Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supplementary Information

Highly Stable Perovskite Solar Cells in Extremely Humid Environment

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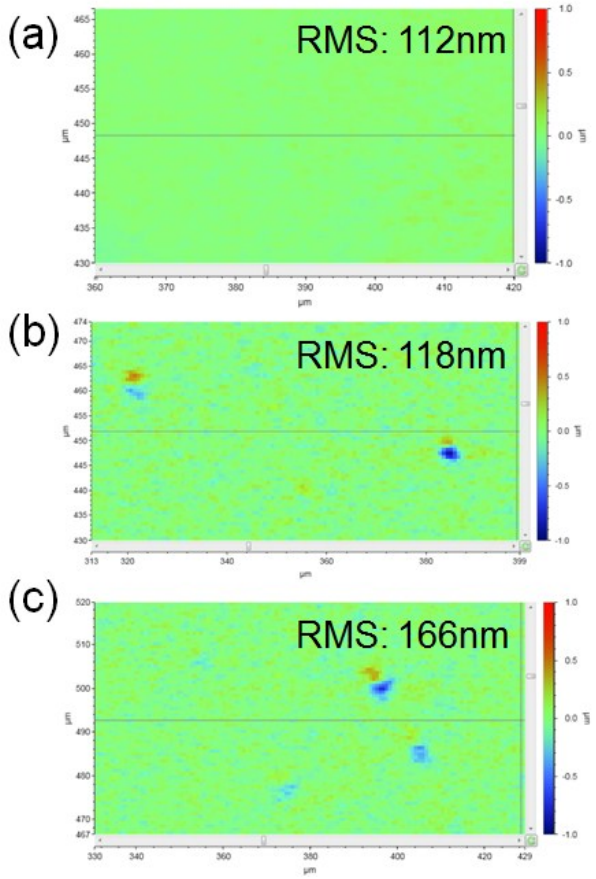

Figure S1. A change in the surface roughness of (a) pure PMMA, (b) PRC (rGO: 1wt%), and (c) PRC (rGO: 2wt%)

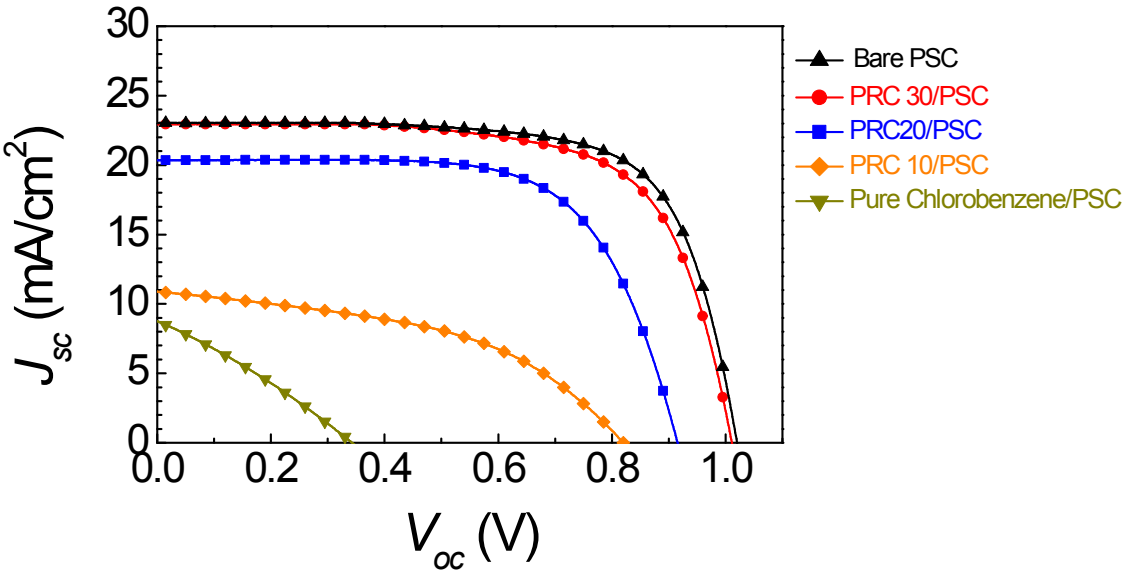

Figure S2. *J-V* curves of the perovskite solar cells coated with solutions containing different amounts of PMMA in chlorobenzene.

