Electronic Supplementary Material (ESI) for Sustainable Energy & Fuels.

Supporting Information

Growing High-quality $CsPbBr_3$ by Using Porous $CsPb_2Br_5$ as an Intermediate: A Promising Light Absorber in Carbon-based Perovskite Solar Cells

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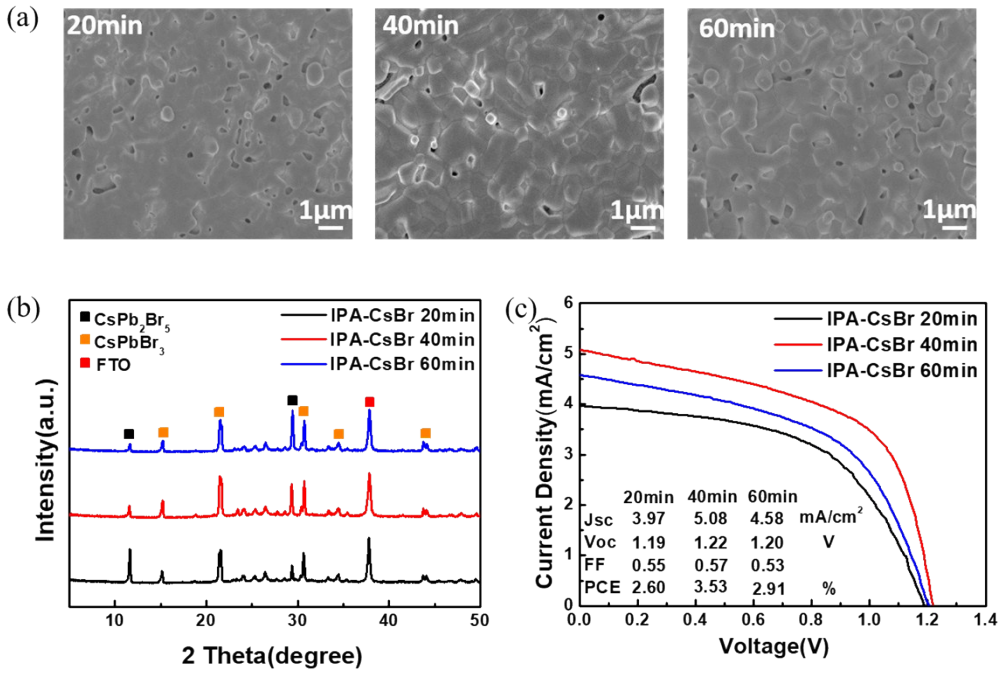

Figure S1 (a) SEM images and (b) XRD patterns of the I-$CsPb_2Br_5$ layers formed in the 1.7 mg/ml CsBr IPA solution for 20, 40, and 60 min. (c) J-V curves and photovoltaic parameters of the C-PSCs on the I-$CsPb_2Br_5$ layers with longer reaction time.

