Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

Supporting Information

Enhanced Charge Collection with Ultrathin AlO_x Electron Blocking Layer for Hole-Transporting-Material-Free Perovskite Solar Cell

Huiyun Wei,[a] Jiangjian Shi,[a] Xin Xu,[a] Junyan Xiao, [a] Jianheng Luo,[a] Juan Dong, [a] Songtao Lv, [a]Lifeng Zhu, [a] Huijue Wu, [a] Dongmei Li, [a] Yanhong Luo, [a] Qingbo Meng [a], and Qiang Chen[b*]*

[a]Key Laboratory for Renewable Energy, Chinese Academy of Sciences; Beijing Key Laboratory for New Energy Materials and Devices; Institute of Physics, Chinese Academy of Sciences, Beijing 100190, P. R. China

[b]Laboratory of Plasma Physics and Materials, Beijing Institute of Graphic Communication, Beijing 102600, P. R. China

* Address correspondence to qbmeng@iphy.ac.cn, *lppmchenqiang@hotmail.com*

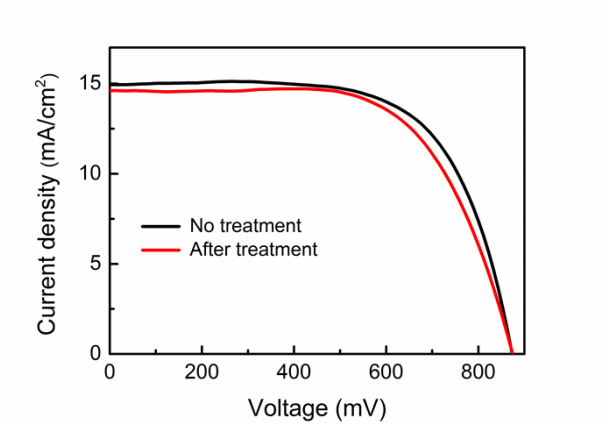

Figure S1. The *I-V* characteristics of the perovskite solar cells without and with the treatment in ALD chamber (0.1 Torr, 100 °C, N_2 flow).

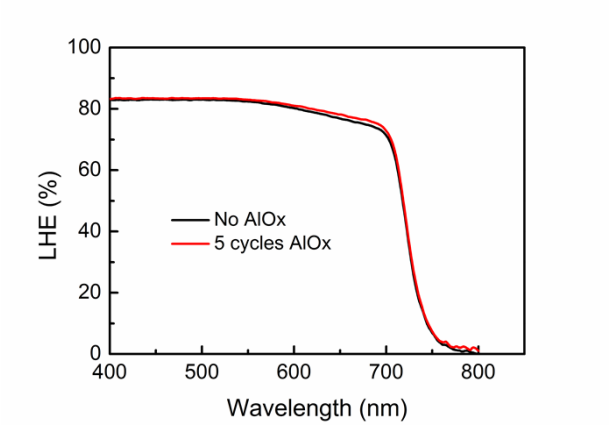

Figure S2. LHE spectrum of the perovskite solar cells with 0, 5 ALD cycles, respectively.

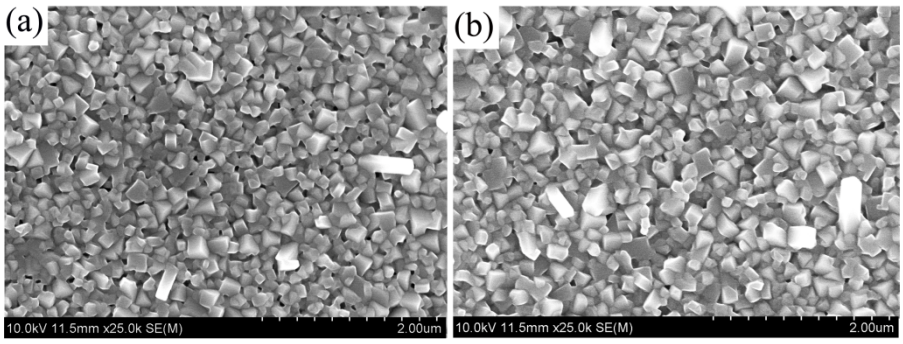

Figure S3. (a) The perovskite film without ALD treatment; (b) The perovskite film with 5 ALD cycles.

Table S1. Photovoltaic parameters of forward and backward for a batch of twelve perovskite solar cells with 0, 3, 5 ALD cycles, respectively.

Cell			J_{SC} (mA/cm^2)	V_{OC} (mV)	FF	PCE (%)	Average PCE (%)
ALD-0	1	Forward	14.71	900.2	0.572	7.57	8.03
		Backward	15.71	900.2	0.600	8.49	
	2	Forward	14.56	900.2	0.591	7.75	8.24
		Backward	15.65	900.2	0.620	8.73	
	3	Forward	15.01	868.7	0.594	7.75	8.25
		Backward	15.53	879.2	0.641	8.75	
	4	Forward	14.33	879.2	0.571	7.19	7.85
		Backward	15.26	868.7	0.642	8.52	
ALD-3	1	Forward	15.38	889.8	0.624	8.54	9.04
		Backward	15.98	900.2	0.663	9.54	
	2	Forward	15.65	889.7	0.597	8.31	8.85
		Backward	16.03	900.2	0.651	9.39	
	3	Forward	15.89	900.2	0.602	8.61	9.00
		Backward	16.46	910.7	0.627	9.40	
	4	Forward	15.85	900.2	0.619	8.83	9.38
		Backward	16.49	910.8	0.665	9.98	
ALD-5	1	Forward	17.46	889.7	0.607	9.43	10.08
		Backward	18.15	910.7	0.649	10.73	
	2	Forward	16.67	910.7	0.615	9.34	9.87
		Backward	17.35	921.2	0.651	10.41	
	3	Forward	16.32	900.3	0.658	9.67	10.03
		Backward	16.96	900.2	0.681	10.39	
	4	Forward	17.29	910.7	0.632	9.95	10.34
		Backward	17.96	921.2	0.649	10.73	

Table S2. Photovoltaic performance of the cells with different thickness of $CH_3NH_3PbI_3$ absorber changed with spin coating conditions

Experiment Condition			J_{SC} (mA/cm^2)	V_{OC} (mV)	FF	PCE (%)
ALD treatment	mp-TiO_2 thickness (nm)	Spin-coating PbI_2 (rpm)				
ALD-0	500	2000	15.46	900.2	0.643	8.95
ALD-5	500	2000	17.23	900.2	0.681	10.56
ALD-0	500	4000	12.96	763.7	0.659	6.52
ALD-5	500	4000	13.83	763.7	0.646	6.82
ALD-0	300	2000	12.40	889.7	0.698	7.70
ALD-5	300	2000	13.69	900.3	0.673	8.29
ALD-0	300	4000	11.82	768.6	0.629	5.71
ALD-5	300	4000	12.65	776.2	0.658	6.46