Direct synthesis of Cu_2ZnSnS_4 thin films on substrates using chemical bath deposition for photovoltaic solar cells

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Photovoltaic solar cells with compound semiconductors like CdTe, Cu(In,Ga)Se_2, and Cu_2ZnSnS_4 (CZTS) known as absorber layers have been extensively studied. Among them, CZTS-based thin film solar cells have recently become of great interest, since all constituent elements of the CZTS are abundant in the earth crust and non-toxic. Moreover, CZTS has a near optimal direct band gap energy of 1.4 - 1.6 eV and a large absorption coefficient of $\sim 10^4$ cm^{-1}. CZTS absorber has been prepared by various methods, such as thermal evaporation, sputtering, electrodeposition, sol-gel, and hydrothermal synthesis. Among them, wet-chemistry methods are of great research interest because of their low fabrication cost. However, most wet-chemistry based CZTS film formations have been based on the synthesis of CZTS particles, followed by collecting and spin-coating them on a substrate and thermal treatment. Little information is available on a direct synthesis of CZTS thin film using wet-chemistry method.

In this work, we report the direct deposition of CZTS thin film onto large-area Mo/glass substrates by chemical bath deposition method. The film formation and morphologies were critically affected by the concentration and ratio of complex agents, such as triethanolamine and ammonia. The CZTS films showed well-developed kesterite crystal structure after sulfurization treatment at 500 ^oC. The CZTS films were analyzed by scanning electron microscopy, X-ray diffraction, micro Raman spectroscopy, photoluminescence spectroscopy, and I-V characteristics. In addition, we will further discuss the photovoltaic solar cell properties of CdS/CZTS thin films.