Bulletin of Electrochemistry 6 (5) May 1990, pp 505–506

Deposition of zinc-cobalt alloy as an undercoat to selective black coatings for solar collectors

S John, P R Thangavel, N V Shanmugam, S Guruviah and K I Vasu

Central Electrochemical Research Instiute, Karaikudi - 623 006, INDIA

Various selective coatings have been reported in the literature to improve the efficiency of flat plate solar collectors. In order to protect the solar absorbers from corrosion and to provide low emissive surface, nickel undercoats are widely used in the flat plate solar collector systems like solar hot water, hot air etc. With increasing trend in the cost of nickel, replacement for nickel coatings are being investigated in this laboratory. Suitability of zinc-cobalt alloy deposits as an undercoat to selective black coating is examined.

Key words: Zinc-cobalt alloy undercoat, selective black coatings, solar collectors

INTRODUCTION

Solar absorber coatings improve the efficiency of flat plate collectors used in solar thermal systems such as solar hot water, solar hot air, solar cooker etc. Various selective coatings have been reported in the literature. In most of the solar thermal systems, the absorber surface is protected against corrosion by providing an undercoat of nickel to a thickness of 10-20 μm. Due to the higher cost of nickel plating, substitute undercoatings are being investigated.

In recent years, zinc alloy coatings received greater attention for use in automotive and has been replacing zinc coatings because of superior corrosion resistance [1-3]. Various formulations and deposit characteristics have been reported in the literature. In the present study, the authors have reported on the development of zinc-cobalt [4,5] as an undercoat for selective black coatings of solar absorbers. The undercoat has been deposited from sulphate-citrate electrolyte.

EXPERIMENTAL

Mild steel and copper substrates of 100 × 100 mm size were mechanically polished, degreased with trichloroethylene, electrocleaned in an alkaline cleaner, washed, pickled in acid, washed and zinc-cobalt alloy was deposited from the following electrolyte:

Zinc sulphate	35 g/l
Cobalt sulphate	2.5 g/l
Citric acid	20 g/l
Pyridine	4 ml/l
Temperature	303 K
Current density	3A.dm^{-2}
Plating time	30 min

The panels were washed thoroughly in water and black coating deposited from the following bath:

Nickel chloride	100 g/l
Stannous chloride	5 g/l
Ammonium bifluoride	25 g/l
Diethanolamine to raise the pH to 6	
Temperature	298-303 K
Current density	1.5-3A.dm^{-2}
Plating time	15-30 sec

All the chemicals used were of laboratory reagent grade and distilled water was used for solution preparation. For arriving at the suitable composition for zinc-cobalt alloy plating, preliminary studies were carried out with Hull Cell panels. In this study, various constituents of the bath were changed and also the operating conditions like temperature, pH, current density and plating time to arrive at the optimum bath composition and operative conditions. The influence of some organic addition agents has also been studied and a suitable one is employed for producing a bright finish. The zinc-cobalt alloy deposit is found to have 1.5% cobalt in the deposit. Optical properties of the coatings were measured with alphatometer and emissometer.

Evaluation of the coating

As the black coating is to be strongly adherent on the base metal, adhesion test was conducted by means of tape test which has been conventionally employed for evaluating thin coatings. Under the optimum conditions, the coatings did not come off from the base metal. Corrosion resistance of the coating was studied by dipping in 5% neutral sodium chloride solution. Change in optical properties and formation of white corrosion product were also studied.

RESULTS AND DISCUSSION

The coating exhibited strong adhesion to the base metal as revealed by the tape test. As the undercoat of zinc-cobalt alloy contains 1.5% cobalt, it exhibited very good corrosion resistance and the coating did not deteriorate even after immersion for 96 hrs, thereby establishing the corrosion resistance of the undercoating. There is no change in the optical values of the coating.

CONCLUSION

From the above study, it has been concluded that solar collectors can be produced with an undercoat of zinc-cobalt prior to selective black coating.

REFERENCES

1. G F Hsu, *Plating Surface Finish*, **71**–4 (1984) 53
2. R G Baker and C A Holden, *ibid*, **72**–3 (1985) 54
3. M Nikolova, I Kristev, J Cenov and L Kristev, *Bull Electrochem*, **3** (1987) 649
4. W M J C Verberne, *Trans Inst Metal Finish*, **64** (1986) 30
5. W Siegert and Hadley, *Metalloberflache*, **43**–2 (1989) 78