Supplementary Information

Morphology Fixing Agent for $PC_{60}BM$ in Planar-Type Perovskite Solar Cells for Enhanced Stability

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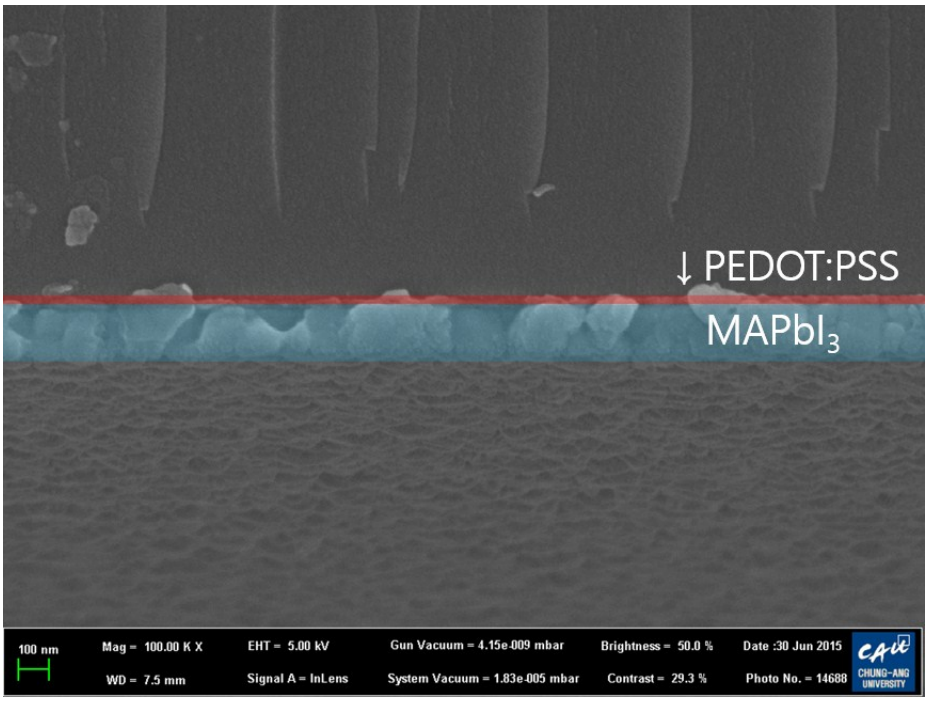

Figure S1. SEM cross sectional image of the PEDOT:PSS and the $MAPbI_3$ layer.

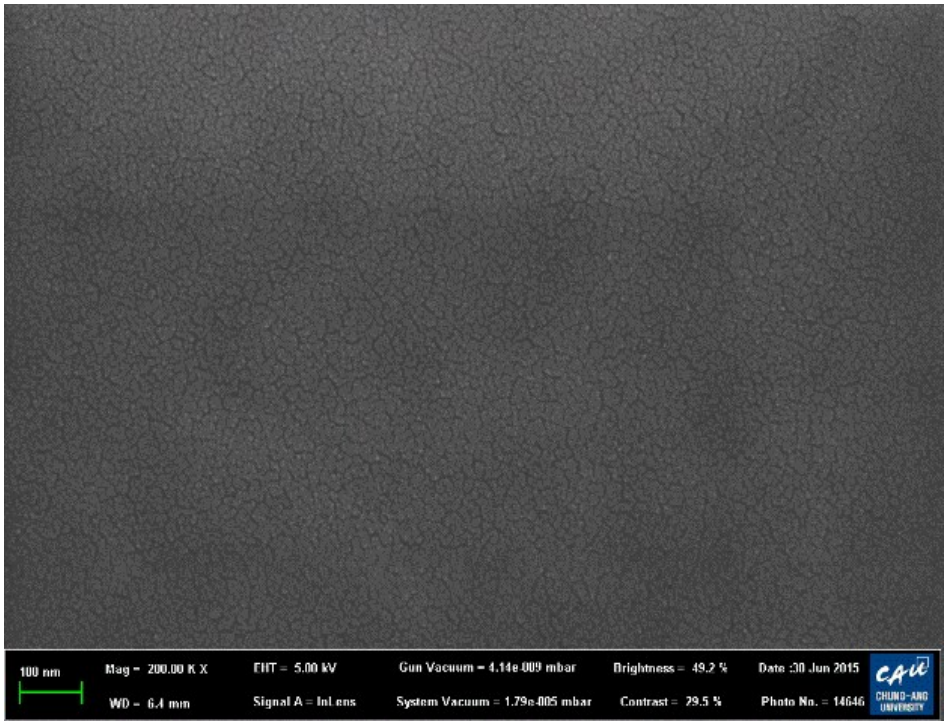

Figure S2. SEM surface image of the $PC_{60}BM$ layer on top of the $MAPbI_3$ layer.

