Thesis Title	Zinc - nickel Pulse Plating for Corrosion Resistance Improvement
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Abstract

This study is aimed to improve corrosion resistance of low carbon steel for automotive application. Pulse plating technique was applied to Zn-Ni alloy coating on low carbon steel substrate. Acid plating bath (chloride bath) was selected for the study, which were a comparison between coating surface properties using pulse and conventional electroplating and an investigation of effects of plating parameters: types of electrolyte, additive, current density, pH, duty cycle and frequency. Three types of electrolytes considered in this experiment were KCl, non-KCl, and non-KCl with Sodium Lauryl Sulfate (SLS, a surfactant). All plating conditions were designed to achieve coating surfaces with 10 μm thick. Non-KCl with SLS electrolyte provided Zn-Ni alloy surfaces with good corrosion resistance for both pulse and conventional electroplating techniques. The optimum plating conditions were SLS 0.075 g/l, $NiCl_2 \cdot 6H_20$ 180 g/l, $ZnCl_2$ 200 g/l, H_3BO_4 40 g/l, pH of 3.5, and plating temperature of 38 °C. Under the plating condition, coating from conventional electroplating with current density of 3 A/dm^2 had corrosion resistance of 781 hours 5% red rust in salts spray. The 0.075 g/l concentration of SLS was the least amount of SLS that caused no precipitation of the electrolyte and gave good corrosion resistance surfaces with little changes in the value as current density changed. Under the same plating condition and with pulse-plating parameters: current density of 3A/dm^2, frequency of 250 Hz, and low duty cycle of 15%, Zn-Ni alloy coating had corrosion resistance of 789 hours 5% red rust in salts spray. Corrosion rate of 4.976 mpy (mil per year) of the surface was obtained using potentiodynamic scan. Energy dispersive spectrometer (EDS) was used for chemical analysis. Scanning Electron Microscope (SEM) and X-Ray Diffraction (XRD) were used for morphology study and crystal structure determination, respectively. No systematic relationship between Ni content and corrosion resistance was found. On the other hand, microstructure seemed to play an important role on corrosion resistance of the coatings and the relationships between them can be summarized as follow: corrosion of coatings with structures of nodular ($(411)_{\gamma}$ และ $(330)_{\gamma}$) > irregular ($(411)_{\gamma}$ และ $(330)_{\gamma}$) > massive cauliflower-like $(101)_{\eta}$, $(411)_{\gamma}$ และ $(330)_{\gamma}$ > whisker structure $(101)_{\eta}$, $(411)_{\gamma}$ และ $(330)_{\gamma}$. Chromating was also applied on the Zn-Ni coatings. Corrosion resistance of the surfaces showed that the method is the complement to Zn-Ni alloy coating.

Keywords: pulse plating / zinc alloy plating / corrosion resistance / Zn-Ni alloy / acid bath /nodular structure/chromating