Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Eliminated hysteresis and stabilized power output over 20% in planar heterojunction perovskite solar cells by compositional and surface modifications to the low-temperature-processed TiO_2 layer

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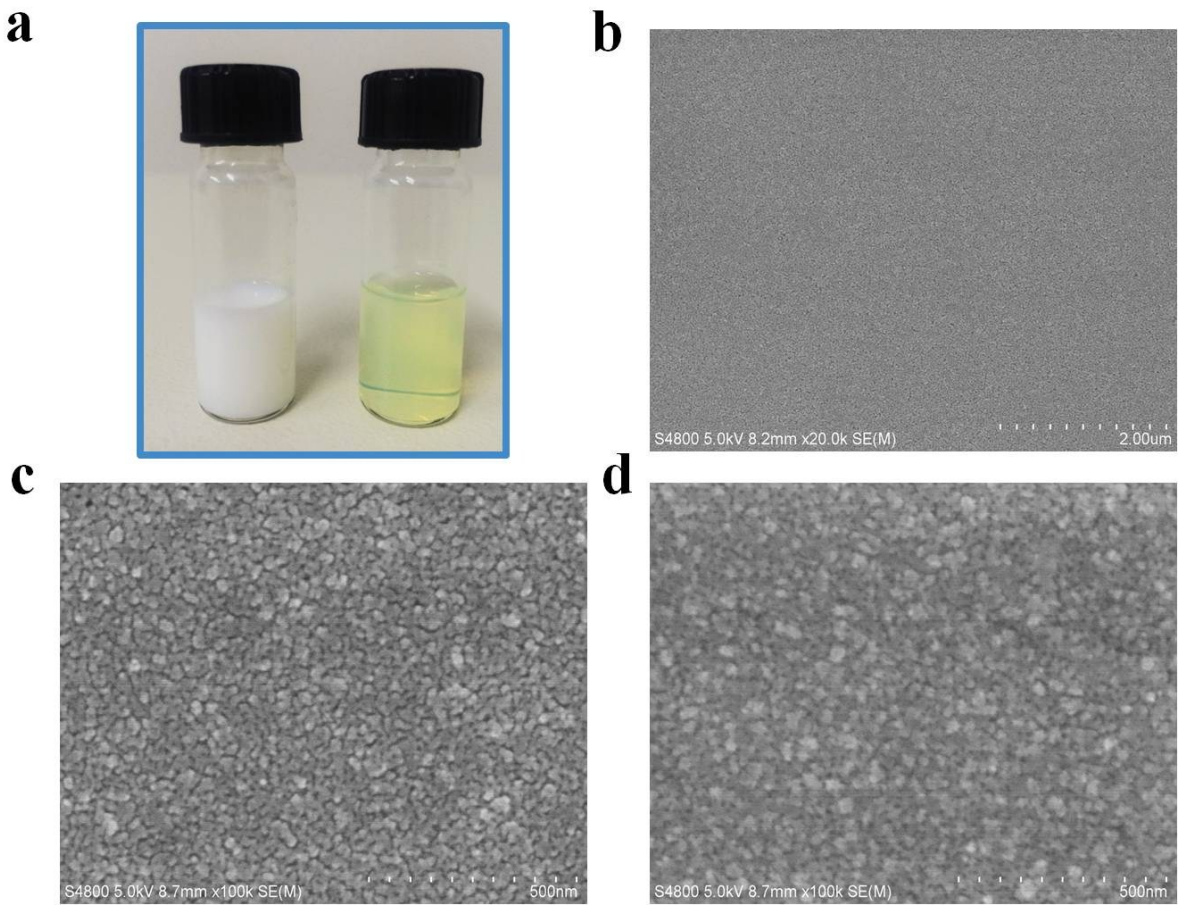

Figure S1. (a) Photos of the TiO_2 solution without (left) and with (right) the addition of TIPD. (b) Scanning electron microscopy (SEM) image of a TiO_2:TOPD film cast on ITO substrate. High magnification SEM images of TiO_2 films cast on ITO substrate with (c) and without (d) the addition of TOPD.

