Electronic Supplementary Material (ESI) for Nanoscale.

Solution-processed pillar[5]arene-based small molecule cathode buffer layer for efficient planar perovskite solar cells

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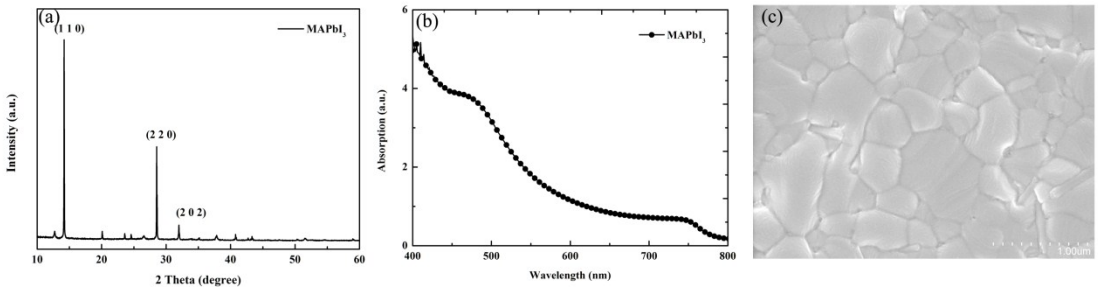

Figure S1 Typical XRD pattern, absorption and morphology of solution-processed $MAPbI_3$ film.

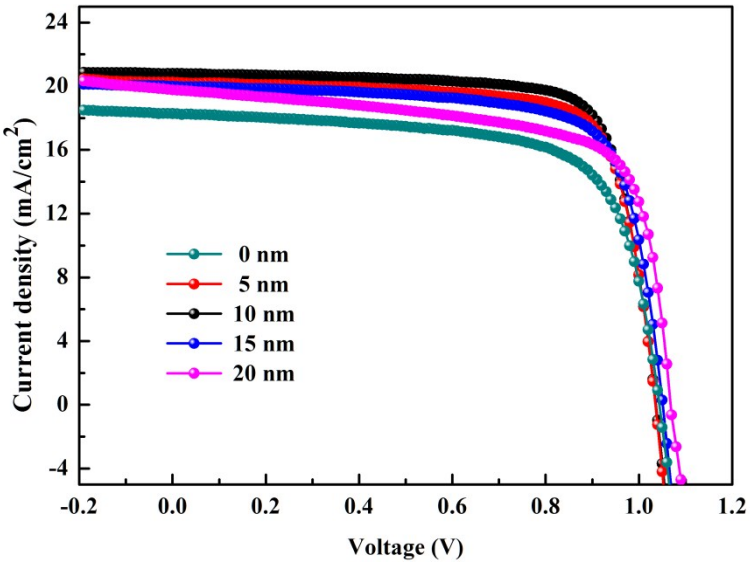

Figure S2 Effects of C3 thickness on device performance with device architecture of FTO/X1/ $MAPbI_3$/PCBM/C3/Ag.

Table S1 Summary of the PCE performances of planar devices based on C3 CBLs with varied thicknesses, obtained from Figure S2.

C3 Thickness	V_{OC} [V]	J_{SC} [mA cm^{-2}]	FF [%]	PCE [%]
0 nm	1.04	18.28	69.10	13.14
5 nm	1.04	20.24	75.50	15.90
10 nm	1.04	20.83	76.31	16.53
15 nm	1.05	19.99	73.88	15.51
20 nm	1.05	19.77	69.14	14.35

