Bulletin of Electrochemistry 15 (7-8) July-August 1999, pp 242-247

0256-1654/99/$ 3-50

ZINC ELECTRODEPOSITION FROM BROMIDE ELECTROLYTES - EFFECT OF ADDITIVES

M CHANDRAN*, R LEKSHMANA SARMA** AND RM KRISHNAN

Central Electrochemical Research Institute, Karaikudi 630 006. INDIA
* N I College of Enggineering, Kumaracoil 629 175. INDIA
** Vivekananda College, Agasteeswaram 629 701. INDIA

Bright zinc electrodeposition can be obtained by the addition of brighteners in the plating bath. Bright deposits improve the appearance of the article, besides offering good corrosion resistance. In this paper, the effects of different additives in the zinc bromide plating baths using Hull Cell technique are explained. Among the different additives studied, vanillin gives bright deposits.

Keywords: Electrodeposition, zinc, bromide electrolytes.

INTRODUCTION

Zinc electrodeposits offer very good corrosion resistance to ferrous metal parts because of its sacrificial action [1]. Zinc electrodeposits can be obtained from different types of electrolytes namely, acid, cyanide and non-cyanide alkaline [2-8]. The matte white nature of zinc deposits can be improved to bright by the addition of brighteners in the plating bath [9-11]. These types of bright deposits improve the appearance of the article, besides offering good corrosion resistance. The authors have earlier studied the electrodeposition of zinc from bromide based electrolytes [12]. In the present work the effect of different additives in bromide electrolytes from the Hull Cell experiments are discussed.

EXPERIMENTAL

Laboratory grade chemicals were used to prepare the plating baths. The bath compositions shown in Table I were used to study the effect of brighteners.

TABLE I: Bath formulation

Low concentration zinc plating bath		High concentrated zinc plating bath	
Zinc bromide	160 g/l	Zinc bromide	290 g/l
Boric acid	80 g/l	Boric acid	80 g/l
Potassium bromide	50 g/l	Potassium bromide	80 g/l
Aluminium sulphate	40 g/l	Aluminium sulphate	20 g/l

Plating experiments were carried out using mechanically buffed cold-rolled steel specimens subjected to the usual pretreatments like degreasing, alkaline electrocleaning and acid dip.

The nature of zinc deposit over a wide range of current density was ascertained from the Hull Cell experiments using a standard 267 ml cell. The Hull Cell experiments were carried out at 1 A cell current for a duration of 5 minutes at 303 K. The additives used are given in Table II.

RESULTS AND DISCUSSION

The results obtained from Hull Cell experiments are summarised in Figs. 1 to 15.

Effect of vanillin

The concentration of vanillin was varied from 0.5 to 5.0 g/l in the low concentrated zinc plating bath and the results are given in Fig. 2. From the Hull Cell patterns, it may be seen

TABLE II: Additives used

Additive	Concentration
Vanillin	0.5 - 5.0 g/l
Thiourea	0.5 - 2.5 g/l
Glycine	0.5 - 5.0 g/l
Dextrin	0.5 - 5.0 g/l
Gelatin	0.5 - 2.5 g/l
Furfural	0.5 - 5.0 ml/l
Triethanolamine	0.5 - 5.0 ml/l

Fig. 1: Legend used for Hull Cell studies

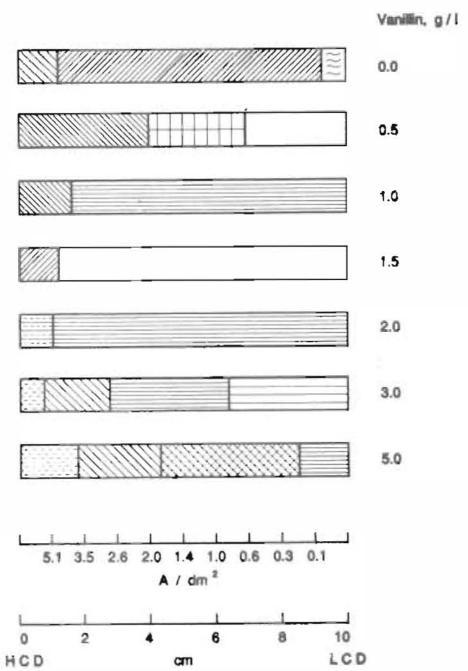

Fig. 2: Effect of change of vanillin concentration in low concentrated zinc plating bath at 303 K and at 1A cell current