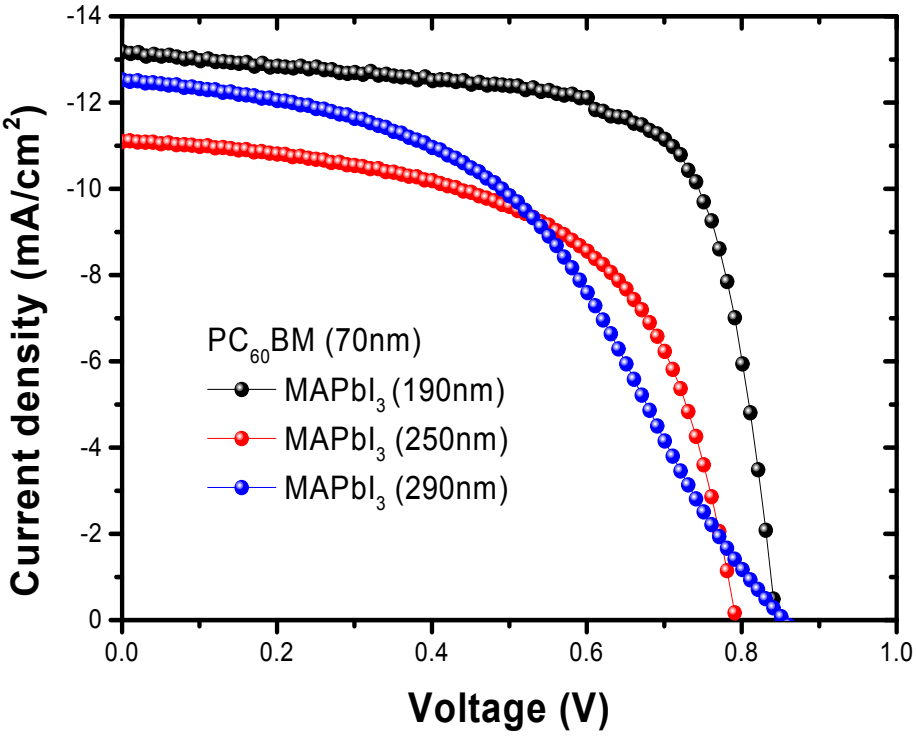

Figure S3. J-V characterization of the PSCs depending on the different thicknesses of $MAPbI_3$. The $PC_{60}BM$ layer was initially coated to a thickness of ~ 70 nm for thickness optimizing of $MAPbI_3$.