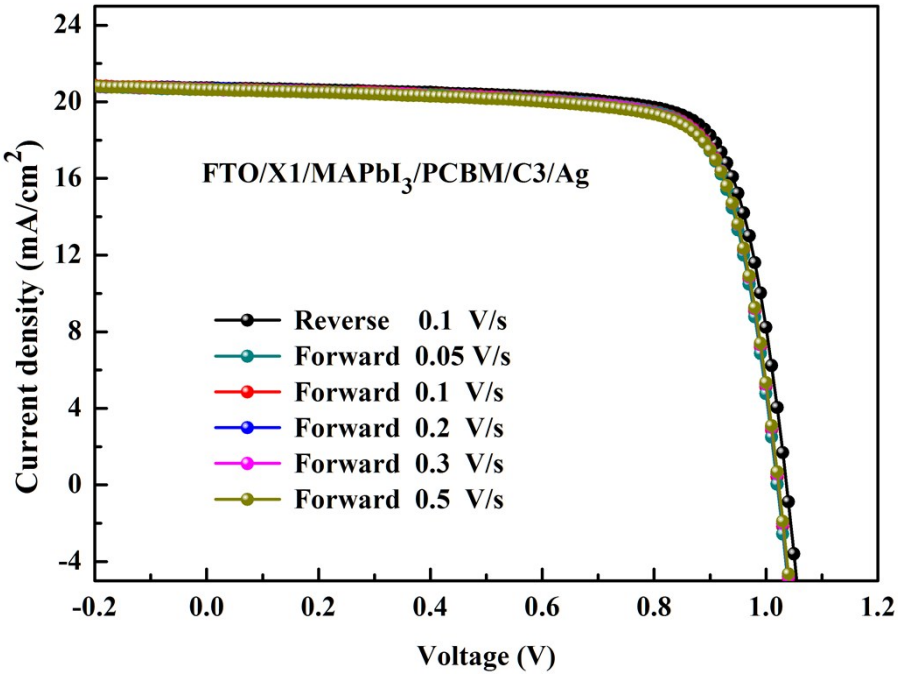

Figure S3 Effects of scan speed and scan direction of *J-V* tests on device performance.

Table S2 Summary of p-i-n planar PVSCs performances reported in literatures with varied CBLs.

Device structures	V_{OC} (V)	J_{SC} (mA/cm^2)	FF (%)	PCE (%)	References
FTO/NiO/Perovskite/**PCBM**/Ag	0.88	16.27	63.5	9.11	1
FTO/PEDOT:PSS/Perovskite/PCBM/**Bis-C60**/Ag	0.92	17.5	73	11.8	2
ITO/PEDOT:PSS/Perovskite–PCBM/**PCBM/Ca**/Al	0.97	20.2	82	16	3
FTO/NiMgLiO/Perovskite/PCBM/**TiNbO$_x$**/Ag	1.07	20.62	74.8	16.2	4
ITO/PEDOT:PSS/Perovskite/PCBM/**DMAPA-C60**/Ag	0.97	17.9	77	13.4	5
ITO/NiO$_x$/Perovskite/**ZnO**/Al	1.01	21	76	16.1	6
ITO/CuSCN/Perovskite/**C60/BCP**/Ag	1.0	21.9	75.8	16.6	7
ITO/CuO$_x$/Perovskite/PCBM/**C60/BCP**/Ag	1.11	22.5	75.8	19	8
ITO/PEDOT:PSS/Perovskite/PCBM/**PCBC**/Al	0.88	21.5	77.2	14.6	9
ITO/Trux-OMeTAD/Perovskite/PCBM/**ZnO NPs**/Al	1.02	23.2	79	18.6	10
FTO/PEDOT:PSS/Perovskite/PCBM/**c-TiO$_x$**/Al	0.94	15.8	66	9.8	11
ITO/PEDOT:PSS/Perovskite/PCBM/**ZnO-PFN**/Ag	0.9	18.41	77	12.76	12
ITO/PEDOT:PSS/Perovskite/PCBM/**Doped ZrO$_x$**/Ag	0.99	21.02	76.2	15.85	13
ITO/PEDOT:PSS/Perovskite/PCBM/**C60/LiF**/Al	0.96	21.67	70.5	14.69	14
ITO/PEDOT:PSS/Perovskite/PCBM/**PN4N**/Al	1.0	20.61	72.5	15	15
ITO/PEDOT:PSS/Perovskite/PCBM/**PDINO**/Al	0.95	18.8	78.5	14	16
ITO/PEDOT:PSS/Perovskite/PCBM/**Bphen**/Ag	0.93	21.51	79	15.75	17
FTO/PEDOT:PSS/Perovskite/PCBM/**TIPD**/Al	0.89	22.57	64.5	12.95	18
ITO/PEDOT:PSS/Perovskite/PCBM/**MUTAB**/Ag	1.03	20.06	79.8	16.5	19
ITO/NiO$_x$/Perovskite/PCBM/**F-R-COOK**/Ag	1.08	18.51	72.13	14.37	20
ITO/PEDOT:PSS/Perovskite/PCBM/**PCBDANI/LiF**/Ag	0.91	21.28	81	15.71	21
FTO/X1/Perovskite/**PCBM**/Ag	1.04	18.35	69.10	13.19	Our work
FTO/X1/Perovskite/PCBM/**C3**/Ag	1.05	21.57	76.90	17.42	Our work

