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Thermally evaporated copper iodide hole transport layer for CdS/CdTe thin film solar cells

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CdS/CdTe thin-film solar cell is a cost effective and reliable photovoltaic device with reported power conversion efficiencies over 22%. Although large-scale thin-film solar panels with efficiency over 18 % are commercially available, it has been reported that the efficiency drops due to copper diffusion to the CdS/CdTe interface. To avoid the Cu diffusion in these devices, Cu-free back contacts have been introduced in the past with reasonable success. This work focuses on studying the photovoltaic performance of CdS/CdTe devices by replacing Cu with copper iodide (CuI). For the device fabrication, the *n*-CdS window layer was fabricated by the chemical bath deposition (CBD) method on a cleaned FTO substrate, and then the *p*-CdTe absorber layer was deposited by closed space sublimation (CSS) on top of the CdS layer at a substrate temperature and source temperature of 580 ˚C and 640 ˚C, respectively in argon gas medium for 25 minutes at 7.9 torr vacuum pressure. In order to study the effect of a CuI hole transport layer on photovoltaic performance of CdTe solar cells, CuI film of varying thicknesses from 5 nm to 30 nm were deposited on the CdTe films by thermal evaporation. After the CuI film deposition, Au layer of thickness 80 nm was thermally evaporated as a back electrode, and then the fabricated device was annealed at 200 °C for 10 min in an N_2 environment. The UV-Visible spectroscopic studies confirmed that bandgap of thermally evaporated CuI hole transporter, chemically deposited *n*-CdS window layer and close spaced sublimated *p*-CdTe absorber layer are 3.0, 2.4 and 1.5 eV respectively. The XRD studies not only confirmed the presence of each layer but also confirmed the phase of thermally evaporated CuI film was hole-transporter (γ-CuI). AFM analysis confirmed the homogeneous well-adhered nature of each layer. Finally, photovoltaic performance of the devices with CuI film of thickness 5 nm to 30 nm was characterized under illuminations of 100 mW/cm^2 (1 sun) with an Air Mass 1.5 filter. An optimized CdS/CdTe device with CuI thickness of 10 nm showed Power Conversion Efficiency of 6.92 % with J_{SC}, V_{OC}, and FF of 21.98 mA/cm^2, 0.64 V, and 0.49 respectively.

Keywords: CdS/CdTe thin film solar cells, Hole transport layer, CuI, Cu diffusion

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