Supplementary Information for

Long-Term Stable Perovskite Solar Cell with Room Temperature Processed Metal Oxide Carrier Transporters

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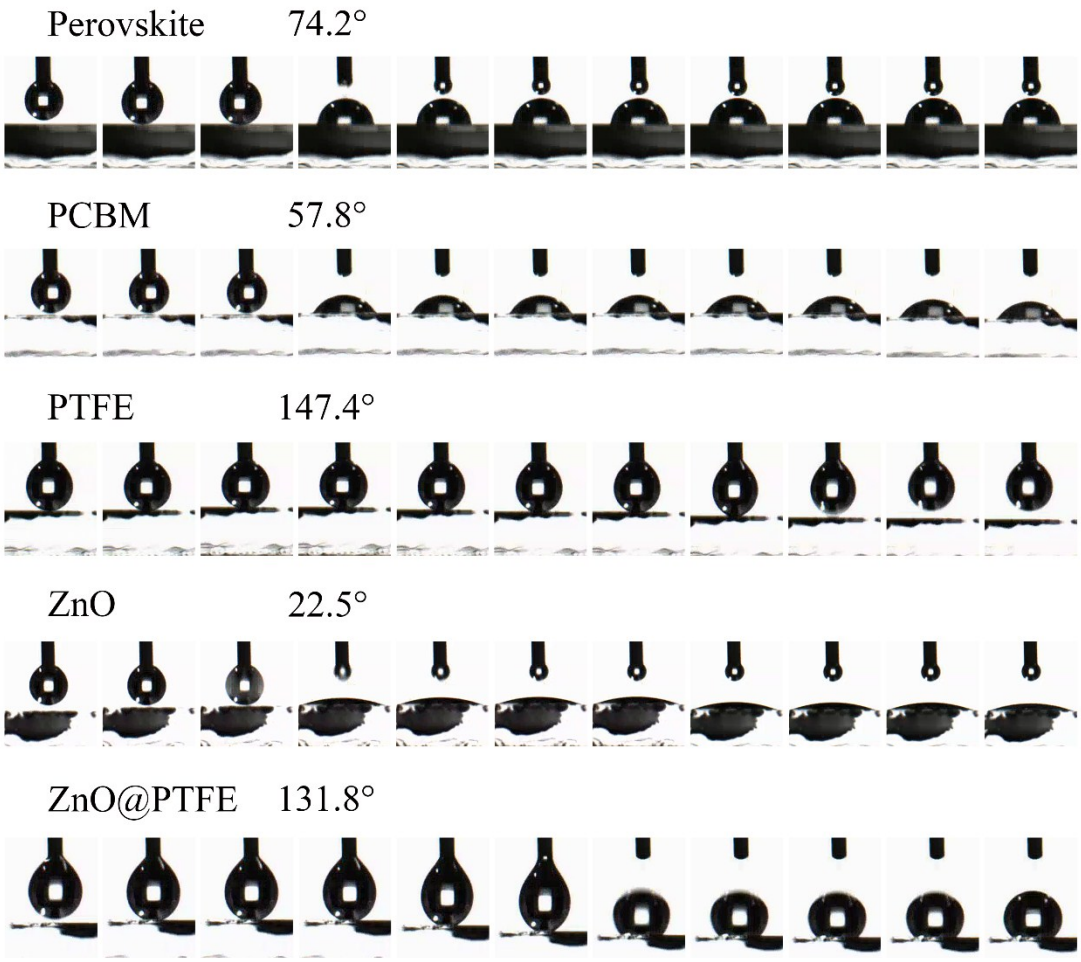

Figure S1. The wetting behaviour and water contact angles (WCAs) between water and different surfaces.

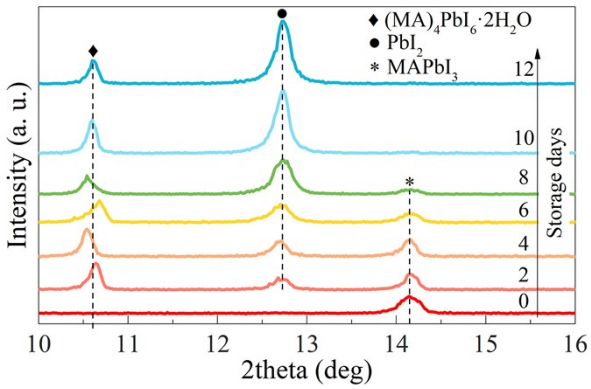

Figure S2. XRD patterns evolution of perovskite film stored in a chamber with constant temperature and humidity of 30 ℃ and 90 RH %.

