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Electrochemical and Microstructure Properties of Chromium-Graphene and SnZn-Graphene Oxide Composite Coatings

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Abstract : Coatings plays an important role in providing protection for a substrate and in improving the surface quality. Graphene/graphene oxide (GO) using in coating systems provides an environmental friendly solution towards protection against corrosion. Issues such as, lack of scale, high cost, low quality limits the practical application of graphene/GO as corrosion resistant coating material. One other way to employ these materials for corrosion protection is to incorporate them into coatings that are conventionally used for corrosion protection. Due to the extraordinary properties of graphene/GO, it has been demonstrated that the coatings containing graphene/GO are more corrosion resistant than pure metal/alloy coatings. In the present work, Cr-graphene and SnZn-GO composite coatings were investigated in enhancing the corrosion resistant property when compared to pure Cr coating and pure SnZn coating respectively. All the coatings were electrodeposited over mild-steel substrate. Graphene and GO were synthesized by electrochemical exfoliation method and modified Hummers' method respectively. In Cr coatings, the microstructural study revealed that the addition of formic acid in the coatings reduced the number of cracks in the coatings. Further addition of graphene in Cr coating enhanced the Cr coating's morphology. Chemically synthesized ZnO nanoparticles were also embedded in the as-deposited Cr and Cr-graphene coatings to enhance the adhesion of the coating, to improve the surface finish and to increase the corrosion resistant property of the coatings. Diffraction analysis revealed that the addition of graphene also altered the texture of the Cr coatings. In SnZn alloy coatings, the morphological and topographical characterization revealed that the relative smoothness and compactness of the coatings increased with increase in the addition of GO in the coatings. The microstructural investigation revealed large-scale segregation of Zn-rich and Sn-rich phases in the pure SnZn coating. However, in SnZn-GO composite coating the uniform distribution of Zn phase in the Sn-rich matrix was observed. This distribution caused the early and uniform formation of ZnO, which is the corrosion product, yielding better corrosion resistance for the SnZn-GO composite coatings as compared to pure SnZn coating. A significant improvement in corrosion resistance in terms of reduction in corrosion current and corrosion rate and increase in the polarization resistance was observed in Cr coating containing graphene and in SnZn coatings containing GO.

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