Electrodeposition of Nickel-Iron Alloy from Sulphosalicylate Bath

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THE process of electrodeposition of nickel-iron alloys helps the electroplater to reduce the operating cost by introducing 30% of iron in the deposit /1/. 10% of the nickel anodes were also substituted by iron anode/2/. Moreover, the solution composition is also very dilute causing no deleterious effect on the nature of deposit by the presence of iron, as it is experienced in nickel plating/3/. Alloys with 80% Ni and 20% Fe are used in high speed memory units of computer/4/. They are also used for magnetic shielding and in the preparation of electronic wire condensers/5/. The recent application of the nickel-iron coatings is for decorative applications both indoor as well as for outdoor purposes6.

Various baths have been developed for the deposition of this alloy. Deposition has been carried out from sulphate/8/, sulphate-chloride/9/, sulphamate/10/, pyrophosphate/11/, fluoborate/12/, acetate/13/, citrate/14/, tartrate/15/ baths using various complexing agents. In this paper we have studied the electrodeposition of nickel-iron alloy from sulphosalicylate bath/16/.

EXPERIMENTAL

A solution of the following composition has been used.

Nickel sulphosalicylate	....	190 gms/l
Iron sulphosalicylate	....	40 gms/l
Nickel (as metal)	...	22 gms/l
Iron (as metal)	....	4.4 gms/l
Boric Acid	....	30 gms/l
pH	....	2.8—3.2
Temperature	....	30—60°

The nickel sulphosalicylate and iron sulphosalicylate were prepared by taking their carbonates and dissolving them in sulphosalicylic acid. Rolled anodes were used and the anode were nicely bagged before plating. Deposition was carried out on platinum metal for analysis for a period of 30 minutes. The deposits were then stripped in dilute nitric acid and analysed for iron gravimetrically as ferric oxide. The cathode current efficiency was calculated from the weight of alloy deposited for a known period of time. The effects of various parameters like iron concentration, nickel concentration, pH, temperature, agitation etc. on the alloy composition have been studied. The deposits were tested for hardness using Knoop tester. The stress measurements were made using Hoar and Arrowsmith method.

RESULTS AND DISCUSSION

Effect of iron concentration in electrolyte : It is found that the percentage iron in the alloy is dependent on the amount of iron present in the solution. Fig. 1 shows the effect of iron concentration on the percentage iron in the alloy. There is a gradual increase in the percentage, and decrease in the cathode current efficiency. The deposits containing upto 20% iron were semi-bright, and smooth also. Fig. 2 shows the effect of nickel concentration on the nickel content of the alloy.

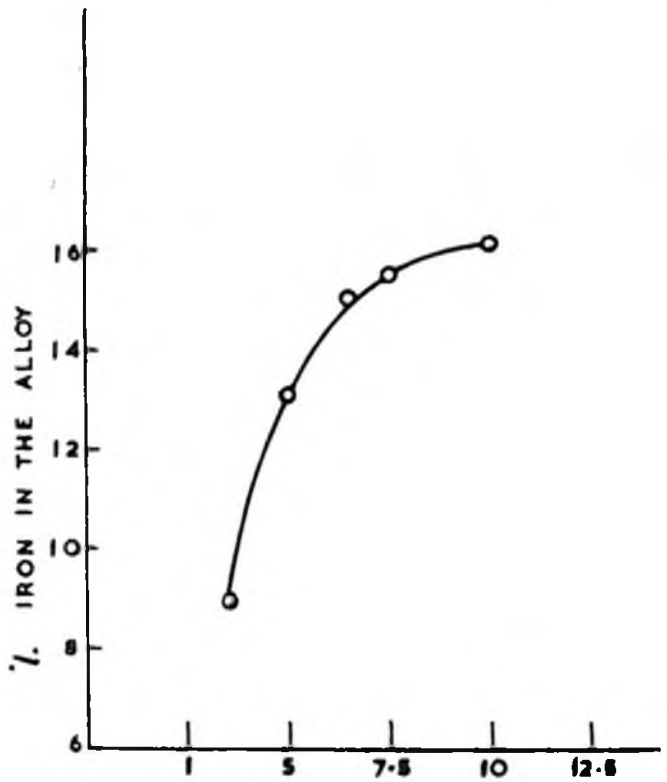


FIG. 1. EFFECT OF IRON CONCENTRATION ON THE PERCENTAGE ALLOY COMPOSITION.

