THE DEVELOPMENT OF PASSIVATED MOS_2 COATINGS FOR SPACE APPLICATIONS

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ABSTRACT
Molybdenum disulfide (MoS_2) based coatings are the most commonly used solid lubricants for space applications due to their excellent tribological properties in vacuum. However, poor tribological properties occur in air, due to the presence of excess contaminants such as water vapour and oxygen [1]. Although mechanisms in space applications are widely operated in vacuum environment, air exposure and ground testing in air is unavoidable. For that reason, the development of MoS_2 coating with excellent tribological properties in air and vacuum are highly desirable.

This study investigates the deposition and the tribological properties of passivated or 'sealed' MoS_2 coatings, where an additional layer was deposited over a pure MoS_2 coating. The purpose of the additional layer is to serve as a sealant to protect the bulk of MoS_2 coating from water vapour adsorption and oxygen incorporation, causing excess oxide formation.

The MoS_2 coatings were deposited using physical vapour deposition (PVD). The protective layer consists of nitrogen-doped MoS_2, which was also deposited using PVD. Nitrogen as a dopant in MoS_2 coatings has gained popularity due to the improved tribological properties in nitrogen atmosphere during testing [2] and prolonged lifetime of coatings when stored in nitrogen atmosphere [3]. Nitrogen cannot form a coating but can be used as a dopant to improve the bulk coating properties. Some literature exists exploring the effects of nitrogen as a dopant in MoS_2 coatings; however, there is no literature exploring nitrogen as a passivating dopant for the top layer of MoS_2.

Mechanical properties were determined using scratch testing and nanoindentation. The tribological properties of the coating were analysed using reciprocating tribometer in air and unidirectional tribometer in vacuum to determine coating suitability for space applications. The chemical and elemental analysis was conducted using Raman spectroscopy and SEM-EDX.

The tribological properties of the nitrogen passivated coating was compared to pure MoS_2, which is un-passivated, as well as commercially available MoS_2 based coatings. Although the CoF of N-passivated MoS_2 in vacuum is higher than pure MoS_2, as shown in Fig 1 (a), its lifetime surpasses all the pure and doped MoS_2 coatings, which is illustrated in Fig. 1 (b).

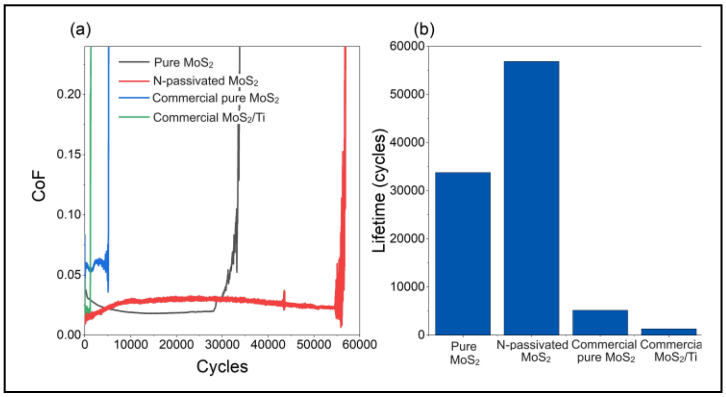

Fig.1 (a) Friction curves and (b) lifetime of various MoS_2 coatings in vacuum at 1.75 GPa contact pressure

It was concluded that nitrogen doping can successfully passivate MoS_2, where the passivating layer adheres to the bulk MoS_2 coating without any signs of delamination. Also, the suitability of the coating for space applications was confirmed.

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