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EFFECTS OF CERAMIC COUNTERPART MATERIALON FRICTION AND WEAR PROPERTIES OF a-C:H COATING AT HIGH TEMPERATURE

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ABSTRACT

Generally tribological behaviors are affected by a counterpart material. Therefore more fundamental researches about counterpart material are necessary. In this research tribological behaviors of carbon coating when slid against various counterpart material, including SiC, SiC(O) that is SiC after annealing at 1000ºC, Si_3N_4, Al_2O_3, Al_2O_3(Si) that includes more Si atomic concentration than Al_2O_3 and Si wafer at various temperatures in air have been investigated. Carbon coating when slid against SiC showed the lowest wear rate at 23ºC, and carbon coating when slid against Si_3N_4 showed the lowest wear rate at 140ºC and carbon coating when slid against SiC(O) showed the lowest friction coefficient at all temperature.

Keywords: diamond-like carbon, wear, counterpart materials, high temperature.

INTRODUCTION

Carbon coatings have a keen attention according to its low friction, high hardness and high wear resistance properties. There are needs to apply carbon coatings into ceramic mechanical parts, such as mechanical seal. However the tribological properties of carbon coatings when slid against ceramics are still not investigated sufficiently (Deng 2013, 2014). Generally tribological behaviors are affected by a counterpart material. Therefore more fundamental researches about counterpart material are necessary. In this research tribological behaviors of carbon coating when slid against various counterpart materials at various temperatures in air have been investigated.

EXPERIMENTAL MATERIALS

Friction pair is a-C:H coated steel ball which dimeter is 8 mm and various kinds of ceramic disks. Hydrogenated amorphous carbon as a-C:H was coated on the high chromium carbon steel ball as SUJ2 bearing steel ball with ionized evaporation method. The a-C:H has 1 μm in thickness, 25.5 GPa in hardness and 5 nm in average surface roughness. The ceramic counterpart materials of disks are SiC, SiC(O) that is SiC after annealing at 1000ºC, Si_3N_4, Al_2O_3, Al_2O_3(Si) that includes more Si atomic concentration than Al_2O_3 and Si wafer. Table 1 shows the properties and compositions of ceramic counterpart materials.

RESULTS AND CONCLUSIONS

Figure 1 shows effect of ceramic counterpart materials and temperature on friction coefficient and specific wear rate of a-C:H coatings on steel ball. It can be seen that SiC(O) shows lowest

friction coefficient in the temperature range from 25 ^{o}C to 140 ^{o}C as less that 0.1. Al_2O_3 and Si_3N_4 disks show the decreasing tendency with the increasing temperature. On the other hand, SiC and Al_2O_3(Si) did not show low friction coefficient at 140 ^{o}C. In the view point of wear of a-C:H, SiC, SiC(O) and Al_2O_3(Si) did not show low wear rate at 140 ^{o}C. On the other hand, Al_2O_3 and Si_3N_4 disks show low wear rate at 140 ^{o}C.

This study shows the ceramic counterpart materials affect friction and wear properties at high temperature as 140 ^{o}C. When we will use the sliding pair of a-C:H coating and ceramic at 140 ^{o}C. Al_2O_3 and Si_3N_4 ceramic disks are better than SiC and others for low friction and wear.

Table 1 - Properties and compositions of ceramics counterpart materials

	Hardness [HV]	Roughness Ra [nm]	Roughness Rz [nm]	Atomic compositions [%]					
				Si	C	N	Al	O	Mg
SiC	2400	5	24	62.1	37.9	0.0	0.0	0.0	0.0
SiC(O)	2380	5	39	65.0	17.7	0.0	0.0	17.3	0.0
Si_3N_4	1500	5	21	49.5	0.0	43.7	3.6	3.2	0.0
Al_2O_3	1250	5	23	1.0	0.0	0.0	33.5	64.0	1.5
Al_2O_3(Si)	1100	5	29	5.5	0.0	0.0	37.7	54.6	2.3

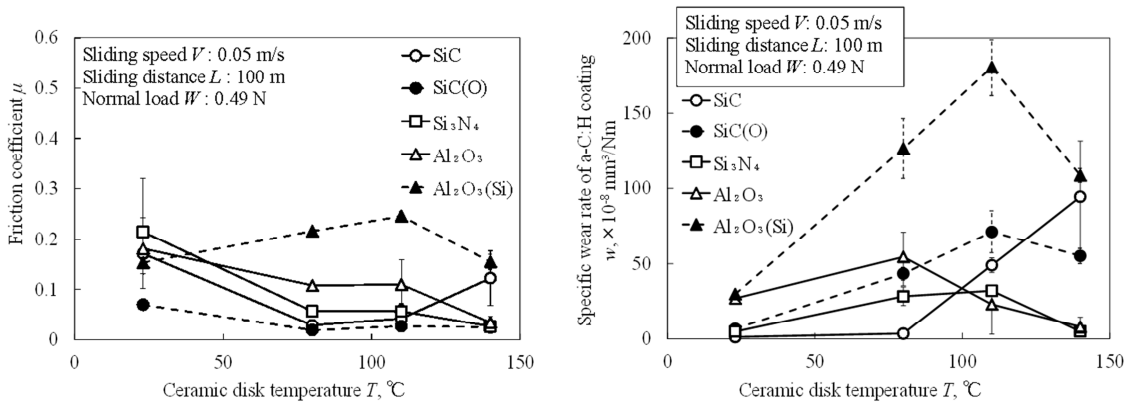

Fig. 1 - Effect of ceramic counterpart materials and temperature on friction coefficient and specific wear rate of a-C:H coatings on steel ball

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