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Diffused zinc-alumina electrodeposited on cold worked copper and steel

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The Zn + Al_2O_3 layer is deposited on cold-worked steel and copper substrate, using conventional zinc-chloride bath with Al_2O_3 particulates and constantly rotated cathode. The electrodeposited cold-worked steel and copper substrate with and without Al_2O_3 particulates were subjected to short time diffusion at a temperature of 873K, followed by aircooling. Potentiodynamic polarization, variation of potential with time and impedance measurements in 3% NaCl solution were obtained for the coated metal and the results are reported in this paper.

Key words: Particulates, electrodeposition of zinc-aluminium, potentiodynamic polarization

INTRODUCTION

Addition of particulate materials in zinc-alloy coatings have been reported, which were observed to improve the mechanical properties when present in higher concentration. However, addition of these fine particulates in controlled amount may selectively trap the defect sites [1] of the surface and improve the corrosion resistance properties.

EXPERIMENTAL

Zn + Al_2O_3 layers were deposited on cold worked steel and copper substrate, using conventional zinc chloride bath with Al_2O_3. The electrodeposited cold worked steel and copper substrate with and without Al_2O_3 particulates, are subjected to short time diffusion treatment at a temperature of 873K, followed by air cooling. Pure zinc anode (99.9%) and circular specimens of cold worked steel and copper, having an area of 113 mm^2 and a rotating cathode, having 120 revolutions per minute was employed. Deposition was conducted under potentiostatic control.

The bath composition and operating parameters are given below.

Bath composition

$ZnCl_2$-50 g/l, NaCl-160 g/l, H_3BO_3-20 g/l, Carrier-50 ml/l; Brightner-5 ml/l, Al_2O_3 (250 mesh)-1 gm/l and 5 gm/l; pH = 4-5, t = 293 K, Cathode-speed = 120 r.p.m; c.d. = 2 A dm^{-2}, Deposition time = 3456 seconds.

RESULTS AND DISCUSSION

Table I reveals the electrochemical parameters of deposited panels by diffusion annealing in air at 873 K. It is seen that as the percentage of particulates in the bath increases, the coating thickness increases and i_{corr} values decrease. This is supported by the increase in polarization resistant values. However, for cold worked copper substrate, the addition of particulate materials seems to aggravate corrosion beyond 0.1%. Figures 1 and 2 reveal that incorporation of Al_2O_3 has changed the structure of the deposit.

TABLE–I: Electrochemical parameter of deposited panels followed by diffusion annealing in air at 873K
Electrolyte = 3% NaCl

% Al_2O_3 in bath	Cold worked steel			Thickness	Cold worked copper	
	i_{corr} (mA/mm)	R_p (Ohms)	E_{corr} (mV)	μ	i_{corr} ($mA.mm^{-1}$)	E_{corr} (mV)
0.0	89	–	−1125	34.0	0.07	−725
0.1	85	5	−1125	43.2	0.02	−640
0.5	83	15	−1450	58.5	85.0	−1200

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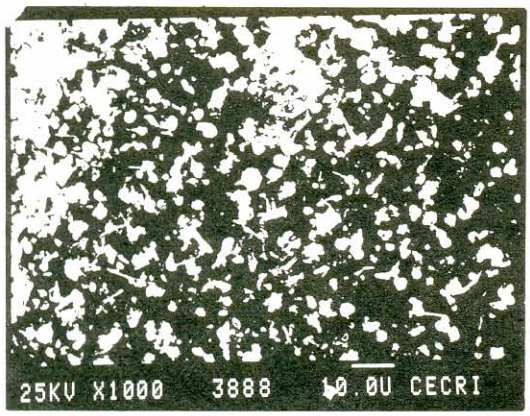

Fig. 1: Zinc deposit without Al_2O_3

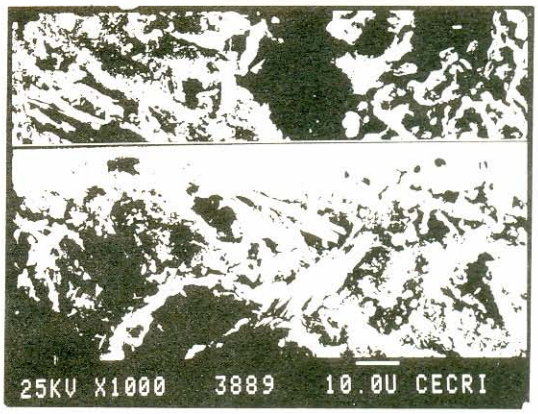

Fig. 2: Zinc deposit with 1 gm Al_2O_3 in the bath

CONCLUSION

It is concluded that electrodeposited and diffused zinc with and without Al_2O_3 on cold worked steel substrate becomes comparable to hot-dip-coated steel. Addition of Al_2O_3 particulates increases thickness and also improves the corrosion resistance.

REFERENCES

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