

Supplementary Information

Enhanced Crystallinity of CH₃NH₃PbI₃ by the Pre-Coordination of PbI₂-DMSO Powders for Highly Reproducible and Efficient Planar Heterojunction Perovskite Solar Cells

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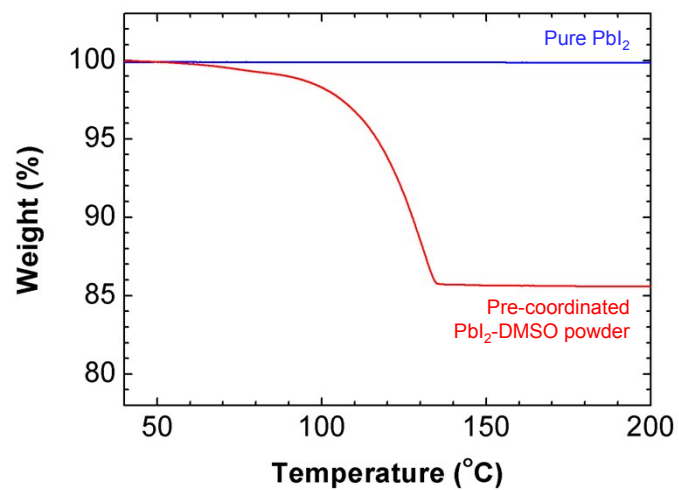


Figure S1. Thermogravimetric analysis (TGA) of the pure PbI₂ and pre-coordinated PbI₂-DMSO powders. The heating rate was 2°C/min under ambient air environment.

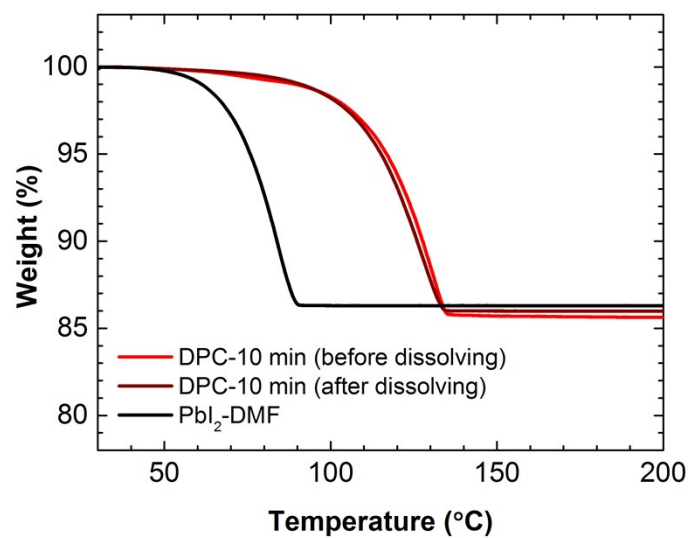


Figure S2. TGA analyses of PbI₂-DMF and DPC-10 min powders before and after dissolving in DMF. The TGA data of DPC-10 min powders before dissolving were reproduced from Figure S1 for comparison.

