Bulletin of Electrochemistry 6 (4) April 1990, pp 418-419

Electroless cobalt-phosphorus deposition

C Joseph Kennedy, K N Srinivasan, M Selvam and S Guruviah
Central Electrochemical Research Institute, Karaikudi - 623 006, INDIA

A suitable bath based on sulfate/citrate has been developed with a deposition rate of 1–4 μm/hr and phosphorus content in the deposit varying from 3–7%. The effect of pH, temperature, bath constituents, cation, anion and substrate effects on the rate of deposition were studied. It is found that the adhesion between the substrate and the coatings was good.

Key words: Electroless plating, cobalt-phosphorus deposition, sulphate/citrate and hypophosphite bath

INTRODUCTION

Thin films of cobalt coatings have been used for magnetic recording purposes [1-7]. Earlier practice of codepositing cobalt with nickel or nickel and iron for use in memory discs is now being replaced by cobalt coating since the magnetic properties exhibited by cobalt alone is desirable for certain applications. Among the various coatings like nickel rich coatings or iron oxide coatings, cobalt rich films have been proposed as information carriers with greater resolution. A thin layer of (1-2 μm) cobalt coating on steel or on nickel plated steel has better corrosion resistance and thereby consumption of nickel used for corrosion prevention can be reduced. In this paper, authors have reported the development of cobalt-phosphorus bath with fairly high rate of deposition and studied the effect of various parameters on the rate of deposition.

EXPERIMENTAL

Various formulations available in the literature [1-7] were selected and their rate of deposition studied. It was found that the bath containing citrate and hypophosphite at alkaline range gave high rate of deposition. The bath constitutents were varied and the rate of deposition on mild steel panels was determined. Based on this, an optimum concentration of ingredients was arrived at. Effect of complexing agent, temperature, anion of the metal, pH of the solution, different substrates on the rate of deposition was also found out. Phosphorus present in the deposit produced at various temperatures was analysed volumetrically by ammonium phosphomolybdate method.

RESULTS AND DISCUSSION

Rate of deposition

Table I shows the rate of deposition of cobalt with various operating temperatures and bath pH. It is found that as the temperature and pH increase the rate of deposition also increases. No deposition was found at pH 8 and at 333 K. So the operating pH was fixed at 10 in order to carry the deposition at lower temperatures.

TABLE–I: Effect of temperature and pH on the rate of deposition

pH	Temp (K)	Rate (μm/hr)
8.0	313	—
	333	—
	353	0.39
10.0	313	0.18
	333	1.83
	353	3.78

Table II shows the effect of changing cation of the complexant of the metal salt and anion on the rate of deposition. It is found that the ammonium cation and sulfate anion increase the rate considerably. Hence ammonium citrate was selected as a complexant and cobal sulfate as the metal ion source.

TABLE–II: Effect of cation/anion on rate of deposition pH = 10.0

Cation/anion	Rate at	
	333 K	353 K
Sodium citrate	0.41	1.19
Ammonium citrate	1.13	3.78
Citric acid	1.13	2.55
Cobalt sulfate	1.83	3.78
Cobalt chloride	0.57	3.05

Table III shows the substrate effect on the rate of deposition. It is found that substrate plays a major role in changing the rate of deposition.

TABLE–III: Effect of substrate on rate of deposition

Substrates	Rate (μm/hr)
Nickel	1.60
Brass	4.29
Steel	4.01
Copper	3.78
Plastic	1.65

Phosphorus content

Table IV shows the phosphorus content present in the deposit at pH 10 at various temperatures. It is found that at higher temperatures (333K) there is no change in the phosphorus content in the deposit.

TABLE–IV: Effect of temperature on P content of the deposit

Temperature (K)	P (%)
313	7.5
333	3.5
353	3.5

CONCLUSION

Based on the studies, it is concluded that the following bath gives fairly high rate of deposition.

Cobalt sulfate	20 g/l
Sodium hypophosphite	35 g/l
Ammonium citrate	30 g/l
pH	10
Temperature	333K
Rate of deposition	1.63μ m/hr

REFERENCES

1. B D Barker and D R Tuberner, *Inst Metal Finishing Annual Conf*, **3** (1979)
2. E Nicholson, *J Electrochem Soc*, **133** (1986) 2342
3. Tetsuya Oska, *Interfinish, 84*
4. D Baudrand and M Malik, *Metal Finish*, **84** (1986)
5. Y H Chang, *J Electrochem Soc*, **133** (1986) 785
6. Ichiro Koiwa, *ibid*, **133** (1986) 165
7. R Subramanian, M Selvam and K N Srinivasan, *Bull Electrochem*, **4** (1988) 25