Supporting Information

Scalable Perovskite Coating via Anti-solvent-free Lewis Acid-Base Adduct Engineering for Efficient Perovskite Solar Module

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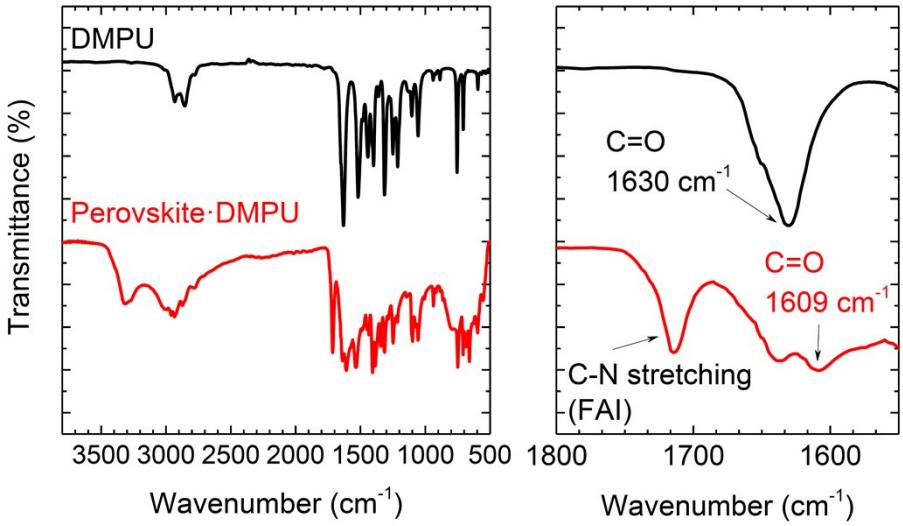

Figure S1. FT-IR spectra of the as-formed perovskite-DMPU powder (red line) and DMPU (black line) as reference. C-N stretching is related to FAI.

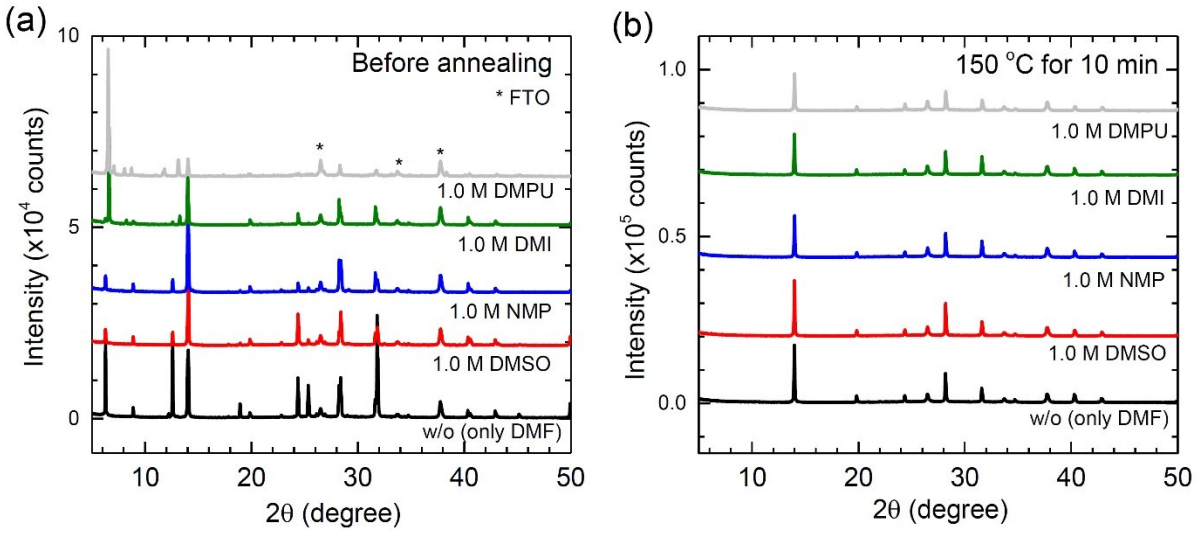

Figure S2. XRD patterns of (a) as-deposited and (b) 150 °C-annealed films formed from the air-knife-assisted D-bar coating using the Lewis base (DMSO, NMP, DMI or DMPU) contained precursor solution. Concentration of the Lewis base was 1.0 M. The perovskite composition was $(FAPbI_3)_{0.95}(CsPbBr_3)_{0.05}$. DMF was used as solvent for the precursor solution.

