

**Oral presentation: 186**

## **Growth of photoactive Cu<sub>2</sub>ZnSnS<sub>4</sub> by single step electrodeposition**

W. T. R. S. Fernando\*, K. M. D. C. Jayathileka, R. P. Wijesundera and W. Siripala

Department of Physics, Faculty of Science, University of Kelaniya, Sri Lanka

\*roshanrsff@gmail.com

Cu<sub>2</sub>ZnSnS<sub>4</sub> (CZTS) is a promising candidate for application in low-cost and environmentally-friendly thin film solar cells due to its optoelectronics properties. It is a perfect absorber material for photovoltaic applications due to its high absorption coefficient ( $>10^4 \text{ cm}^{-1}$ ) and direct optical bandgap (1.4 - 1.5 eV). Among the CZTS preparation techniques, single step electrodeposition is an attractive because of its simplicity, low cost and easy to control stoichiometry. In this study, CZTS thin films on Mo substrate were potentiostatically electrodeposited in a three electrode electrochemical cell containing 0.02 M copper (II) sulfate pentahydrate (CuSO<sub>4</sub>·5H<sub>2</sub>O), 0.01 M zinc sulfate heptahydrate (ZnSO<sub>4</sub>·7H<sub>2</sub>O), 0.02 M tin sulfate (SnSO<sub>4</sub>) and 0.02 M sodium thiosulfate (Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>) at room temperature. 0.2 M tri-sodium citrate (C<sub>6</sub>H<sub>5</sub>Na<sub>3</sub>O<sub>7</sub>:Na<sub>3</sub>-citrate) was used as complexing agent and tartaric acid (C<sub>4</sub>H<sub>6</sub>O<sub>6</sub>) was used as pH control solution. pH of the bath was maintained at 5.0 Ag/AgCl and platinum electrodes were used as reference and counter electrodes respectively. Mo substrate with a deposition area of 1×2 cm<sup>2</sup> was used as the working electrode. Electrodeposition was carried out at -1.05 V vs Ag/AgCl using a Hokuto Denko model HZ-5000 Potentiostat/Galvanostat. CZTS samples were prepared using different deposition durations (5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55 min). Optimum bath conditions were explored using cyclic voltammetry. Samples were characterized using XRD, optical absorption, dark and light I-V measurements and spectral response measurements in a PEC containing 0.1 M sodium acetate. XRD measurements evidenced that the formation of single phase polycrystalline CZTS. Reflectance measurements has revealed that the band gap energy of the films is 1.5 eV and I-V measurements revealed that CZTS thin films were photoactive and p-type. To enhance the photoactive properties films were annealed at different temperatures (500, 550, 600°C) and durations (15, 30, 45 min) in H<sub>2</sub>S surrounding. As the results, photoactive performance of the films enhance with the annealing treatment in H<sub>2</sub>S. In conclusion, it can be mentioned that the highest photoactive p-CZTS thin films can be grown by annealing the 40 min deposited samples at 550°C for 30 min in H<sub>2</sub>S. The methodology developed in this study will be further investigated, in order to develop the material for wider applications.

**Keywords:** Cu<sub>2</sub>ZnSnS<sub>4</sub>, I-V characteristics, single step electrodeposition

**Acknowledgment:** This work was supported by National Research Council under the research grant of (NRC 15-41).