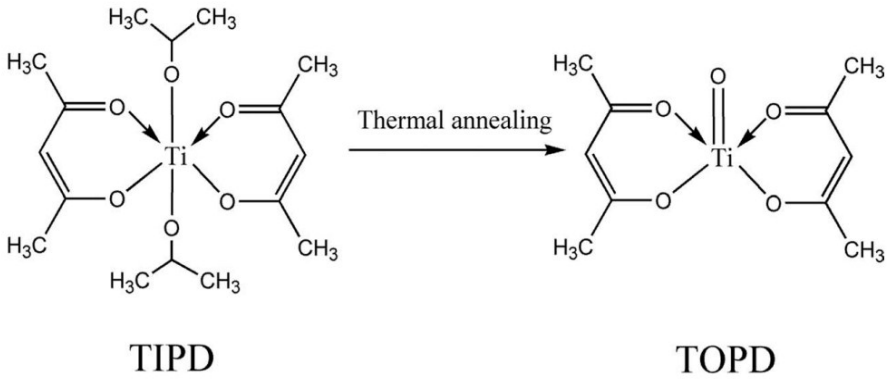

Figure S2. Conversion of TIPD to TOPD upon thermal annealing[1,2].

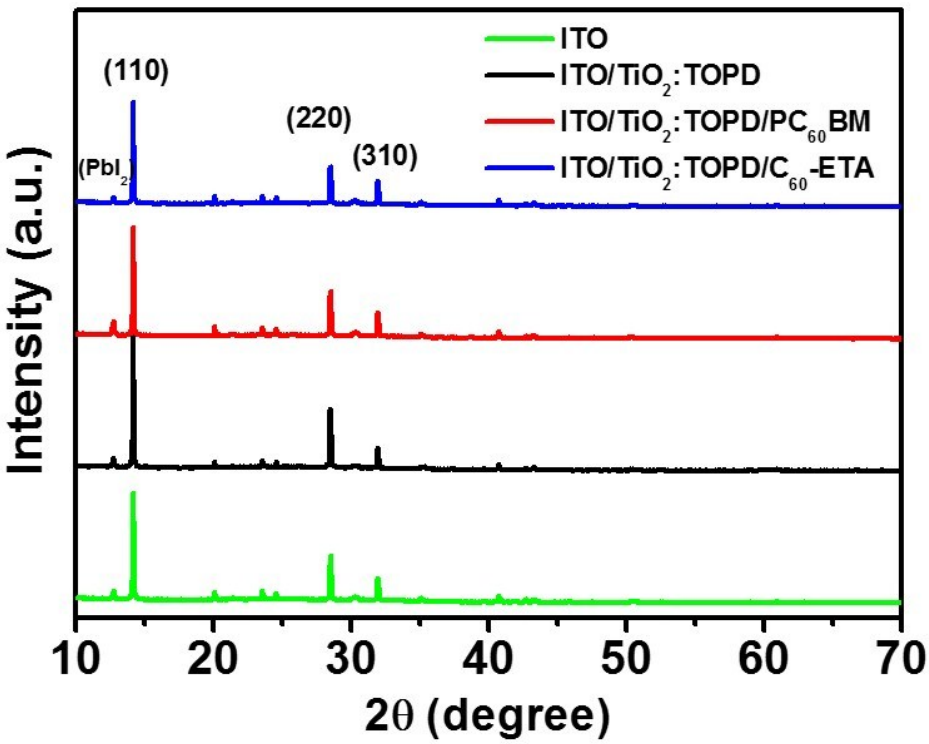

Figure S3. The XRD spectra of perovskite on ITO (green line), TiO_2:TOPD (black line), TiO_2:TOPD/PC_{60}BM (red line), TiO_2:TOPD/C_{60}-ETA (blue line) surfaces.

