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An Investigation on the Pulse Electrodeposition of Ni-TiO2/TiO2 Multilayer Structures

Authors : S. Mohajeri

Abstract : Electrocodeposition of Ni-TiO2 nanocomposite single layers and Ni-TiO2/TiO2 multilayers from Watts bath containing TiO2 sol was carried out on copper substrate. Pulse plating and pulse reverse plating techniques were applied to facilitate higher incorporations of TiO2 nanoparticles in Ni-TiO2 nanocomposite single layers, and the results revealed that by prolongation of the current-off durations and the anodic cycles, deposits containing 11.58 wt.% and 13.16 wt.% TiO2 were produced, respectively. Multilayer coatings which consisted of Ni-TiO2 and TiO2-rich layers were deposited by pulse potential deposition through limiting the nickel deposition by diffusion control mechanism. The TiO2-rich layers thickness and accordingly, the content of TiO2 reinforcement reached 104 nm and 18.47 wt.%, respectively in the optimum condition. The phase structure and surface morphology of the nanocomposite coatings were characterized by X-ray diffraction (XRD) and scanning electron microscopy (SEM). The cross sectional morphology and line scans of the layers were studied by field emission scanning electron microscopy (FESEM). It was confirmed that the preferred orientations and the crystallite sizes of nickel matrix were influenced by the deposition technique parameters, and higher contents of codeposited TiO2 nanoparticles refined the microstructure. The corrosion behavior of the coatings in 1M NaCl and 0.5M H2SO4 electrolytes were compared by means of potentiodynamic polarization and electrochemical impedance spectroscopy (EIS) techniques. Increase of corrosion resistance and the passivation tendency were favored by TiO2 incorporation, while the degree of passivation declined as embedded particles disturbed the continuity of passive layer. The role of TiO2 incorporation on the improvement of mechanical properties including hardness, elasticity, scratch resistance and friction coefficient was investigated by the means of atomic force microscopy (AFM). Hydrophilicity and wettability of the composite coatings were investigated under UV illumination, and the water contact angle of the multilayer was reduced to 7.23° after 1 hour of UV irradiation.

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