Bright cadmium Plating from Cyanide Electrolyte

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Cadmium coatings are of pleasing appearance and easily solderable apart from being highly resistant to corrosion under marine conditions. Cyanide cadmium baths are known for their ease of operation and control and ability to give high quality deposits. In this paper, the authors report the results of their studies on the combined effect of furfural ethanolamine complex and sodium gluconate as addition agent in a cyanide cadmium bath for obtaining smooth, bright coherent deposits.

The advantages of Cadmium plating are too well known (1-3). Cadmium is generally plated from a cyanide bath which requires only very simple control and less surface preparation as compared to zinc plating. But coatings obtained from plain cyanide baths without addition agents are very rough especially at higher thickness (4). Baths containing brightener additions give rise to satisfactory deposits with a high degree of smoothness and brightness. Various aromatic aldehydes were tested as brightener additives in cadmium bath. To avoid any difficulty in solubilising the aldehydes, they were added in the form of ethanolamine complexes. Studies were carried out with salicylaldehyde, benzaldehyde, anisaldehyde, piperonaldehyde furfuraldehyde and vanillin. Having found furfuraldehyde complex as a suitable brightness additive, further studies were made for improving lustre and bright current density range.

EXPERIMENTAL

Hull cell studies were carried out in a 267 ml Hull cell (5) with 2A current for 10 minutes with polished steel panels as cathodes. An electrolyte of the following composition was prepared by using laboratory grade reagents:

Cadmium oxide	: 45 g/l
Sodium cyanide	: 120 g/l
Sodium hydroxide	: 30 g/l

The solution was purified by the usual active carbon treatment and low current density electrolysis.

The furfuraldehyde-ethanolamine complex was prepared by dissolving 2 ml of furfuraldehyde in a hot solution of 2 ml of ethanolamine in 10 ml of water and stirring well. The mixture was cooled, made up to 20ml and then allowed to age for 2 or 3 days. Small quantities (0.8 - 1.2 ml) of this aged solution were used for the Hull cell studies. Having identified the conditions of obtaining semi-bright deposits, further experiments were carried out with addition of sodium gluconate (0.5 to 1 g/l) along with furfuraldehyde-ethanolamine complexes, to study improvement in the deposit brightness.

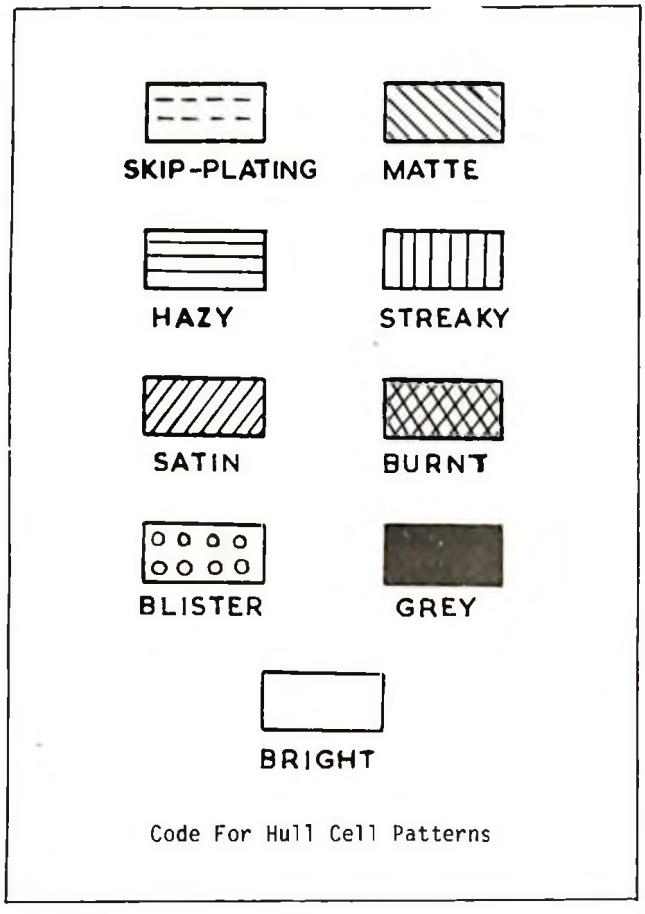
Experiments were conducted with the selected brightener system to determine the effects of changing the concentration of constituents of bath, and the operating conditions on the brightness of the deposit and the workable current density range. The current efficiency in presence of the additives was calculated from weight gain of each steel panel (7.5 x 5.0 cm) after deposition. The effects of inorganic contaminants like lead, chromium, copper and zinc were also determined by adding the required ions as their salts at ppm levels.

