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Electrodeposition of black chromium-nickel coating for photo thermal conversion of solar energy

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Selective black coatings are promising candidate for increasing the efficiency of solar collectors used in solar thermal devices such as solar water heater, solar cooker and solar drier systems. A variety of black coatings have been proposed and some of them are used industrially. This paper reports on the characteristics of electroplated black chromium-nickel alloy. The studies made indicate the suitability of this coating for high temperature applications, such as solar concentrators, where conventional black coating systems fail.

Key words: Electroplated black chromium-nickel alloy, photothermal conversion, solar energy

INTRODUCTION

There is hardly any need to emphasise the utility of solar energy as a remedy for the present day energy crisis. Efficient conversion of solar thermal energy requires collector panels which absorb all of the solar radiation while emitting poorly in the infrared region. In addition, the coating should have long term stability at the desired operating temperature of the solar collectors. In the case of concentrators, where the temperature obtained is high, grain growth/recrystallization of the coating takes place and hence most of the conventional black coatings, such as black chrome, black nickel, black copper, black aluminium and various black alloy coatings cannot be employed [1]. Hence there is a need for the development of high temperature resistant selective coatings. Again the black coatings, which are selective at low temperature applications, lost their selectivity at high temperatures, due to increase in emittance and also recrystallization, thereby creating necessity for high temperature stable black coatings. In this investigation, the authors report the feasibility of using black chromium-nickel coatings from a chloride-acetate bath.

EXPERIMENTAL

Copper panels of size 100 × 100 mm were mechanically polished, degreased, alkaline cleaned, washed, pickled, washed, nickel undercoated, plated from nickel-manganese bath, washed and black plated from the following bath:

Chromic chloride	100 g/l
Nickel chloride	25 g/l
Acetic Acid	100 ml/l
Ammonium acetate	20 g/l
Temperature	293 K
Current density	15 A.dm^{-2}

Hull cell studies were carried out using standard procedures for optimizing the bath composition and operating conditions. Absorptance and emittance of the coatings were measured with Alphatometer and Emissometer respectively. All the chemicals used were of LR grade. Distilled water was used for solution preparation. The coatings were heated to a temperature of 873K using electric furnace for 8 hours duration for 8 days. Changes in appearance and optical properties were made.

RESULTS AND DISCUSSION

The nickel undercoating produced from Ni-Mn bath showed no blistering of the coating after heating. As Ni-Cr alloys were known for their high temperature oxidation resistance, no appreciable change in appearance and optical properties were noted. However, freshly produced coating exhibited $\alpha = 0.94$ and $\epsilon = 0.35$ and thereby showed that they possess only moderate selectivity. Even then as the black coating is stable at high temperatures, it can be used in the absorber pipes of the concentrator systems. As adequate thickness of undercoating of nickel was provided, no corrosion or deterioration was observed.

CONCLUSION

Electroplated nickel-chromium black coating exhibits high temperature stability and shows promising future as a selective coating for solar concentrator systems.

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