Interface Modification of TiO_2 in Planar Perovskite Solar Cells using Low-temperature Brookite TiO_2 Nanoparticles

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Hybrid organometal halide perovskites solar cells (PSCs) have attracted much attention in the third-generation of thin-film photovoltaic. Interface modification turns a promising strategy to yield highly efficient planar heterojunction (PHJ) PSCs. The deep trap states on the compact-TiO_2 surface results in a huge leakage current and recombination of charge carriers. To solve the problems, the interfacial engineering of electron transport layer (ETL) compact TiO_2 was conducted by coating a low-temperature single crystalline brookite (BK) TiO_2 nanoparticles (NPs) with average diameter sizes about 30 nm, which causes a uniform and pin-hole-free layer. Herein, the compact TiO_2/BK-TiO_2 NPs bilayers were formed by spray pyrolysis (SP) deposition and spin coating (SC) process, respectively, and applied to PSCs as an ETL. The BK-TiO_2 films were sintered at low-temperature (<180 ˚C). Fig.1(a) shows the current-voltage (*J-V*) characteristics of the solar cells with a conventional compact TiO_2 and the bilayer. The power conversion efficiency was enhanced from 10.71% to 14.89% (Reverse Scan) according to the increases in short-circuit current density (J_{sc}) from 21.22 to 22.09 mAcm^{-2}, open-circuit voltage (V_{oc}) from 0.98 V to 1.05 V and fill factor (FF) from 0.51 to 0.64, by the bilayer of optimum 50-nm-thickness SC-BK TiO_2. The bilayer ETL led more efficient electron transport in the interface and charge extraction from the perovskite photovoltaic layer. The bilayer based PSCs exhibit a higher spectral response from visible light to near-infrared region with a broad, and flat absorption peak of 90% intensity, compared with the conventional compact TiO_2 PSCs, as shown in Fig 1(b). The present work is expected to provide us an important sign to obtain the low-cost and flexible PSCs.

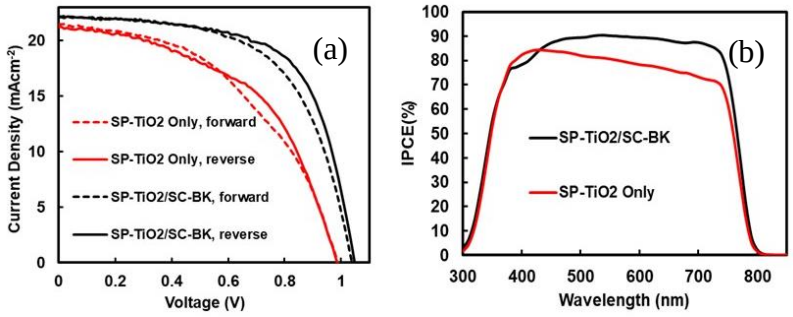

Fig. 1. Current density *versus* voltage (*J-V*) characteristics (a) and photon-to-current conversion efficiency (IPCE) spectra (b) of PSCs with conventional compact TiO_2 and the bilayer with BK-TiO_2.

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