$Cu(InGa)(SeS)_2$ Electrodeposition from a Single Bath

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$Cu(In,Ga)(S,Se)_2$ (CIGSS) offers potential advantages over $CuInGaSe_2$ (CIGS) as a photovoltaic film due to its higher band gap. Generating such photovoltaic materials by electrodeposition is particularly attractive due to the lower capital cost and the relatively high throughput of such processes[1-3]. Several recent publications report CIGSS electrodeposition; however, none reports the complete fabrication of such compound without the need for additional sulfur addition from the vapor phase[4].

We introduce here a new electrolyte composition which enables the direct electrodeposition of CIGSS from a single bath. The electrolyte is significantly more dilute in comparison to common baths described in the literature[1-4]. The bath composition we introduce is: 0.45 mM $CuCl_2$-H_2O; 0.4 mM $InCl_3$; 0.77 mM H_2SeO_3; 0.51 mM $GaCl_3$; and 0.3 mM $Na_2S_2O_3$. PHydrion is applied to buffer the electrolyte to pH=2, and 0.7 M LiCl is applied as supporting electrolyte.

Electrodeposition was carried out at room temperature from onto a rotating disk electrode which provides quantitative characterization of the flow. The effects of mass transport on the deposit composition and its adhesion to the substrate are discussed. Sample polarization curves at different electrode rotation rates are provided in Fig. 1. The subsequent annealing step was conducted under argon atmosphere with no need for metals addition from the gas phase during annealing. Final sulfur atomic ratio of 5% and 15% was tested in two different absorber samples. The final composition was determined using Energy-dispersive X-ray spectroscopy technique (EDS). XRD technique used to analyze CIGSS crystallography.

Acknowledgements

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References

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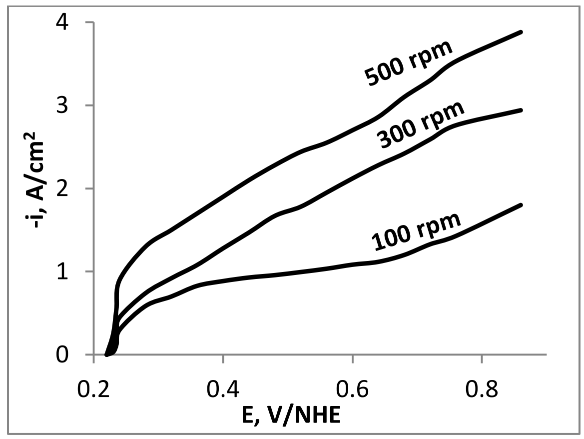

Fig. 1: Polarization curves for CIGSS deposition at different RDE rotation speeds.

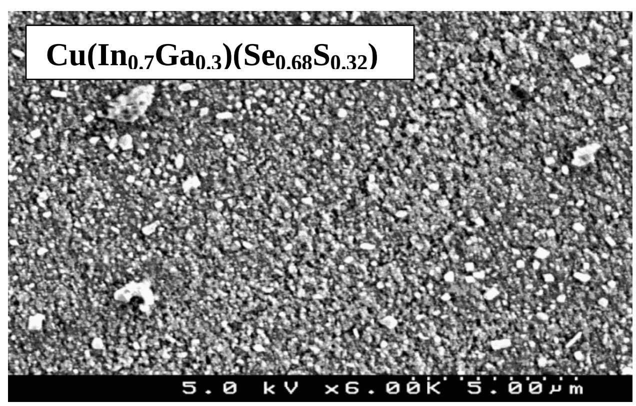

Fig. 2: SEM photograph of CIGSS film deposited from the dilute electrolyte. The film contains 15% sulfur (atomic ratio).