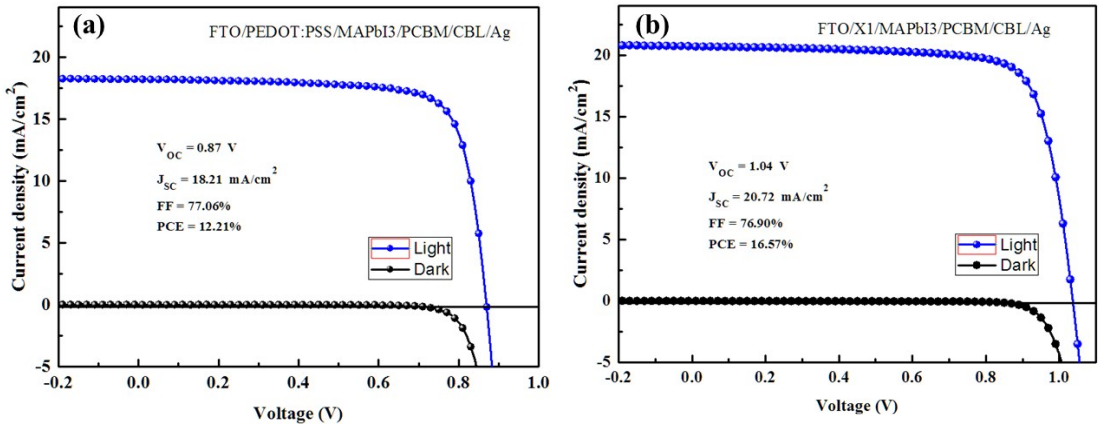

Figure S4 Typical *J-V* curves of $MAPbI_3$ solar cells based on PEDOT:PSS and X1 HTLs with C3 as CBLs.

