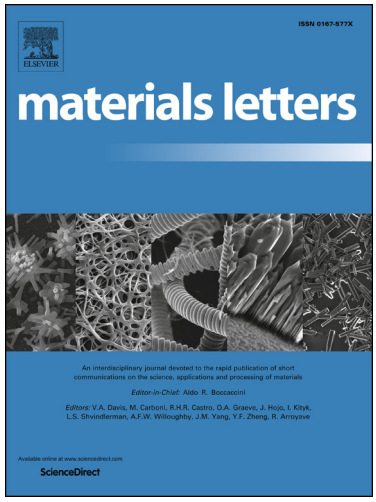

Instant WS_2 platelets reorientation of self-adaptive WS_2/a-C tribocoating

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Instant WS_2 platelets reorientation of self-adaptive WS_2/a-C tribocoating

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Abstract:

WS_2/a-C nanocomposite coatings were deposited by magnetron co-sputtering using WS_2 and graphite targets. The microstructure and triboperformance of the coatings were scrutinized via microscopy (AFM, SEM, FIB, HRTEM), spectroscopy (XRD, XPS) and tribometry. Atomic WS_2 platelets are randomly embedded in an amorphous carbon matrix of the as-deposited nanocomposite coating. HRTEM observations of tribofilm/transfer layer reveal that the sliding contact immediately reorients WS_2 platelets parallel to the sliding interface and thereby leads to self-adaptive "frictionless" response. The coefficient of friction falls to 0.02 in dry air and reaches 0.10 in humid air, and is reversible as testing atmosphere cycles between dry air and humid air.

Keywords: WS_2; Nanocomposites; Magnetron sputtering; Self-adaptation; Reorientation; Self lubrication

1. Introduction

Transition metal dichalcogenides (TMD) are well known for their solid lubricating behavior and are applied widely in aerospace industry [1–3]. Their MX_2-type structure is highly anisotropic. For instance, WS_2 crystallizes in the hexagonal units where layers of W atoms are sandwiched in-between layers of packed sulphur atoms. The bonding within each unit, i.e. the M-X bond is covalent, while the different units are held together by weak Van der Waals interactions [4]. The ultralow shear strength (1-2 MPa) in (002) orientation renders an easy glide of each WS_2 layer, yielding an ultralow friction [1,5].

However, pure WS_2 coatings prepared by sputtering exhibit porous structure and degrade their lubricating properties through oxidizing in moisture [6]. This is because the edge-plane orientation of WS_2 readily suffers from oxidations due to the passivation of their dangling bonds and active sites. Fortunately, edge-oriented or even amorphous WS_2 can adapt itself during a sliding contact forcing nano-laminae to favor the frictionless orientation where their basal planes are parallel to the sliding

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