Seminar

==========

Institute for Plasma Research

==========

Title: Investigation on Metallurgical, Mechanical, Corrosion and Erosion Behaviour of Laser Cladded High Entropy Alloy Coatings

Speaker: Dr. Akash Vyas

SVNIT, Surat, Gujarat

Date: 1st May 2023 (Monday)

Time: 03:30 PM

Venue: Join the talk online:

https://meet.ipr.res.in/join/5608555837?be_auth=MTQyNjg2

(Conference ID: 5608555837; Password: 142686)

Abstract

In the present investigation AlFeCuCrCoNi-Cx (X: 0.3, 0.7, 1.2, 1.6 and 2.0 wt.%) and AlFeCuCrCoNi-WCx (x=0, 5, 10 and 15 wt.%) high entropy alloy (HEA) coatings with an approximate thickness of 900 µm was synthesized by the optimized laser-assisted cladding process parameters on the AISI-316 substrate. The microstructure, elemental distribution and phase constituents were characterized by optical microscopy, scanning electron microscopy, energy dispersive spectroscopy (FESEM/EDS) and X-ray diffraction (XRD), respectively. The electrochemical work station was used to evaluate the corrosion behavior of AlFeCuCrCoNi-Cx/ WCx coating in 3.5 wt.% NaCl solution with the help of potentiodynamic polarization measurement.Furthermore, the slurry erosion tests were performed on the AISI-316 and laser cladded AlCrCoCuFeNi-Cx/WCx HEA coating with variation in impingement angle (30_o, 60_o and 90_o), velocity (15, 30 m/s) as well aserodent concentration (0.5, 2.0%) at constant test time of 1 hour. The optical microstructural observation of asdeposited coating reveals that the equiaxed multi-principal element coating composed of cladding zone (CZ), bonding zone (BZ) and heat-affected zone (HAZ). The EDS analysis indicated that elemental segregation is efficiently reduced, and elements are uniformly distributed in the cladding. The XRD showed the presence of two phases namely FCC and BCC phases along with additional peaks of carbon for carbon-reinforced HEA. The phase analysis of AlCrCoCuFeNi-WCx revealed that in addition to the combination of two FCC + BCC phases, a set of diffraction peaks corresponding to WC and $Cr_{23}C_6$ phases is observed in the case of AlCrCoCuFeNi- WC10 and AlCrCoCuFeNi-WC15. Compared to the substrate AISI 316 (164.5 HV0.5), the hardness of the coatings was enhanced by approximately 31.7%, 32.9%, 33.7%, 36.6%, 42.9%, 43.2%, 49.6%, 73.5% and 79.7% with respect to AlFeCuCrCoNi, AlFeCuCrCoNi-C0.3, AlFeCuCrCoNi-C0.7, AlFeCuCrCoNi- C1.2, AlFeCuCrCoNi-C1.6 and AlFeCuCrCoNi-C2.0, AlFeCuCrCoNi-WC5.0, AlFeCuCrCoNi-WC10 and AlFeCuCrCoNi-WC15 HEA coating respectively. The Potentiodynamic test, FESEM and EDS suggested that HEA underwent pitting and there was no evidence of uniform corrosion. The corrosion resistance of all the AlFeCuCrCoNi-Cx and AlFeCuCrCoNi-WCx HEA coatings in 3.5% NaCl corrosive environment is better than that of the substrate AISI 316. However, the corrosion rate of the HEA coating increases and corrosion resistance deteriorates with the increase of C and WC content respectively. The erosion results revealed that, the average erosion performance of the AlFeCuCrCoNi, AlFeCuCrCoNi- C0.3, AlFeCuCrCoNi-C0.7, AlFeCuCrCoNi-C1.2, AlFeCuCrCoNi-C1.6, AlFeCuCrCoNi-C2.0, AlFeCuCrCoNi- WC5.0, AlFeCuCrCoNi-WC10 and AlFeCuCrCoNi- WC15 are enhanced by 8.65%, 11.61%, 10.95%, 11.87%, 15.44%, 15.15%, 23.19%, 43.44% and 62.55% respectively as compared to AISI 316. Detailed analysis of the erosion mechanism was carried out with the help of a scanning electron microscope. The conclusion of research in terms of a coating having the best corrosion and erosion resistance is presented.

Keywords: High Entropy Alloy, Laser Cladding, Microstructure, Slurry Erosion, Corrosion, ANOVA, Optimization, Eroded Surface Morphology and Corroded Surface Morphology.