	J_{sc} (mA/cm^2)	V_{oc} (V)	η (%)	*FF*
Bare PSC	23.01	1.02	16.69	0.71
PRC 30/PSC	22.95	1.01	15.88	0.68
PRC 20/PSC	20.35	0.91	12.49	0.68
PRC 10/PSC	10.98	0.82	4.13	0.46
Pure chlorobenzene/PSC	8.79	0.34	0.87	0.29

Figure S3. Characteristics of the perovskite solar cells coated with solutions containing different amounts of PMMA in chlorobenzene, which are deduced from *J-V* curves of Figure S1.

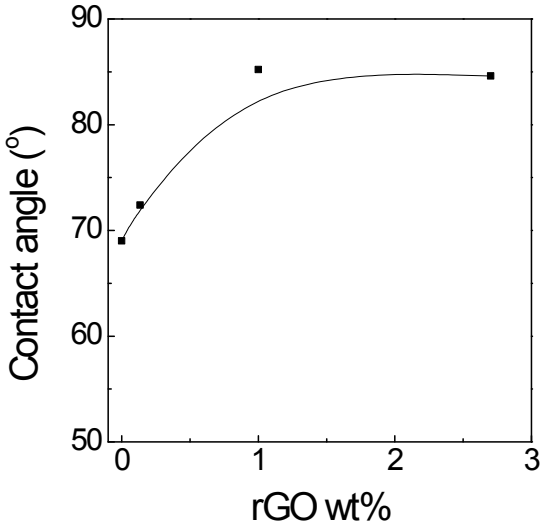

Figure S4. Change of the contact angle on PRC/PSCs, as function of rGO contents.

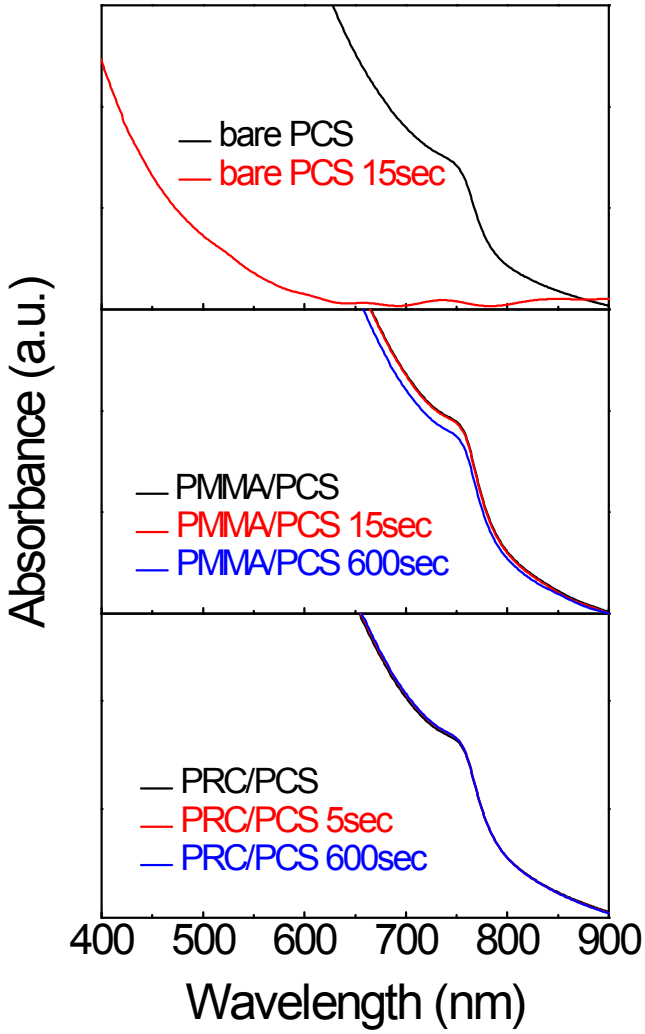

Figure S5. Absorbance of bare PSC, PMMA/PSC and PRC/PSC after samples were submerged in water for 15 sec and 600 sec.

