ASIA-PACIFIC SOLAR RESEARCH CONFERENCE

Solution-processed ultra-thin SnO_2 passivation of Cu_2ZnSnS_4/CdS heterointerface and Cu_2ZnSnS_4 grain boundaries for kesterite Cu_2ZnSnS_4 solar cells

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Photovoltaic (PV) industry has been recognized as one of the most promising renewable energy resources to dominate the future energy market and thereby addressing the energy crisis and environmental issues. Thin film solar cells have drawn a great attention due to its higher specific power with lower cost than that of bulk photovoltaics. Chalcogenide $Cu(In,Ga)Se_2$ (CIGS) and CdTe solar cells are forerunners among the high efficient (both demonstrating > 22% champion efficiencies) with a great stability. However, both CIGS and CdTe photovoltaics suffer a low potential production capacity due to the scarcity of In for CIGS and Te for CdTe as well as the toxicity of Cd. Cu_2ZnSnS_4 (CZTS), as a promising photovoltaic material derived from CIGS, possesses a wide range of advantages including high absorption coefficient, cost effectiveness, earth-abundancy and environmentally benign constituents. However, V_{oc} deficit has been a major obstacle for CZTS photovoltaic devices against further improving the conversion efficiency, which is induced by the serious non-radiative recombination at the CZTS/CdS heterointerface, CZTS grain boundaries and grain interior.

Introducing an intermediate layer is one of the routes aiming to diminish the recombination at the interface. Previous report showed an effective interface recombination alleviation through chemical bath deposited a lattice-matched CeO_2 layer, whereas, it is detrimental to the overall efficiency due to the poorer fill factor (FF) and short circuit current density (J_{sc}) [1]. The effectiveness of atomic layer deposited Al_2O_3 has been confirmed to improve the carrier lifetime and thereby overall efficiency [2-3]. However, ALD involves high processing cost and is also strongly related to the sample morphology. In this presentation, a solution-processed ultra-thin tin IV oxide via a successive ionic layer adsorption and reaction (SILAR) method will be introduced as a passivation layer on top of the as-sulfurized CZTS absorber to mitigate the recombination at the CZTS/CdS heterointerface and CZTS grain boundaries. *JV* characteristics reveals the improvement in both open circuit voltage (V_{oc}) and FF. Further investigation on the underlying mechanism shows that, with the insertion of this tin IV oxide layer, the carrier lifetime is enhanced as demonstrated by time-resolved photoluminescence (TRPL) profiles. Additionally , both the ideality factor (n_2) and the dark current (J_{02}), obtained from the *JV* curves using the Double-diode model, decreases which further proves the recombination mitigation. The Kelvin probe force microscope (KPFM) images provides a direct evidence of the grain boundary passivation.

Keywords

- Kesterite Solar Cells
- Interface Engineering; Grain Boundary Engineering
- SnO_2 Passivation

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