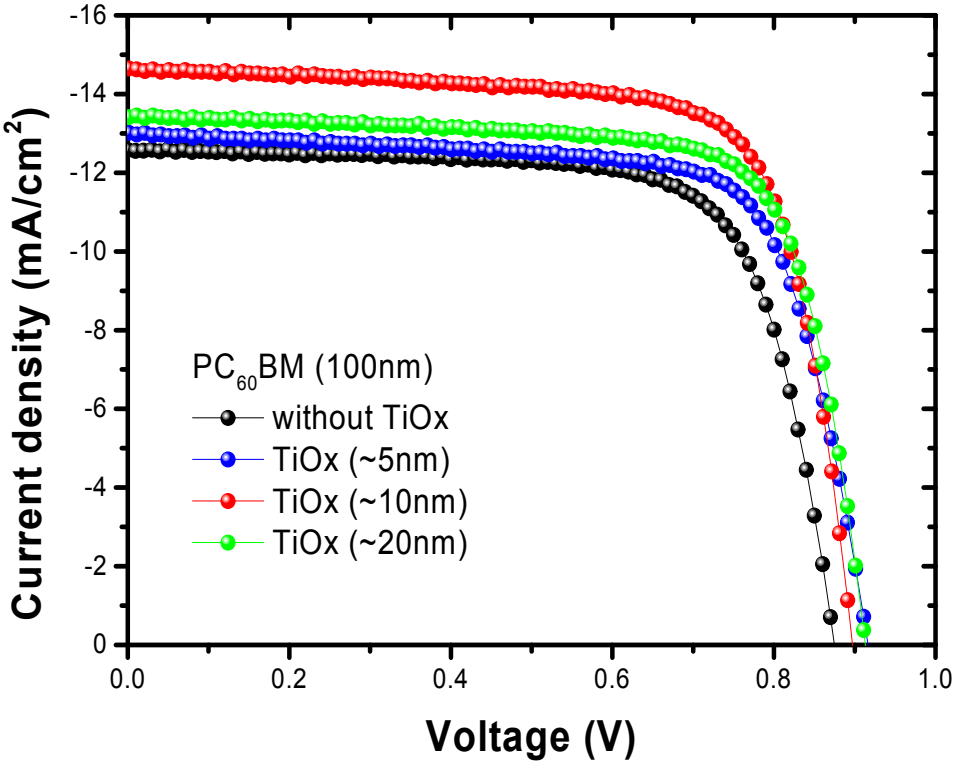

Figure S4. J-V curves of the PSCs with different thicknesses of TiO_x layer (0 to 20 nm).

