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Synthesis, characterisation and erosion behaviour of AlCoCrMoNi high entropy alloy coating

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Abstract

AlCoCrMoNi equiatomic high entropy alloy (HEA) powders were prepared by mechanical alloying. High energy planetary ball-mill was employed to mill the powders till single solid solution formation. X-Ray Diffraction (XRD) analysis of as prepared powder was done at 5, 10, 15 and 20 hours of milling. A single BCC phase was formed after 20 h. Field emission scanning electron microscopy (FESEM) was used to study the microstructure of the prepared powder. After 20 hours of milling, a homogenous mixture formed, which was further confirmed by EDAX mapping of as prepared powders. The alloy was coated onto a 316 steel substrate using High-velocity Oxy-fuel (HVOF) coating. Cross-section of the coating was analysed using scanning electron microscope (SEM). The slurry erosion resistance exhibited by the coating was tested using Water-jet Erosion tester with 20 m s^{-1}, 25 m s^{-1} and 30 m s^{-1} jet velocity at 30°, 60° and 90° angular impingement. The coating exhibited high ductility along with superior erosion resistance compared to conventional wear resistant coatings.

1. Introduction

AISI 316 L is the standard potential structural material and finds application in chemical, marine, oil & gas and biomedical industries since they possess excellent corrosion resistance combined with good toughness and weldability [1]. Over a prolonged time, their surface gets degraded due to their poor hardness and wear resistance which limits their application [2]. To stop degradation and improving lifetime of these materials surface modification techniques are used. Currently, High-entropy alloys (HEAs) comprising of atleast five or more elements have gained attention as one of the interesting new class materials due to their attractive properties including high strength,hardness, good structural stability, exceptional high-temperature strength, excellent corrosion and oxidation resistance [3]. Their properties can be tailored by choosing appropriate elements for the desired applications [4]. In order to obtain HEA, several methods have been explored, including arc melting, ball milling, thin-film sputtering etc Among these techniques, ball milling is an effective method to prepare HEA powders [5].

Recently, HEAs are applied as a thin coating on the surfaces without altering the bulk material properties. Continuous development of surface modification techniques such as HVOF, Laser cladding [6–8], electrochemical deposition [9, 10] and magnetron sputtering [11, 12] paves the way to successfully synthesize HEA coatings on different alloys. HEA coatings offer better properties than conventional materials [13]. HVOF is one of the many surface modification techniques used to improve the corrosion and erosion properties of metals. By using this technique various ceramic materials can be densely coated with low oxide content and high bonding strength so that life of the components can be extended [14]. However, till date only few research results dealing with HEA coatings produced by HVOF have been published [14, 15]. A non-equiatomic HEA comprising of AlFeCrMnNi was studied for air jet erosion resistance and it was found that the erosion is higher