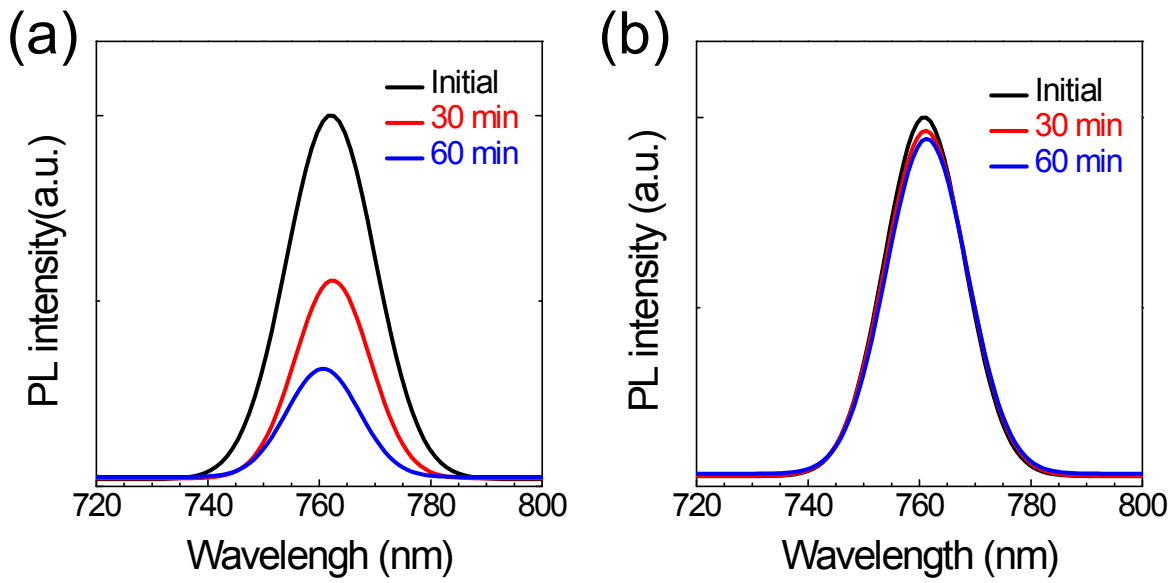

Figure S6. Steady-state Photoluminescence (PL) of the perovskite films (a) perovskite/TiO_2/FTO, (b) PRC/perovskite/TiO_2/FTO film with aging time in very humid condition, under 560 nm excitation

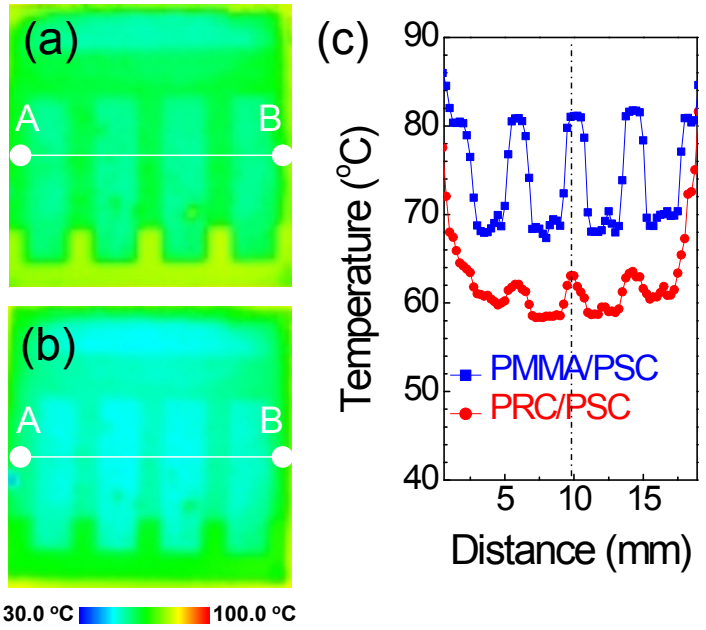

Figure S7. Infrared thermal camera image of (a) the PMMA layer coated perovskite solar cell and (b) the PRC layer coated perovskite solar cell, (c) surface temperature variation of PMMA/PSC and PRC/PSC on the hot plate at 93 °C.