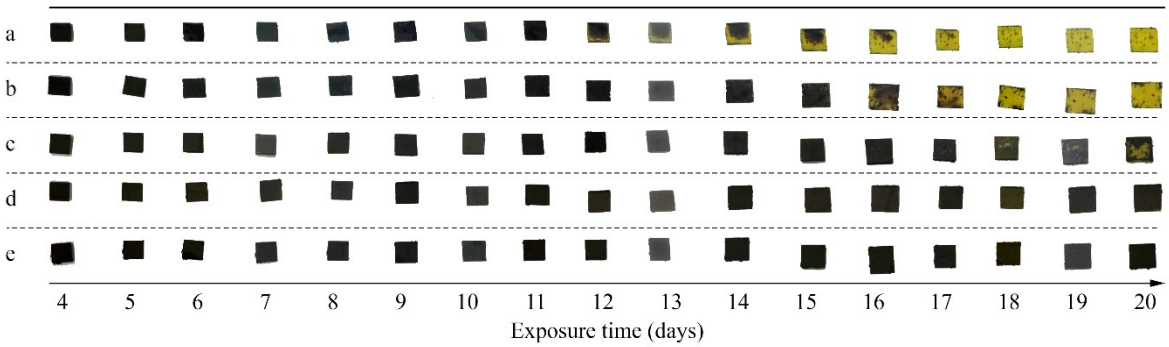

Figure S3. Photographs of perovskite film without coating (a) and with different coatings: (b) PCBM, (c) PTFE, (d) ZnO and (e) ZnO@PTFE after different storage times in a 30 ℃ and 60 RH % environment.

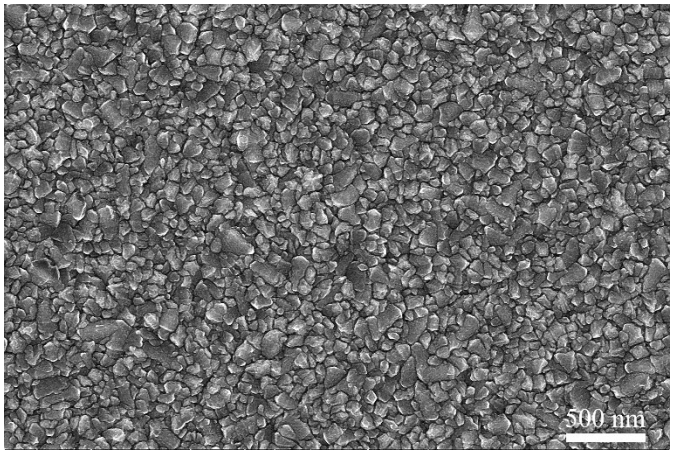

Figure S4. SEM image of Cu:NiO_x coated FTO fabricated by direct current sputtering of Cu and Ni targets at room temperature.

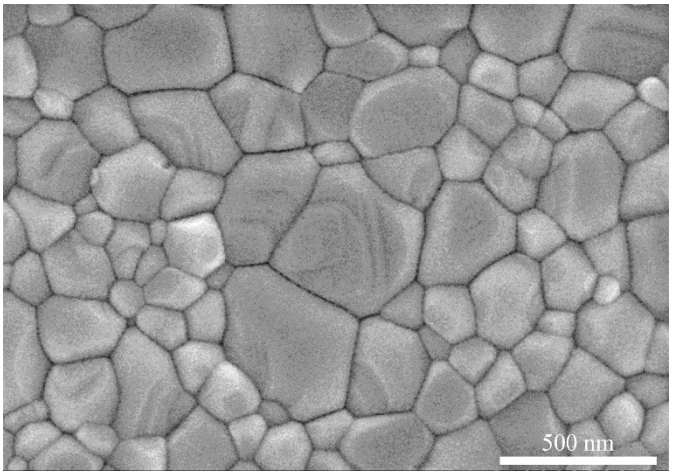

Figure S5. The top-view SEM image of $MAPbI_3$ on Cu:NiO_x. The average grain size in view is 215.72 ± 85.25 nm.

