Synthesis and Characterization of NiCoP Alloys via Electrodeposition

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Numerous studies have been carried out on deposition of ternary NiCoP thin films, primarily due to their potential applications in high density recording (1-4), microelectromechanical systems (5-7), batteries (8, 9) and other engineering areas. These alloys exhibit unique magnetic (10, 11), wear resistant (12), heat conductive (13, 14) and electrocatalytic properties (15, 16). Electrodeposition and electroless deposition techniques are usually preferred over more expensive and high maintenance vacuum processes due to their ability to tailor the deposit structure and properties at low operating temperatures. Electrodeposited amorphous alloys are generally more porous, less uniform and less corrosion resistant than their electroless counterparts (17). However, due to the ease of operation, lower cost, faster deposition rates and stable baths (17), electrodeposition is preferable for most applications.

A number of electrodeposition studies of NiCoP deposition are reported (18 – 25). Electrodeposition of these alloys is of special interest since they exhibit two types of phenomena – anomalous deposition and induced deposition (26). In anomalous deposition, the less noble metal deposits preferentially, and consequently, its content in the alloy is much higher than its relative content in the solution. In induced deposition, metalloids such as P and B are deposited in the presence of Ni and Co although they cannot be deposited alone. Since the

properties of these alloys are greatly affected by their composition as well as the structure, the effect of various process variables on the composition and structure is an important issue for their wide application. Djokic (18) used a phosphorus acid bath to study the effect of current density on the deposit composition. He found that increasing the current density enhanced the Co content in the electrodeposit, while that of Ni and P decreased. Park et al (27) observed that increasing the Co content in the solution resulted in an increase in the relative Co content in the deposit. However, the current efficiencies were found to remain essentially constant. In addition, the phosphor (P) content in the deposit was found to increase with the hypophosphite (source of P) concentration in the electrolytic bath. The morphology and the structure of the deposits were also found to be dependent on the P content. In general, the incorporation of phosphor and its relative content in the alloy deposit leads to the production of amorphous alloys (26).

The purpose of the present work is to establish the influence of the electrodeposition process variables on the composition of the NiCoP amorphous deposits and the Faradaic current efficiency of deposition. In addition, the influence of phosphorus acid concentration and the buffer (phosphoric acid) concentrations on the structure and composition of the deposits is also evaluated. Finally, the effect of the relative P content on the deposit properties such as corrosion resistance, hardness and thermal stability is presented.

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