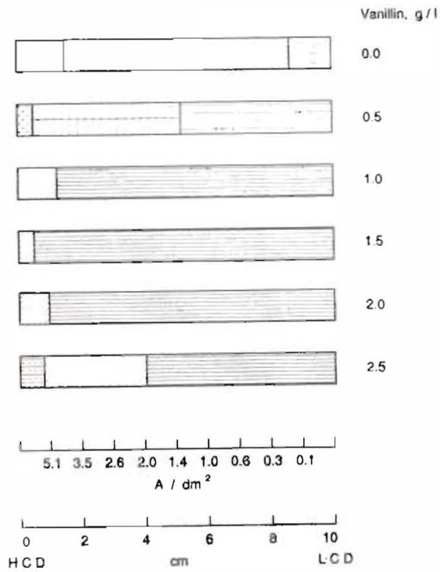

Fig. 3: Effect of change of vanillin concentration in high concentrated zinc plating bath at 303 K and at 1A cell current

that the increase in concentration of vanillin improves the nature of deposit and at a vanillin concentration of 1.5 g/l, a mirror bright deposit was noted between a current density range of 0.05- 4.68 A/dm^2. Further increase in concentration produced semi bright and grey powdery deposits. The optimum concentration of vanillin has been fixed as 1.5 g/l. Experiments were also done with varying concentration of vanillin in the high concentrated zinc plating bath and the

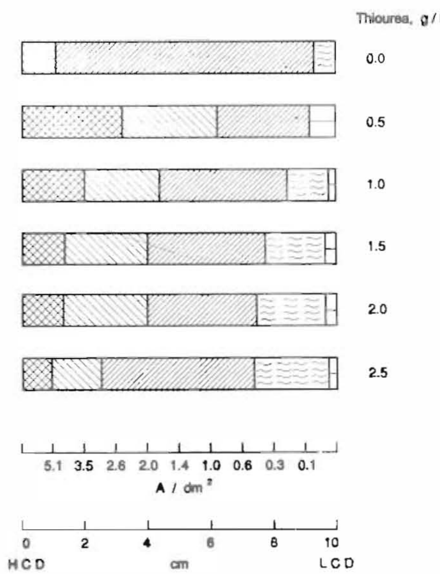

Fig. 4: Effect of thio urea concentration in low concentrated zinc plating bath at 303 K and at 1A cell current

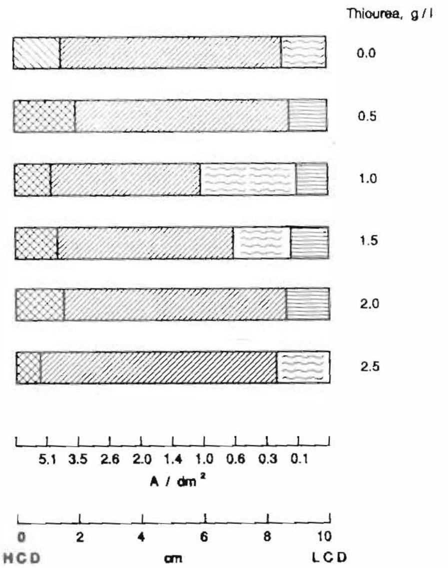

Fig. 5: Effect of change of thio urea concentration in high concentrated zinc plating bath at 303 K and at 1A cell current

results are given in Fig. 3. When the concentration of vanillin was 0.5 g/l, a bright deposit was observed between a current density range of 0.05-1.4 A/dm^2 and at 1.5 g/l, a semi bright deposit was obtained over a wide current density range of 0.05-6.68 A/dm^2. When the concentration of vanilin was further increased, grey deposit region increases. Hence, the optimum concentration of vanillin has been fixed as 0.5 to 1.5 g/l.