RESULTS AND DISCUSSION

ADDITION AGENT

Fig 1 shows the effects of the different combinations of additives in cyanide cadmium electrolyte. In the absence of any additive, the deposits have a matte appearance and exhibit dendritic growth at higher current densities (above 6A/dm^2). Addition of 0.5 g/l of sodium gluconate leads to the formation of smooth deposit with satin like appearance and considerably reduced dendritic growth at higher current densities. A concentration of 1 g/l of gluconate helps in producing smooth deposits with substantial grain refinement over the entire current density range. However, gluconate addition alone does not give rise to fully bright deposits.

With addition of a small quantity of furfuraldehyde ethanolamine complex (0.2 g/l) the deposits produced are found to be semi bright. An additive of 0.5 ml of the complex results in hazy bright deposits which can be improved further by a subsequent dip in 0.5% nitric acid. With a quantity of 0.8ml of the above complex, bright deposit was



Code For Hull Cell Patterns

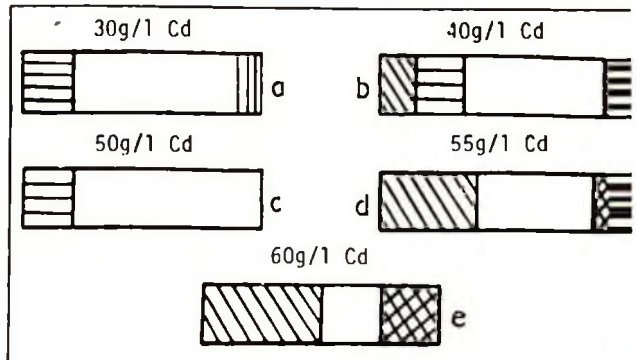


Fig. 2 Effect of Metal Content in Bright Cadmium Bath [NaCN 120g/l NaOH 30g/l Cd Conc. Varying]

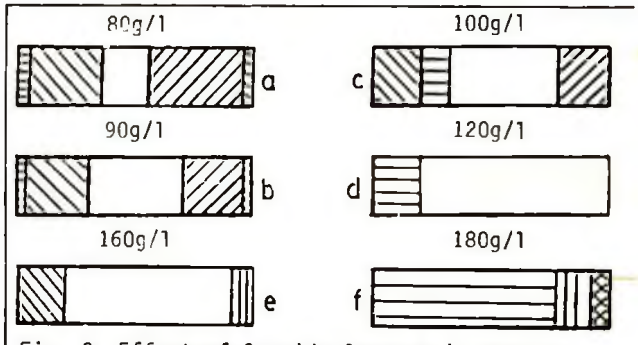


Fig. 3 Effect of Cyanide Content in Bright Cadmium Bath [CdO 45g/l NaOH 30g/l NaCN Varying

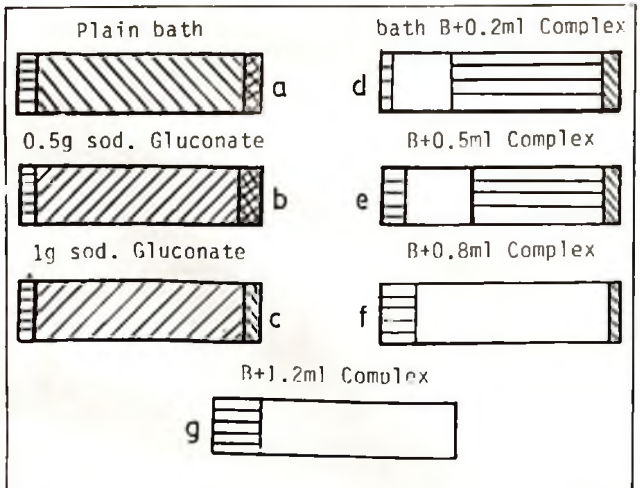


Fig. 1 Effect of Brightener Additions in Cadmium Cynide Bath Composition [CdO 45g/l NaCN 120g/l NaOH 30g/l i 2A, time 5mts.]

