The Study of the Electrodeposition of Nickel-alumina Composite

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Introduction

Composite coatings can be produced by electro-deposition of metals accompanied with nometallic powders such as carbide, oxide or organic compounds to obtained coatings with high wear-resistance, anti-friction or anti-corrosion.

From the literatures, the plating parameters including type of agitation, particle size [1], current density, particle concentration [2], as well as the physic-chemical characteristics of electrolyte and non-metallic powder has been investigated [3]. But few studies emphasized the effect of temperature on the properties of coatings. This paper will report the electrolyte temperature effect on the coatings.

Experimental Conditions

Watts bath was used in this study. The electrolyte contained 0.76M $NiSO_4$ $6H_2O$, 0.56M NH_4Cl, 0.48M H_3BO_3, 1.0g/L saccharin and 0.1g/L sodium dodecyl sulfate. The pH was adjusted with NaOH and HCl. The electrolyte also contained 20g/L alumina powders with a particle size about 0.05μm. A copper plate and a nickel plate were used as the working electrode and counter electrode, respectively. Constant currents were applied with a potentiostat (EG&G model 273A), and the corresponding potentials were reported based on Ag/AgCl electrode.

The distribution of particle sizes in the coatings were obtaind from SEM micrographs, and the volume of alumina powders incorporated into the coatings were determined from micrograph images.

Results and Discussion

From the experiment, the current density increased with temperature. For any particular current density, the deposition at higher temperature needed less negative potential, or smaller overpotential, as shown in Figure 1. Figure 2 shows that current efficiency for nickel electrodeposition increased with current density before reaching a maximum current efficiency. The current efficiency also increased with temperature, corresponding to lower overpotential. At low current density, or low overpotential, the current efficiency decreased due to competitive reaction, or proton reduction [3-5].

The volume percentage of alumina incorporated into the nickel matrix was effected by temperature as shown in Figure 3. It appeared that the amount of alumina in the nickel matrix increased with current density, and reached a maximum about 10% in the current density of 10~20mA/cm^2 for temperature range of 30~50^{o}C. The current density to reach the maximum amount of alumina in the matrix increased temperature.

References

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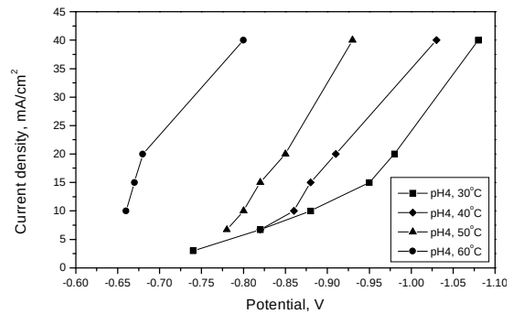

Fig. 1 Polarization curves for different temperatures.

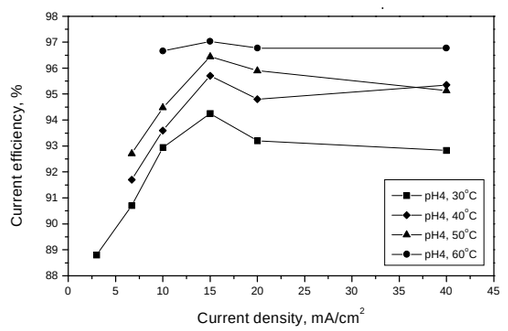

Fig. 2 Effect of current density on current efficiency at various temperatures.

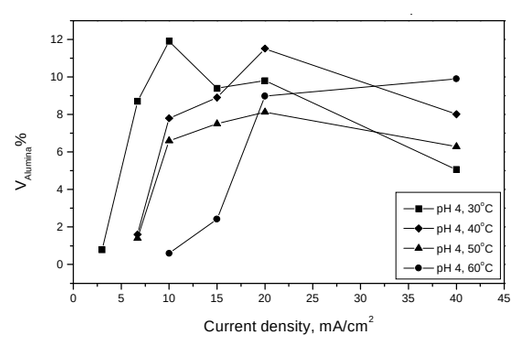

Fig. 3 Effect of current density on volume percentage of alumina particles in composite at various electrolyte temperatures.