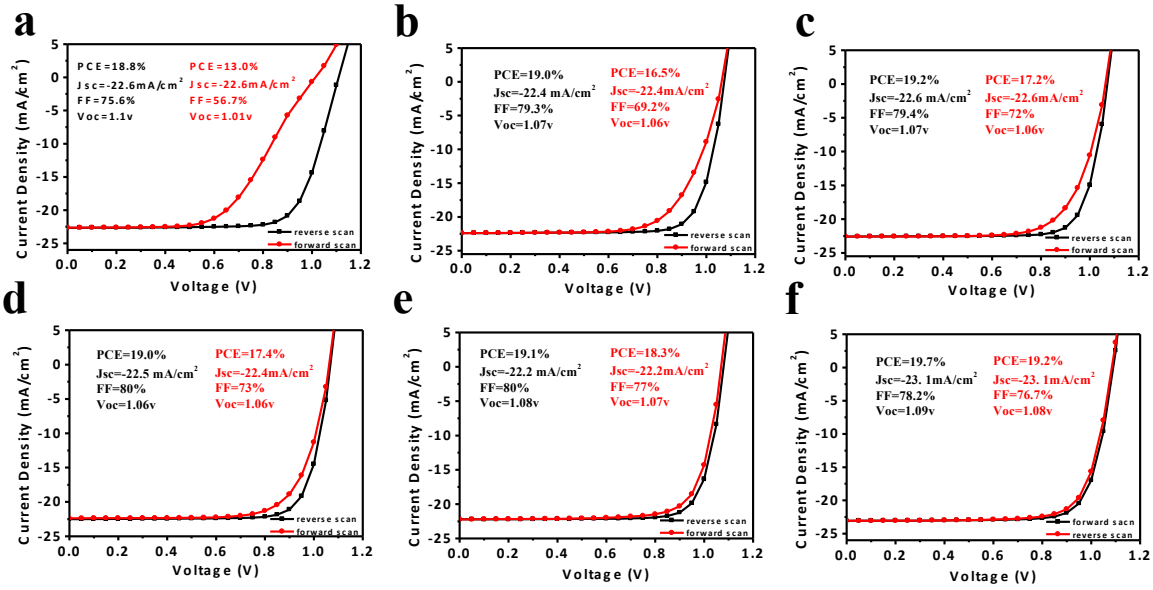

Figure S4. The *J-V* curves of devices using TiO_2:TOPD/PC_{60}BM as ETLs with (a) 0 nm, (b) 29 nm, (c) 33 nm, (d) 35 nm, (e) 37 nm, (f) 50 nm, respectively. PCEs close to the average values were selected and plotted in this figure.

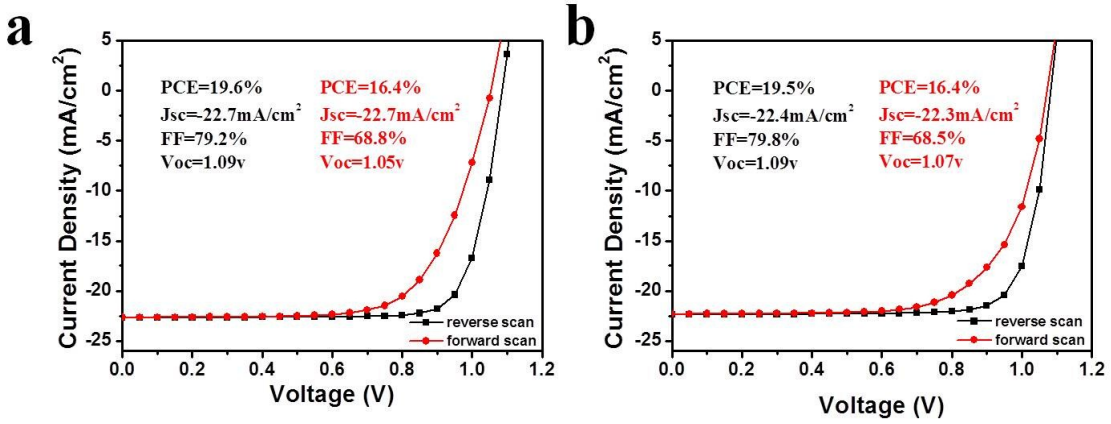

Figure S5. The *J-V* curves of devices using (a) TiO_2:TOPD/$PC_{60}BM$(2nm) and (b) TiO_2:TOPD/C_{60}-ETA(2 nm) as ETLs, respectively. PCEs close to the average values were selected and plotted here.

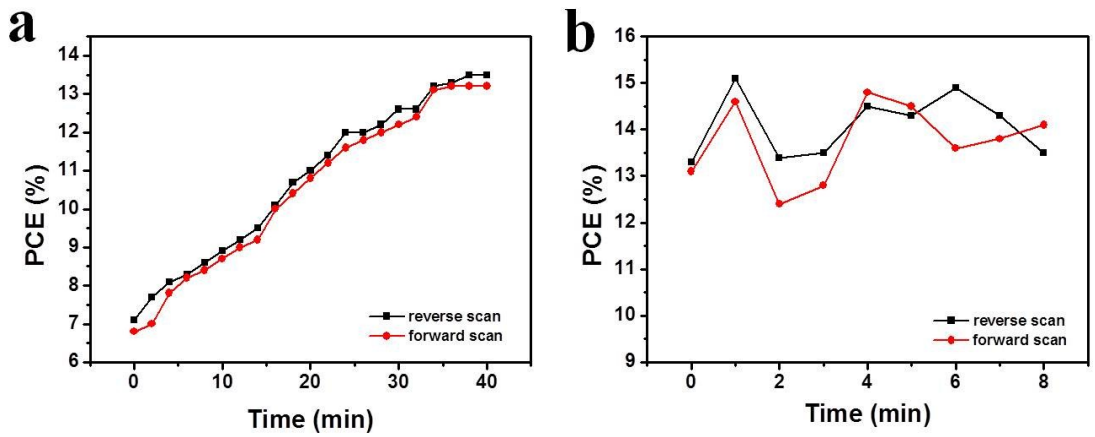

Figure S6. The evolutions of PCE as a function of illumination time using (a) 50 nm $PC_{60}BM$ and (b) 30 nm $PC_{60}BM$ as the ETLs.