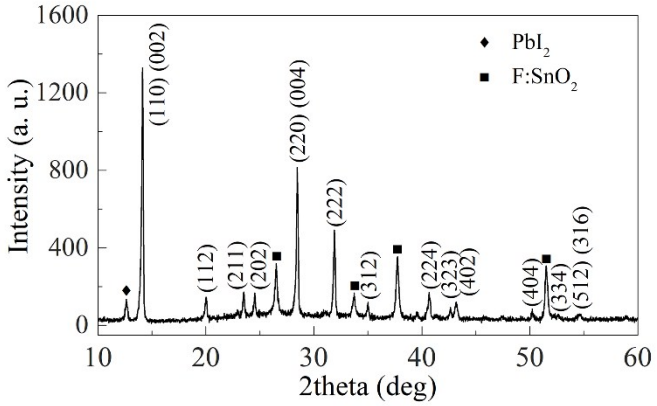

Figure S6. The XRD pattern of $MAPbI_3$ on Cu:NiO_x. Three typical diffraction peaks centred at 14.15°, 28.48° and 31.92° were assigned to (110) (002), (220) (004) and (222) lattice planes of $MAPbI_3$.

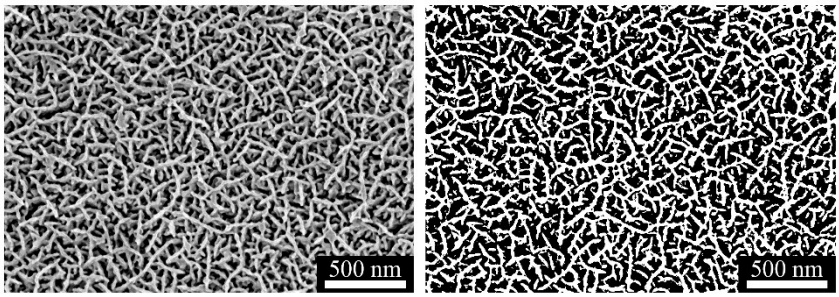

Figure S7. The top-view SEM image of PTFE nanowire network (left). The image on the right is obtained by applying a threshold on the original picture with ImageJ. The information below the threshold was discarded. The processed image was used to estimate the surface fraction of PTFE.

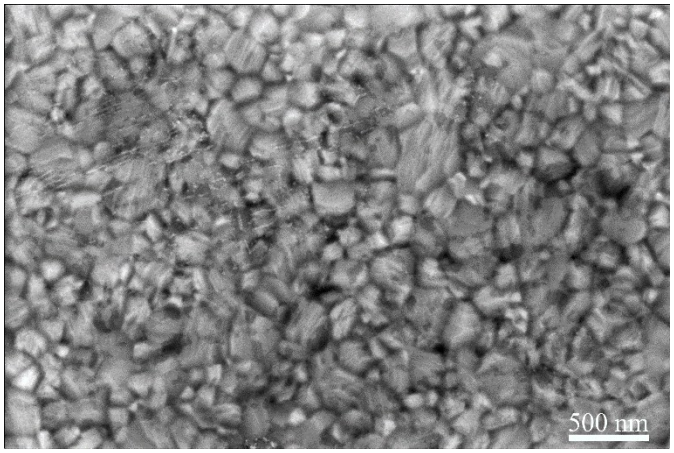

Figure S8. The top-view SEM image of PCBM coated perovskite film.

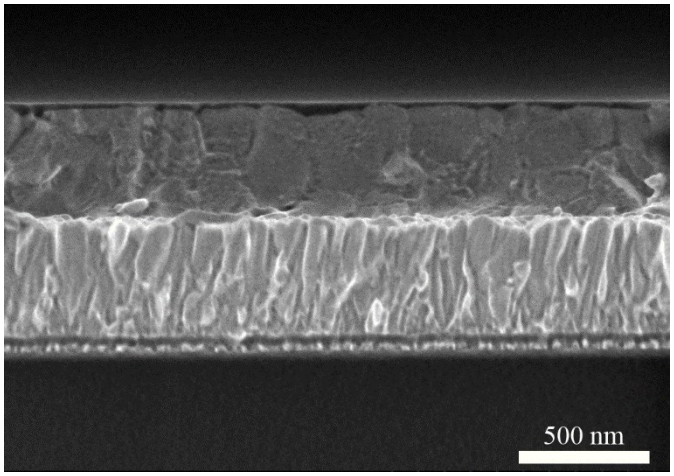

Figure S9. The cross-section SEM image of PCBM coated perovskite film.