Effect of thiourea

The concentration of thiourea was varied from 0.5 to 2.5 g/l in both low and high concentrated zinc plating baths and the results are given in Figs. 4 and 5 respectively. From the Hull Cell patterns obtained, it may be seen that the introduction of thiourea has no effect in producing bright deposit.

Effect of glycine

The effect of change of concentration of glycine (0.5 to 5.0 g/l) in both low and high concentrated zinc plating baths are shown in Figs. 6 and 7 respectively. From the figures, it may be seen that glycine gives matte white or grey powdery deposit.

Effect of dextrin

The concentration of dextrin was varied from 0.5 to 5.0 g/l in the low concentrated zinc plating bath and the results are

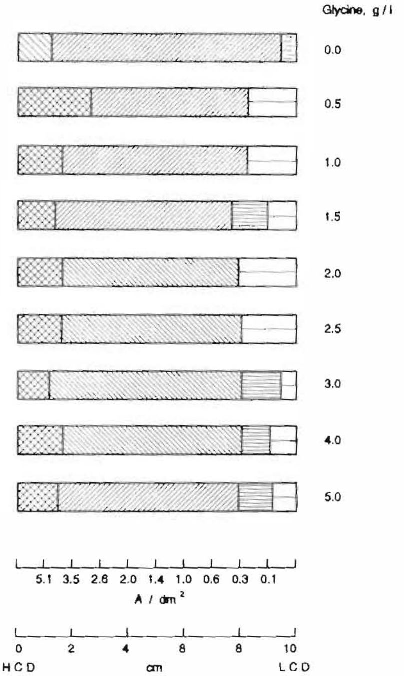

Fig. 6: Effect of change of glycine concentration in low concentrated zinc plating bath at 303 K and at 1A cell current

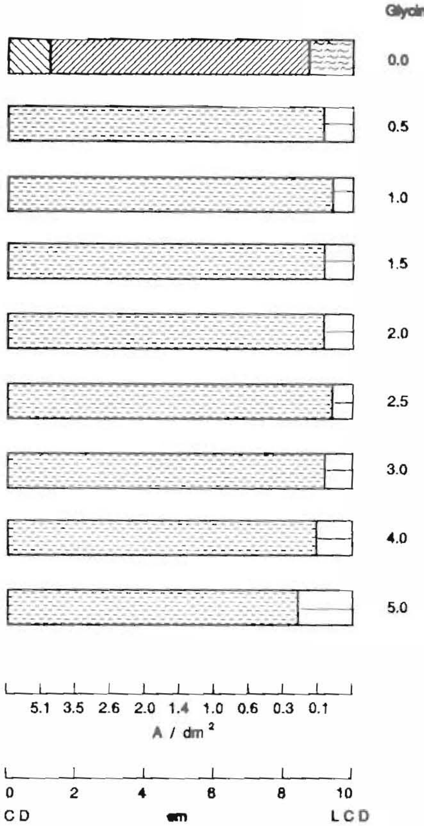

Fig. 7: Effect of change of glycine concentration in high concentrated zinc plating bath at 303 K and at 1A cell current

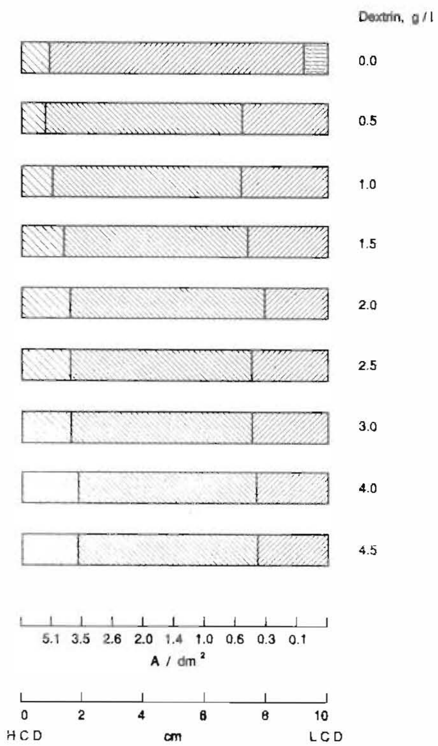

Fig. 8: Effect of change of dextrin concentration in low concentrated zinc plating bath at 303 K and at 1A cell current