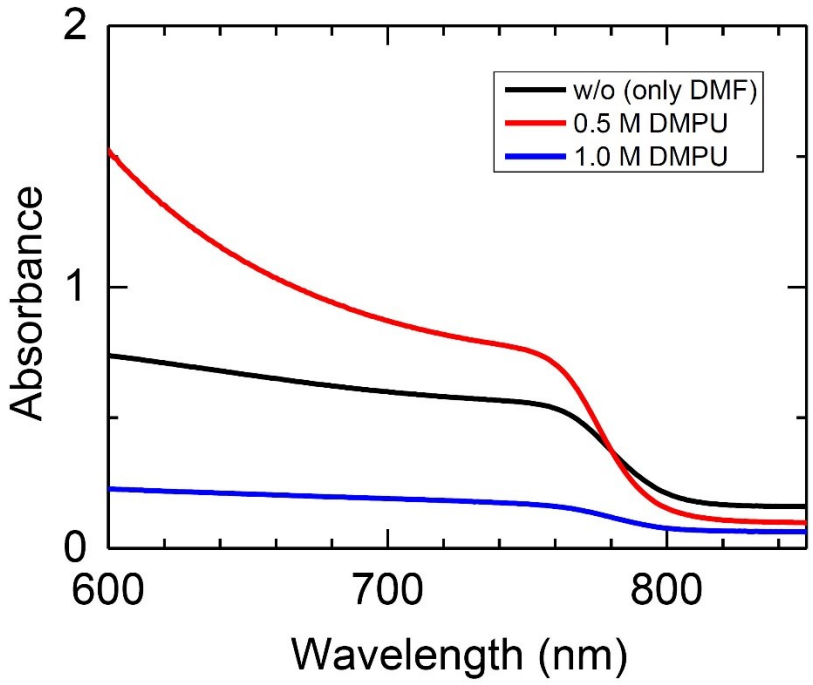

Figure S3. Optical absorption spectra of the 150 °C-annealed perovskite films formed from the DMPU-contained precursor solution with different DMPU concentration of 0.5 M and 1.0 M. DMF was used as a solvent for the precursor solution. Perovskite $(FAPbI_3)_{0.95}(CsPbBr_3)_{0.05}$ films were coated on the SnO_2-coated FTO substrates by the air-knife-assisted D-bar coating.

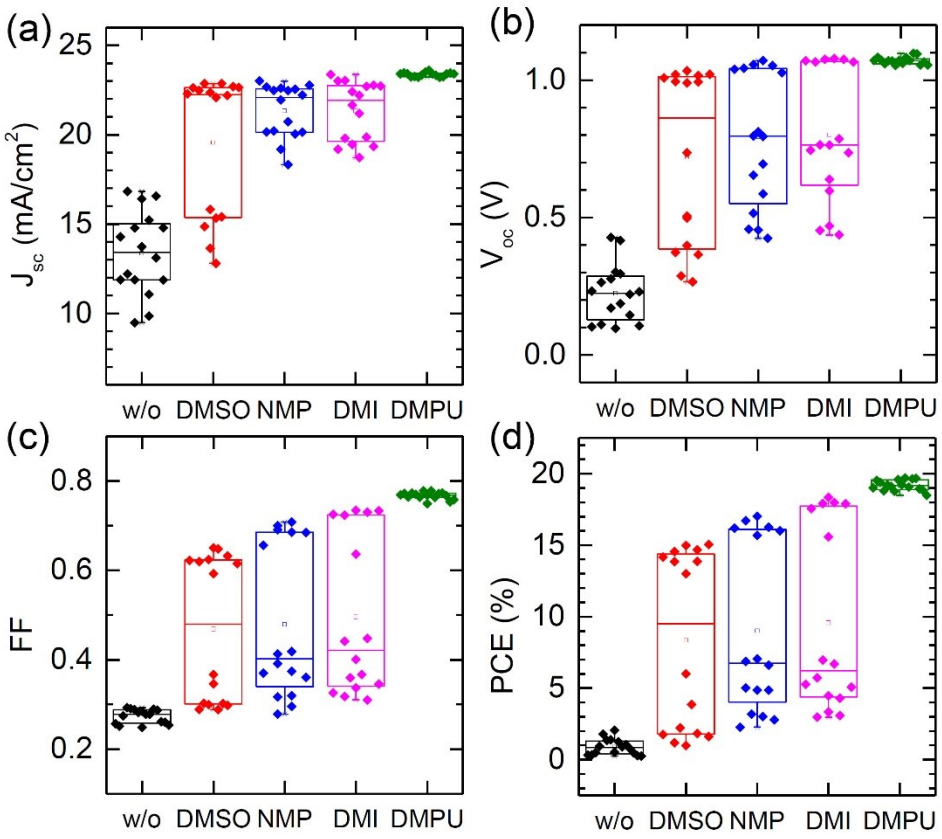

Figure S4. Statistical photovoltaic parameters of (a) J_{sc}, (b) V_{oc}, (c) FF and (d) PCE for PSCs employing the $(FAPbI_3)_{0.95}(CsPbBr_3)_{0.05}$ perovskite films formed from the air-knife-assisted D-bar coating using the Lewis base (DMSO, NMP, DMI or DMPU) contained precursor solutions. The Lewis base concentration was 0.5 M. The reverse scanned data are presented.

