Wide band gap CIGS based absorber for photovoltaic application
Kush Nagaich and Stephen A. Campbell
University of Minnesota
Department of Electrical and Computer Engineering

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**Objectives**

- Fabricating wide bandgap Al doped Copper Indium Gallium diSelenide films.
- Optimizing the fabrication processes for improving the efficiency for photovoltaic cells.
- Controlling the deposition process for the absorber layer and buffer layer.
- Developing wide band gap material with good morphology and low defect density in order to achieve an increase in efficiency.

**Fabrication Process**

- Molybdenum back contact sputtered on 4” diameter soda-lime wafer.
- CIGS layer deposited using co-evaporation.
- CdS is deposited using chemical bath deposition (CBD).
- ZnO window layer deposited using sputtering.
- Al doped ZnO (AZO) top window layer is deposited using sputtering.
- Top contact Nickel (Ni) is deposited using sputtering.

**Absorber layer deposition (CIGS)**

- A single stage process followed by post deposition Se has been developed
- A uniform composition corresponding to the
  - Cu/(In+Ga) = 0.9 and Ga/(In+Ga) = 0.30 achieved
- Composition measured using EDS

**Characterization of CIGS films**

- CIGS films were characterized for morphology and bandgap
- Films with varying Ga compositions were grown and bandgap values were found to be in accordance to the literature values

**CIGS co-evaporation UHV system design**

- UHV system with an integrated resistive heater for in-situ annealing of the wafer.
- Copper, Indium and Gallium fluxes monitored and controlled in a feedback loop using atomic absorption spectroscopy.
- Deposition is carried out in Selenium overpressure.

**Characterization of CIGS films**

**Absorber layer deposition (CIAGS)**

- Copper, Indium, Gallium and Aluminum are co-evaporated under Selenium over pressure
- Modest amount of Al is added to the film in order to obtain a wide band gap close to 1.5 eV and maintaining good morphology
- EDS analysis for CIAGS films is not possible
- WDS technique is used for compositional analysis
- Composition close to Cu/(In+Ga+Al) = 0.9, Ga/(In+Ga+Al) = 0.3 and Al/(In+Ga+Al) = 0.05 – 0.08 has been achieved
- Sequential two stage process for adding Al to CIGS will also be investigated

**Characterization of CIAGS films**

- Process control is needed in order achieve good morphology for CIAGS films
- We have done some band gap measurements on CIAGS films and there is an increase in CIGS band gap