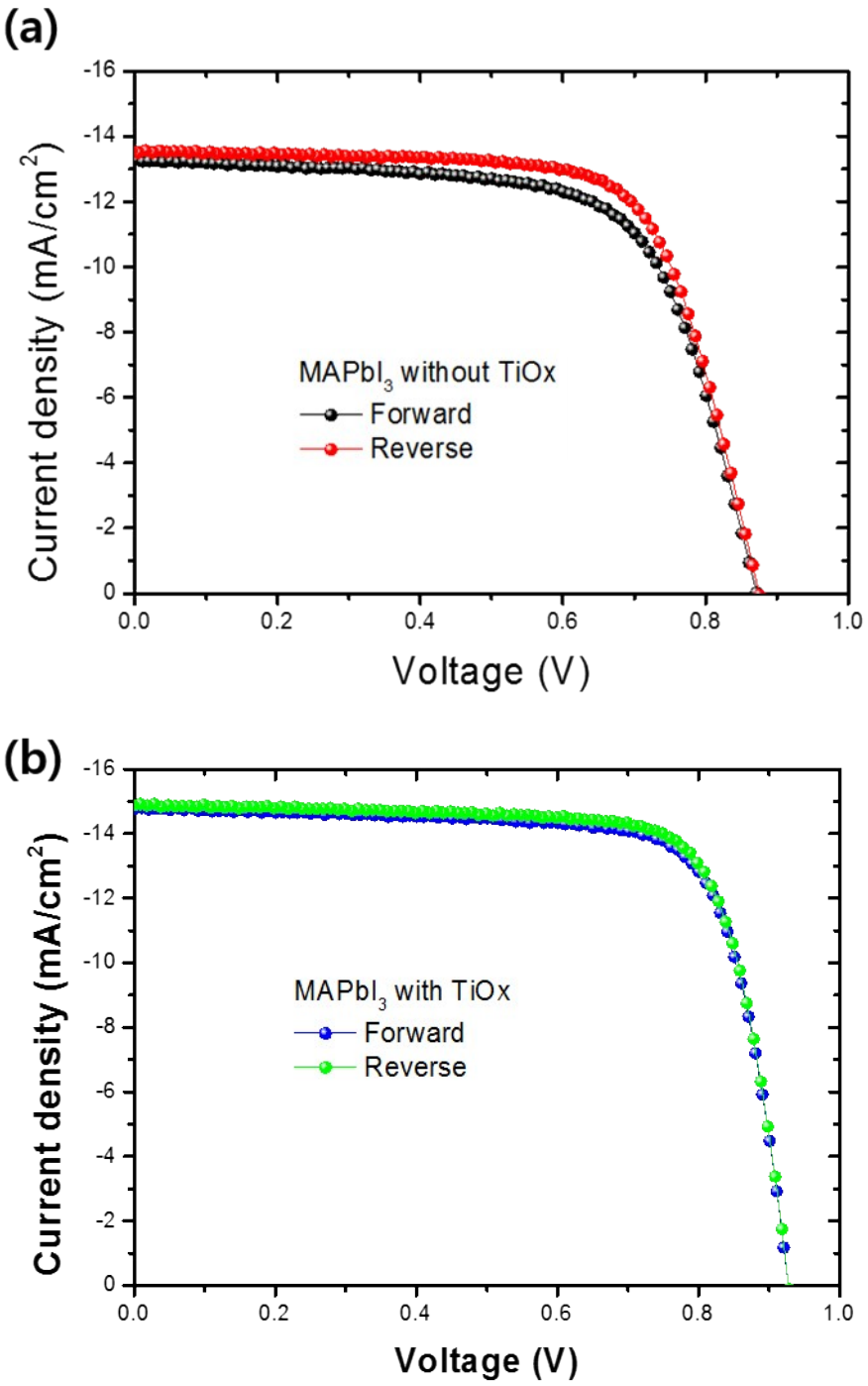

Figure S5. J-V curves of the PSCs measured by forward and reverse scans, fabricated by (a) without and (b) with the TiO_x layer.

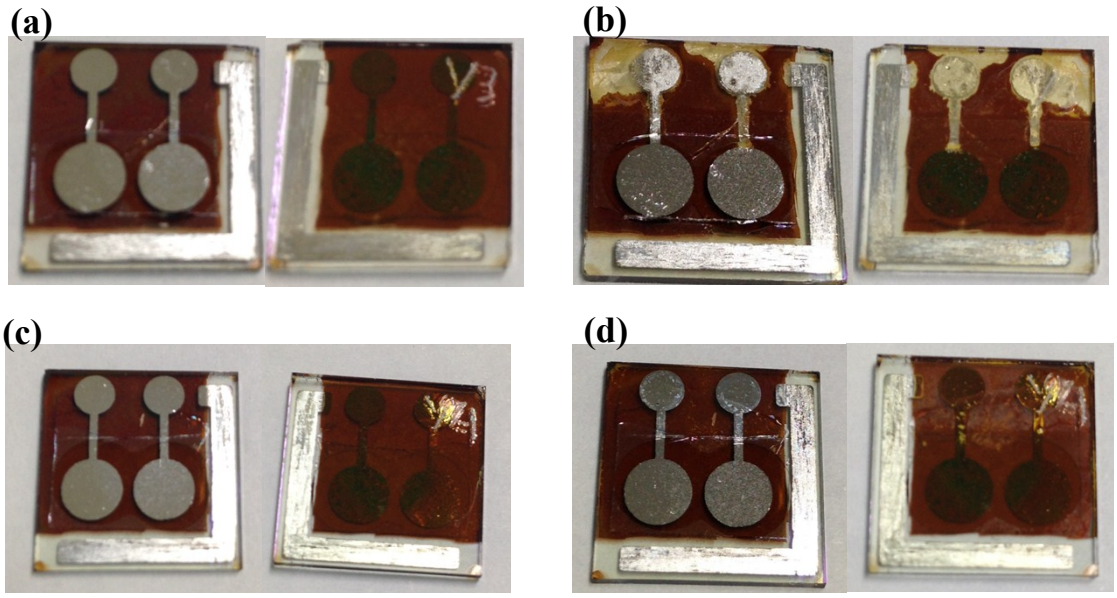

Figure S6. Photographs of the devices without and with the TiO_x morphological fixing agent and after the stability test: (a, b) PSCs without TiO_x, and (c, d) PSCs with TiO_x; (a, c) as cast and (b, d) after 3 days.

