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Effects of Fe Addition and Process Parameters on the Wear and Corrosion Characteristics of Icosahedral Al-Cu-Fe Coatings on Ti-6Al-4V Alloy

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Abstract : The performance of material surface under wear and corrosion environments cannot be fulfilled by the conventional surface modifications and coatings. Therefore, different industrial sectors need an alternative technique for enhanced surface properties. Titanium and its alloys possess poor tribological properties which limit their use in certain industries. This paper focuses on the effect of hybrid coatings Al-Cu-Fe on a grade five titanium alloy using laser metal deposition (LMD) process. Icosahedral Al-Cu-Fe as quasicrystals is a relatively new class of materials which exhibit unusual atomic structure and useful physical and chemical properties. A 3kW continuous wave ytterbium laser system (YLS) attached to a KUKA robot which controls the movement of the cladding process was utilized for the fabrication of the coatings. The titanium cladded surfaces were investigated for its hardness, corrosion and tribological behaviour at different laser processing conditions. The samples were cut to corrosion coupons, and immersed into 3.65% NaCl solution at 28oC using Electrochemical Impedance Spectroscopy (EIS) and Linear Polarization (LP) techniques. The cross-sectional view of the samples was analysed. It was found that the geometrical properties of the deposits such as width, height and the Heat Affected Zone (HAZ) of each sample remarkably increased with increasing laser power due to the laser-material interaction. It was observed that there are higher number of aluminum and titanium presented in the formation of the composite. The indentation testing reveals that for both scanning speed of 0.8 m/min and 1m/min, the mean hardness value decreases with increasing laser power. The low coefficient of friction, excellent wear resistance and high microhardness were attributed to the formation of hard intermetallic compounds (TiCu, Ti2Cu, Ti3Al, Al3Ti) produced through the in situ metallurgical reactions during the LMD process. The load-bearing capability of the substrate was improved due to the excellent wear resistance of the coatings. The cladded layer showed a uniform crack free surface due to optimized laser process parameters which led to the refinement of the coatings.

Keywords : Al-Cu-Fe coating, corrosion, intermetallics, laser metal deposition, Ti-6Al-4V alloy, wear resistance
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