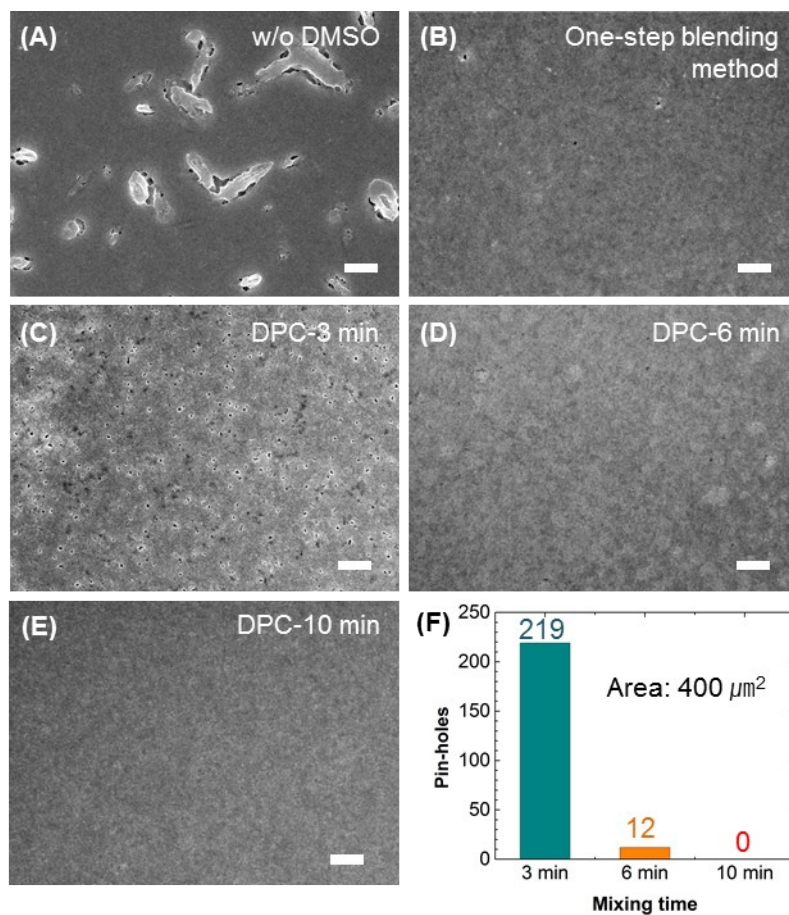


Figure S3. Top-view SEM images of $\text{CH}_3\text{NH}_3\text{PbI}_3$ films prepared without DMSO (A), by the one-step blending method (B), and by the DPC method (C-E). The scale bar is 2 μm . (F) The number of pin-holes in the perovskite films prepared by the DPC method (counting area = 400 μm^2).

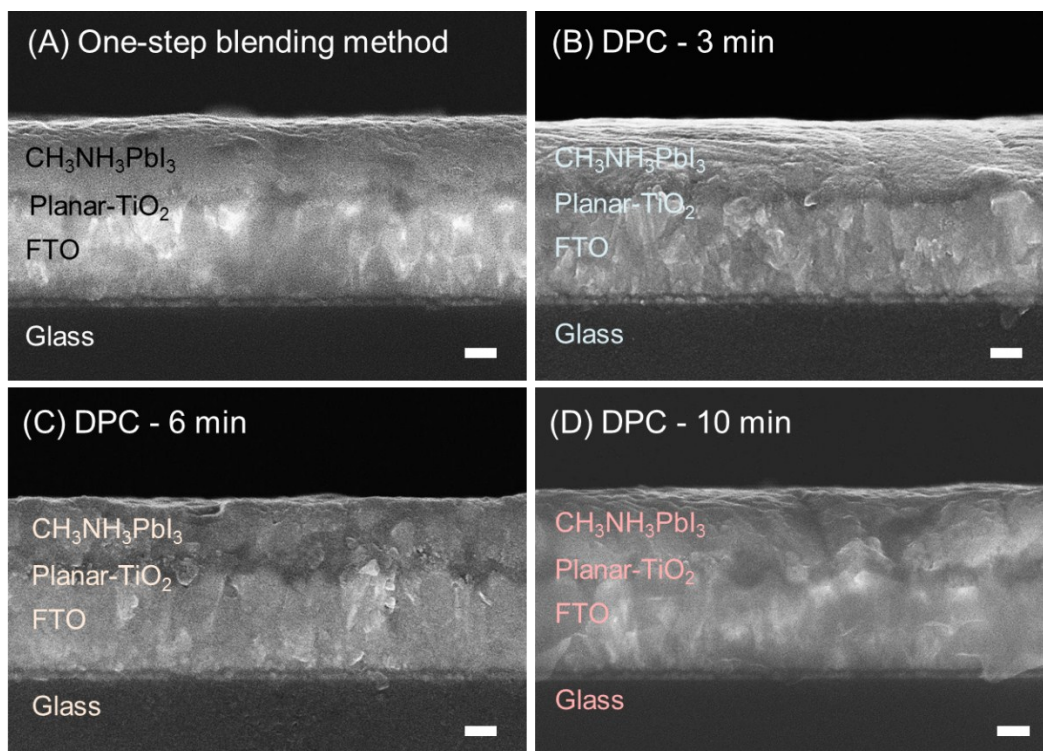


Figure S4. Cross-sectional SEM images of the CH₃NH₃PbI₃ films prepared by the one-step blending method (A) and DPC method (B-D). The scale bar is 200 nm.

