High temperature vacuum friction test and IPXRD analysis of sulfide metal bonded films

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Molybdenum disulfide is proven material in space development technology. Especially, it is possible to make long endurance life and low friction coefficient in case of fabrication by bonded film as like using binder. Molybdenum disulfide bonded has superior lubrication at normal vacuum. Molybdenum disulfide show good performance under 200℃ vacuum. Tungsten disulfide shows superior lubrication properties at high temperature than proven lubrication for space. In this study, compare the variation of lubrication surface by Imaging Plate X-ray Diffraction analysis before and after tribological test and discuss the difference in crystal state.
Keywords: Solid lubrication, Bonded film, Sulfide metals, Tungsten, Vacuum

1. Introduction

Spacecrafts often has deployment system and/or some driving system as like high gain telecommunication, synthetic aperture radar system and solar power paddle etc. Mechanical components associated with tribological elements are often use lubrication for prevent some problems. Molybdenum disulfide (MoS_2) is famous lubrication as a proven technology for space that can be make low friction at vacuum. Reliability is very important in space development, there are trend to select reliable materials and adopt proven products because hard to care on orbit. Tungsten disulfide (WS_2) has similar crystal structure【1】 with MoS_2 that is big advantage because it is necessary to carefully introduce new technology in space development. The presence of the (002) surface of these lubricants is related with low friction. Another feature of WS_2 is starting temperature of oxidation【2】that is higher than that of MoS_2. We have to preparation for future mission as like probe of inner planet.
In this study, fabricated WS_2 bonded film as same as possible with MoS_2 bonded films. We used same triborogical equipment by same condition around same time for confirmation possibility of WS_2 for space lubrication. Furthermore, each sample were experimented at elevated temperature vacuum.

2. Tested condition and results

Specification of metal sulfide for use bonded lubrication films show in Table 1. The powder conditions were controlled as much as possible, and the same type powder was prepared. In this study, we used inorganic (Na_2SiO_3) binder. Thickness of each coupon are 10 μm. Friction test equipment was setting up in high vacuum chamber. When raising temperature, can be use a heater beside on sample. The vacuum level when test start is approximately 10^{-5} Pa.

Table1 metal sulfide type for use bonded films

	MoS_2	WS_2
Grain size(μm)	0.94	
Degree of crystallization (%)	80	-
Powder morphology circularity(%)	0.7～1	
Inorganic specimen Vol (%)	40	

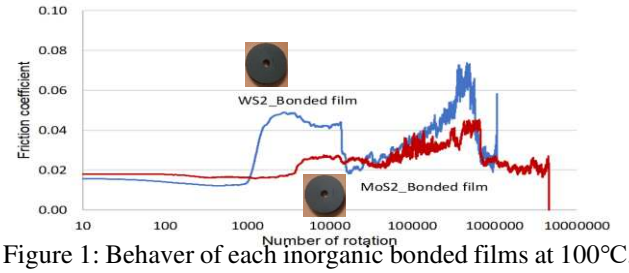

Figure 1: Behaver of each inorganic bonded films at 100℃.

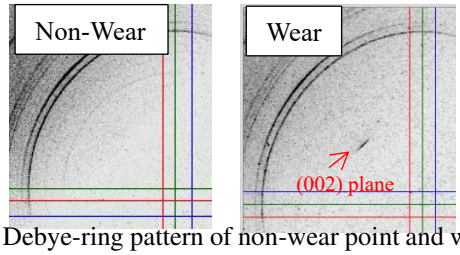

Fig. 2: Debye-ring pattern of non-wear point and wear point.

Both sulfide metals showed similar tendency in room temperature vacuum friction tests【3】. In 100℃ vacuum test, both coupon did appear low friction coefficient until 1000 times. Endurance of MoS_2 is longer than that of WS_2. A remarkable difference indicated in endurance life was confirmed at over 300℃ vacuum【4】. State of the (002) plane of before and after friction test show in Fig.2. The bonded film is formed with lubrication powder floating in the binder. The (002) plane were not detected from the virgin area. The (002) plane was confirmed that aligned from wear point.

3. Discussions

A long-endurance coating can be made by bonded method. In case of WS_2, MoS_2 coating method available use without any changes. It was confirmed by IPXRD that the (002) plane which is the sliding mechanism were not oriented before friction test.

References

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