Single-Crystalline Titanium Oxide (TiO_2) Polymorphs Nanoparticle Electron Transport Bilayer for Efficient Perovskite Solar Cells

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In the design of electron transport layers (ETLs) to enhance the performance of perovskite solar cells (PSCs), efficient electron extraction and transport are important aspects. Herein, we examine the effect of different titanium oxide (TiO_2) polymorphs such as anatase and brookite in the resultant PSCs performance. In the first half, we introduce the interface modification of TiO_2 compact layer (CL) by using single-crystalline anatase TiO_2 nanoparticles (NPs) with average diameter sizes about 6 to 10 nm was applied as an ETL (bilayer CL) and thus leads power-conversion efficiencies (PCEs) as high as 17.05% compared to the TiO_2 single layer-based counterparts (**Fig. a**).[1]

In the second half, we design and fabricate, pure-phase brookite-based TiO_2 heterophase junctions on FTO as the substrate. We attempt to investigate and compare single phase anatase (A) and brookite (B) and heterophase anatase−brookite (AB) and brookite−anatase (BA) as ETLs in PSCs. The PCE of PSCs with single crystalline FTO-B only layer as the ETL was as high as 14.92% that is the highest reported efficiency of FTO-B-based single-layer PSC (**Fig. b**).[2] This result suggests that FTO-B acts as an active phase, which can be a potential candidate as an ETL scaffold in planar PSCs. Hetero junction FTO-AB ETLs based PSCs showed PCEs as high as 16.82%, which is higher to those of PSCs with single-phase anatase (FTO-A) and brookite (FTO-B) as the ETLs (13.86% and 14.92%, respectively). This work presents an effective strategy to manipulate the interfacial energy band for improving PSCs performance and enable clean, and eco-friendly fabrication of low-cost mass production.

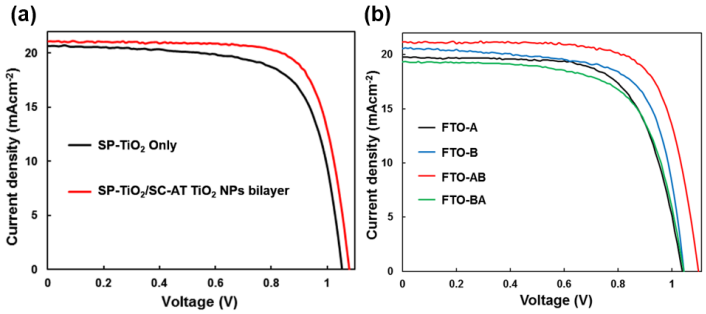

Fig. Reverse scan of (a) *J–V* curves obtained for solar cells based on substrates with and without the NP bilayer and (b) *J-V* curves of PSCs with FTO-A, FTO-B, FTO-AB, and FTO-BA as the ETL.

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References:

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