applied load and radiation environment on tribological properties were investigated. Results of friction tests to confirm whether PTFE films can be used for future sample return mission and to select the best performance film will be reported.

2. Evaluation methods

2.1. Tested materials

Many PTFE bonded films with different binders, additives and their ratios were produced experimentally. Some of them with good tribological characteristics in air were selected and evaluated in a vacuum. Polyamide-imide (PAI) or Polyimide (PI) were used as binder. Baking temperature was changed from 190 ºC to 280 ºC.

2.2. Friction test

Reciprocating pin-on-disk friction test was carried out in a vacuum. Applied load during test was changed. The test with high load of 17 N and the evaluation to compare the tribological properties between before and after irradiation of radiation of 100kGy were also conducted, because generally PTFE does not have good properties under high load condition and radiation environment.

3. Results and discussion

Figure 1 shows typical friction behaviors of tested films on aluminum alloy with PAI or PI binders and different additives. The films with PAI binder showed lower friction coefficient of 0.07 to 0.09 than the film with PI binder, although difference in wear lives was not observed between binders. Aluminum alloy substrate had longer wear lives than stainless steel substrate, however, friction coefficient was not different between substrates. The effect of radiation was not observed for the tested PTFE bonded films. These results indicate that some PTFE bonded films can be applied to sample return mission in space exploration.

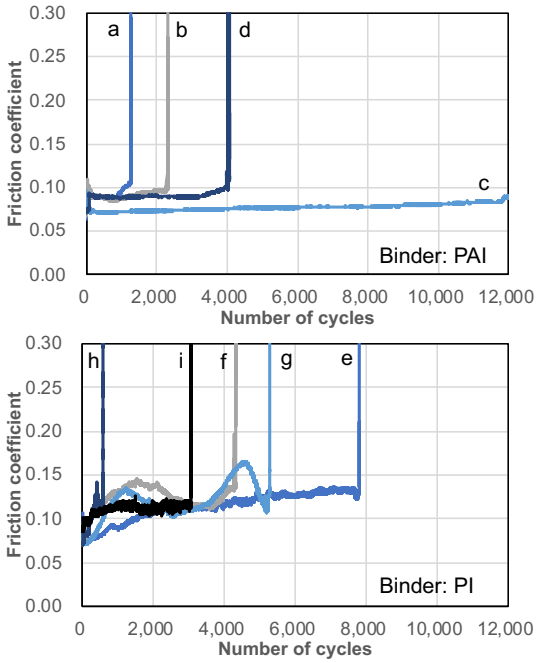

Figure 1: Friction behaviors of tested films with binders of PAI and PI.

4. References

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