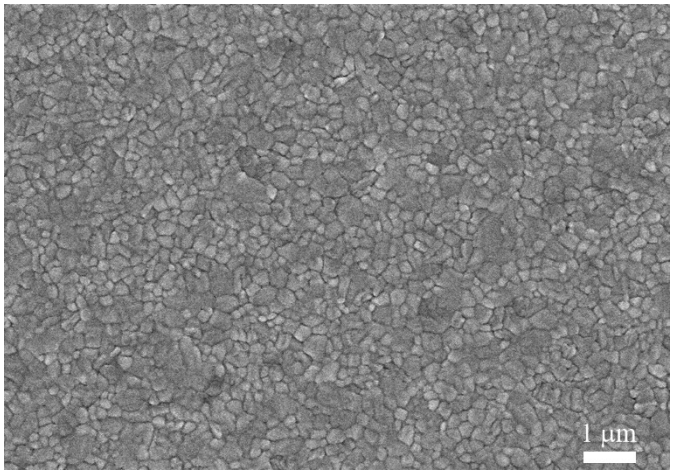

Figure S10. The top-view SEM image of ZnO coated perovskite film.

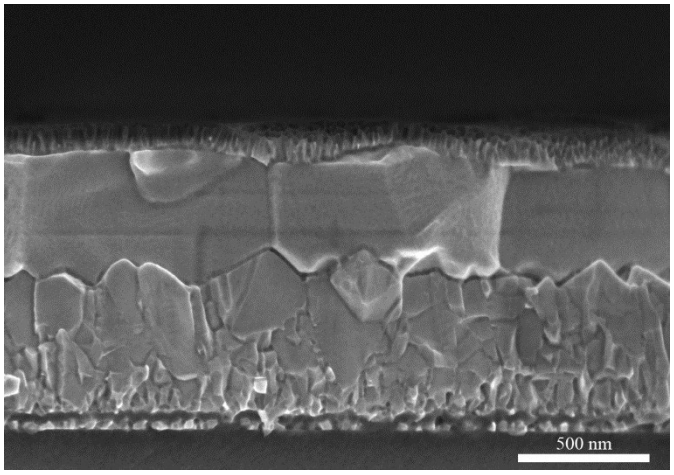

Figure S11. The cross-section SEM image of ZnO coated perovskite film.

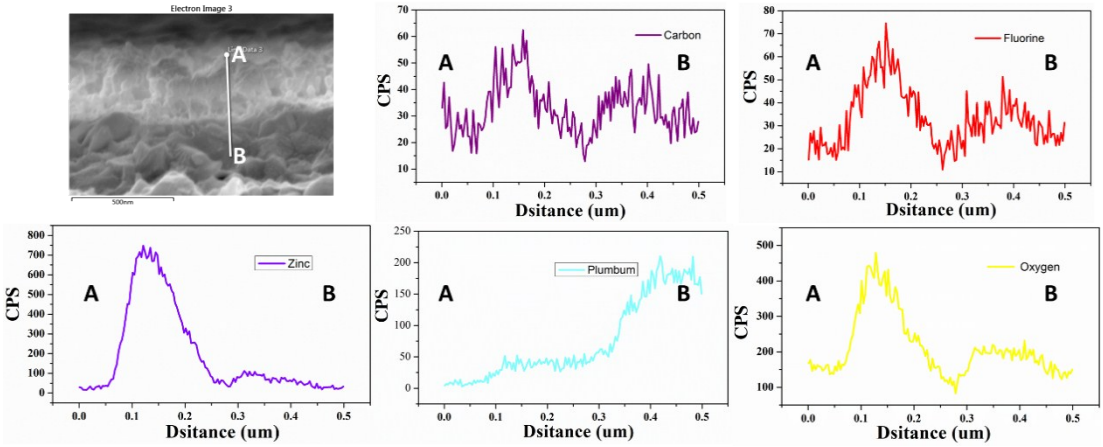

Figure S12. EDS line scanning patterns of elements of C, F, Zn, Pb and O along the direction marked in the cross-section SEM image of ZnO@PTFE coated perovskite film from point A to point B.

