Simultaneous performance and stability improvement of polymer:fullerene solar cells by doping with piperazine

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Support Information



Figure S1. Statistical data of P3HT: $PC_{61}BM$ cells with different piperazine doping concentration



Figure S2 Degradation behavior of P3HT:PC₆₁BM doped with 3% piperazine aged at different load condition. For comparison, reference P3HT:PC₆₁BM cell without piperazine doping aged at mpp point is also shown in this Figure.



Figure S3. EQE spectra of PTB7-Th:PC₆₁BM (a) and PffBT4T-2OD:PC₆₁BM cells (b) at different piperazine doping concentration



Figure S4. Evolution of V_{OC} , J_{SC} , FF and PCE of PTB7-Th:PC₆₁BM cells aged at mpp with continuous light illumination



Figure S5. Evolution of *V*_{OC}, *J*_{SC}, FF and PCE of PffBT4T-2OD:PC₆₁BM cells aged at mpp with continuous light illumination



Figure S6. GIWAXS patterns of P3HT:PC₆₁BM blend films with different piperazine doping concentration (a-d) and aged P3HT:PC₆₁BM blend film (e). In-plane (f) and out-of-plane (g) profiles of these films.



Figure S7. TEM images of P3HT:PC61BM films with different piperazine concentration.



Figure S8 (a) Experimental setup of MIS-CELIV of selective hole mobility measurements. (b) CELIV triangle pulses with varying offset voltage in forwards bias. MIS-CELIV transients for P3HT:PC₆₁BM (c) and P3HT:PC₆₁BM:piperazine (3%) devices with and without a voltage offset.



Figure S9 Transient photocurrent measurement of devices doping with or without piperazine



Figure S10. Electronic Spin Resonance (ESR) spectra of PTB7-TH (a) and PTB7-TH: PC₆₁BM (b) films blended with piperazine in dark and in light measured at 123 K.



Figure S11. Electronic Spin Resonance (ESR) spectra of PffBT4T-2OD (a) and PffBT4T-2OD: PC₆₁BM (b) films blended with piperazine in dark and in light measured at 123 K.