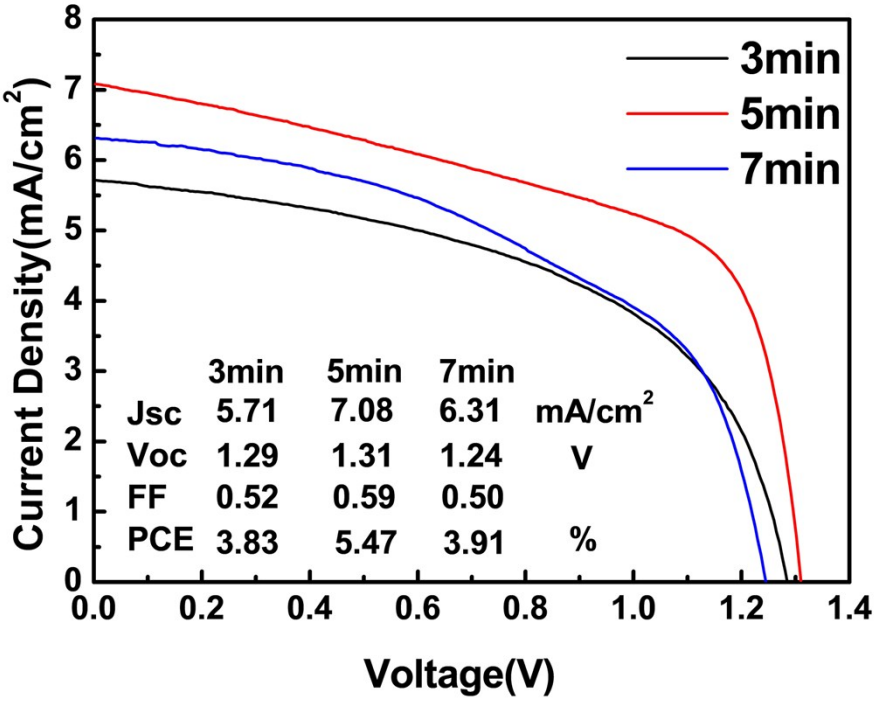

Figure S2 J-V curves and photovoltaic parameters of the C-PSCs with the $CsPbBr_3$ films converted from I-$CsPb_2Br_5$ layers in 17 mg/ml CsBr methanol solution under different reaction time.

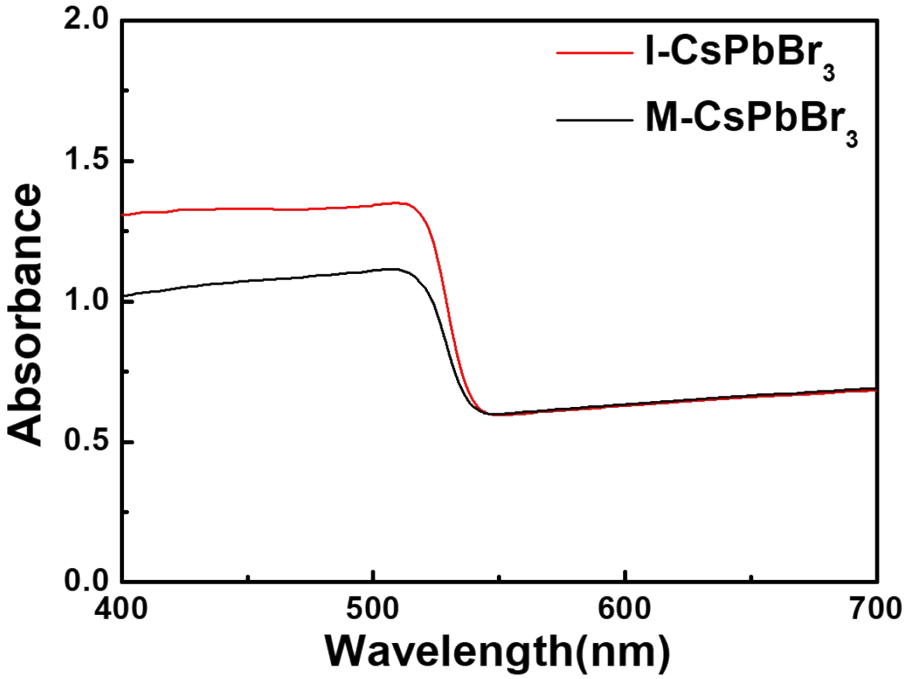

Figure S3 UV-vis absorption spectra of the I-$CsPbBr_3$ and M-$CsPbBr_3$ films.

