

Supporting Information

**Efficient planar n-i-p type heterojunction flexible perovskite solar cells with sputtered TiO₂
electron transporting layers**

Sawanta S. Mali,^a Chang Kook Hong^{a*}

*^aPolymer Energy Materials Laboratory, School of Applied Chemical Engineering, Chonnam
National University, Gwangju, 500-757, Republic of Korea*

Figure S1 FESEM micrographs of BI-TiO₂ deposited at different deposition techniques. (a) RF-sputtered TiO₂ 30nm, (b) RF-sputtered TiO₂ 50nm, (c) RF-Sputtered TiO₂ 100nm, (d) RF-Sputtered TiO₂ 50nm on Glass substrate, (e) spin coated and annealed at 450°C on FTO, (f) sol-gel processed TiO₂ spin coated on ITO, (f) sol gel processed TiO₂ spin coated on PET substrate. (g-j) Cross sectional images of RF-sputtered BI-TiO₂ with 30, 50 and 100nm thickness respectively. (Scale bar 100nm)

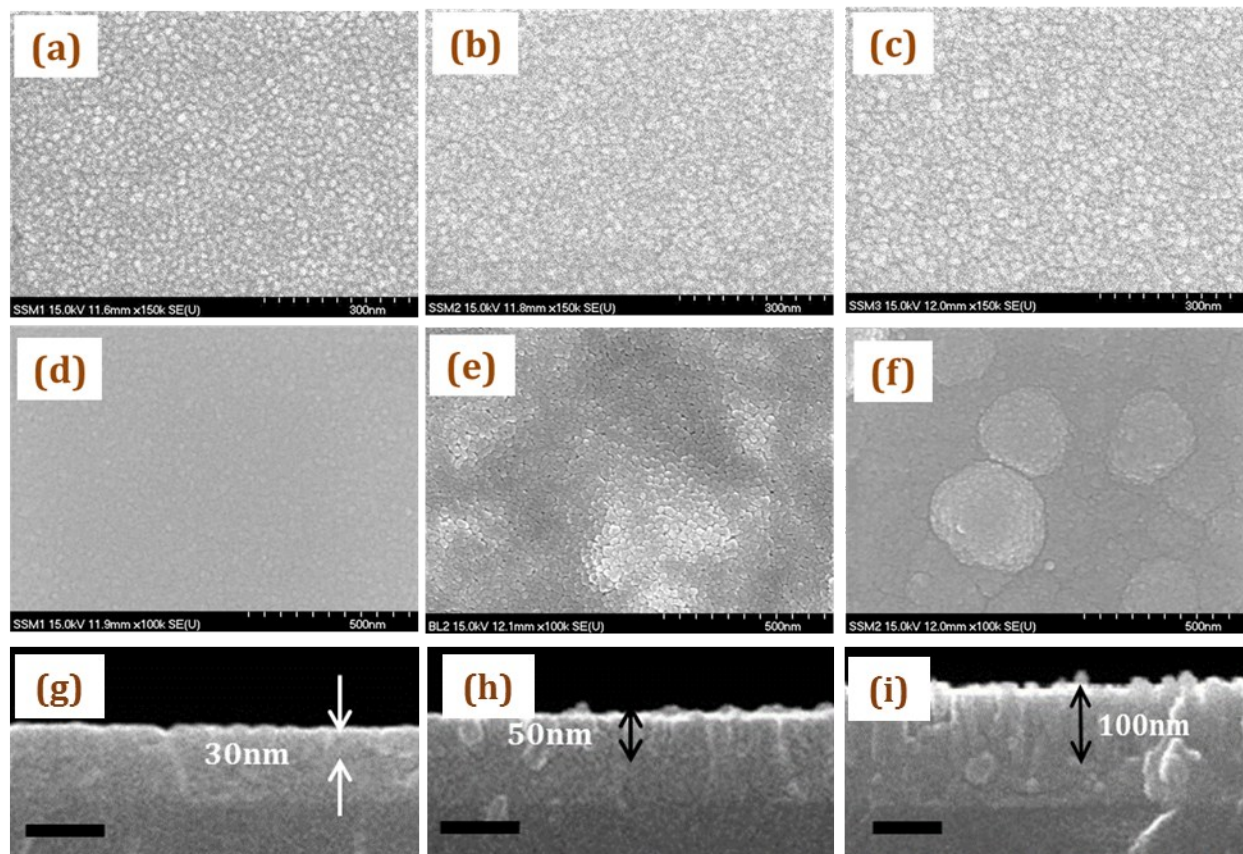


Figure S2. XRD patterns of BI-TiO₂ deposited at different deposition techniques: (a) traditional method spin coated and annealed at 450°C (b) sol-gel processed spin coated and annealed at 450°C (c) room temperature processed RF-magnetron sputtered TiO₂ at different thicknesses. Inset shows respective photographs of each sample. (d) Photograph of highly transparent 50nm thick BI-TiO₂ layer deposited by RF-magnetron sputtering.

