Electronic Supplementary Material (ESI) for Nanoscale.

Supplementary Information

Electro-spray Deposition of Mesoporous TiO_2 Charge Collection Layer: Toward Large Scale and Continuous Production of Highly Efficiency Perovskite Solar Cell

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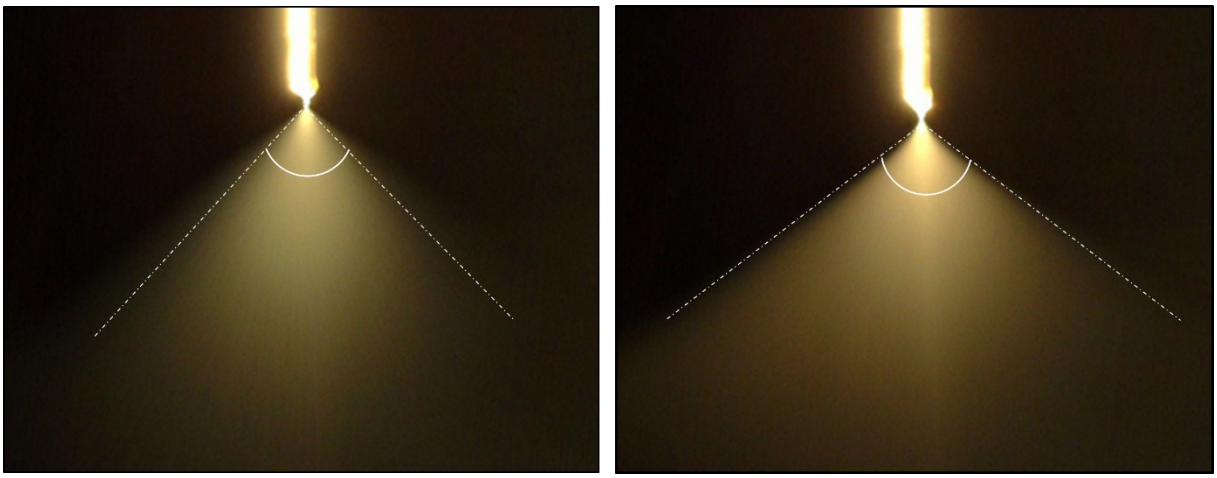

Figure S1 Magnified view of cone-jet spraying mode of electro-spray deposition (ESD) system during deposition. Spray angle of low applied voltage mode (Left) shows smaller than that of high applied voltage mode (Right)

