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A novel method designed for electrodeposition of nanocrystalline Ni coating and its corrosion behaviors in Hank's solution

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Abstract

Unlike the traditional direct current deposition, a novel method of ultrasonic-assisted double pulse current deposition was developed to fabricate nanocrystalline Ni coatings on the surface of pure Titanium (TA2) substrate. In order to make surface modification of TA2 substrate for better electrodeposition of Ni coatings with strong interfacial adhesion, an effectively activating solution of a dilute HF-containing solution contained of DMF, $TiCl_3$ and $Ce(NO_3)_3$ additives was applied. Attentively, different ultrasonic frequencies (i.e., 0, 45, and 80 kHz) produced by ultrasonic field were employed for comparing their effects on managing textural evolution of Ni growth. Besides an optimization of periodic variation for ultrasonic frequency (UF) was innovatively designed as a novel approach to prepare nanostructured Ni coatings with better densification. In addition, several electrochemical measurements of electrochemical impedance spectroscopy (EIS) and polarization curves were devoted to making a comparative study of corrosion behaviors for electrodeposited Ni coatings under different ultrasonic frequencies. Survey results showed that a fully denser structure of nanocrystalline Ni coating was achieved by adding ultrasonic oscillations into the electroplating processes. So it exhibited superior corrosion resistance for Ni coatings prepared at 45+80 kHz (PV), followed by 45, 0, and 80 kHz in Hank's solution at 36.5 °C. Considering combined effects from both ultrasonic oscillations and double-pulsed current on structural evolution of electrodeposited Ni coating, an analytical modeling was illustrated for evaluating their mechanisms on modifications of concentration polarization and cathodic overpotential for more dynamic recrystallization and better structural densification of Ni grains.

Keywords: Electrodeposition; Ultrasonic oscillations; Textural evolution; Ni coatings; Hank's solution; Corrosion resistance

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