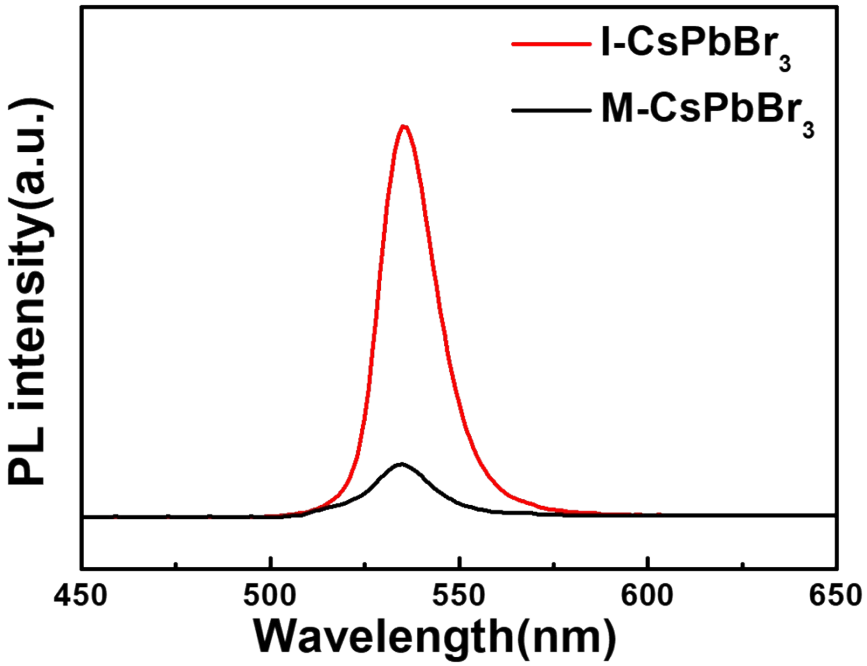

Figure S4 Room-temperature steady-state PL spectra of the I-$CsPbBr_3$ and M-$CsPbBr_3$ films on glass substrates.

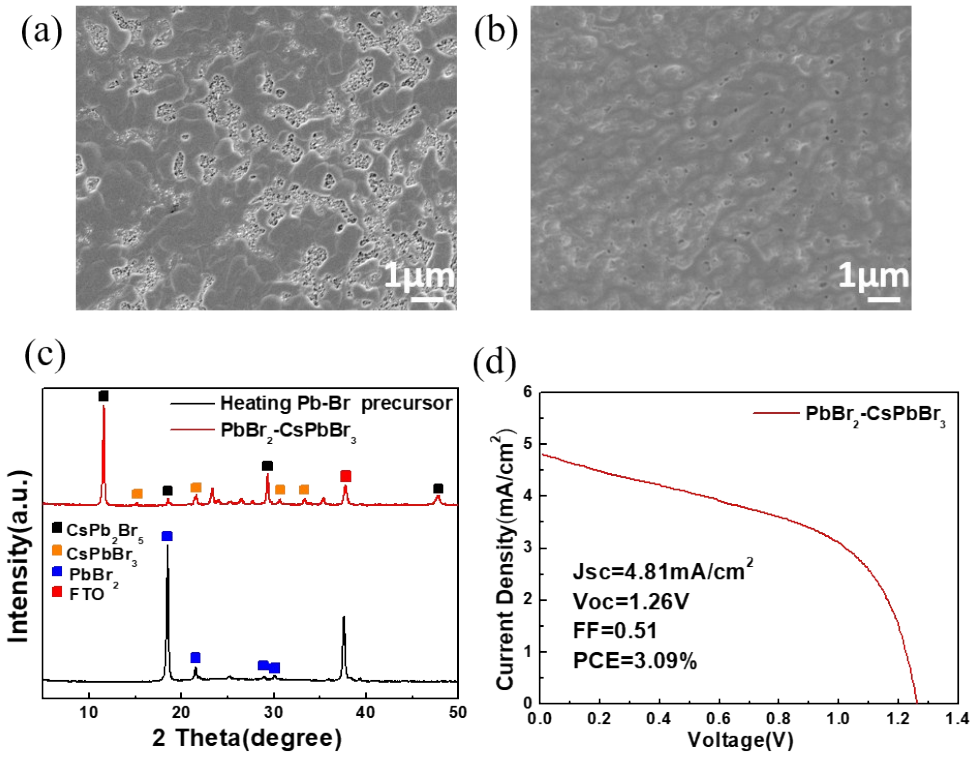

Figure S5 (a)-(b) SEM images and (c) XRD patterns of $PbBr_2$ film (obtained by heating Pb-Br precursor at 100 ℃ for 40 min) and the $CsPbBr_3$ film converted from the $PbBr_2$ film in the 17 mg/ml CsBr methanol solution for 5 min. (c) J-V curves and photovoltaic parameters of the C-PSCs based on the above $CsPbBr_3$ film.