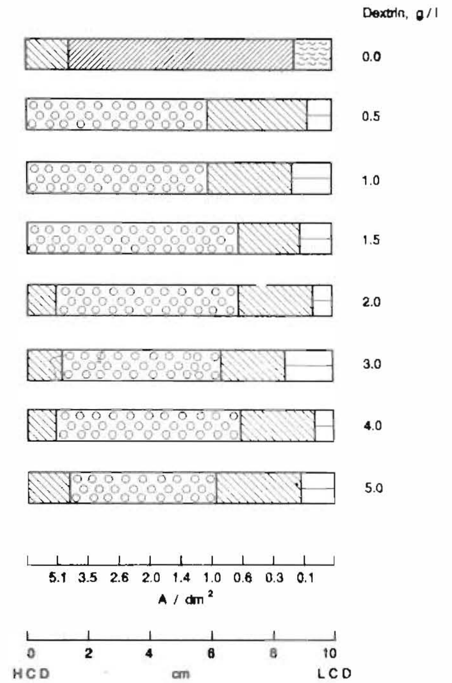

Fig. 9: Effect of change of dextrin concentration in high concentrated zinc plating bath at 303 K and at 1A cell current

presented in Fig. 8. It is clear from the Hull Cell patterns that the grey matt deposit is obtained to a greater extent.

Experiments were also carried out by varying the concentration of dextrin in the high concentrated zinc plating bath. From Fig. 9, it may be seen that matte white powdery deposit is obtained to a greater extent in the Hull Cell plate.

Effect of gelatin

The effect of gelatin in the low concentrated zinc plating bath is shown in Fig. 10. Gelatin produces slight black and streaky grey deposits in the high current density region. From Fig. 11, it may be seen that the addition of gelatin in the high concentrated zinc plating bath does not produce zinc deposit of improved quality.

Effect of furfural

The concentration of furfural was varied from 0.5 to 5.0 ml/l in both low and high concentrated zinc plating baths and the results are presented in Figs. 12 and 13 respectively. It may be noted that the introduction of furfural produces grey powdery or streaky yellow deposit.

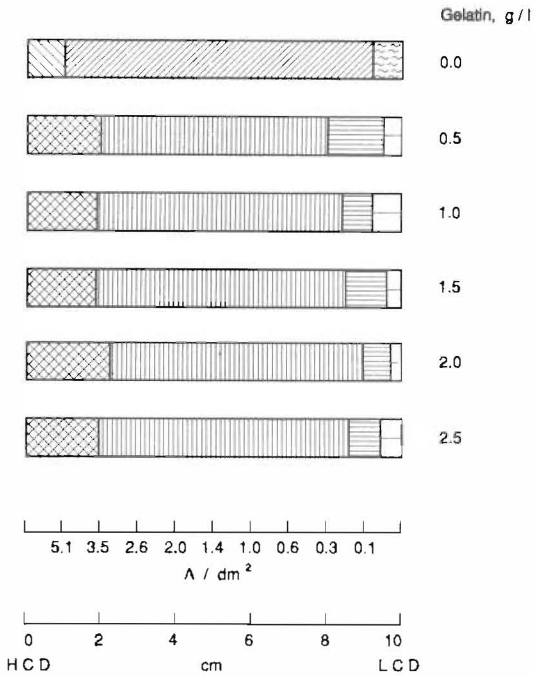

Fig. 10: Effect of change of gelatin concentration in low concentrated zinc plating bath at 303 K and at 1 A cell current

