Effects of Dilution Rate and Parameter Sensitivity on the Microstructure and Mechanical Properties of Laser Cladded Ti-Cu-Al Coatings on Ti-6Al-4V Alloy.

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Titanium Alloy (Ti-6Al-4V) unlocks a wide range of useful applications in aerospace industries; these industries make use of different additive manufacturing (AM) techniques to obtain parts of different properties for different uses by this titanium alloy. titanium alloy mainly stands out due to the properties such as high specific strength to weight ratio, and excellent corrosion resistance. Despite these benefits, the formation of defects such as pores and cracks play a vital role in the quality of the deposited coatings. The presence of these unwanted artefacts on laser deposited coatings depends on the melting, cooling and solidification of the melt pool, dilution rate and process parameters. The success of laser metal deposition (LMD) will rely on the detailed understanding of the relationship between the process parameters and the resulting material properties. This research paper focuses on the effect of hybrid coating of Ti-Cu-Al on a grade five titanium alloy (Ti-6Al-4V) using LMD process at different laser process parameters.

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 Ti-Cu-Al coatings on Ti-6Al-4V alloy. The titanium cladded surfaces were investigated for its microstructure, mechanical properties and wear resistance characteristics at different laser processing conditions. Hardness measurements were done using a Vickers micro-hardness tester and wear tests were performed on prepared Titanium substrate deposited sample using the reciprocating tribometer (CERT UMT-2) under dry reciprocating conditions with continual recording of the dynamic coefficient of friction values. Ti-6Al-4V/Ti-Cu-Al composites were analysed using optical microscopy, scanning electron microscopy (SEM) with energy dispersive microscopy (EDS), and x-ray diffraction (XRD). The enhanced tensile strength, yield strength and micro-hardness were attributed to the formation of hard intermetallic compounds (TiCu, Ti_2Cu, $CuTi_3$, $TiCu_3$, Al_3Ti) produced through the in situ metallurgical reactions during the LMD process. The effect of Cu interlayer on wear resistance is obviously distinguished. The excellent wear resistance of $CuTi_3$, Cu_3Ti protects the formed layer against the dry sliding wear. In addition, the rapidly solidified homogeneous fine microstructure imparts the coatings good combination of strength and toughness, which also contributes to the excellent resistance of the coating to spallation and delamination during dry sliding wear process. The addition of Cu impacts positively on the Young's modulus of the coatings. The enhanced Young's modulus was because of copper interlayer which is attributed to the presence of Ti-Cu intermetallics (like $CuTi_3$ and Cu_3Ti).

Keywords: Ti-6Al-4V alloy; Mechanical Properties; Microstructure; Ti-Cu-Al coating; dilution rate; Laser parameters.