Effect of pH of the electrolyte : Fig. 3 shows that the percentage of iron in the deposit decreases as we increase the pH from 3-5. Similarly at low pH velues also, the amount of iron codeposited is

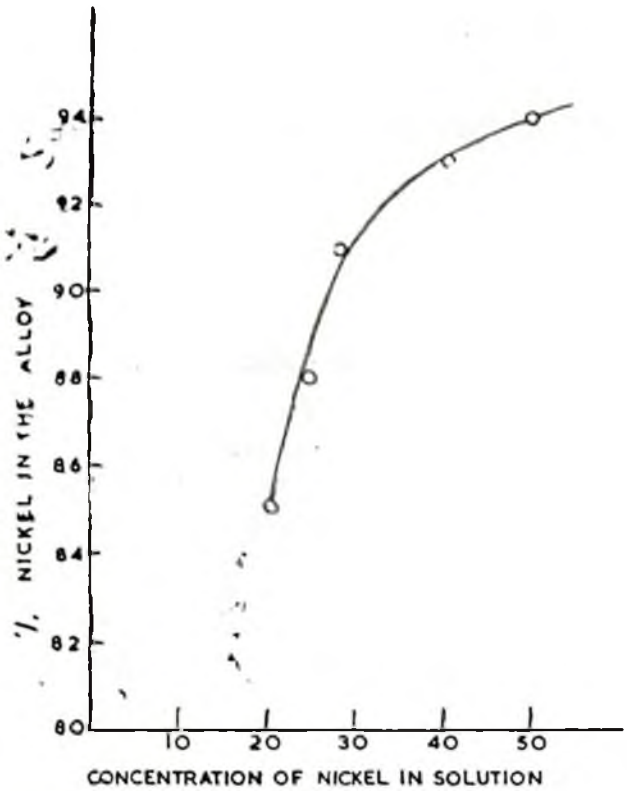


FIG. 2. EFFECT OF NICKEL CONCENTRATION ON THE PERCENTAGE ALLOY COMPOSITION.

very much lesser and below pH 2 there is no indication for the presence of iron in the deposit at all.

Effect of temperature of the electrolyte : It is found that rise in temperature results in a decrease in the iron content of the alloy and increase in cathode current efficiency also.

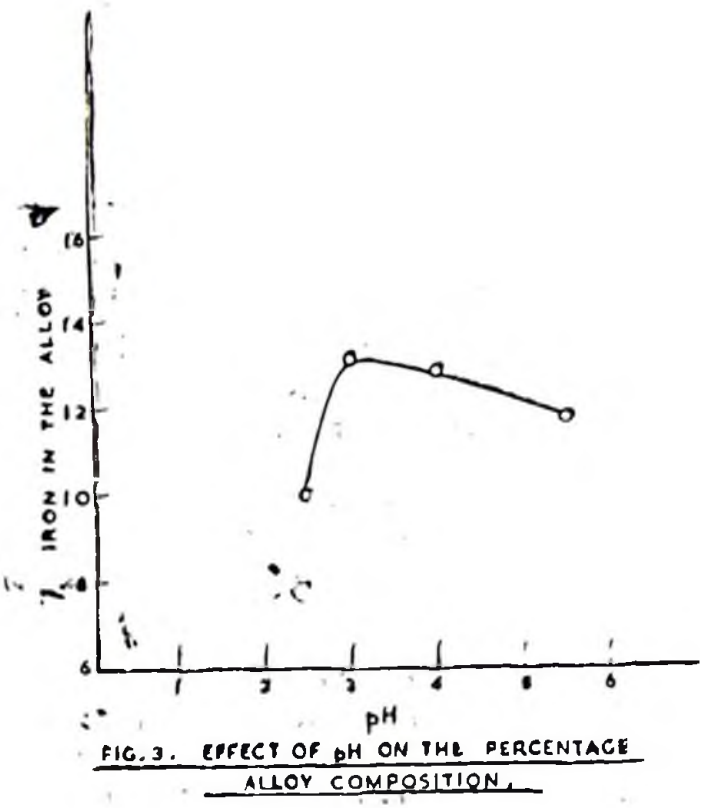


FIG. 3. EFFECT OF pH ON THE PERCENTAGE ALLOY COMPOSITION.

