Nickel-Iron Alloy Plating from the Sulphamate Bath

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ABSTRACT

Nickel has been codeposited with iron from the sulphamate bath. Detailed studies on alloy composition, cathode efficiency and potential have established the conditions for obtaining satisfactory alloy plates containing 32-95 per cent iron.

INTRODUCTION

Nickel—iron deposits have been mentioned as bright protective coatings, as undercoats for nickel and tin plates and enamel, and for magnetic shielding (35 and 50 per cent iron). They have been deposited from sulphate[1-3], chloride[4], sulphate chloride[5,6], cyanide[7], citrate[8,9] and pyrophosphate[10] solutions. A number of patents have been taken. Since the nickel situation has now changed and the metal is no longer in shortage, significant developments can be expected in the field of nickel-iron alloy plating. The sulphamate bath has been used for the plating of nickel in this laboratory[11] as well as elsewhere, and has established itself for commercial work. The plating of iron has been mentioned by Piontelli and Guilotto[12], and Barrett[13] has recently presented data for iron. Work done in this laboratory has shown that the bath is suitable for the plating of iron[14].

EXPERIMENTAL AND RESULTS

The alloy plating solutions contained nickel sulphamate, ferrous sulphamate, sodium acetate and sulphamic acid to adjust the pH. The addition of 0.2M sodium acetate and the required amount of sulphamic acid buffered the solution to a pH of about 3.5. This was necessary since with unbuffered solutions there was a large rise in pH during electrolysis resulting in precipitation. It was possible to obtain good quality deposits, grey to bright in appearance in the composition range 32-95 per cent iron under the following conditions: bath composition—nickel 9-175 g/l, iron 5.5-165 g/l, sodium acetate 0.2M; pH 3.5; temperature 25-35°C; bath voltage 0.8-2.6 volts; copper coated platinum cathode and alloy anode—60 per cent iron, still plating; cathode current density (max.) —10 amp/dm^2; cathode efficiency 51-92 and anode efficiency close to 100 per cent. Table I gives some typical results to show the effect of variables on deposit composition, cathode efficiency and potential.

SUMMARY OF RESULTS

The iron content in the alloy deposit increased with an increase in the iron concentration of the solution and current density; it decreased with an increase in the nickel concentration of the solution and slightly with temperature. There was a tendency for constancy of composition at higher current densities, as during the deposition of this alloy from pyrophosphate solutions[10]. The cathode efficiency increased with increase in the current density and metal concentration of the solution, and decreased with agitation. The limiting current density increased with an increase in the iron concentration of the solution as well as temperature. The cathode potential increased with increase in the current density and on agitation; there was a slight decrease with increase in the nickel concentration of the solution or temperature. The potential variations were, however, not marked. The anode presented no difficulties, the corrosion being satisfactory. The anode potential values were in the range 0-0·27 volt. Several addition agents were tried in order to improve the quality of the deposit or the bath performance. Glycerine 20 cc/l was somewhat beneficial and increased the limiting current density. Citric and boric acids had no effect, whereas the deposits with caffein and dextrin were less satisfactory and the limiting current density was decreased.

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TABLE I

Effect of Different Variables on Deposit Composition, Cathode Efficiency and Potential

Temperature 25°C (*35°C), sodium acetate 0·2M, pH 3·5, still plating (**agitation, 1000 r.p.m). For each concentration the first figure under current density gives the iron per cent by weight in the deposit, the second the cathode efficiency per cent, and the third the cathode potential (–ve sign) in volts on hydrogen scale.

Bath composition, N		*c.d. amp/dm²*						
Ni	*Fe*	*0 5*	*1*	*3*	*4*	*5*	*6*	*10*
0·15	1·5		91	94	95	95	94	95
			63	85	87	88	88	91
			0·71	0·74	0 78	0·78	0·79	0·83
1	1·5	74	79	84	84	84		
		61	75	86	87	88		
		0·65	0·68	0·71	0·71	0·72		
*1	*1·5		76	79	79	79	79	80
			75	85	86	88	88	91
			0 65	0·68	0·69	0·70	0·71	0·72
**1	**1·5		73	84	85	85	85	
			34	70	75	80	82	
			0·71	0·81	0·83	0·90	0·91	
1	0·1	49	42	32				
		51	74	82				
		0·65	0·68	0·72				
1	3	80	85	90				
		82	91	92				
		0·65	0·66	0·70				
3	1·5	59	66	70	70			
		68	82	90	91			
		0.61	0·63	0·67	0·68			

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