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An alternative sulfur precursor for chemical bath deposition of CdS thin film

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Solar energy is the most appropriate electrification method for a tropical county like Sri Lanka. At present, Sri Lanka generates more than 72% of its electricity needs at a high cost by burning coal and diesel. To overcome the major obstacle of high initial cost in installation of solar power plants, many research groups worldwide at present are focusing towards manufacture of low cost and highly efficient photovoltaic cells based on cadmium sulfide and cadmium telluride (CdS/CdTe) semiconductors. Among the range of methods available for fabrication of CdS window layer, the chemical bath deposition (CBD) is an ideal method due to its simplicity and low cost. In this study, CdS layers were deposited on the FTO glass substrate by CBD method, using an alternative sulfur precursor; ammonium thiosulfate ($(NH_4)_2S_2O_3$) against the well-established but costly precursor thiourea ($CS(NH_2)_2$). The CBD bath was prepared with 0.25 mol/L cadmium acetate ($Cd(CH_3COO)_2$), 1.00 mol/L ammonium acetate (NH_4COOCH_3), concentrated NH_4OH (pH adjuster), and 0.50 mol/L $(NH_4)_2S_2O_3$. The best growth condition for CdS was identified by varying the parameters; Cd:S ratio, pH, deposition temperature, and deposition time while preserving a constant stirring speed. Uniform CdS layers rich in Cd, were observed in an alkaline electrolyte with Cd:S ratio of 2:5 at a temperature of 95 °C in 90 minutes. The spectrophotometric studies revealed the energy band gap of the material as 2.41 eV which is the typical value for CdS. Further, the X-ray diffractions observed at angles of 26°, 28°, 36°, and 53° representing the planes of (002), (101), (102), and (201) verified the cubic structure, while the scanning electron microscopic studies confirmed the uniform surface morphology of the material with average grains sized of 105 nm. However, the presence of pin-holes observed in the cross-sectional view implied the need of further optimization of parameters to obtain materials comparable to thiourea based chemical bath deposited CdS layers.

Keywords: Thin film CdS, Ammonium thiosulfate, Thiourea, Chemical bath deposition (CBD)

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