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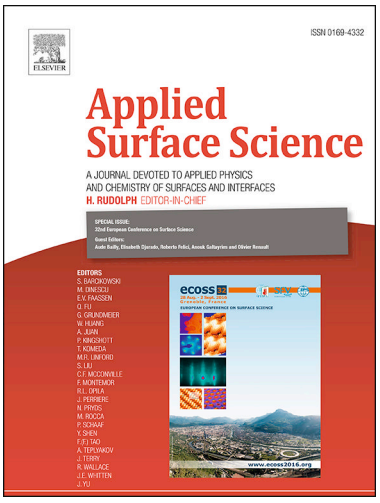

Full Length Article

Optimum chemical composition of antimony sulfide selenide for thin film solar cells

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Optimum chemical composition of antimony sulfide selenide for thin film solar cells

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Abstract: Antimony sulfide (Sb_2S_3) with an optical bandgap (E_g) of 1.88 eV and antimony selenide (Sb_2Se_3) with E_g 1.1 eV, both of orthorhombic crystalline structure, offer a unique opportunity to prepare solar cell absorbers of E_g, 1.3 – 1.6 eV poised toward economically viable, non-toxic and 'earth-abundant" devices. We prepared chemical precipitates of Sb-S-Se from solutions containing potassium antimony tartrate, thioacetamide and selenosulfate, which were used as sources in vacuum thermal evaporation to produce thin films (280 - 300 nm) of composition, $Sb_2S_xSe_{3-x}$ (x = 0.7 – 2). The E_g of 1.43 – 1.6 eV and photoconductivity, 4 x 10^{-5} and 8 x 10^{-7} Ω^{-1} cm^{-1}, respectively of these films help to combine a high open circuit voltage (V_{oc}) of 0.609 V with a conversion efficiency (η) 5.5% or a V_{oc} of 0.503 V with η of 6.2%. A dual-crucible thermal evaporation system allowed the preparation of absorber films of varying composition (x) in the cell structure, SnO_2:F (FTO)/CdS/$Sb_2S_xSe_{3-x}$/C-Ag. The cell area were, 0.2-0.8 cm^2. A prototype module of seven series-connected cells of area 1 cm^2 each produced a V_{oc} of 3.5 V, short circuit current 12 mA at η, 2.4%. Evaluation of the composition of the $Sb_2S_xSe_{3-x}$ films through gracing incidence x-ray diffraction is illustrated; and device parameters and solar cell perspectives of these materials are presented.

Key words: antimony sulfide selenide, thin films, solid solutions; Gracing incidence x-ray diffraction, GIXRD, optical bandgap, photoconductivity; solar cells, thin films photovoltaics, solar cell efficiency; solar energy, renewable energy