

Supporting Information

Triple Cathode Buffer Layers Composed of PCBM, C₆₀ and LiF for High Performance Planar Perovskite Solar Cells

Xiaodong Liu¹, Hao Yu¹, Li Yan¹, Qingqing Dong¹, Qun Wan¹, Yi Zhou^{1*}, Bo Song^{1*}, Yongfang Li^{1,2*}

1. Laboratory of Advanced Optoelectronic Materials, College of Chemistry, Chemical Engineering and Materials Science, Soochow University, Suzhou, Jiangsu 215123, China.
2. Beijing National Laboratory for Molecular Sciences, Institute of Chemistry, Chinese Academy of Sciences, Beijing 100190, China.

*Corresponding authors: Y. Zhou (yizhou@suda.edu.cn), B. Song (songbo@suda.edu.cn) and Y. Li (liyf@iccas.ac.cn)

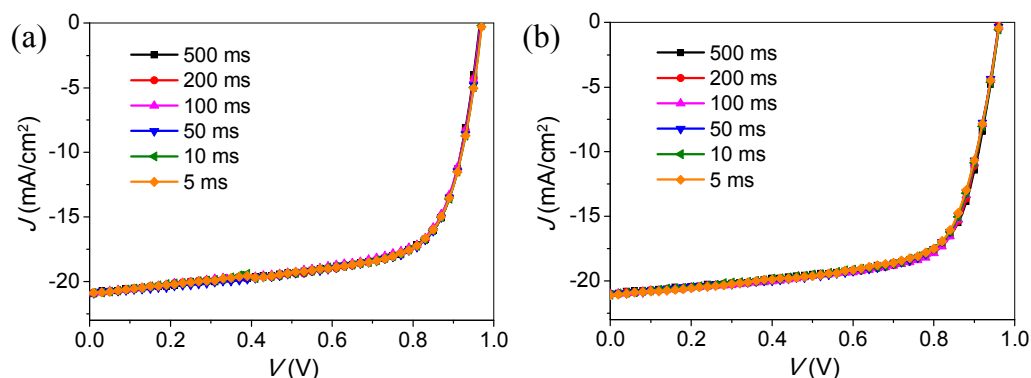


Figure S1 *J-V* characteristics of the planar *p-i-n* PSCs with PCBM/LiF (1 nm) CBLs measured by (a)FS and (b)RS with different delay times after each 10 mV voltage step under the illumination of AM 1.5 G, 100 mW/cm².

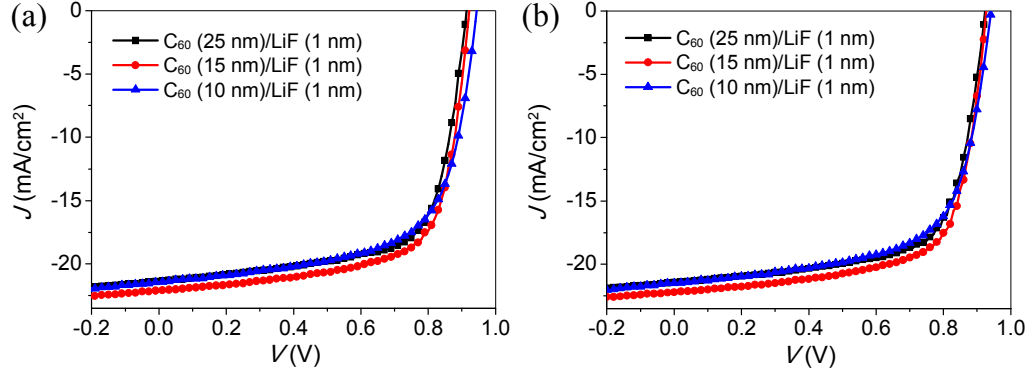


Figure S2 Effect of C_{60} layer thickness on J - V curves of the p - i - n PSCs with PCBM/ C_{60} /LiF CBLs measured by (a) FS and (b) RS under the illumination of AM 1.5 G, 100 mW/cm².

Table S1 Effect of C_{60} layer thickness on the photovoltaic performance of the p - i - n PSCs with PCBM/ C_{60} /LiF triple CBLs.

