EFFECTS OF COATING THICKNESS ON FRICTION AND WEAR BEHAVIOURS OF MOS2 AND MOS2-TA SOLID LUBRICANTS

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ABSTRACT
MoS2-based coatings have been used for decades to lubricate space mechanisms such as bearings or gears. However, these coatings are sensitive to oxidization and therefore their performance can be damaged during pre-launch ground tests [1]. Co-deposition of 1 µm thick tantalum doped MoS2 was found to be an interesting way to preserve the good lubrication properties of MoS2 both in vacuum and in humid air [2]. Such a thickness is commonly recommended to asses MoS2 coatings performances on tribometers, although thinner thicknesses are used in some mechanisms [1]. As MoS2-Ta coating is quite different in its morphology and density from classic MoS2 coating, its actual optimal thickness in terms of friction and lifetime needs to be determined.

To assess this, three thicknesses (0.5, 1 and 1.5 µm) were tested for two different PVD depositions (MoS2-Ta and space qualified MoS2) on a pin-on-disk tribometer in an alternative rotating motion (MFT 5000, R-Tec, USA). Substrates were made of AISI 440C stainless steel, with Ra below 0.6 µm and sled against 6 mm diameter AISI 440C balls. Maximal contact pressure was set to 1 GPa and sliding speed to 10 $mm.s^{-1}$. Temperature (23 ± 2°C) and humidity (50 ± 5%) were controlled. Tests were stopped when coefficient of friction was higher than 0.3.

Overall, results show a significant improvement in lifetime and friction performance for MoS2-Ta coating compared to classic MoS2 coating (+170 % lifetime and -57 % friction), corroborating the results from previous study for the latter [2]. For MoS2, lifetime does not depend on thickness while friction is slightly higher for 1 and 1.5 µm deposition than for 0.5 µm (0.14 vs 0.12). For MoS2-Ta, a similar trend is observed for friction as both 0.5 and 1 µm deposits show a decrease in friction compared to 1.5 µm (0.06 vs 0.08). Regarding lifetime however, 0.5 µm and 1.5 µm allow better lifetimes than 1 µm thickness. To investigate this behaviour, scratch tests have been performed on microsratch tester (MST3, Anton-Paar, Austria), using Rockwell C diamond indenter. The scratch test reveals an earlier failure of 1µm thick coating and a change in rupture mechanisms from ductile to brittle/delamination with increasing thickness (Fig. 1). Investigation points towards an equilibrium condition between coating morphology, thickness, debris size, replenishment of contact with 3rd body materials.

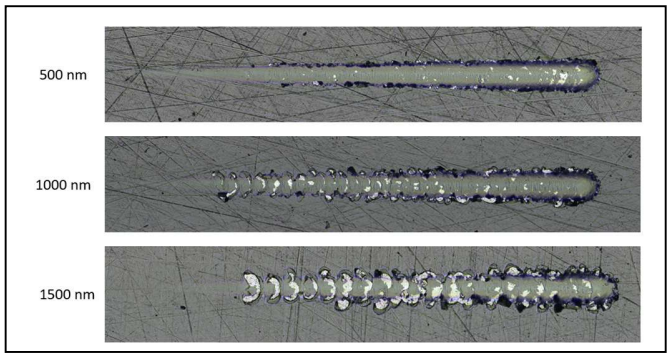


Fig.1: Post scratch-test tracks for each thickness of MoS2-Ta.

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