Bulletin of Electrochemistry 14 (4-5) April-May 1998, pp 157-159

0256-1654/98/$ 3-50
© 1998 CECRI

UNIVERSAL CELL FOR EVALUATING PLATING BATHS

S M Silaimani, P R Thangavelu and S John

Central Electrochemical Research Institute, Karaikudi 630 006. INDIA

[Received: 22 January 1998 Accepted: 30 March 1998]

Electroplating test cells like Hull Cell, throwing power cell etc. are employed widely to evaluate the characteristics of electroplating baths. The universal cell fabricated was tested for replacing the various cells used for evaluating plating baths by this single cell.

Keywords: Electroplating baths, throwing power, current efficiency.

INTRODUCTION

Testing cells like Hull Cell [1], current efficiency cell, throwing power cell [2], bent cathode cell [3], Lu Cell [4,5], rotating Hull Cell [6] and recently jiggled cell are widely employed in the plating industry to evaluate the characteristics of electroplating baths. The Hull Cell is for optimizing the bath composition, operating parameters like *p*H, current density, temperature etc. The throwing power cell is used for finding out the ability of the electrolyte to form uniform deposit. The present study deals with a universal cell used for doing all the experiments viz. the Hull Cell experiment, throwing power and current efficiency experiment in a single cell which occupies small space, avoid wastage of the solution during transformation from one cell to another and there is not even a small change in the bath constituents during all the experiments.

EXPERIMENTAL

A schematic of the universal cell used in the present study is shown in Fig. 1. The universal cell is a rectangular cell made of PVC with 180 mm length, 68 mm width and 65 mm height. This cell is provided with grooves at both the edges for positioning of the cathodes used in throwing power study and a groove at 30 mm from one of the edges for positioning the anode. A groove started at 50 mm from the anode position in one side towards the other side in cross direction and ending at 125 mm is also there for positioning the Hull Cell cathode. The capacity of the cell is 600 ml. Nickel sulphamate bath and zinc sulphate of the following compositions were used for the present study.

Nickel sulphamate bath

Nickel sulphamate 240 g/l, nickel chloride 10 g/l, boric acid 40 g/l, sodium lauryl sulphate 0.1 g/l, *p*H 3.5-4.0

Zinc sulphate bath

Zinc sulphate 180 g/l, zinc chloride 14 g/l, boric acid 12 g/l, dextrin 3 g/l, sulpho salicylic acid 1.5 g/l, *p*H 3-4.

Hull Cell experiments were carried out by using the above baths at various cell currents viz. 1, 2 and 3 A in the conventional Hull Cell (267 ml) as well as the universal cell described as above using brass cathodes. The throwing power of the solutions nickel sulphamate/zinc sulphate were also found out by using the above universal cell and the conventional throwing power cell. Stainless steel was used as the cathode material. The experiments were carried out at various cathode current densities viz. 1, 2 and 3 A/sq.dm.

The throwing power of the solutions on different cathode materials viz. stainless steel, mild steel, copper and brass at

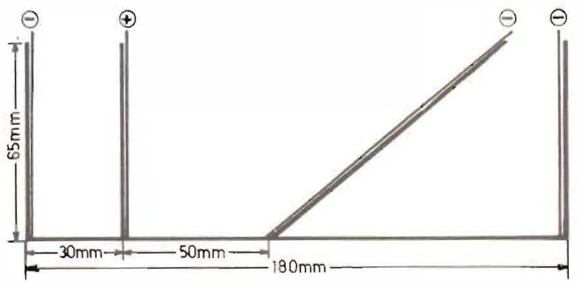

Fig. 1: Universal cell

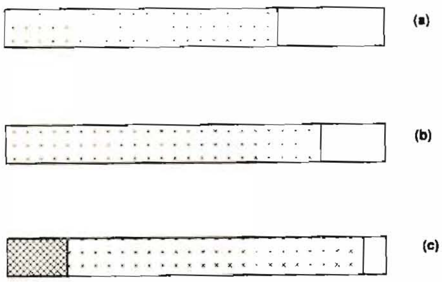

Fig. 2: Hull cell pattern obtained from nickel sulphamate bath using universal cell at various cell current (a) 1A, (b) 2A, (c) 3A

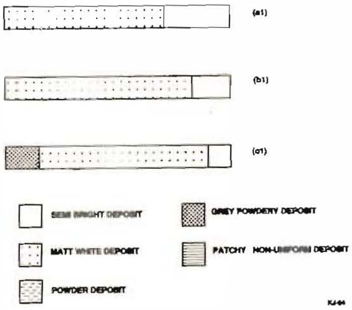

Fig. 3: Hull cell pattern obtained from nickel sulphamate bath using conventional cell at various cell current (a_1) 1A, (b_1) 2A, (c_1) 3A

various cathode current densities viz. 1, 2 and 3 A/sq.dm. was carried out in universal cell.

Current efficiency studies were carried out from the above baths by passing a fixed quantity of electricity with the help of a Coulometer and a regulated power supply. From the gain in weight the efficiency was calculated.

