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Improved corrosion and wear resistance of laser alloyed Zn-Sn-Ti composite coatings on UNS G10150 steel in 0.5 M H_2SO_4 solution

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Surface deterioration by corrosion is one of the complications associated with ageing facilities and components especially under some service environments. The research work examines the corrosion behavior of laser alloyed UNS-G10150 steel; coatings have been obtained by laser surface alloying technique. Ternary combinations of Zn-Sn-Ti metallic powders were mixed and injected onto the surface of UNSG10150 mild steel substrate under different laser processing parameters. The steel alloyed samples were cut to corrosion coupons, immersed in sulfuric acid (0.5M H_2SO_4) solution at 30°C using electrochemical technique and investigated for its corrosion behavior. The morphologies and microstructures of the developed coatings and uncoated samples were characterized by Optic Nikon Optical microscope (OPM) and scanning electron microscope (SEM/EDS). Moreover, X-ray diffractometer (XRD) was used to identify the phases present. The improved properties were attributed to the formation of new corrosion phases ($(Zn(OH)_2$, ZnO, $ZnSn(OH)_6$, Ecandrewsite, syn ($ZnTiO_3$), Anatase, syn(TiO_2), Romarchite, syn(SnO), Zinc Tin Oxide (Zn_2SnO_4), Chinese white (ZnO), and fine eutectic microstructures. An improvement of 6.9-times the hardness of the steel substrate was achieved at high scanning speed which may be attributed to the fine microstructure, dislocations and the high degree of saturation of solid solution brought by the high scanning speed. The polarization resistance Rp (5388300 $\Omega.cm^2$) was 337,803-times the polarization of the UNSG10150 substrate and significant reduction in the corrosion rate was also achieved. In addendum, Response Surface Model [RSM] and Artificial Neural Network Model [ANN] were used for the optimization and modeling of the laser parameters since processing parameters played an important role in the quality of alloyed coating produced. Corresponding experimental results show a good qualitative conformity with the numerical model predictions.

Biography

O S Fatoba is currently a PhD researcher completing his Doctorate degree at Department of Chemical, Metallurgical and Materials Engineering, Tshwane University of Technology, Pretoria, South Africa. He holds BS (Mechanical Engineering) degree and MS degrees in Mechanical Engineering & Metallurgical and Materials Engineering. His research works are on Laser Based Surface Engineering of Steels for Enhanced Service Performance as well as process optimization via Artificial Neural Network, Genetic Algorithm, Finite Element Method, Taguchi and Response Surface Models. His research experience has culminated in publications of over 16 articles in peer-reviewed journals and several oral presentations in both local and international conferences.

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