Table S1. Bi-exponential decay parameters and average life time of TRPL analysis. (A) Perovskite/Glass. (B) Perovskite/TiO₂/Glass. (C) Spiro-OMeTAD/Perovskite/Glass.

Structure		(A) CH ₃ NH ₃ PbI ₃ /Glass			
Method	One-step blending		DPC		
τ (ns)	τ_1	τ_2	τ_1	τ_2	
	2.03	13.61	2.51	17.08	
A (%)	A_1	A_2	A_1	A_2	
	54	47	48	52	
Average carrier lifetime (ns)		11.93	15.34		
Structure		(B) CH ₃ NH ₃ PbI ₃ /TiO ₂ /Glass			
Method	One-step blending		DPC		
τ (ns)	τ_1	τ_2	τ_1	τ_2	
	1.76	9.49	1.43	8.84	
A (%)	A_1	A_2	A_1	A_2	
	53	47	66	34	
Average carrier lifetime (ns)		8.16	7.07		
Structure		(C) Spiro-OMeTAD/CH ₃ NH ₃ PbI ₃ /Glass			
Method	One-step blending		DPC		
τ (ns)	τ_1	τ_2	τ_1	τ_2	
	0.57	5.02	0.55	3.47	
A (%)	A_1	A_2	A_1	A_2	
	54	46	58	42	
Average carrier lifetime (ns)		4.49	2.95		

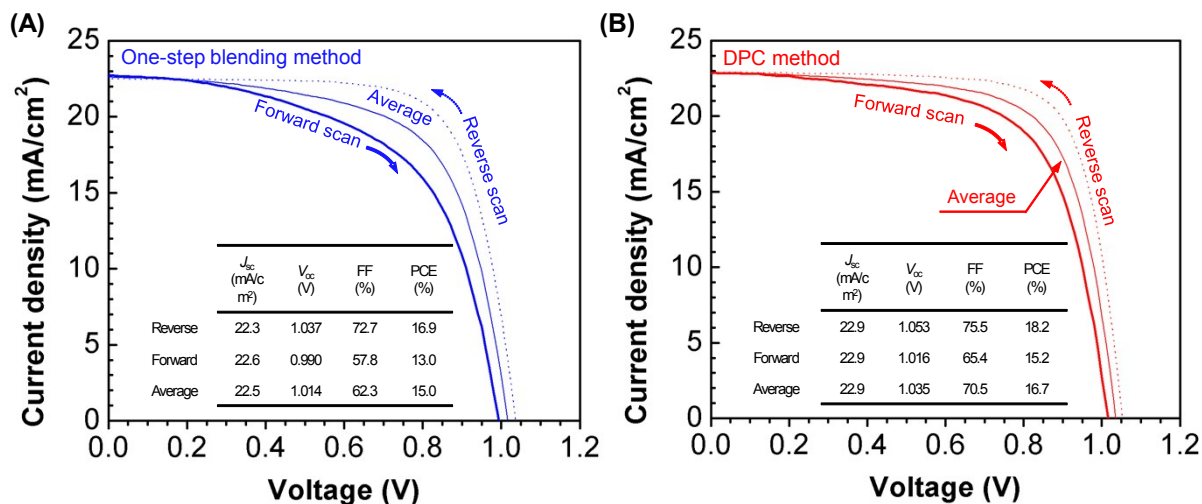


Figure S5. The hysteresis analysis of J - V curves depending on the scan direction. The voltage scan rate was 0.3V/s. (A) One-step blend mixing method. The forward scan and average PCE values were 13 and 15 %. (B) DPC method. The forward scan and average PCE values were 15.2 and 16.7 %.

