Perovskite $CH_3NH_3PbI_3$ as absorber material in planar configuration for all-thin film tandem solar cells

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The research field of perovskite solar cells has experienced unprecedented advancements with power conversion efficiency soaring from 3.8% just five years ago to the current record efficiency of 20.1%. Many different synthesis methods for the $CH_3NH_3PbI_3$ absorber layer and various device architectures have been reported. Broadly, the deposition approaches can be described as solution based or vacuum based methods and the device structures can be grouped in meso-porous or planar. In the planar structure the two step synthesis of single phase perovskite from thick planar PbI_2 typically requires long reaction time, elevated temperature and/or post deposition treatments (e.g. annealing). In this contribution we will discuss a novel concept that combines the advantages from solution and vacuum based deposition methods. With this approach a porous precursor PbI_2 layer consisting of nanoplates is employed to rapidly prepare single phase perovskite with a compact and flat morphology. The size and aspect ratio of the PbI_2 nanoplates can be well controlled during the deposition by thermal evaporation. The porosity of the PbI2 precursor layer allows the rapid penetration of CH_3NH_3I solution into the whole PbI_2 layer, thus facilitating a fast and complete conversion. The high quality perovskite film allows us to fabricate planar perovskite devices with a power conversion efficiency of 14.2% under reverse *J-V* measurements.

The relatively large band gap of 1.57 eV and the high NIR transmission of the $CH_3NH_3PbI_3$ absorber layer makes the perovskite solar cells an ideal candidate as top cell in tandem devices together with highly efficient low band gap bottom cells such as $Cu(In,Ga)Se_2$ (CIGS). Such all thin film tandem solar cells have the potential to reach efficiencies towards 30% if a high band gap perovskite solar cell with high efficiency and high transparency in NIR can be realized with all contacts transparent. In this contribution we will show perovskite solar cells fabricated with the method described above using transparent conductive oxide materials as front and rear side contacts. We will present results on perovskite-CIGS tandem devices in a 4-terminal configuration and discuss further prospects.