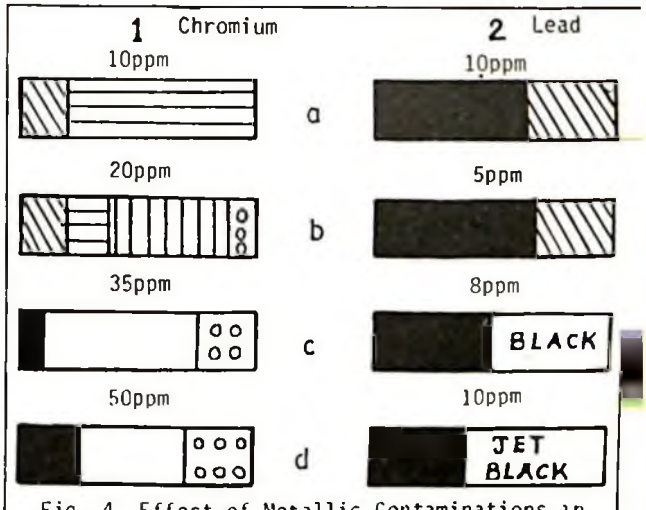


Fig. 4 Effect of Metallic Contaminations in Bright Cadmium Bath

observed over a wide range of current densities.

CYANIDE/METAL RATIO

With increasing cadmium concentration, cyanide/metal ratio decreases and hence the workable current density range also decreases. At lower cadmium concentration, the deposits obtained are bright, and the current density range is wide, but due to heavy gas evolution, the deposit tends to have a streaky appearance especially at higher current densities, blisters being produced on storage. Typical behaviour is shown in Fig.2. A similar behaviour is observed with the change in the cyanide concentration in the bath (Fig.3). So, it is to be concluded that the cyanide/metal ratio is the major factor in regard to the nature of the deposits and the optimum ratio is about 3 for the particular brightener system under study.

ALKALI CONTENT

Increase in metal ion concentration increases the current efficiency. When Cd concentration increases from 15-40g/l the current efficiency increases from 75-100%. Efficiency remaining nearly 100% at higher Cd concentration. NaCN/Cd ratio has been changed within 2.75-3.75; current efficiency is found to decrease from 100% to 90%. The alkali concentration is not usually critical as far as Hull cell experiments are concerned. But presence of an excessive quantity of caustic causes a decrease in the permissible current density and too little of it tends to yield brittle deposits. The maximum tolerated level is related to the concentration of the metal ion in the electrolyte-the higher the latter, the higher the alkali concentration that can be tolerated. A slight increase in current efficiency is possible with increased caustic concentration.

CURRENT EFFICIENCY

As in all complex cyanide baths, current efficiency decreases at higher current densities. Current efficiency decreases from nearly 100% to 80% when the current density increases from 25-75 A/dm^2. This is due to secondary current distribution and consequently the throwing power is improved, uniform plating occurs in peaks and valleys. Higher bath temperatures are conducive for increased current efficiency but are not generally adopted for bright cadmium plating. The brightener system under study does not work at temperatures higher than 45°C, the deposits becoming dull in appearance.

IMPURITIES

Fig. 4 shows the effects of some of the generally encountered inorganic contaminants on the performance of the brightener system. Chromium in minute amounts (10 ppm) causes an overall white haze from 1 A/dm^2 to 10 A/dm^2. As the chromium concentration increases to 20 ppm. white streaks appear in the hazy region upto 7A/dm^2. At a chromium concentration of 35 ppm, slight blistering begins to appear at the extreme high current density end and at still higher concentrations grey black deposits appear below 1.0 A/dm^2.

The presence of zinc has no deleterious effect on the brightness of the deposit upto 5 g/l concentration. Presence of copper also has no significant visible effect upto 1 g/l concentration. But deposits turn black on subsequent bright dip operation.

Minute amounts of lead (as little as 0.001 g/l) makes the bath inoperable. In the normal plating range of 0.5 - 4 A/dm^2, a dull grey black deposit is produced and at high current densities the deposit is matte. At 0.005 g/l, the deposit turns grey black and at 0.01 g/l concentration, intense black deposit at high current densities appear and it is uniform grey in colour below 5 A/dm^2.

CONCLUSIONS

Presence of a combination of furfuraldehyde-ethanolamine complex and sodium gluconate is helpful in obtaining bright deposits of cadmium from a cyanide electrolyte.

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