Supporting Information

Efficient panchromatic inorganic-organic heterojunction solar cells with consecutive charge transport tunnels in hole transport material

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The TiO_2 (anatase) colloidal solution was prepared according to a previous report.[1] Subsequently, it was diluted in ethanol at 1:2.5 by weight and stirred overnight to form a paste. Patterned conducting fluorine-doped SnO_2 (FTO) glass (15 Ω/□) was etched with Zn powder and 2 M aqueous HCl solution. Then it was cleaned with successive sonication in milliQ water, isopropanol and acetone for 5 min and dried with clean dry air. To make a dense TiO_2 under layer, the cleaned FTO glass was immersed in 0.15 M aqueous $TiCl_4$ solution at 60 ℃ for 30 min. After rinsing with water, it was dried with clean dry air and sintered in air at 510 ℃ for 30 min. The TiO_2 paste was deposited on FTO glass by using a spin-coating technique at the speed of 2000 rpm for 30 s and annealed in air at 510 ℃ for 30 min. The TiO_2 film was ~600 nm in thickness measured by a surface profilometer (XP-2, AMBIOS Technology Inc., USA). $CH_3NH_3PbI_3$ precursor solution was prepared according to a previous report.[2] The $CH_3NH_3PbI_3$ precursor solution was spin-coated on TiO_2 films at speed of 2000 rpm for 30 s and dried at 100 ℃ for 20 min in glovebox. The hole transport material (HTM) was a chlorobenzene solution containing 10 mg/mL P3HT, 0.2 M 4-tert-butylpridine (TBP), 0.06 M bis (trifluoromethane) sulfonimide lithium salt. A second P3HT solution with MWNTs accounting for 2 wt% of P3HT was also prepared. Thereafter the different HTM solutions were coated on the $CH_3NH_3PbI_3$ deposited TiO_2 films using spin-coating technique at 2000 rpm for 50 s and dried at 120 ℃ for 30 min in glovebox. Then a gold electrode was deposited on top by magnetic sputtering. The active area of the hybrid solar cells was 0.09 cm^2. For DC conductivity measurement, P3HT or P3HT-MWNTs solution was cast on clean glass and dried in a glovebox. The Van der Pauw four-probe method, using Keithley 2402 source meter, was employed for conductivity measurement of the P3HT and P3HT-MWNTs samples.

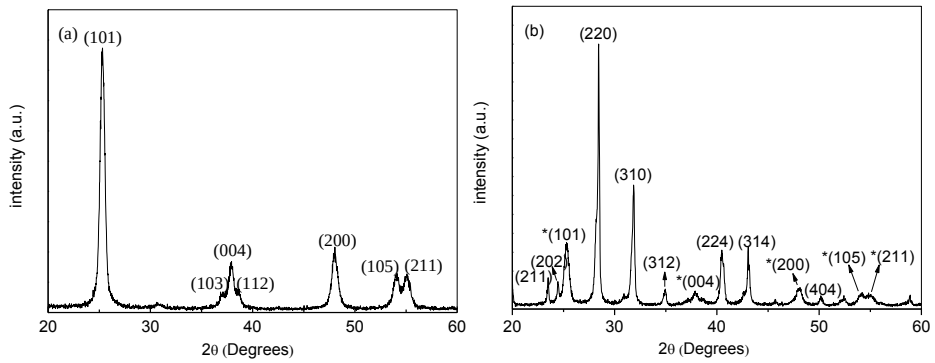

Fig. S1 X-ray Diffraction (XRD) pattern of (a) TiO_2 and (b) $CH_3NH_3PbI_3$ deposited on TiO_2.

In Fig. S1b, the peaks with "*" were attributed to TiO_2 and the peaks without one were attributed to $CH_3NH_3PbI_3$.

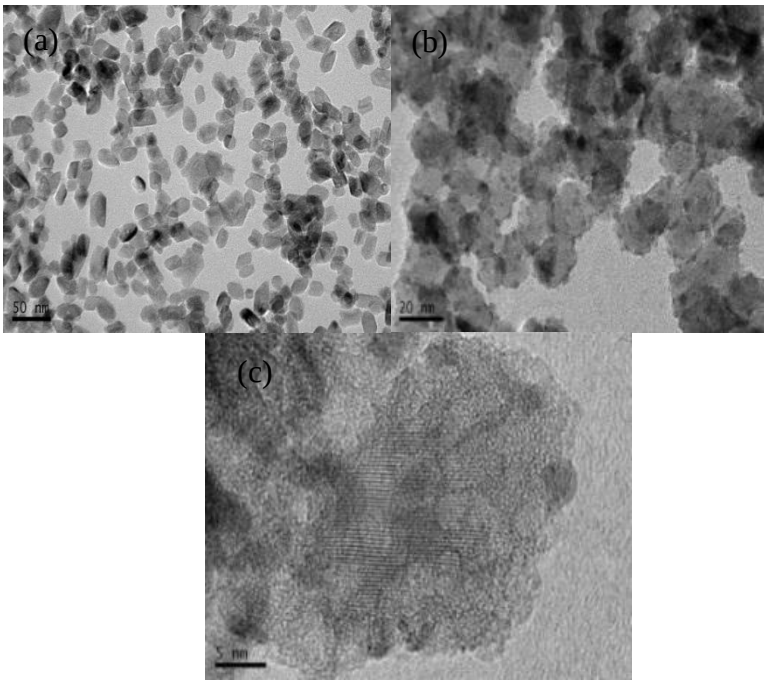

Fig. S2 TEM image of (a) TiO_2 nanoparticles, (b) $CH_3NH_3PbI_3$ deposited TiO_2 nanoparticles and (c) magnified picture of $CH_3NH_3PbI_3$ deposited TiO_2.

1. L. H. Hu, S. Y. Dai, J. Weng, S. F. Xiao, Y. F. Sui, Y. Huang, S. H. Chen, F. T. Kong, X. Pan, L. Y. Liang and K. J. Wang, *J Phys Chem B*, 2007, **111**, 358-362.
2. J. H. Im, C. R. Lee, J. W. Lee, S. W. Park and N. G. Park, *Nanoscale*, 2011, **3**, 4088-4093.