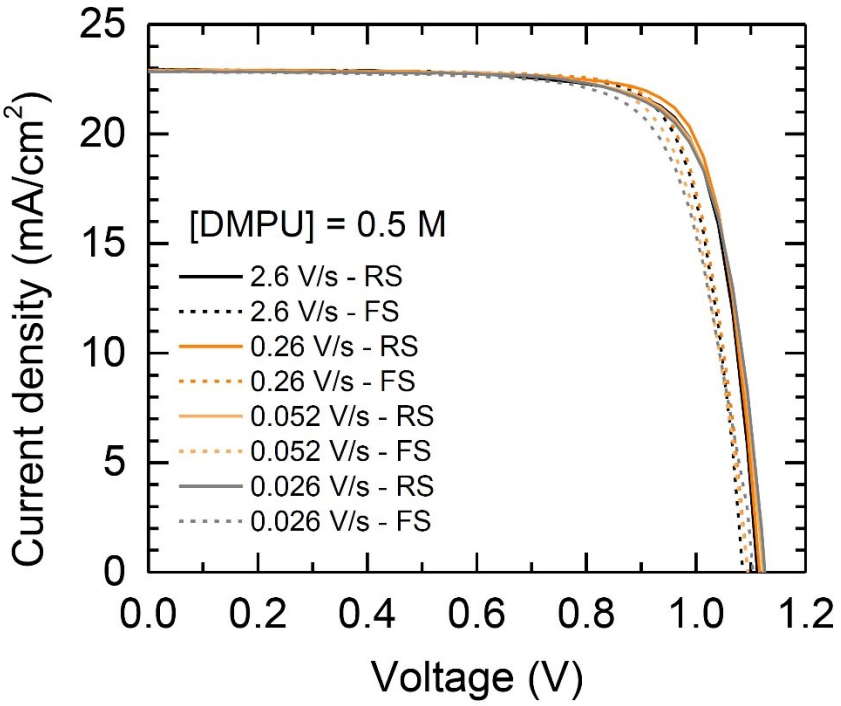

Figure S5. Scan-rate and direction dependent J-V curves of PSC employing a piece of the large-area perovskite film formed from the D-bar coating the 0.5 M DMPU-contained precursor solution. The device was measured under AM 1.5G 1 sun illumination with active area of 0.125 cm^2. RS and FS stand for reverse scan and forward scan, respectively.

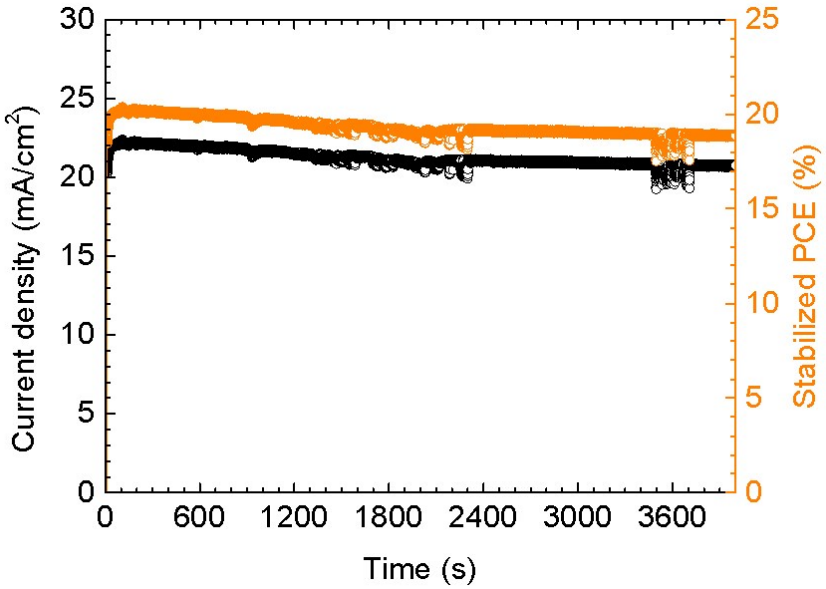

Figure S6. The steady-state PCE and current density at maximum power voltage for PSC (active area = 0.125 cm^2) employing the $(FAPbI_3)_{0.95}(CsPbBr_3)_{0.05}$ film formed from the 0.5 M DMPU-contained solution.