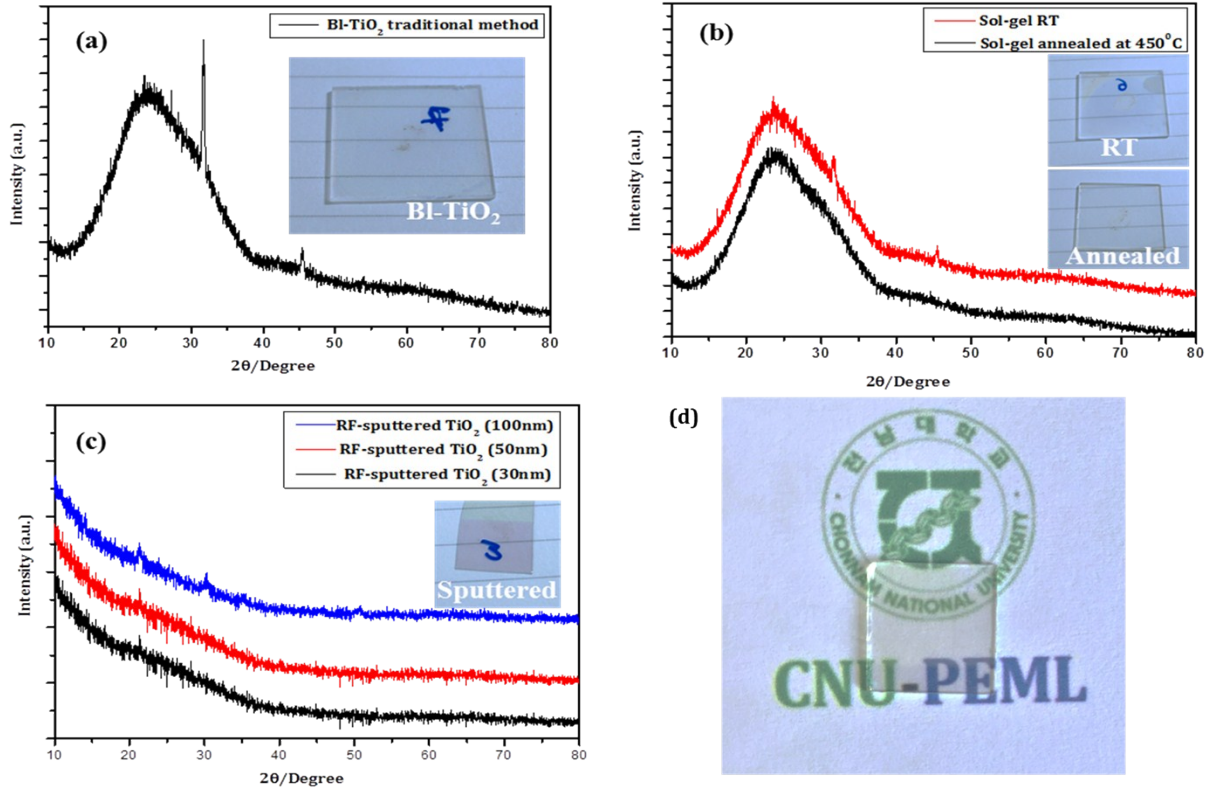


Figure S3 XPS spectra of the TiO₂ ETL deposited by different techniques. (a) Ti2p core level spectra (b) core level spectra of O1s.