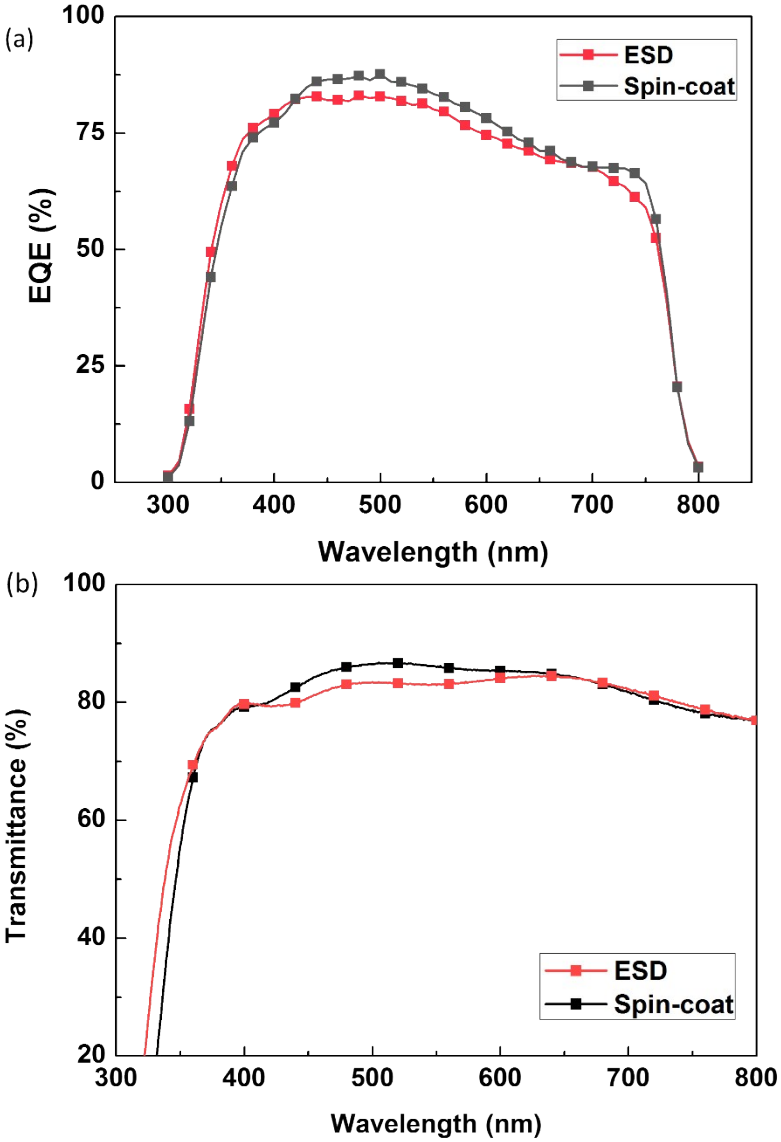

Figure S2 (a) EQE spectrum of the average-performing Perovskite solar cell with electro-sprayed TiO_2 and spin-coated TiO_2 respectively. (b) Transmittance of TiO_2 deposited onto FTO/glass substrate by spin-coating and electro-spraying respectively.

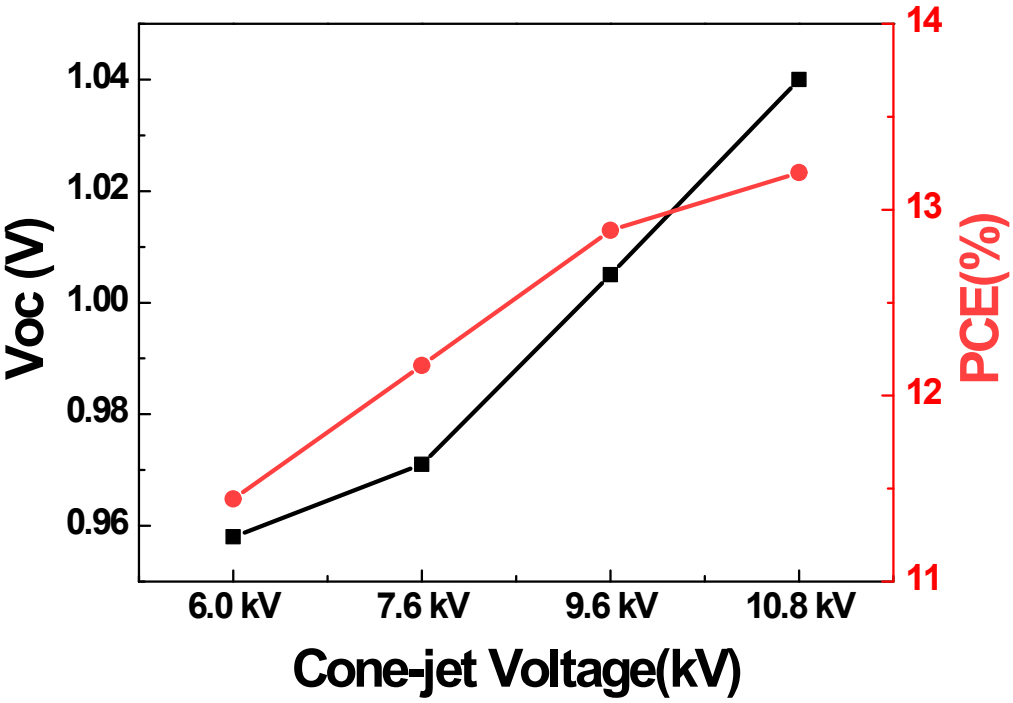

Figure S3 Dependence of the open circuit voltage (V_{oc}) and power conversion efficiency (PCE) on the applied voltage of the electro-spray (ESD) deposition system.