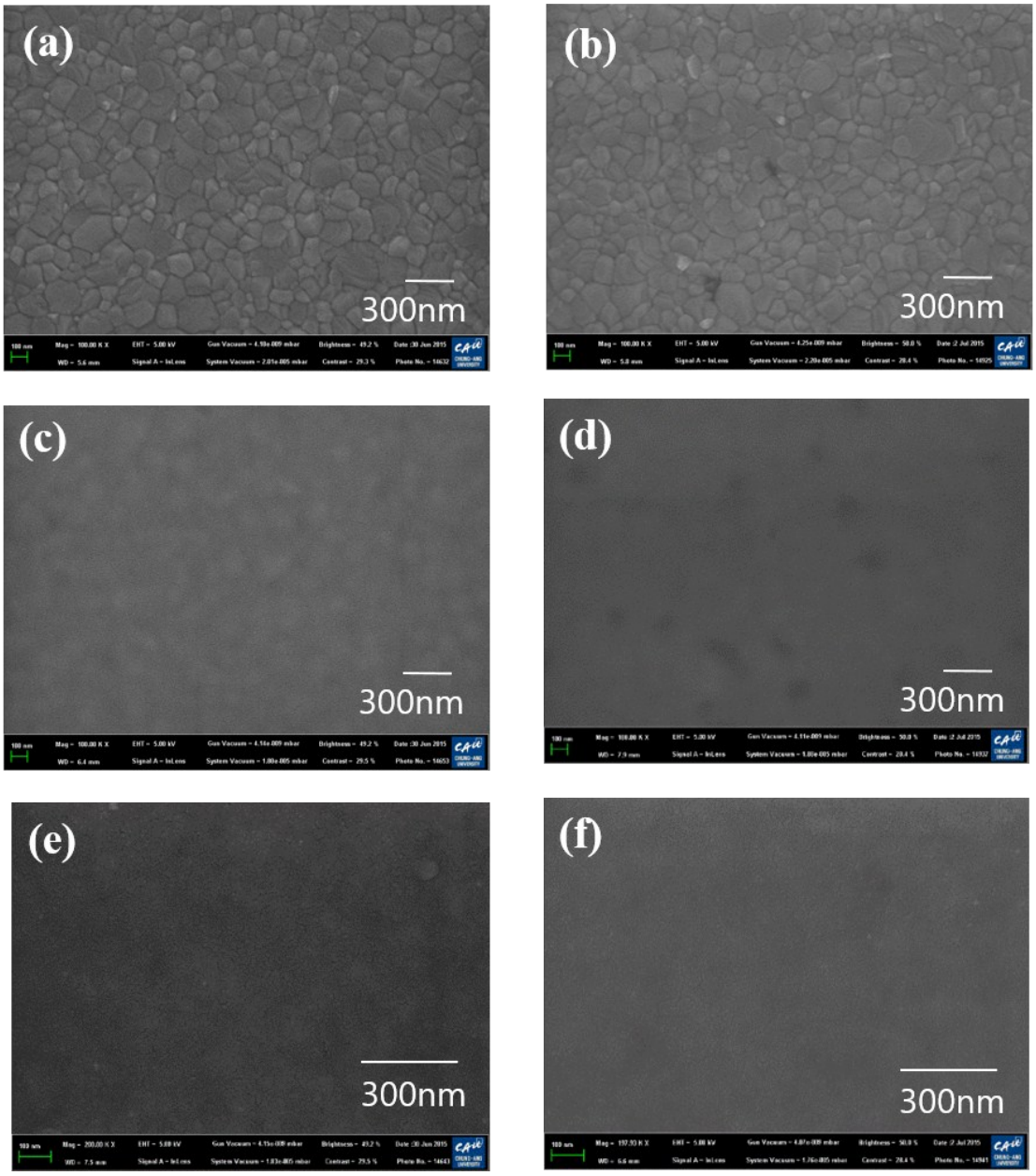

Figure S7. SEM surface images of (a, b) $MAPbI_3$, (c, d) $MAPbI_3/PC_{60}BM$, (e, f) $MAPbI_3/PC_{60}BM/TiO_x$; (b, d, f) are the SEM images after 3 days.

$PC_{60}BM$ (70nm)	V_{OC} (V)	J_{SC} (mA/cm^2)	FF (%)	PCE (%)
$MAPbI_3$ (190nm)	0.844	13.18	70.2	7.81
$MAPbI_3$ (250nm)	0.793	11.10	58.4	5.14
$MAPbI_3$ (290nm)	0.854	12.53	46.2	4.95

Table S1. Electrical parameters of the PSCs depending on the controlled thickness of $MAPbI_3$ as shown in Fig. S3.

$PC_{60}BM$ (100nm)	V_{OC} (V)	J_{SC} (mA/cm^2)	FF (%)	Eff. (%)
without TiOx	0.875	12.58	72.8	8.01
With TiOx (~5nm)	0.917	13.01	72.8	8.68
With TiOx (~10nm)	0.928	14.78	75.9	10.41
With TiOx (~20nm)	0.913	13.41	74.9	9.17

Table S2. Electrical parameters of the PSCs depending on different thickness of TiO_x layer as corresponded with Fig. S4.

PSCs	Scan direction	V_{OC} (V)	J_{SC} (mA/cm^2)	FF (%)	PCE (%)
Without	Forward	0.872	13.27	67.5	7.81
	Reverse	0.875	13.53	70.7	8.37
With TiO_x	Forward	0.928	14.78	75.9	10.41
	Reverse	0.928	14.89	76.7	10.59

Table S3. Electrical parameters of the PSCs without and with the TiO_x layer depending on the different scan directions as shown in Fig. S5.