Electrodeposition of Ni from Choline Chloride/Ethylene Glycol Deep Eutectic Solvent and Pure Ethylene Glycol

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Abstract The electrochemical behavior of Ni(II) ions at the glassy carbon electrode was studied using choline chloride-ethylene glycol (ChCl-EG) and ethylene glycol (EG) as solvents. The deposition behavior of Ni(II) was investigated by cyclic voltammetry (CV) tests. The results showed that the reduction of Ni(II) ions in both non-aqueous solvents was an irreversible process controlled by diffusion, and the cathodic efficiency of Ni(II) ions in EG (67%) was higher than that in ChCl-EG (28%), and the diffusion coefficient in EG (3.11×10^{-7} cm^2/s) was higher than that in ChCl-EG is larger than its diffusion coefficient in ChCl-EG (8.34×10^{-8} cm^2/s), indicating that Ni(II) diffuses faster and has a higher deposition efficiency in EG. The nucleation process of Ni was investigated in detail by chronoamperometry (CA) experiments, and the results showed that the reactions of Ni in EG and in ChCl-EG conformed to the three-dimensional transient nucleation mechanism and three-dimensional continuous nucleation mechanism, respectively, including three processes: adsorption process (j_{ads}), diffusion-controlled three-dimensional nucleation/growth process ($j_{3D\text{-}DC}$) and water reduction process (j_{WR}). Scanning electron microscopy (SEM) and x-ray diffraction (XRD) were used to study the microscopic morphology and phase composition of nickel plating, and it was verified that different species of complex anions $[NiCl_3(EG)_3]^-$ and $[NiCl_4]^{2-}$affected the morphology and density of nickel metal, and that the nickel plating in EG had small ‘‘needle-like’’ nuclei. The corrosion resistance of the nickel plating was investigated by polarization curves and AC impedance tests, and the results showed that the nickel plating obtained by electrodeposition in EG and EG-NaCl had the best corrosion resistance.

Keywords: Ethylene glycol, Nickel, Electrochemical behavior, Non-aqueous solvent

Reference

[1] Zhang F, Yao Z, Moliar O, et al. Nanocrystalline Ni coating prepared by a novel electrodeposition[J]. Journal of Alloys and Compounds, 2020, 830: 153785.

[2] Omar I M A, Al-Fakih A M, Aziz M, et al. Part II: Impact of ionic liquids as anticorrosives and additives on Ni-Co alloy electrodeposition: Experimental and DFT study[J]. Arabian Journal of Chemistry, 2021, 14(1): 102909.