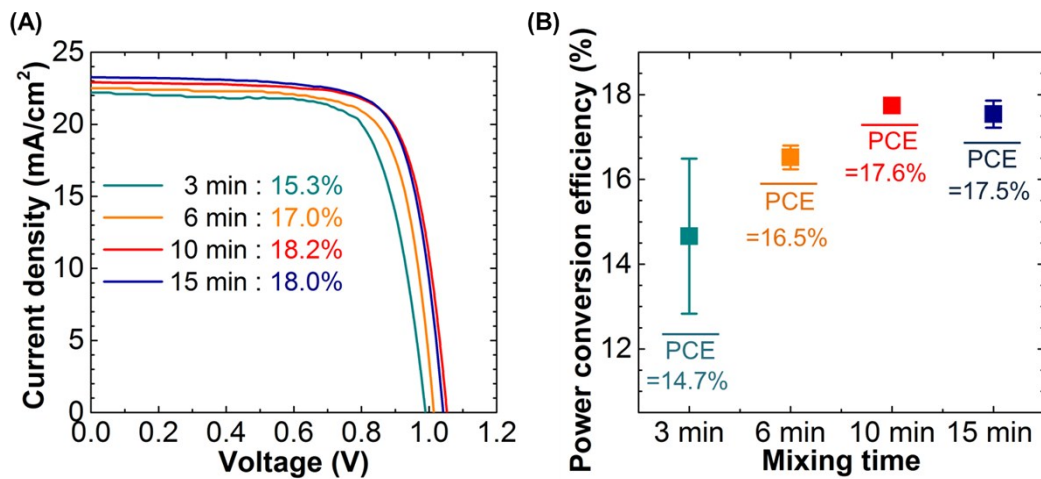


Figure S6. The performance comparison of perovskite solar cells prepared by the DPC method (mechanical mixing time = 3, 6, 10 and 15 min). (A) The best J - V curves. (B) Power conversion efficiency. Five cells were analyzed for each type.

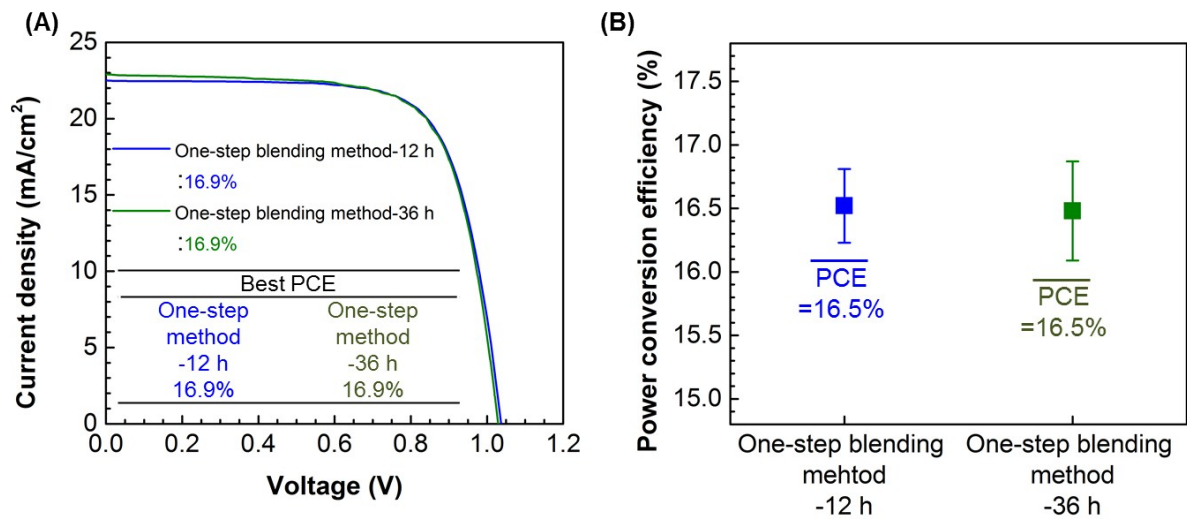


Figure S7. The performance comparison of perovskite solar cells prepared by the one-step method (stirring time = 12 h and 36 h) (A) The best $J-V$ curves. (B) Power conversion efficiency. Five cells were analyzed for each type.