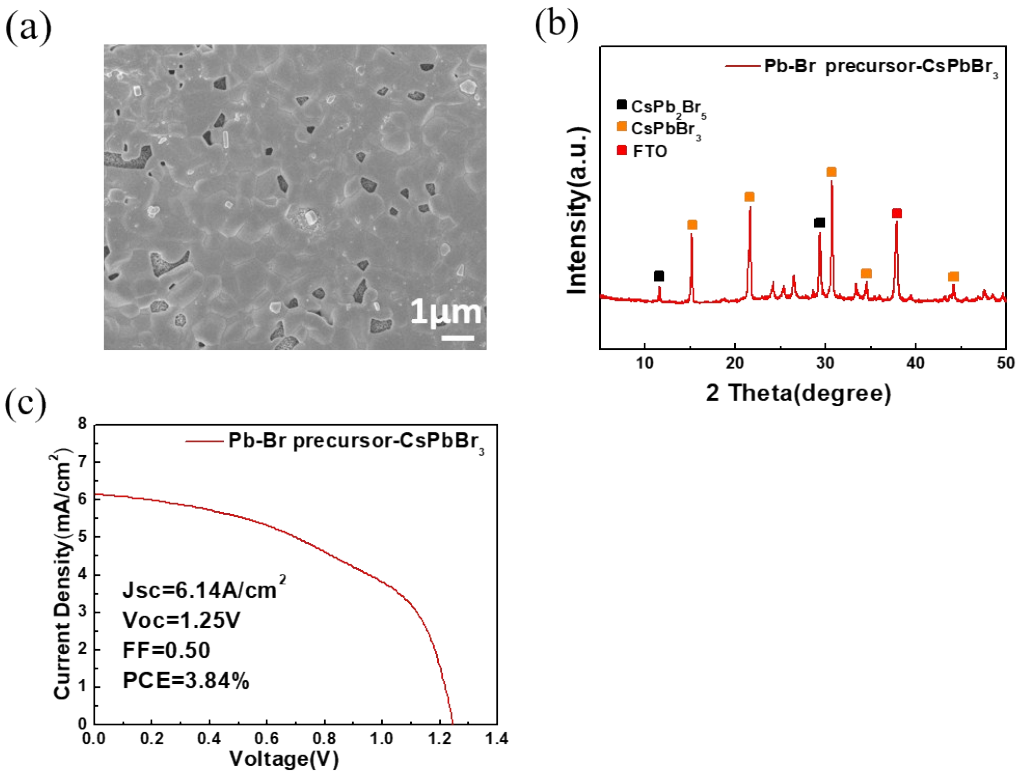

Figure S6 (a) SEM images and (b) XRD patterns of the $CsPbBr_3$ film obtained by directly immersing the Pb-Br precursor film in the 17mg/ml CsBr methanol solution for 5 min. (c) J-V curve and photovoltaic parameters of the C-PSCs on the above $CsPbBr_3$ film.

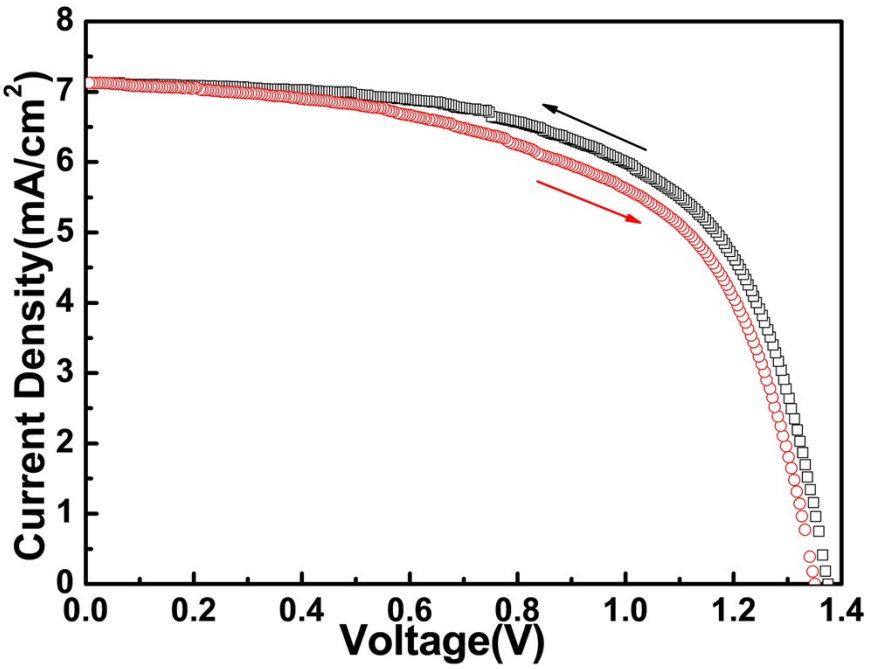

Figure S7 J-V curves of the champion C-PSCs measured in forward and reverse scanning modes.