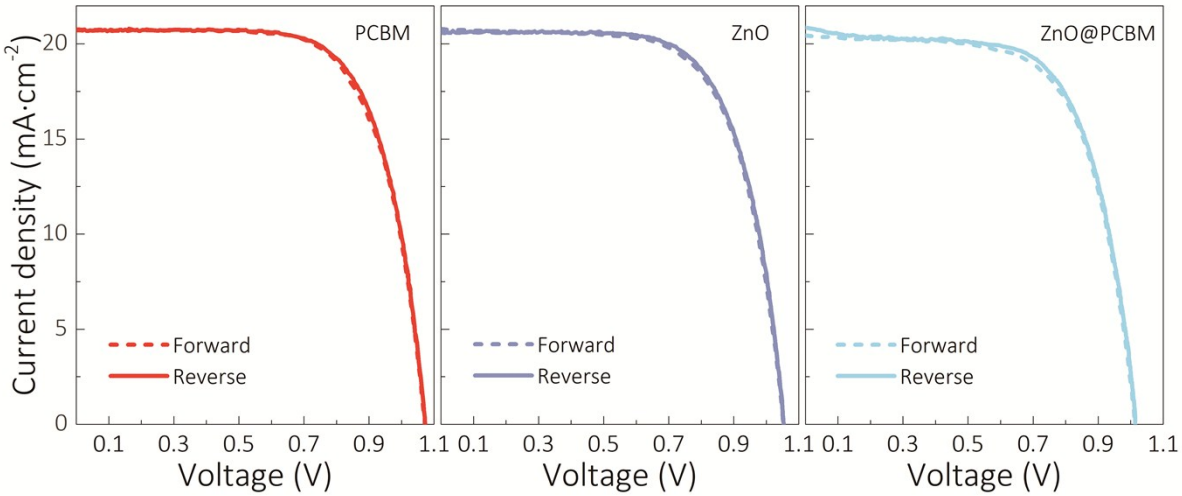

Figure S13. The forward (short circuit current density to open circuit voltage) and reverse (open-circuit voltage to short circuit current) scan J-V curves of PSCs with different ETMs.

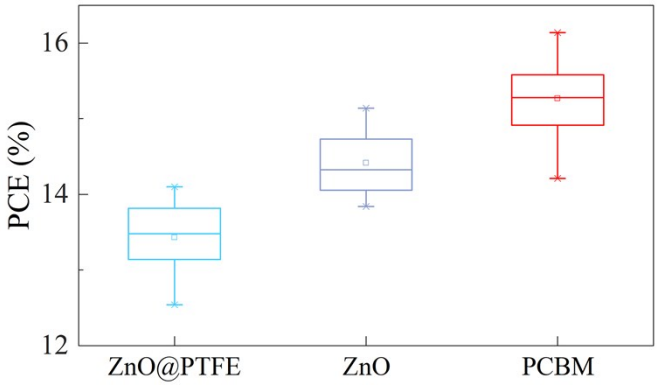

Figure S14. Photovoltaic performance distribution of the PSCs based on different electron transporters.

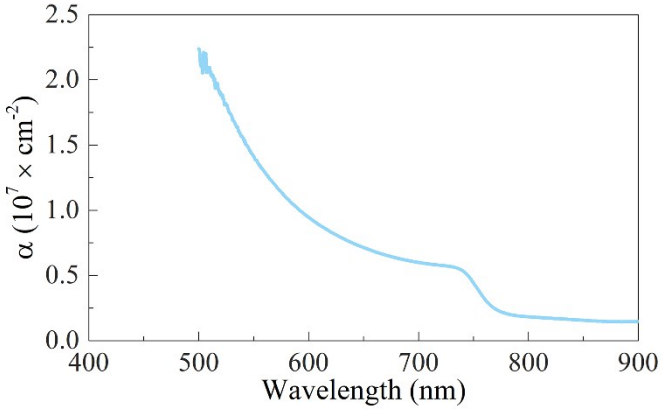

Figure S15. The light absorption coefficient of the perovskite film calculated from the visible-near infrared absorption spectrum.

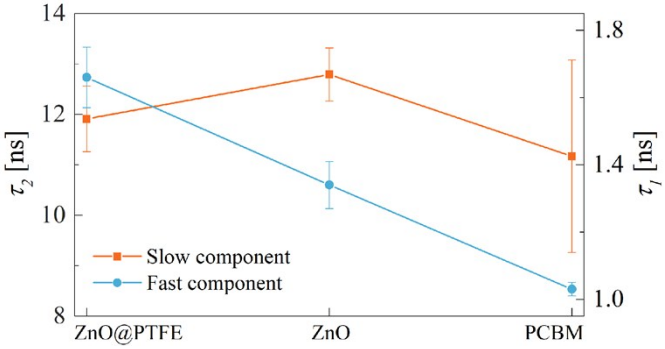

Figure S16. Photovoltaic performance distribution of the PSCs based on different electron transporters.