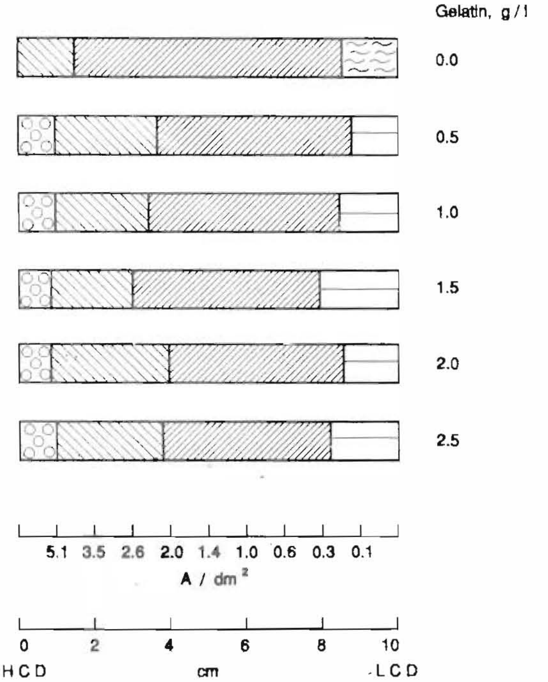

Fig. 11: Effect of change of gelatin concentration in high concentrated zinc plating bath at 303 K and at 1 A cell current

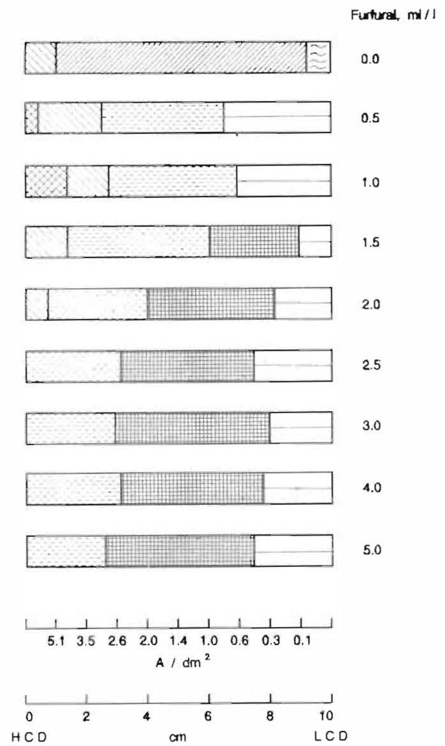

Fig. 12: Effect of change of furfural concentration in low concentrated zinc plating bath at 303 K and at 1 A cell current

Effect of triethanolamine

From Figs. 14 and 15, it may be seen that the addition of triethanolamine (0.5 to 5.0 ml/l) in to the low and high concentrated zinc plating baths gives grey or white powdery deposit to a larger extent in the Hull Cell plate.

CONCLUSION

From the experiments carried out it may be concluded that bath of the following composition is suitable for producing mirror bright zinc deposit.

Bath composition

Zinc bromide 160 g/l; boric acid 80 g/l; potassium bromide 50 g/l; aluminium sulphate 50 g/l; vanillin 1.5 g/l; temperature 303 K and current density 0.05-4.68 A/dm^2.

Acknowledgement: One of the authors (M. Chandran) expresses his sincere thanks to the Director, CECRI, Karaikudi, for having granted permission to make use of the facilities of the Institute. He also expresses his gratitude to the Chairman and the Principal of N.I. College of Engineering, Kumaracoil, for their patronage.

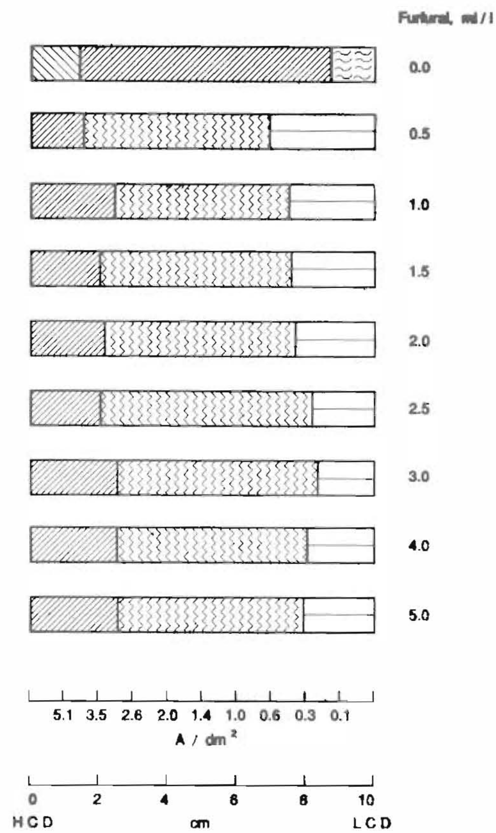

Fig. 13: Effect of change of furfural concentration in high concentrated zinc plating bath at 303 K and at 1 A cell current