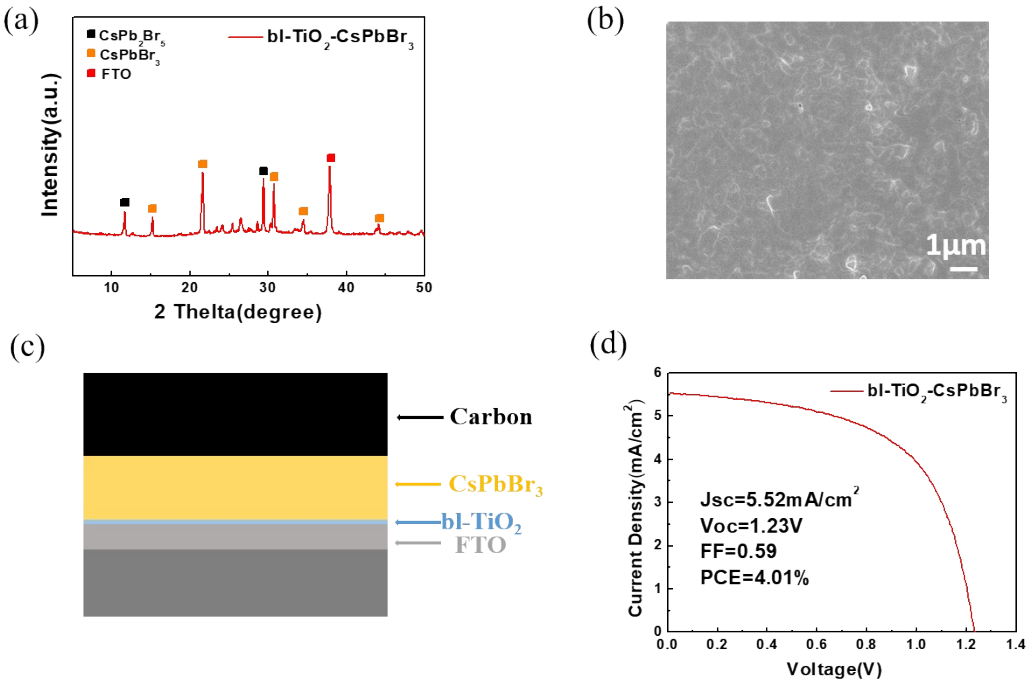

Figure S8 Planar C-PSCs. (a) XRD pattern and (b) SEM image of the I-$CsPbBr_3$ film fabricated on bl-TiO_2 substrate. (c) Schematic illustrating the device structure of the planar C-PSCs. (d) J-V curve and photovoltaic parameters of the planar C-PSCs.

Table S1 Comparison of the photovoltaic parameters for the published PSCs based on *pure $CsPbBr_3$ thin film* (not include the QDs solar cells).

Configuration	Voc (V)	PCE (%)	Reference
FTO/bl-TiO_2/m-TiO_2/$CsPbBr_3$/carbon	1.38	6.1	This work
FTO/bl-TiO_2/m-TiO_2/$CsPbBr_3$/carbon	1.29	5.0	14
FTO/bl-TiO_2/m-TiO_2/$CsPbBr_3$/PTAA/Au	1.25	6.2	18
FTO/bl-TiO_2/m-TiO_2/$CsPbBr_3$/carbon	1.24	6.7	19
FTO/bl-TiO_2/m-TiO_2/$CsPbBr_3$/ spiro-OMeTAD/Au	1.00	4.98	21
FTO/bl-TiO_2/m-TiO_2/$CsPbBr_3$/CBP/Au	1.32	4.92	21
FTO/bl-TiO_2/m-TiO_2/$CsPbBr_3$/Au	1.21	5.47	21
FTO/bl-TiO_2/m-TiO_2/$CsPbBr_3$/carbon	1.15	2.53	22
FTO/bl-TiO_2/m-TiO_2/$CsPbBr_3$/carbon	1.308	7.54	23
FTO/bl-TiO_2/$CsPbBr_3$/carbon	1.34	5.86	24
FTO/bl-TiO_2/m-TiO_2/$CsPbBr_3$/ spiro-OMeTAD/Au	1.34	6.44	25
FTO/$CsPbBr_3$/carbon	1.05	2.35	26
ITO/SnO_2/$CsPbBr_3$/spiro-OMeTAD/Au	1.26	9.81	43
FTO/bl-TiO_2/m-TiO_2/$CsPbBr_3$/ CuPc/carbon	1.26	6.21	44