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Growth of Cu_2MnSnS_4 PV absorbers by sulfurization of evaporated precursors

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Abstract

Earth abundant Cu_2MnSnS_4 (CMTS) absorbers for thin film solar cells were grown for the first time by a two-step vacuum approach. Metal precursors deposited on Mo-coated soda lime glass by thermal evaporation were annealed in sulfur vapors. Two series of CMTS samples were prepared to evaluate the effect of both the precursor stack (thickness and order of the metal layers) and the annealing procedure on the thin film quality. Several techniques, including Scanning Electron Microscopy, Energy Dispersive Spectroscopy, Raman, X-ray Diffraction and Photoluminescence were used to test the CMTS layers and to study any possible secondary phase. Large grain size, high absorption coefficient and direct band suitable for PV applications have been obtained for Cu-poor/Mn-rich samples grown by sulfurization at 500°C<T<585°C with an initial step at 115°C to enhance the alloy formation. Encouraging but improvable performance were obtained (efficiency 0.33%, open-circuit voltage 226 mV, short-circuit current density 4 mA/cm^2, fill factor 36.3%), confirming the potential of CMTS as absorber layer for low-cost solar cells.

Keywords Cu_2MnSnS_4, Thin films, Earth-abundant, Evaporation, Photovoltaics