Bulk and Interfacial Defect Passivation for High Perofrmance Perovskite Solar Cells

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Nowadays, perovkite materials are considered to be the most promising absorber media for the third generation photovoltaics. Outstanding material properties allowed perovskite solar cells' power conversion efficiency values to exceed 25% in ten years, demonstrating the highest efficiency increase rate among all the available photovoltaic technologies. Despite such progress technology commercialization requires further device performance enhancement. Here, we report a performance increase strategy implying passivation of both bulk and interfacial defect states. To passivate the bulk defects an organic cross linker, 2,2′-(ethylenedioxy)bis (ethylammonium iodide) (GAI), was added into the mixed perovskite absorber layer. Different experimental techniques reveal that optimized amount of GAI, indeed, passivates defect states via cross-linking perovskite grains, while excess amount of cross-linker material deteriorates device performance due to generation of new defects and poor conductivity of the organic additive. The interfacial defects were passivated by interface engineering technique, namely, via application of a composed electron transport layer (ETL) consisting of quantum dot (QD) SnO_2, nanoparticle (NP) SnO_2 and a passivation layers based on PMMA:PCBM. It was demonstrated that a single-layer ETL made of QD SnO_2 or NP SnO_2 causes devices to show I-V hysteresis, while application of a triple-layer ETL effectively suppresses the hysteresis due to the optimization of ETL/perovskite interface. Thus, the cumulative effect of both applied techniques allowed to increase device' power conversion efficiency, almost completely remove hysteresis and improve the solar cell stability.

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