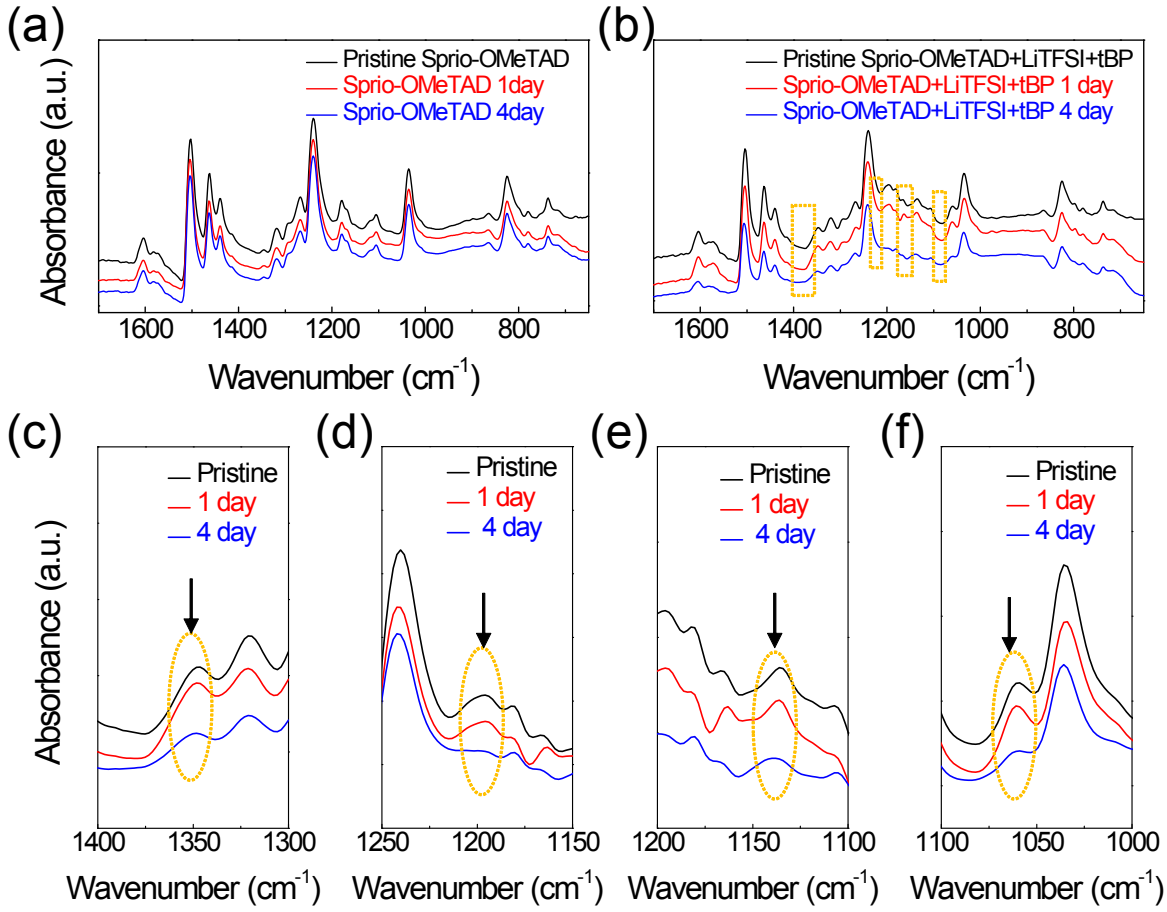

Figure S8. ATR-FTIR spectra of (a) the undoped spiro-OMeTAD and (b) spiro+LiFTSI+tBP films after aging at 90 °C. Magnified regions of (c, d, e, f) highlighting the differences.