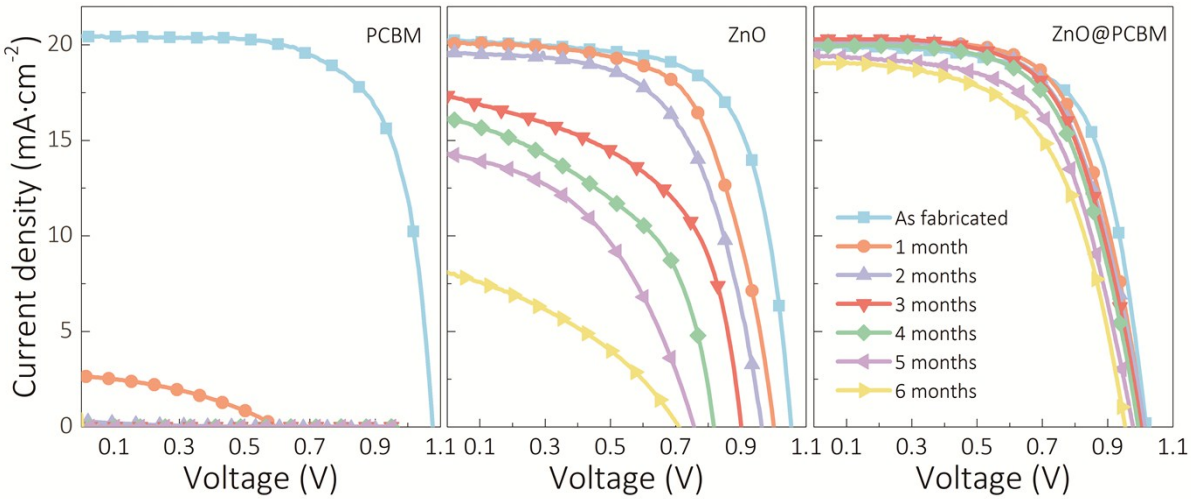

Figure S17. J-V curves evolution of PSCs with different electron transporter stored in ambient condition for several months.

Table S1. Summary of photovoltaic parameters of PSC based on PCBM stored in ambient conditions.

Time (months)	0	1	2	3	4	5	6
J_{SC} (mA cm^{-2})	20.55 ± 0.06	2.73 ± 0.26	0.24 ± 0.04	--	--	--	--
V_{OC} (V)	1.073 ± 0.004	0.561 ± 0.033	0.500 ± 0.021	--	--	--	--
FF (%)	68.33 ± 0.56	35.26 ± 2.65	15.43 ± 1.06	--	--	--	--
PCE (%)	15.06 ± 0.13	0.54 ± 0.06	0.02 ± 0.01	--	--	--	--

Table S2. Summary of photovoltaic parameters of PSC based on ZnO stored in ambient conditions.

Time (months)	0	1	2	3	4	5	6
J_{SC} (mA cm^{-2})	20.24 ± 0.07	20.12 ± 0.07	19.61 ± 0.17	17.36 ± 0.15	16.16 ± 0.14	14.34 ± 0.35	8.00 ± 0.78
V_{OC} (V)	1.055 ± 0.004	1.000 ± 0.004	0.960 ± 0.008	0.900 ± 0.007	0.816 ± 0.006	0.754 ± 0.02	0.704 ± 0.018
FF (%)	67.60 ± 0.31	63.54 ± 0.42	59.36 ± 0.58	53.27 ± 0.52	48.00 ± 0.89	44.61 ± 1.54	36.22 ± 2.03
PCE (%)	14.44 ± 0.08	12.78 ± 0.08	11.17 ± 0.11	8.32 ± 0.09	6.32 ± 0.13	4.82 ± 0.15	2.03 ± 0.26

Table S3. Summary of photovoltaic parameters of PSC based on ZnO@PTFE stored in ambient conditions.

Time (months)	0	1	2	3	4	5	6
J_{SC} (mA cm^{-2})	20.04 ± 0.11	20.07 ± 0.04	19.96 ± 0.21	20.04 ± 0.23	19.78 ± 0.17	19.27 ± 0.15	18.88 ± 0.15
V_{OC} (V)	1.012 ± 0.005	1.010 ± 0.004	1.008 ± 0.007	1.002 ± 0.002	0.997 ± 0.004	0.975 ± 0.006	0.945 ± 0.009
FF (%)	66.45 ± 0.71	64.45 ± 0.58	63.39 ± 0.74	62.42 ± 0.64	61.72 ± 0.51	60.50 ± 0.69	58.00 ± 0.35
PCE (%)	13.48 ± 0.12	13.06 ± 0.12	12.76 ± 0.10	12.51 ± 0.22	12.17 ± 0.15	11.37 ± 0.05	10.35 ± 0.20