Effect of agitation of the electrolyte : Agitation of the electrolyte increases the iron content of the deposit. It is found that by cathode movement the percentage of iron increases to nearly 19% and and with air agitation it increases to 27%. It is also found that stirring improved the brightness of the deposit in comparison to that obtained from the unstirred electrolyte. However, stirring decreases cathode current efficiency.

TABLE 1 : *Effect of agitation on the percentage of Iron in the alloy*

Sl. No.	Condition	% Iron	% C.C.E.
1	Unstirred	11	92
2	Cathode rod movement	19	90
3	Air agitation	27	82

Effect of percentage composition of the alloy on hardness of electrodeposits : It is found that as the iron content of the alloy increases the hardness of the alloy increases. The hardness obtained for the deposits from these baths are lower, when compared to those obtained from citrate baths.

TABLE 2 : *Effect of percentage Iron in the alloy on the hardness of the alloy*

No.	Percentage iron in the alloy	Hardness VPN
1	10	378
2	13	400
3	18	478
4	27	580

The measurements of internal stress in deposits obtained in this bath shows that the stress values are lesser than those obtained from citrate bath. In citrate bath, deposits from pure bath were only cracked and peeled off very easily due to high stress. Without the presence of a stress reliever like saccharin, it is impossible to get good deposit. In this bath due to low stress, the deposits were semibright and good and adherent even in the absence of stress relievers. It is also found that the stress values obtained with 13% iron alloy is even lesser than those obtained for pure nickel deposits. The studies on

electrodeposition of nickel-iron alloy from sulphosalicylate bath have revealed that the composition of the alloy primarily depends on the concentration of metals getting codeposited and secondarily on the pH and temperature.

Increase of metal ion concentration in the bath increases the concentration of respective metal ions in the cathode diffusion layer and hence increases the percentage of metal in the deposit. Stirring increases the iron content by increasing its content in the cathode diffusion layer. The effect of pH on the alloy composition is mainly due to the preferential complexing of iron by sulphosalicylate, The effect of temperature can be ascribed to the shift in the polarisation more towards the nickel side to that more of nickel gets codeposited at high temperatures. The relatively low stress of the alloy may be due to the fact that sulphosalicylate itself acts as a stress releiver.

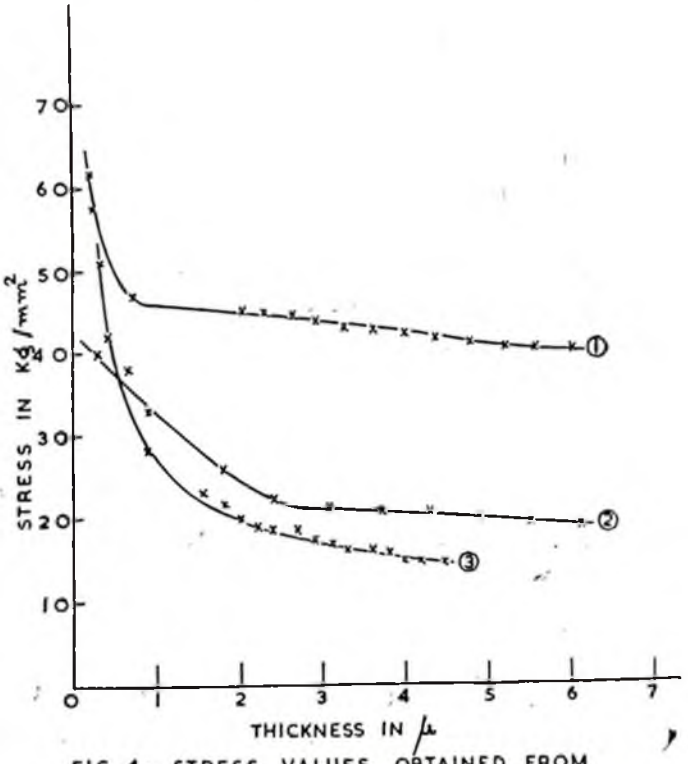


FIG. 4. STRESS VALUES OBTAINED FROM DIFFERENT BATHS.

CONCLUSION

From our results, it is clear that the nickel-iron alloy obtained from sulphosalicylate bath give smooth, semibright deposits, with low stress. This bath has high stability that permits work at corresspondingly high temperatures compared to sulpamate bath.

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