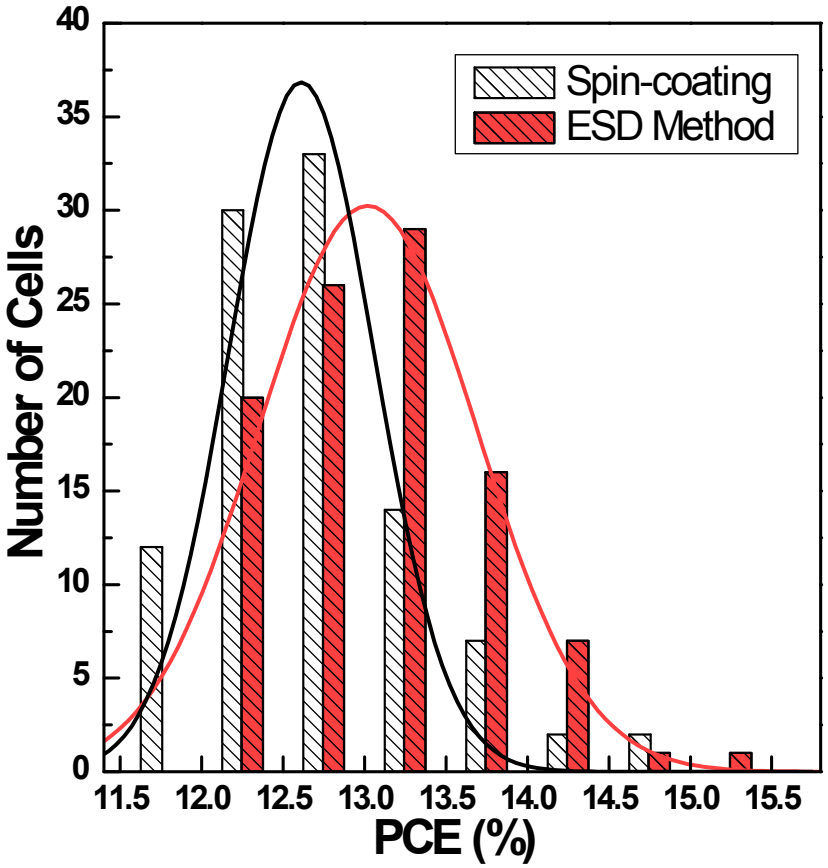

Figure S4 Histogram of 100 perovskite solar cells fabricated with electro-sprayed TiO_2 and spin-coated TiO_2 layers, respectively.

Cell#	#1	#2	#3	#4	#5
PCE(%)	12.21	11.46	11.87	11.58	11.04
#7	#8	#9	#10	#11	#12
11.46	12.09	11.52	11.27	11.20	11.14
#13	#14	#15	#16	#17	#18
11.64	11.62	11.57	11.01	11.58	12.33
#19	#20	#21	#22	#23	#25
12.11	11.91	11.50	12.13	11.90	12.31
		Average	11.67	Deviation	0.39

Table S1 PCE of 23 perovskite solar cells fabricated by dividing the 10 cm×10 cm large-area substrate into smaller regions.

Figure S5 25 divisions for each large-area characterized perovskite solar cells. Power conversion efficiencies for those small divisions are shown in Table S1.

