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Surface characteristics underpinning fretting wear performance of duplex chameleon/PEO coatings on Al under high contact loads

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Being a consequence of contact fatigue, fretting wear is detrimental to durability of many structural components. The application of solid lubricants can reduce the damage resulting from fretting. In this work, duplex coatings comprising MoS_2/Sb_2O_3/graphite ('chameleon') layer deposited on the top of plasma electrolytic oxidation (PEO) treated 6082 series Al alloy substrates were subjected to a series of fretting wear tests against two different counterpart materials and under varying loads, displacement amplitudes and environments. XRD, instrumented indentation, SEM, energy dispersive spectrometryEDX, laser confocal microscopy and Raman spectroscopy were employed to examine the surface phase composition, hardness, elastic modulus, as well as microstructure, elemental distribution and 3D surface topographies of the wear scars. The duplex coating was found to effectively enhance the wear performance of the Al alloy, with friction coefficients reduced from ~0.9 to ~0.08 in dry N_2 and from ~0.6 to ~0.1 in humid air against alumina counterpart. About an order of magnitude improvement over a single layer PEO coating was observed in specific stick-slip (~3 mm amplitude), partial slip (5-10 mm) and gross slip (>10 mm) regimes. Importantly, in the latter regime, high normal loads (about 1.4 GPa contact pressure) affected the duplex coating performance against 440 stainless steel in oxidising atmosphere, with Fe/Al/Cr oxides/hydroxides generated in the contact region, leading to the formation of micro-cracks penetrating throughout the PEO coating. However, when the contact pressure was reduced to ~1 GPa, the coating showed low friction and wear rate, with no appearance of fatigue cracks after 10,000 fretting cycles.

Keywords
Plasma Electrolytic Oxidation
Aluminium alloys
Chameleon coating
Fretting wear