

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

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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.

Keywords : electrodeposition, hydrophilicity, multilayer, pulse-plating

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