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# ELECTRODEPOSITED AMORPHOUS ALLOYS

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The main characteristic of amorphous materials is their lack of long range crystallographic order, although they present some short range order over a few atomic distances. This confers in these materials, chemical and physical properties different from their crystallographic counterparts. An example of great importance is the superior corrosion resistance of certain amorphous alloys (like iron base alloys) when compared to that of their crystalline counterparts (like stainless steels).[1] This improved corrosion resistance was attributed to the chemically homogeneous monophasic structure of the amorphous material [2], the presence of a certain amount of chromium [3] and a large amount of elements such as B, C, Si, and P.[2,4] The practical application of amorphous coatings to protect other metals is limited by the form, stability and workability of these alloys as obtained by conventional methods such as rapid solidification from the vapor or liquid phase.[5] A number of other techniques have been used successfully to obtain amorphous alloys on various substrates [6], and among these, conventional electrodeposition from aqueous solutions is considered to be simple, quick and economical.[7] This paper presents the effect of certain processing parameters on the characteristics of the amorphous deposits.

The basic composition of the electrolytic bath used to deposit the amorphous alloys is shown in Table 1. The addition of complexing agents to the electrolytic bath has the function of forming complex compounds of Fe ions at negative deposition potentials, which permit their co-deposition with Cr ions. Table 2 presents the experimental parameters utilized in the electrodeposition of the Fe-Cr-P amorphous alloys. The electrodeposits were analyzed semi-quantitatively using X-ray fluorescence and the degree of amorphization determined by X-ray diffraction. The morphology was examined in a SEM. The results showed that (a) the current efficiency (~ 15 %) at bath temperature of 25 °C, independent of current density and duration of deposition; (b) the mean crystallite size of the deposits was 15 Å; (c) the chromium content of the deposit increased with increase in current density and duration of deposition, and was also in the desirable range (6-9 at%) to confer corrosion resistance to the substrate;[3] and (d) hydrogen evolution during the electrodeposition affected the morphology of the deposits (Fig. 1 and 2).

References

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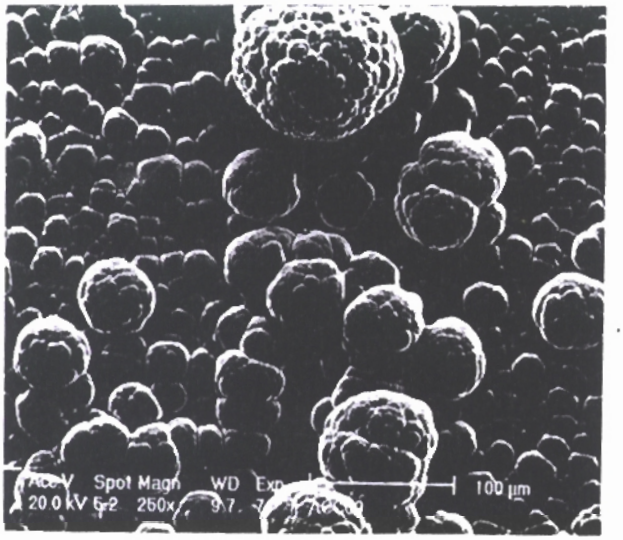
1

| Reagent | Concentration (g/l) | Function |
|---|---|---|
| $FeNH_4(SO_4)_2.H_2O$ | 60 | source of Fe |
| $H_3BO_3$ | 40 | pH reducer |
| $Na_3C_6H_5O_7.2H_2O$ | 45 | complexant agent |
| $C_6H_8O_7.H_2O$ | 30 | complexant agent |
| $Cr_2(SO_4)_3.nH_2O$ | 182 | source of Cr |
| $NaH_2PO_2.H_2O$ | 10 | source of P |
| $(NH_4)_2SO_4$ | 80 | complexant agent |
| $K_2SO_4$ | 20 | to increase conductivity |

2

| Parameter | Condition |
|---|---|
| Bath pH | 0,6 - 0.7 |
| Bath temperature (°C) | 15 e 25 |
| Current density $(mA/cm)^2$) | 100 e 150 |
| Deposition time (min) | 60, 90 e 120 |
| Bath agitation | moderate |

3

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1 Table 1 : Electrolytic bath composition utilized in the deposition of Fe-Cr-P amorphous alloys.

2 Table 2 : Process parameters of electrodeposition of Fe-Cr-P amorphous alloys.

3 Figure 1: Deposit near specimen edge obtained at 100 $mA/cm^2$ and 25°C after 120 minutes.

4 Figure 2: Deposits near specimen center. Conditions identical to deposit in Figure 1.