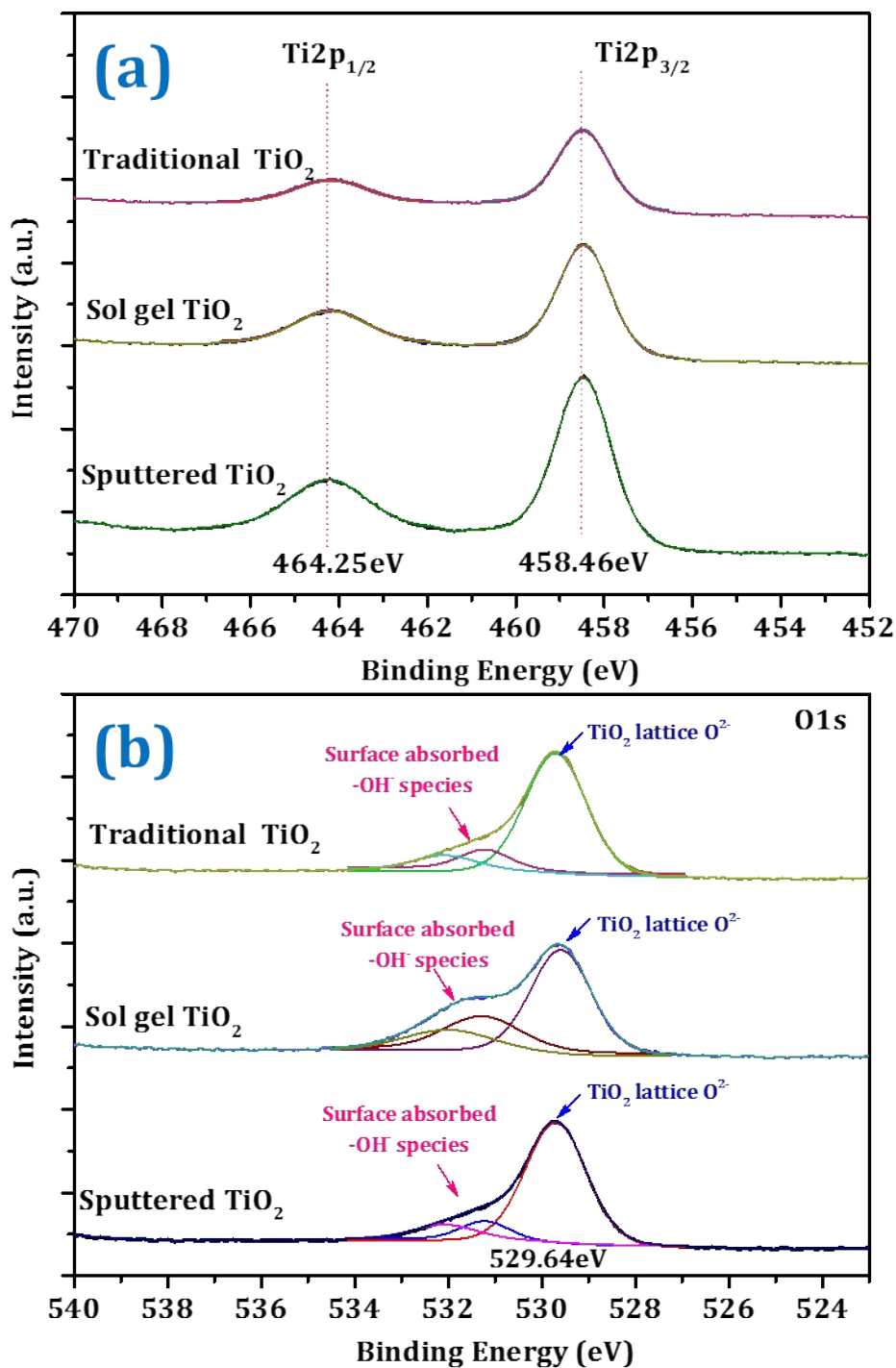


Figure S4 FESEM and AFM images of a perovskite layer (a) Highly magnified FEEM image of $\text{MAPb}(\text{I}_{1-x}\text{Br}_x)_3$ thin film deposited without toluene dripping (b) AFM topography top view and (c) three-dimensional views (right) of the surface of the $\text{MAPb}(\text{I}_{1-x}\text{Br}_x)_3$ thin film. The size of the AFM images is $5 \times 5 \mu\text{m}^2$. The measured root mean square roughness is 22.234nm.