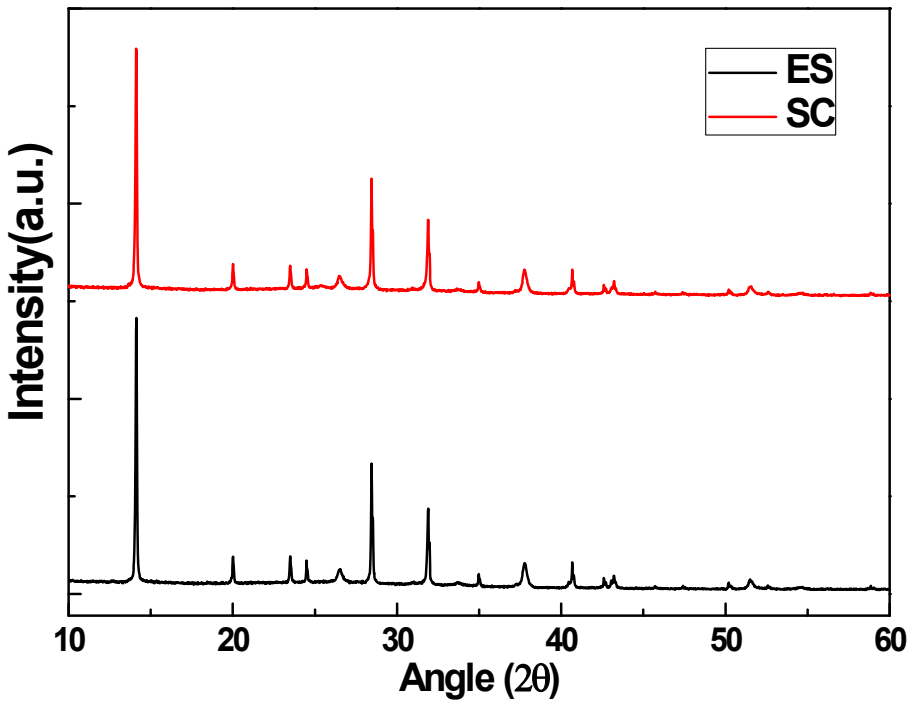

Figure S6 XRD patterns of the $CH_3NH_3PbI_3$ perovskite thin films fabricated onto Electro-sprayed TiO_2 layer and Spin-coated TiO_2 layer respectively.

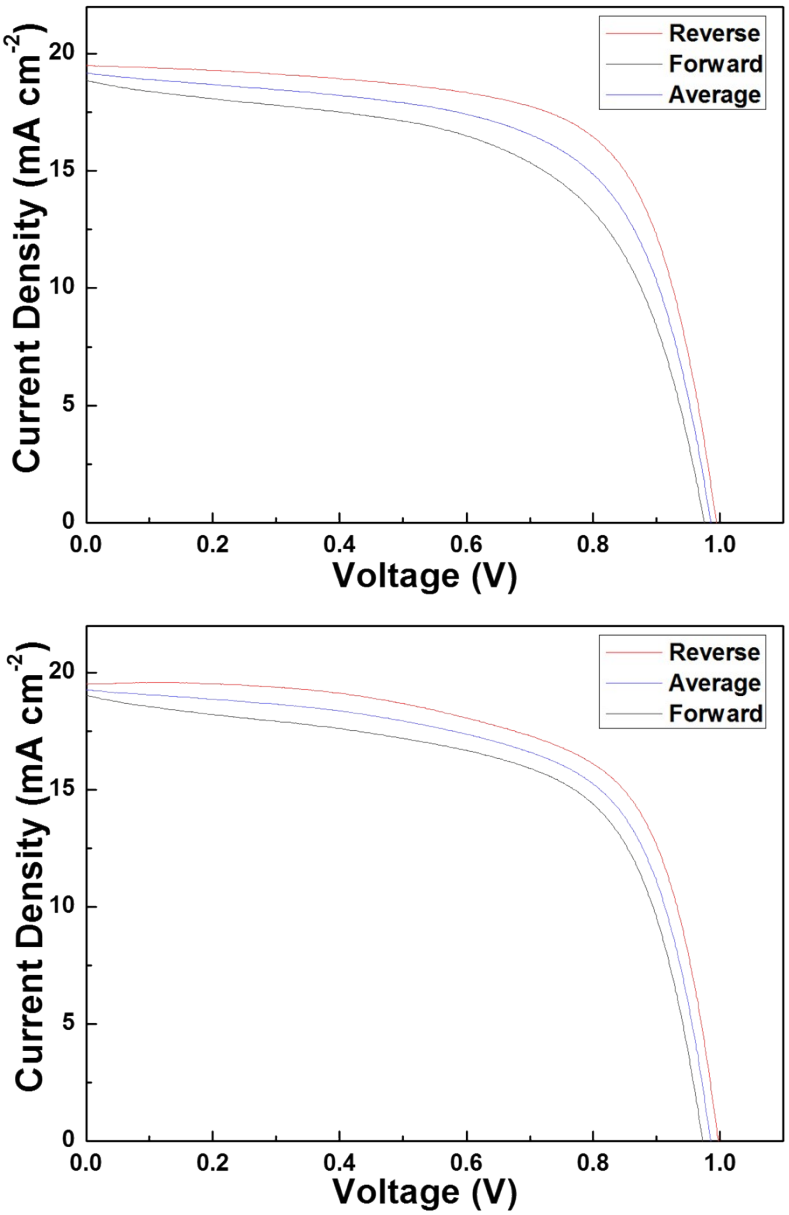

Figure S7 Forward and reverse measurement of J-V curves measured under AM1.5 simulated sun light with a scan rate of 0.05 Vs^{-1} for each device with (a) electro-sprayed TiO_2 and (b) spin-coated TiO_2.