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Compactness Impact of the Hole-blocking TiO_2 Layer upon $CH_3NH_3PbI_3$ Perovskite Solar Cells

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Introduction:

In the past five years, perovskite solar cells have remarkably marched with the power conversion efficiency (PCE) elevating from 3.8% in 2009, 15.4% in 2013, to 19.3% in April 2014 [1, 2], which has reached a comparative performance with their counterparts—multicrystalline silicon solar cells. The perovskite solar cells are now approaching large-scale application for their properties of cost-effective production, solution processibility, sufficiency in raw material sources and capability for application in flexible substrates. TiO_2 dense-layer is usually used to transport electrons and block holes from injecting into the anode and the compactness of this layer is very critical for highly-efficient cells [3, 4]. We had conducted series of investigations for its impact upon cells' performance by a spin-coating route.

Results and discussion:

Experiments were conducted roughly by the prior literature [5], except that spin-coating and titanium isopropoxide were applied for the TiO_2 dense-layer with some modifications. Samples from one-time spin-coating and two-time spin-coating with a $TiCl_4$ dipping for dense-layer were labeled as A and B respectively. Another group of samples (in Fig.1 D) had been fabricated for compactness characterization by such a way that the dense-layer was spin-coated on FTO glass substrates, on which the Al electrode of 200 nm in thickness were thereafter vacuum-deposited with a width of 2.0 mm for two neighboring stripes.

Fig.1 has demonstrated the resulting perovskite solar cells: Sample A with a compact dense-layer and Sample B with a less compact dense-layer, both of which had an identical structure of FTO/TiO_2 dense-layer/TiO_2 meso-layer: $CH_3NH_3PbI_3$/HTM/Au. The resistances had been tested averagely as 6.1 Ω and 2.0 Ω for A and B respectively, which denotes that Sample A has contained much less pin holes than Sample B, as can significantly reduce shunting current of the cells. The *J-V* curves in Fig.1 have indicated that Sample A has a much higher short circuit current of 19.8 mA/cm^2 and better PCE of 4.12%, whereas the B is inferior in Jsc, Voc and PCE but superior in fill factor. The improvements should be attributed to the efficacy of compactness of dense-layer. A higher efficiency for more compact layers and the mechanism are still under investigation.

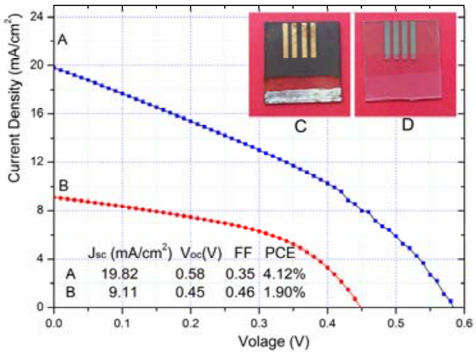

Fig. 1 J-V curves (A, B) and picture (C) for the $CH_3NH_3PbI_3$ solar cells and samples for resistance testing (D)

Reference

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