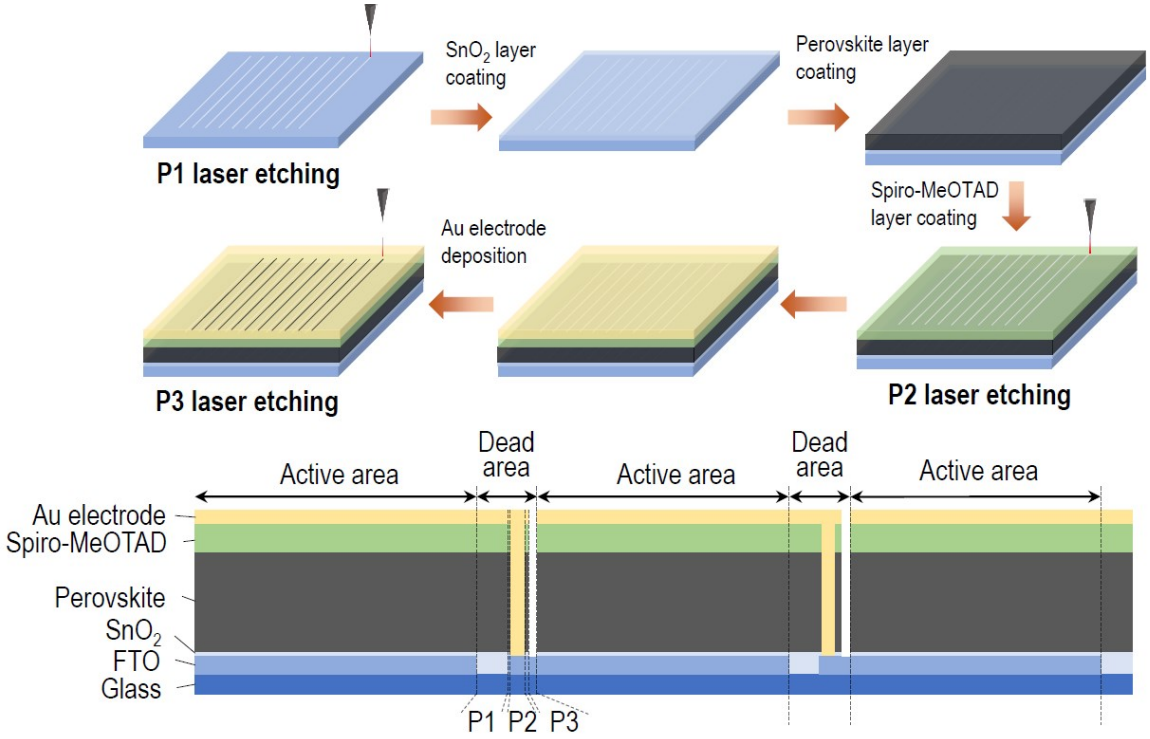

Figure S7. Schematic illustration of the fabrication process (top panel) and cross-sectional structure (bottom panel) for a perovskite solar module. P1, P2 and P3 etching was performed by a laser scriber.

Table S1. Amplitude (A_1 and A_2) and time constant (τ_1 and τ_2) obtained from fitting the TRPL data with a bi-exponential equation. Average lifetime (τ_{ave}) was calculated from $(A_1\tau_1^2 + A_2\tau_2^2)/(A_1\tau_1 + A_2\tau_2)$.

[DMPU]	A_1 (%)	τ_1 (ns)	A_2 (%)	τ_2 (ns)	τ_{ave} (ns)
0 M	35.60 (46.92%)	213.42	40.27 (53.08%)	2032.61	995.73
0.3 M	15.94 (21.12%)	98.70	59.52 (78.88%)	2737.74	2138.97
0.5 M	8.23 (11.13%)	49.91	65.74 (88.87%)	4412.92	3916.35
0.8 M	26.58 (38.93%)	137.96	41.70 (61.07%)	2488.31	1469.46
1.0 M	41.99 (59.68%)	52.37	28.37 (40.32%)	1141.91	433.19

Table S2. Photovoltaic parameters of J_{sc}, V_{oc}, FF and PCE for the PSCs depending on scan rate and scan direction (RS = reverse scan, FS = forward scan). Perovskite films were prepared by D-bar coating using a 0.5 M DMPU-contained solution.

Scan rate – direction	J_{sc} (mA/cm^2)	V_{oc} (V)	FF	PCE (%)
2.6 V/s – RS	22.93	1.112	0.783	19.95
2.6 V/s – FS	22.95	1.086	0.788	19.63
0.26 V/s – RS	22.91	1.116	0.797	20.37
0.26 V/s – FS	22.92	1.095	0.789	19.79
0.052 V/s – RS	22.90	1.123	0.772	19.86
0.052 V/s – FS	22.88	1.095	0.768	19.23
0.026 V/s – RS	22.85	1.126	0.766	19.71
0.026 V/s – FS	22.84	1.104	0.745	18.78