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Enhanced Performance of Perovskite Solar Cells by Modifying Interfacial Properties Using MoS2 Nanoflakes

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Abstract : Organic-inorganic perovskite solar cells (PrSCs) have emerged as a promising solar photovoltaic technology in terms of realizing high power conversion efficiency (PCE). However, their limited lifetime and poor device stability limits their commercialization in future. In this regard, interface engineering of the electron transport layer (ETL) using 2D materials have been currently used owing to their high carrier mobility, high thermal stability and tunable work function, which in turn enormously impact the charge carrier dynamics. In this work, we report an easy and effective way of simultaneously enhancing the efficiency of PrSCs along with the long-term stability through interface engineering via the incorporation of 2D-Molybdenum disulfide (2D-MoS_2, few layered nanoflakes) in mesoporous-Titanium dioxide (mp-TiO_2)scaffold electron transport buffer layer, and using poly 3-hexytheophene (P3HT) as hole transport layers. The PSCs were fabricated in ambient air conditions in device configuration, FTO/c-TiO_2/mp-TiO_2:2D-MoS_2/CH3NH3PbI3/P3HT/Au, with an active area of 0.16 cm^2. The best device using c-TiO_2/mp-TiO_2:2D-MoS_2 (0.5wt.%) ETL exhibited a substantial increase in PCE ~13.04% as compared to PCE ~8.75% realized in reference device fabricated without incorporating MoS_2 in mp-TiO_2 buffer layer. The incorporation of MoS_2 nanoflakes in mp-TiO_2 ETL not only enhances the PCE to ~49% but also leads to better device stability in ambient air conditions without encapsulation (retaining PCE ~86% of its initial value up to 500 hrs), as compared to ETLs without MoS_2.

Keywords : perovskite solar cells, MoS_2, nanoflakes, electron transport layer
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