原子状酸素に暴露された二硫化タングステン固体潤滑剤の TEM 観察

TEM Studies of Solid Lubricant Tungsten Disulfide Exposed in Atomic Oxygen

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【Introduction】

Solid lubricants are one of the most important materials in space-crafts, which are always exposed to extreme environments like high vacuum, high and low temperature cycle and atomic oxygen. Tungsten disulfide (WS_2), which due to its peculiar characteristics is expected to be applied at higher temperatures than conventionally used molybdenum disulfide (MoS_2), both sulfides have a unique hexagonal layered structure and a very low friction coefficient by sliding between sulfur layers. Our previous studies have suggested that lattice defects such as stacking faults are a key role in the low-friction mechanism. The objective of this research is to analyze the obtained images of lattice defects in an atomic level to demonstrate their relationship with the low –friction mechanism of WS_2.

【Experimental】

In this study, WS_2 coated disc were expose in atomic oxygen 500kGy in a vacuum. A rotational friction test was carried out to measure the friction coefficient at room temperature up to $9.0X10^3$ m distance. During rotational friction test, WS_2 flakes have been created on the wear track. These WS_2 flakes were gathered and diluted in hexane, and a drop of the concentrate solution was poured into a micro-grid. Then the micro-grid with WS_2 was observed by using a Transmission Electron Microscope (TEM) model JEM2000FX operated at 200keV.

【Results】

Friction coefficient of WS_2 film has been keeping around 0.06 during rotational friction test. Many abrasion powders of WS_2 could been seen on the surface, generally in an oval shape, with a small size of 300 nm. All the abrasion powders were analyzed in their structure looking for lattice defects. Figure 1 shows a clear pattern whose zone axis is [0002]. WS_2 abrasion powders having (0002) plane which S-S bonding is destroyed and create (0002) plane cleavage facet. In Fig.2, bright field image shows typical moiré pattern which spacing is 6.0 nm. When two of WS_2 thin plates overlapped together, rotational moiré pattern will be appeared. Calculated rotational angle e is 2.4 degrees which is quite small. The observation of this moiré pattern and very small rotational angle would strongly suggest the existence of lattice defect such as a dislocation or a partial dislocation in WS_2 (0002) plane.

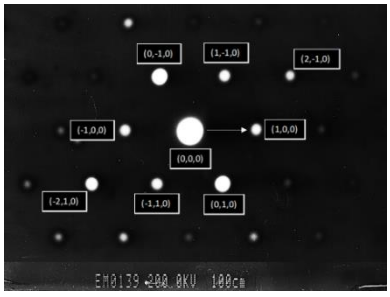

Fig. 1. Hexagonal diffraction pattern with zone axis of [0002].

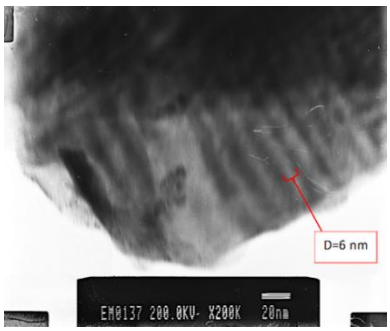

Fig. 2. Bright-field image showing a moire pattern due to overlapped WS_2 flakes.

【Acknowledgements】

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