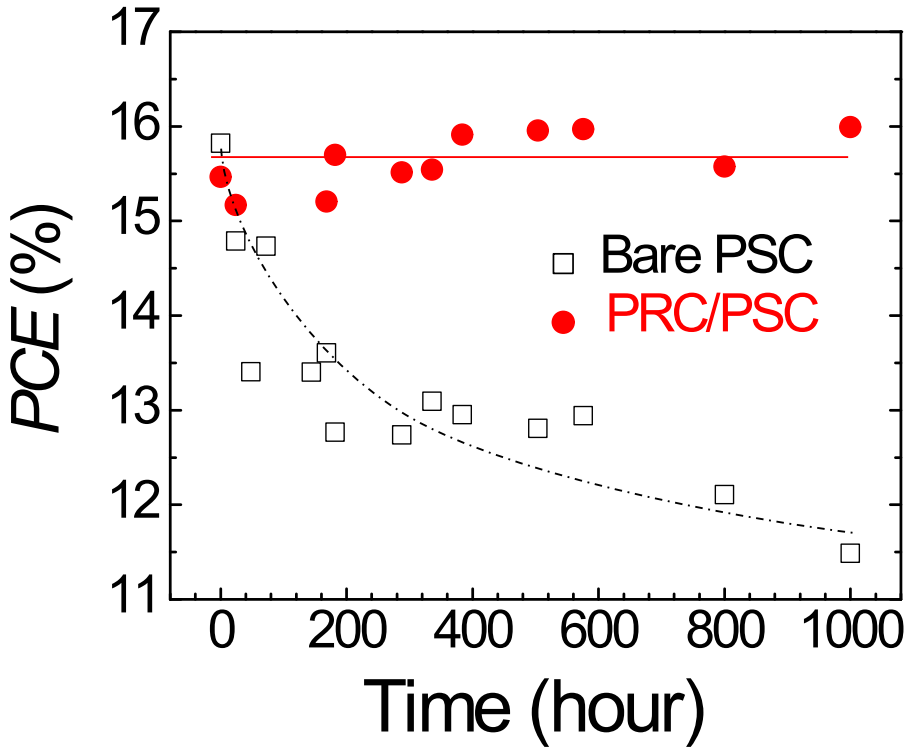

Figure S9. Long term stability of a bare PSC and PRC/PSC as a function of storage time in air for 1000 h (Humidity: ~40 %, Temperature: ~35 ^{o}C).

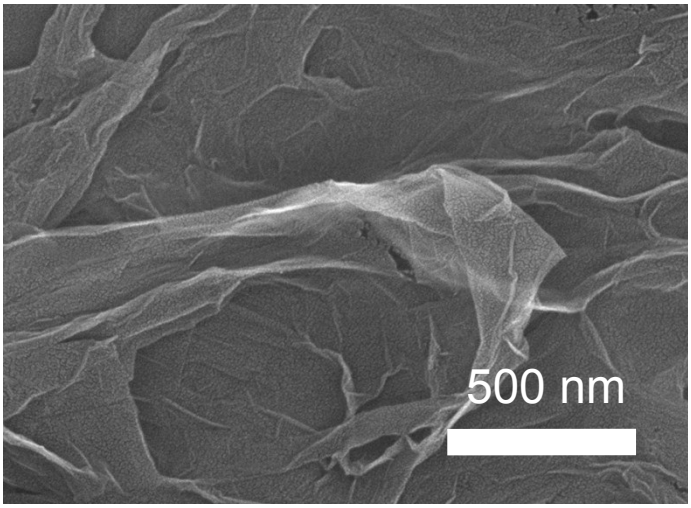

Figure S10. SEM image of synthesized reduce graphene oxide (rGO).