EFFECTS OF ORGANIC ADDITIVES ON ELECTROPLATED IRON-GROUP METALS AND ALLOYS.

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Thin films of the iron- group elementals metals and theirs alloys have numerous important industrial applications. Three great groups of magnetic films can be distinguished: nickel-iron, cobalt-iron and ternary alloys, which are composed of cobalt-iron and other elements like nickel, copper or chromium. To improve coating characteristics, several electroactive species can be added into electrolysis bath. They are the key for successful electroplating even though the amounts used in coating formulations are small. Several studies have investigated the influence of organic additives in the plating bath [1-6]. Some additives are known to enhance the morphology and physical properties of metal electrodeposits. Saccharin, thiourea and others compounds are commonly used as leveling and brightening agents in electroplating [1-3, 5, 6]. Despite the widespread use of plating additives, relationship between molecular structure and the final performance of additives for a deposited metal are not still completely known.

The objective of the study is also to investigate the effect of organic additives: saccharin (SAC), phthalimide (PHTA) and a new additive (OAS), on the electrochemical preparation of alloys composed of cobalt-iron. The properties as for example composition, stress, morphology, inclusion of sulfur, electric and magnetic properties and corrosion resistance were analysed. The originality of this work is to understand the influence of molecular structure of SAC, which was used as conventional additive in manufactures. The sulfonamide group (R-SO_2-NHR) seems to play an important role on the electrodeposition by inclusion of sulfur in the deposit. That's why, the OAS additive was tested as another additive inclusing the sulfonamide group in its molecular formula. The molecular structure of PHTA compound differs from saccharin by only one functional group. The sulfonamide group present in SAC was replaced by a carbonyl group in phthalimide. View to the experimental results, the presence of the sulfonamide group influence the deposit morphology and the nucleation rate by poisoning the active sites of the surface. We can observe that the CoFe morphology produced with OAS was acicular (Fig. 1). In the case of phthalimide, deposits were dark and mat and we can note an inhomogeneous morphology with crystal aggregates of a size between 0.5 and 0.7 µm (Fig. 2). In addition, it was evidenced that organic species are incorporated in the metal and they change corrosion resistance properties (Fig. 3).

Moreover, to find and investigate into more details the organic additives interactions occuring during the electrodeposition, the electrochemical reaction rates have been studied using a copper rotating disk electrode. The influence of SAC, PHTA and OAS have been approached for single metals and for cobalt and for iron present in the binary CoFe alloy. In the case of cobalt, we can observe that the partial current densities were shifted towards more negative values. The bigger concentration in SAC, the slower electrolytic deposition kinetic of cobalt is represented in the figure 4. The measured Tafel slopes for single metal deposition were deduced for the plots of partial current density versus potential. The data of this study were compared to the values proposed in the litterature by Zech and Sasaki [7, 8].

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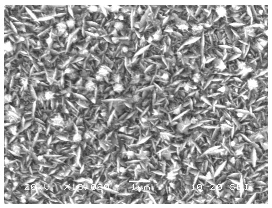

Figure 1

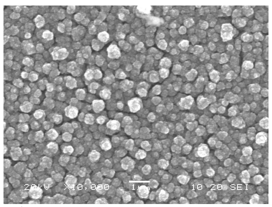

Figure 2.

SEM micrographs of CoFe alloy electrodeposited with OAS (Figure 1) and with PHTA (Figure 2).

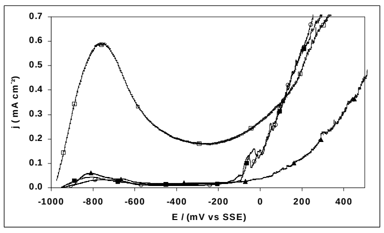

Figure 3. Corrosion behavior of $Co_{91.5}Fe_{8.5}$ electrodeposited with phthalimide (□), saccharin (○), OAS (▲), without additives (■).

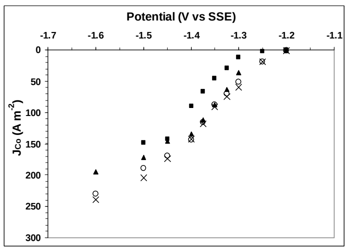

Figure 4. Partial current densities of cobalt for CoFe deposits produced from electrolyte containing no additives (O), OAS (×), PHTA (▲) and SAC (■).