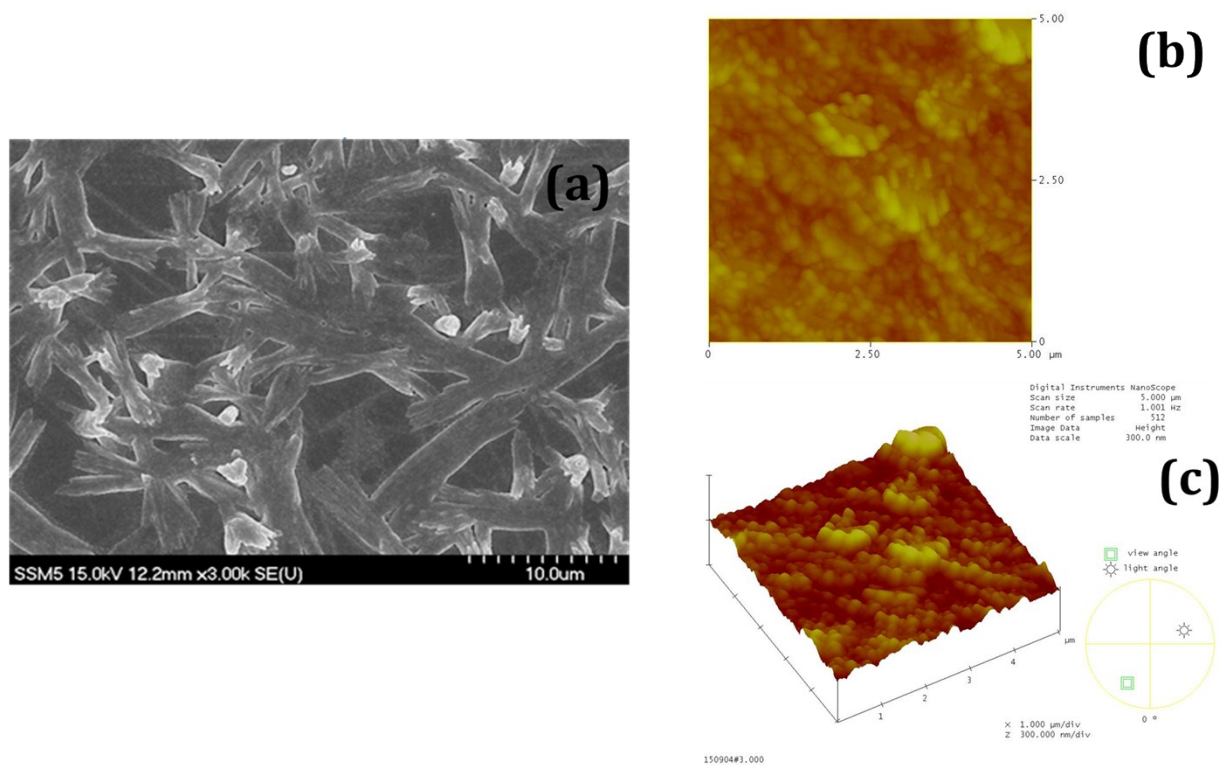


Figure S5 FESEM and AFM images of a perovskite solar cell;(a) Highly magnified FEEM image of MAPb(I_{1-x}Br_x)₃ thin film deposited on FTO/Bi-TiO₂ (b) AFM topography top view and (c) three-dimensional views (right) of the surface of the MAPb(I_{1-x}Br_x)₃ thin film deposited on Glass/FTO/Bi-TiO₂ substrate. The size of the AFM images is 5 x 5 μm². The measured root mean square roughness is 15.653nm.