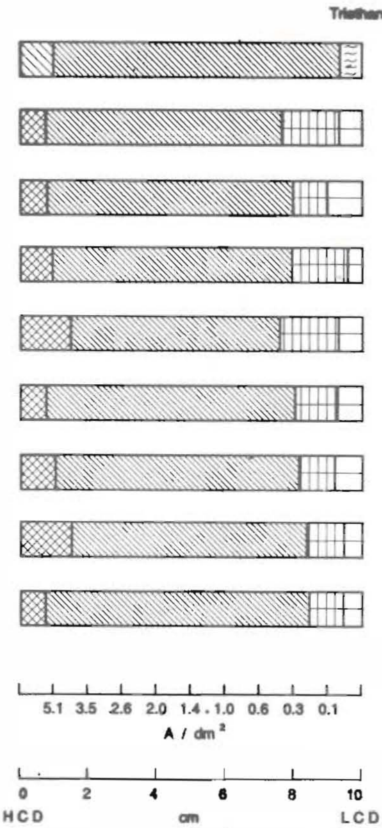

Fig. 14: Effect of change of triethanolamine concentration in low concentrated zinc plating bath at 303 K and at 1 A cell current

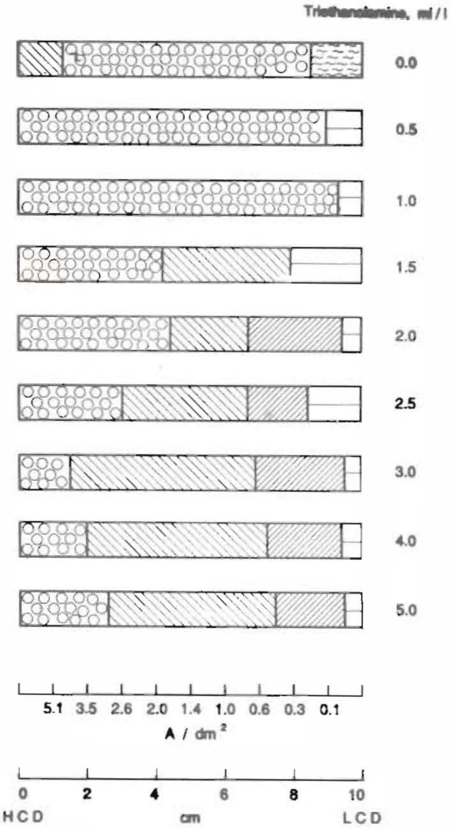

Fig. 15: Effect of change of triethanolamine concentration in high concentrated zinc plating bath at 303 K and at 1 A cell current

REFERENCES

1. F A Lownheim (Edn), Modern Electroplating, Wiley Inter Science Publications, New York (1974)
2. H G Crentz and S Martin, *Plat and Surf Finish,* **60** (1975) 681
3. T R Anantharaman and J Balachandra, *J Electrochem Soc,* **100** (1953) 237
4. Goto, Japan patent 75, 110, 940, September (1975)
5. R M Krishnan et al, *Met Finish,* **89(2)** (1991) 15
6. J J Duprat, *Surfaces,* **269** (1997) 14
7. W R Pitner and C L Hussey, *J Electrochem Soc,* USA, **144(9)** (1997) 3095
8. A Ramachandran and S M Mayanna, *Met Finish,* **90(2)** (1992) 61
9. T V Venkatesha, *Bull Electrochem,* **12(7/8)** (1996) 472
10. Fabio Galvani and Ivani A Carlos, *Metal Finishing,* **95(2)**, (1997) 70
11. G N K Rameshbapu and R Kumaresan, *Bull Electrochem,* **13(4)** (1997) 166
12. M Chandran, R Lekshmana Sarma and R M Krishnan, *Natl Conf on Emerging Trends in Electrometal and Eighth Natl Convention of Electrochemists,* Abstracts January 28-30 (1998) 26(A)