	CBL	J_{sc} (mA/cm ²)	V_{oc} (V)	FF (%)	PCE (%)	R_s (Ω cm ²)	R_{sh} (Ω cm ²)
FS	PCBM/ C_{60} (25 nm)/LiF	21.34	0.91	68.9	13.45	3.74	330.67
	PCBM/ C_{60} (15 nm)/LiF	22.08	0.92	69.2	14.09	3.12	357.79
	PCBM/ C_{60} (10 nm)/LiF	21.42	0.94	64.9	13.12	3.86	310.76
RS	PCBM/ C_{60} (25 nm)/LiF	21.42	0.92	68.7	13.59	3.87	352.52
	PCBM/ C_{60} (15 nm)/LiF	22.21	0.93	69.2	14.24	3.14	368.53
	PCBM/ C_{60} (10 nm)/LiF	21.49	0.94	65.0	13.15	3.98	317.13

Table S2 Photovoltaic performance parameters of the *p-i-n* PSCs with different CBLs.

	CBL	J_{sc}^a (mA/cm ²)	V_{oc}^a (V)	FF ^a (%)	PCE ^a (%)
FS	PCBM	18.87±0.42	0.94±0.03	61.5±1.7	10.98±0.51
	PCBM/LiF (1 nm)	21.58±0.10	0.95±0.01	70.6±0.3	14.52±0.14
	PCBM/LiF (5 nm)	20.08±0.61	0.91±0.01	56.6±3.3	10.32±0.83
	PCBM/C ₆₀ (15 nm)/LiF (1 nm)	22.04±0.14	0.92±0.01	68.2±1.3	13.87±0.24
	PCBM/C ₆₀ (15 nm)/LiF (5 nm)	21.92±0.13	0.94±0.01	65.9±1.2	13.61±0.13
	Ca	21.14±0.30	0.84±0.01	63.4±2.9	11.30±0.28
RS	PCBM	18.94±0.25	0.92±0.03	61.6±1.0	10.72±0.50
	PCBM/LiF (1 nm)	21.79±0.25	0.95±0.01	69.7±1.4	14.36±0.23
	PCBM/LiF (5 nm)	20.01±0.77	0.90±0.01	60.3±1.2	10.86±0.65
	PCBM/C ₆₀ (15 nm)/LiF (1 nm)	22.09±0.20	0.92±0.01	68.4±1.4	13.97±0.30
	PCBM/C ₆₀ (15 nm)/LiF (5 nm)	21.90±0.14	0.95±0.01	65.3±1.1	13.52±0.16
	Ca	21.19±0.24	0.84±0.02	66.8±0.68	11.95±0.31

^a) Average values (for five devices) with standard deviation.

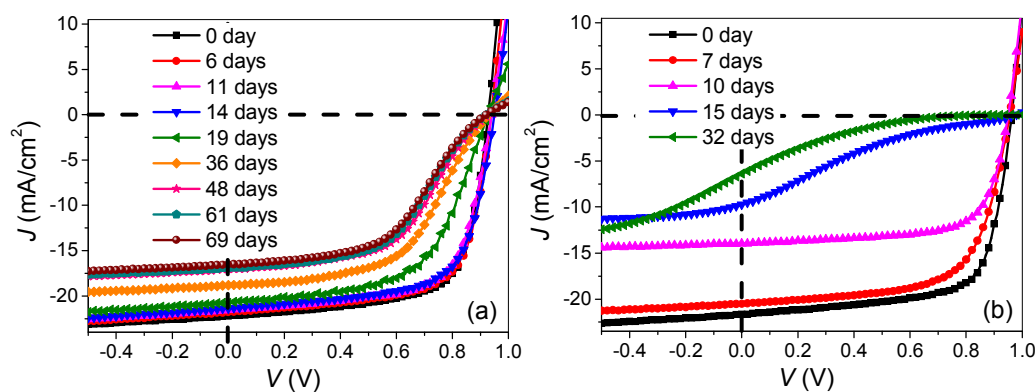


Figure S3 Evolution of the *J-V* curves, as a function of storage time in the glove box, for the devices with (a) PCBM/C₆₀ (15 nm)/LiF (1 nm) and (b) PCBM/LiF (1 nm) CBLs. These two devices were exposed to air for ~5 min after storage in the glove box for 15 (triple CBLs) and 11 days (double CBLs).