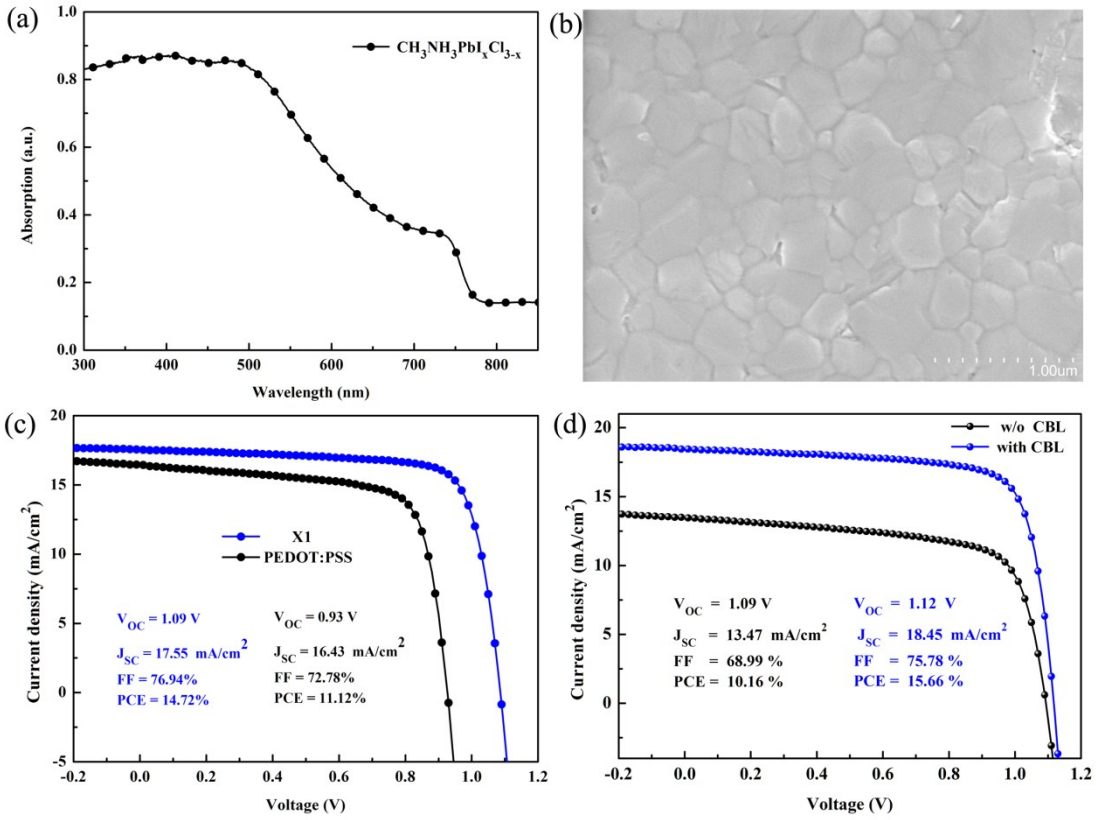

Figure S5 (a) Absorption spectrum of $CH_3NH_3PbI_{3-x}Cl_x$ film, (b) surface morphology of $CH_3NH_3PbI_{3-x}Cl_x$ film, (c) $CH_3NH_3PbI_{3-x}Cl_x$ solar cell performance based on X1 and PEDOT:PSS HTLs,(d) $CH_3NH_3PbI_{3-x}Cl_x$ solar cell performance with and without C3 CBL based on X1 HTL.

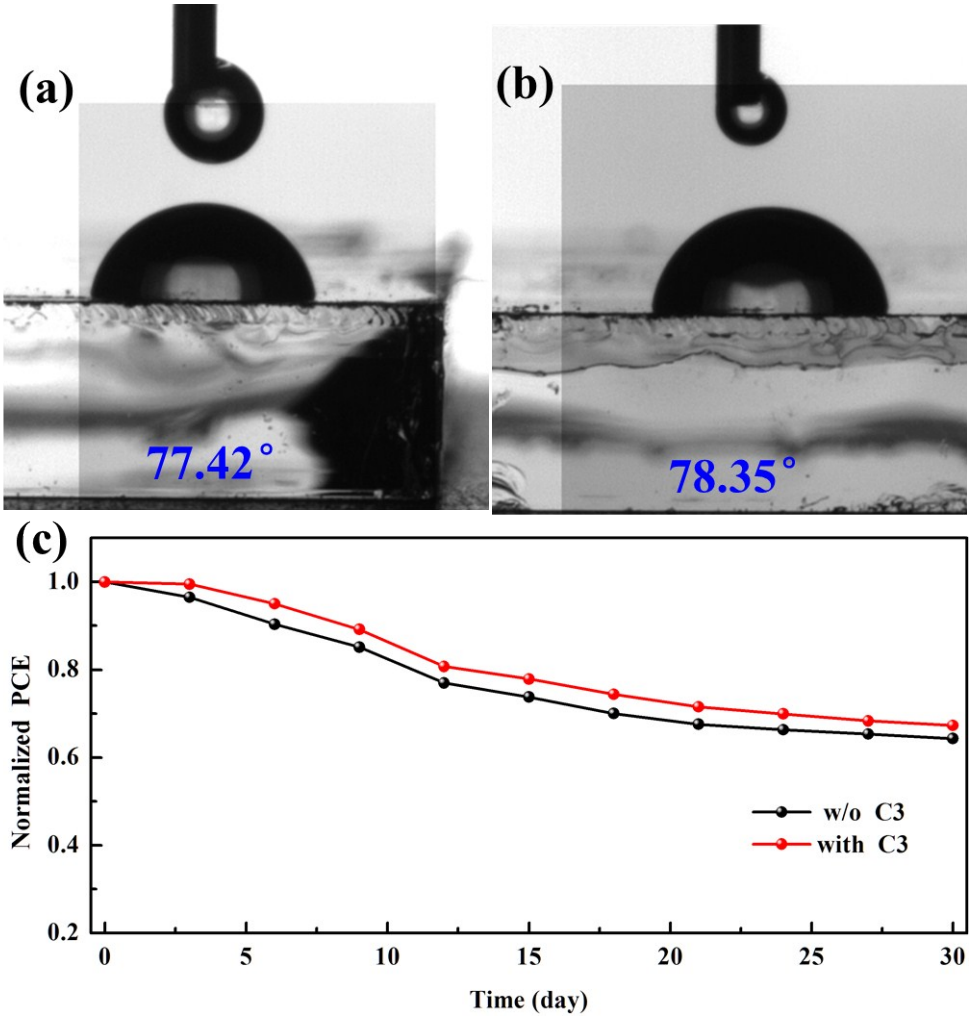

Figure S6 (a) water contact angle of PCBM film, (b) water contact angle of C3 CBL film, (c) long-term stability of $CH_3NH_3PbI_3$ solar cells with and without C3 CBL.

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