Contribution ID: **105** Type: **Poster Presentation**

Synthesis and characterization of Zn_(1-x)S:Cu_x nanoparticle thin films by using spin-coating for enhancement of UV-LEDs and Solar Cells

Tuesday, 26 June 2018 15:00 (2 hours)

Efficient enhancement of solar cells has become more important due to the need for environmentally friendly renewable energy sources. Using thioglycerol as the capping agent and concentrated HCl as the catalyst, ZnS:Cu sol-gels with different Cu concentrations were successfully used to grow nanoparticle thin films on ultrasonically cleaned glass substrates. The as-deposited films were spin-coated at room temperature for 30 s at different spin speeds, heat-treated at 275 ℃ for 10 minutes and annealed at different temperatures in air. The x-ray diffraction studies revealed that both the un-doped and Cu-doped ZnS films were amorphous when annealed at 300 ℃ and possess a hexagonal wurzite crystal structure with preferred orientations at higher temperatures. The films were optically characterized at room temperature using a Cary Eclipse spectrophotometer and UV-visible spectroscopy. Photoluminescence (PL) spectra showed green and red emissions which may be due to excited electron transitions from both the shallow donor level and the deep donor level (sulphur vacancies) to the t₂ level of Cu²⁺, respectively. The Zn_{0.05}S:Cu_{0.05} film yielded the highest PL intensity when excited at 237nm and was used to study the effect of annealing temperature and spin speed. Optical absorbance and reflectance measurements revealed that changing both the Cu concentration, annealing temperature and spin speed tunes the band gap of the ZnS:Cu thin films. Copper doped zinc sulphide nanoparticle thin films with a hexagonal wutzite crystal structure were successfully synthesized using the spin coating method and can be used for efficient enhancement of solar cells.

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Session Classification: Poster Session 1

Track Classification: Track A - Physics of Condensed Matter and Materials