NANOTRIBOLOGICAL INVESTIGATION OF WEAR MECHANISMS ON TRANSITION METAL DICHALCOGENIDE THIN COATINGS

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INTRODUCTION

Thin amorphous solid lubricating films, based on transition metal dichalcogenides (TMD) have been known for their outstanding frictional properties, especially in vacuum. Their low coefficient of friction is only contrasted by average wear properties, due to poor adhesion and low hardness [1-2].

Atomic force microscopy (AFM) is a very powerful nanotribological tool for analysis of the tribological properties on the nano-scale and provides useful insight in the intrinsic frictional properties of the analyzed material. Here we utilize AFM to study nano-tribological properties of MoS_2 coatings after the tribotests, with the purpose of assessing nanoscale contributions to friction and wear behavior on the macro-scale.

EXPERIMENTAL DETAILS

MoS_2 coatings were deposited by non-reactive r.f. magnetron sputtering (AJA International, Inc., United States) from a single MoS_2 target on polished steel samples. Prior to the deposition, substrates were sputter cleaned for 45 min by plasma etching. Macro-scale tribotests were performed in a custom made vacuum tribometer (CTU, Czech Republic) at various loads and sliding speeds. 100Cr6 balls with a diameter of 6mm were used as sliding counter bodies. Wear-tracks were first analyzed by 3D optical profilometry, for an initial assessment of wear, which was followed by detailed topographical and frictional AFM analysis.

Atomic force microscopy (Agilent AFM5500, United States and Witec alpha300RAS, Germany) was performed in contact mode at environmental conditions. Probes with different spring constants were used, which allowed us to work with a wide range of contact loads (from nN to uN). Low loads were used to study nano-scale frictional properties of the wear tracks, while higher loads were utilized to analyze nano-scale wear mechanisms and provide an insight in the nano-frictional properties beneath the surface of the wear tracks.

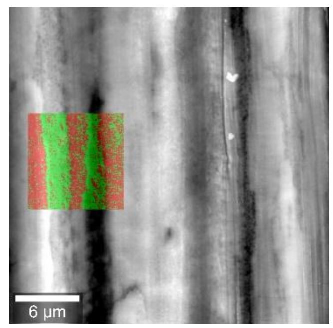

Fig.1 Overlay of the friction signal over the topography of the wear track; green region indicates lower friction

RESULTS

Macro-scale coefficients of friction as low as 0.025 and the reduction on the coefficient of friction with increasing load were observed, which is in good agreement with the literature [2]. We have identified regions with significantly different nano-frictional characteristics within the wear track (Fig. 1). The distribution of the observed regions presented on Fig. 1 is non-homogeneous across the entire wear track and indicates the formation of different compounds in the contact during sliding.

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