

Growth of CuZnS thin films by sequential electrodeposition and sulphurisation

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Copper Zinc Sulphide (CuZnS) is a promising new absorber material for solar cell applications. Indeed, this material is very attractive for low cost device applications due to abundance and low cost of the starting materials. Very recently, a CuZnS based solar cell with In₂S₃ window material has been reported having V_{oc} of 0.41 V, J_{sc} of 10.6 mA/cm², FF of 45% and η of 1.94%. This initial finding has proven the possibility of developing this material as a solar energy material. Among the CuZnS preparation techniques, electrodeposition is an attractive technique because of its simplicity, low cost and possibility of making large area thin films.

In this study, possibility of growth of CuZnS thin films by sulphurisation of electrodeposited Cu and Zn stack layers using S powder has been investigated. Cu thin film was electrodeposited on Ti substrate at -700 mV Vs Ag/AgCl for 15 min in an electrochemical cell containing 0.05 M sodium acetate and 0.005 M cupric acetate. Deposition of Zn thin film on Ti/Cu electrodes was carried out at -1.2 V Vs Ag/AgCl for 1 min in an electrochemical cell containing 0.2 M ZnSO₄. Deposition parameters of Cu and Zn have been obtained by voltammograms. Set of identical Ti/Cu/Zn thin film electrodes having Cu/Zn ratio of ~3.2 were prepared by maintaining the respective Cu and Zn thin film deposition durations for studying the sulphurisation process. In order to grow CuZnS, Ti/Cu/Zn thin film electrodes were annealed at different temperatures (400 °C, 450 °C, 500 °C, 550 °C and 600 °C) with different S contents (10 mg, 20 mg, 30 mg, 40 mg and 50 mg) for a duration of 60 min. CuZnS thin films were characterized using dark and light current voltage measurements in a PEC containing 0.1 M sodium acetate to obtain the best sulphurisation condition.

Dark and light I-V characteristics revealed that the films annealed at 600 °C with the S content between 10 to 20 mg exhibits photoactivity. Further, photocurrent was always cathodic confirming the formation of p-CuZnS thin films. It was revealed in this preliminary investigation that the best photoactive films could be produced when films are annealed at 600 °C for 60 min in 20 mg S content. We have found, that photoactive p-CuZnS thin films can be grown by employing the technique of annealing electrodeposited Cu and Zn stack layers using S powder. Cu/Zn ratio of the stack layers could be the crucial parameter in determining the structure, conductivity type and resistivity of CuZnS films and therefore the methodology developed in this study could be further investigated, in order to develop the material for wider applications.

Keywords: Copper Zinc Sulphide, Electrodeposition, I-V characteristics

Acknowledgement: Funding from National Research Council (NRC) of Sri Lanka NRC 15-41 is acknowledged