RESULTS AND DISCUSSION

Fig. 2 shows the Hull Cell pattern obtained from the nickel sulphamate bath using the universal cell and Fig. 3 shows the pattern obtained from the conventional Hull Cell. From the above two figures, it is observed that there is no change

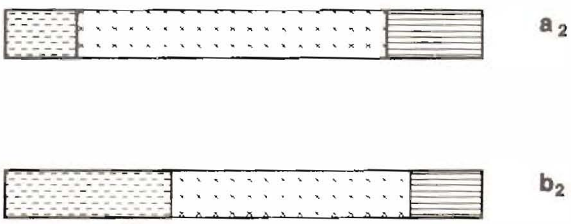

Fig. 4: Hull cell pattern obtained from zinc sulphate bath using universal cell at various cell current (a_2) 1A, (b_2) 2A

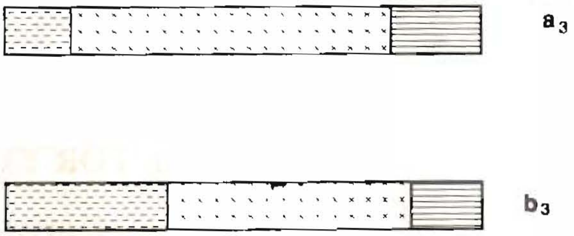

Fig. 5: Hull cell pattern obtained from zinc sulphate bath using conventional cell at various cell current (a_3) 1A, (b_3) 2A

TABLE I: Throwing power of the nickel sulphamate bath at various current density

Currtent density (A/sq.dm)	% Throwing power	
	Conventional cell	Universal cell
1	17.96	17.90
2	15.21	15.38
3	13.01	12.89

in the Hull Cell pattern obtained from the two cells under study at all cell currents.

Figs. 4 and 5 show the Hull Cell pattern obtained from the zinc sulphate bath using the conventional Hull Cell and the universal cell respectively. These two figures also show no difference in the pattern obtained.

Table I shows the throwing power of the nickel sulphamate electrolyte on stainless steel substrate from the conventional as well as from the universal cell. From the above table it is observed that there is no change in the throwing power of the bath from the two cells under study. The role of the cathode substrate material on throwing power of nickel sulphamate is shown in Table II. On stainless steel substrate the throwing power of the solution is minimum, whereas it is maximum on copper or brass substrate.

Table III shows the results of throwing of the zinc sulphate bath on stainless steel substrate using conventional and the universal cell. From this Table also it is seen that there is no difference in the throwing power value of the zinc

TABLE II: Throwing power of nickel sulphamate bath on various substrate materials

Substrate material	% Throwing power at		
	1A/sq.dm	2A/sq.dm	3A/sq.dm
Stainless steel	17.90	15.38	12.89
Mild steel	31.16	25.46	21.62
Copper	41.24	35.32	31.43
Brass	41.50	35.54	31.06

TABLE III: Throwing power of the zinc sulphate bath at various current density

Currtent density (A/sq.dm)	% Throwing power	
	Conventional cell	Universal cell
1	15.04	15.45
2	12.10	11.80
3	6.88	6.85

TABLE IV: Throwing power of zinc sulphate bath on various substrate materials

Substrate material	% Throwing power at		
	1A/sq.dm	2A/sq.dm	3A/sq.dm
Stainless steel	15.45	11.80	6.85
Mild steel	17.66	13.50	8.43
Copper	20.41	17.57	12.21
Brass	20.09	17.64	12.29

sulphate electrolyte using the two cells under consideration. The role of the cathode material on the throwing power of the zinc sulphate bath is seen from Table IV. The same trend on throwing power for the nickel sulphamate bath with respect to the substrate materials was observed for the zinc sulphate bath also. From these results it is observed that the throwing power of the electrolyte depends on the substrate material also.

Table V shows the cathode current efficiency obtained for the nickel deposition at various current density in the universal cell and Table VI shows the cathode current efficiency obtained for the zinc deposition at various current density in the universal cell.

TABLE V: Effect of current density on nickel deposition efficiency

Current density (A/sq.dm)	Current efficiency (%)
1	97.2
2	95.3
3	93.5

TABLE VI: Effect of current density on zinc deposition efficiency

Current density (A/sq.dm)	Current efficiency (%)
1	96.2
2	97.6
3	92.1

CONCLUSION

From the results it is concluded that the universal cell is a suitable tool for carrying out Hull Cell experiments, throwing power experiments and current efficiency experiments. It replaces all the three cells by a single cell.

REFERENCES

1. R O Hull, *Am Electroplat Soc*, 27 (1939) 52
2. H E Haring and W.Blum, *Trans Amer Electrochem Soc*, 44 (1923) 313
3. S Field and A D Weill, *Electroplating*, 6th Ed Pitman, London (1964)
4. E A Ollard and E B Smith, *Handbook of Industrial Electroplating*, Iliffe & Sons Ltd, Glassgow (1948)
5. P O YenLu, *Plat Surf Fin*, 78 (10) (1991) 62
6. I Kadiji, J A Abys, V Chinchankar and H K Straschil, *Plat Surf Fin*, 78 (7) (1991) 60