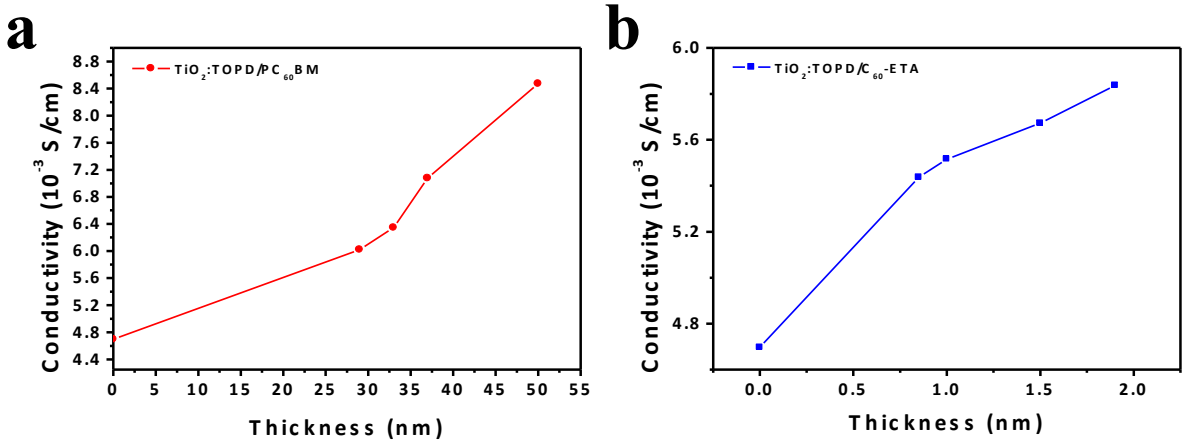

Figure S7. (a) The conductivity of TiO_2:TOPD/$PC_{60}BM$ films with various $PC_{60}BM$ thickness. (b) The

conductivity of TiO_2:TOPD/C_{60}-ETA films with various C_{60}-ETA thickness.

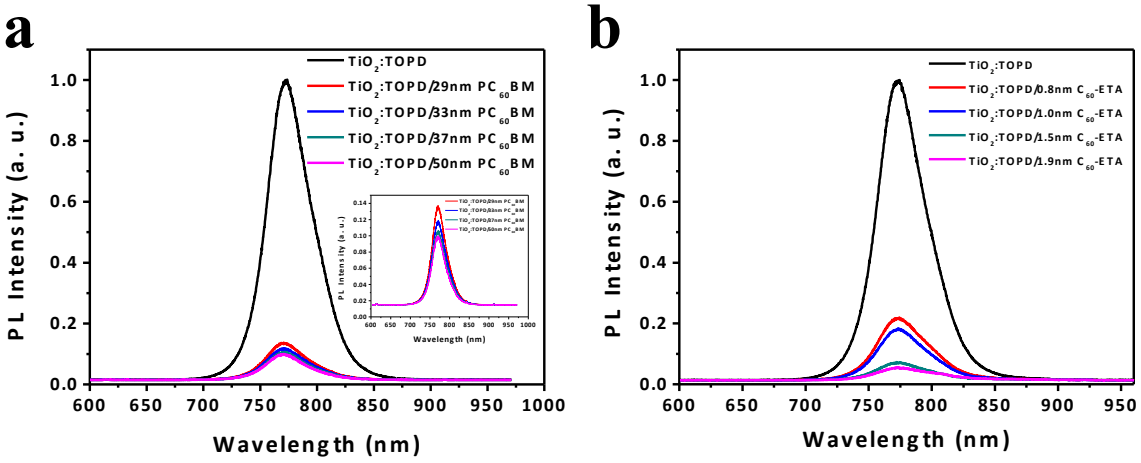

Figure S8. (a) The PL spectra of perovskite films on TiO_2:TOPD/PC_{60}BM with different PC_{60}BM thickness. (b) The PL spectra of perovskite films on TiO_2:TOPD/C_{60}-ETA with different C_{60}-ETA thickness.

[1] Z. A. Tan, W. Zhang, Z. Zhang, D. Qian, Y. Huang, J. Hou, Y. Li, *Adv. Mater.* **2012**, 24, 1476.

[2] Y. Yan, F. Cai, L. Yang, J. Li, Y. Zhang, F. Qin, C. Xiong, Y. Zhou, D. G. Lidzey, T. Wang, *Adv. Mater.* **2017,** 29, 1604044.