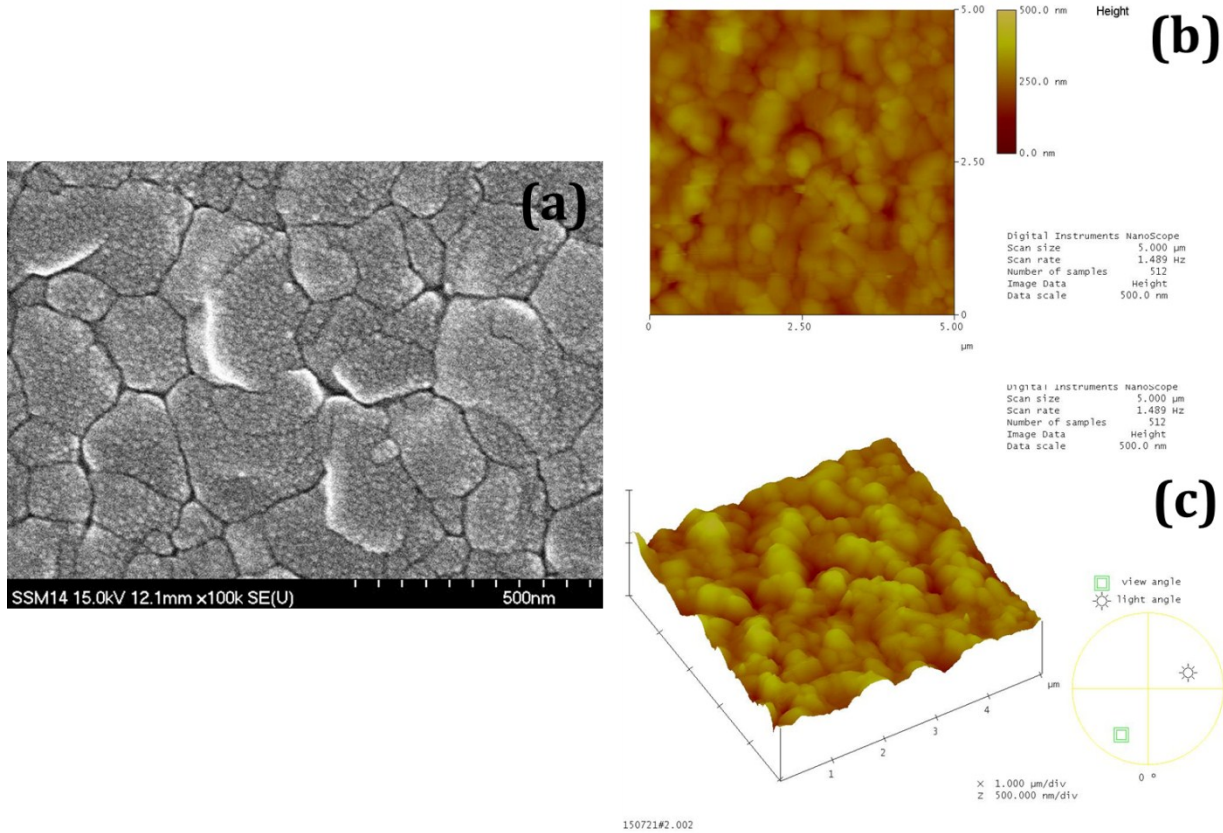
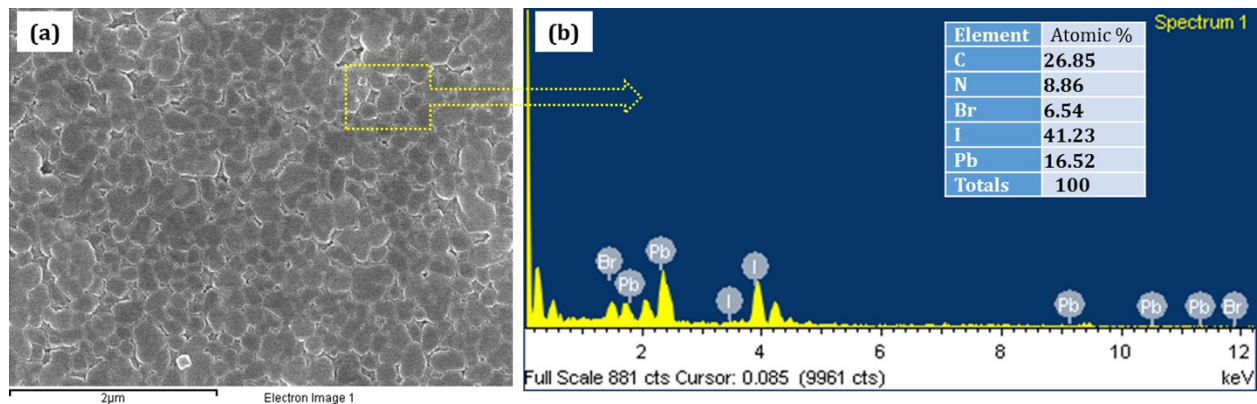


Figure S6. Compositional analysis of MAPb(I_{1-x}Br_x)₃ (a) FESEM (b) EDS spectrum, Inset table shows EDS analysis.



From the above figure, it is clear that, the signals of Pb, I and Br were detected. Furthermore, the C and N signal have been taken into consideration for the exact 100% composition of the MAPb(I_{3-x}Br_x)₃ composition. The ratio of atomic content of Pb:I:Br was about 1:2.50:0.39, close to the ratio of 1:2.7:0.3 as per experimental composition.

Figure S7. Effect of toluene dripping study: (a) SEM microscopic images of planar heterojunction flexible perovskite solar cell with and without toluene drop casting (b) respective hysteresis analysis.

