
# Supporting Information

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# Significant Stability Enhancement in High-Efficiency Polymer:Fullerene Bulk Heterojunction Solar Cells by Blocking Ultraviolet Photons from Solar Light

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## Significant stability enhancement in high efficiency polymer:fullerene bulk heterojunction solar cells by blocking ultraviolet photons from solar light

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**Table S1**. Summary of solar cell performances for glass/ITO/ZnO/PTB7-Th:$PC_{71}BM$/$MoO_3$/Ag solar cells without (a) and with (b) UV-cut filter (UCF).

| | w/o UCF (under 100 mW/cm$^2$) | | | w/ UCF (under 100 mW/cm$^2$) | | | w/o UCF (under 80 mW/cm$^2$) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 min | 60 min | 120 min | 0 min | 60 min | 120 min | 0 min | 60 min | 120 min |
| $J_{SC}$ (mA/cm$^2$) | 17.29 | 14.39 | 11.89 | 14.85 | 14.69 | 14.41 | 14.01 | 13.07 | 12.84 |
| $V_{OC}$ (V) | 0.78 | 0.66 | 0.61 | 0.77 | 0.75 | 0.75 | 0.76 | 0.71 | 0.70 |
| FF (%) | 65.7 | 45.4 | 42.2 | 64.0 | 61.5 | 60.4 | 69.0 | 56.5 | 53.5 |
| PCE (%) | 8.87 | 4.31 | 3.06 | 7.33 | 6.77 | 6.53 | 7.35 | 5.25 | 4.81 |
| $R_S$ (Ω·cm$^2$) | 80 | 150 | 180 | 90 | 90 | 90 | 80 | 120 | 130 |
| $R_{SH}$ (kΩ·cm$^2$) | 12.9 | 2.2 | 2.7 | 6.8 | 8.3 | 6.6 | 28.4 | 4.5 | 9.4 |

**Table S2**. Summary of solar cell performances for glass/ITO/ZnO/PEI/PTB7-Th:$PC_{71}BM$/$MoO_3$/Ag solar cells without (a) and with (b) UV-cut filter (UCF).

| | w/o UCF (under 100 mW/cm$^2$) | | | | w/ UCF (under 100 mW/cm$^2$) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 h | 1 h | 5 h | 14 h | 0 h | 2 h | 6 h | 10 h | 14 h | 21 h |
| $J_{SC}$ (mA/cm$^2$) | 17.40 | 13.95 | 10.95 | 8.09 | 15.81 | 15.78 | 15.39 | 15.01 | 14.87 | 14.79 |
| $V_{OC}$ (V) | 0.78 | 0.61 | 0.59 | 0.57 | 0.77 | 0.74 | 0.74 | 0.74 | 0.74 | 0.74 |
| FF (%) | 65.7 | 46.0 | 41.2 | 40.0 | 61.8 | 61.6 | 58.9 | 60.4 | 61.6 | 60.8 |
| PCE (%) | 8.91 | 3.91 | 2.66 | 1.84 | 7.53 | 7.19 | 6.71 | 6.71 | 6.78 | 6.65 |
| $R_S$ (Ω·cm$^2$) | 80 | 150 | 210 | 370 | 150 | 120 | 140 | 110 | 100 | 100 |
| $R_{SH}$ (kΩ·cm$^2$) | 5.7 | 2.2 | 1.8 | 2.6 | 8.4 | 4.2 | 11.0 | 5.4 | 5.5 | 7.3 |

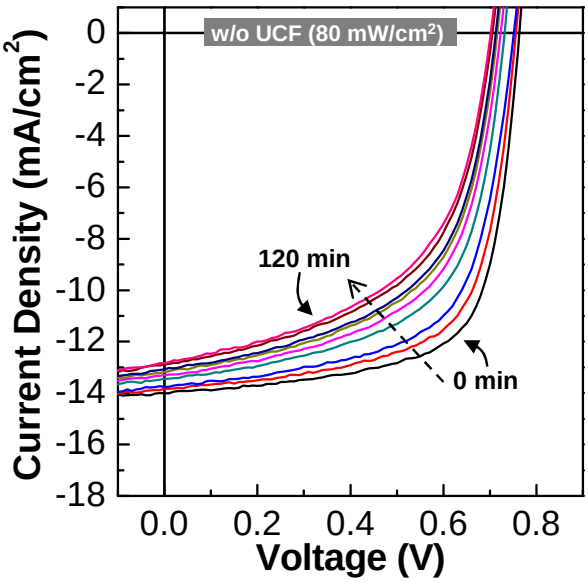


**Figure S1**. Current density – voltage (J-V) curves of glass/ITO/ZnO/PTB7-Th:$PC_{71}BM$/$MoO_3$/Ag solar cells under continuous illumination with simulated solar light (air mass 1.5G, 80 mW/cm$^2$) for 120 min without UCF.

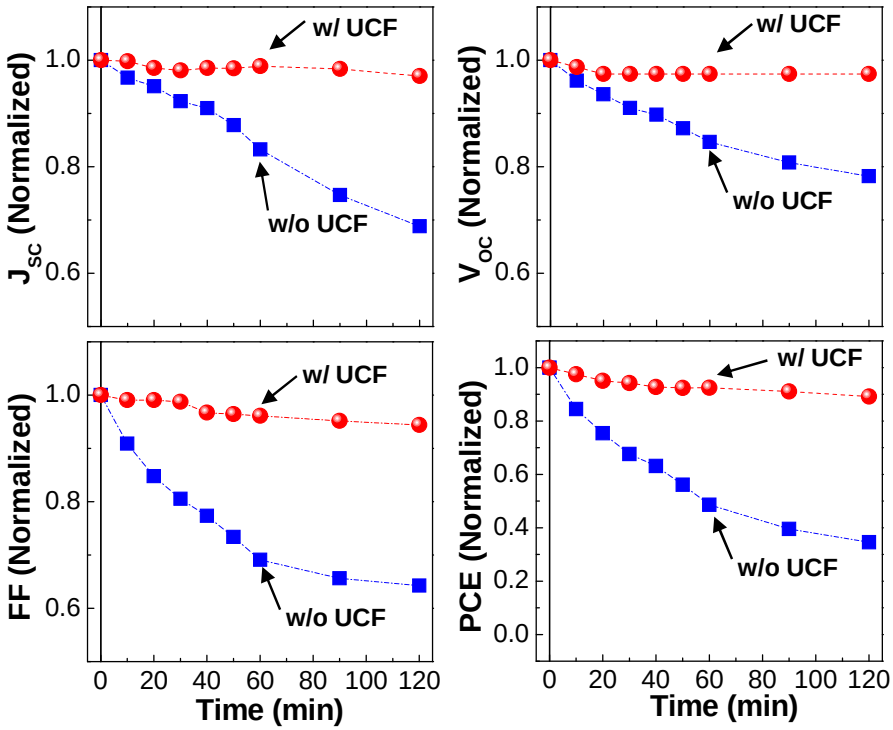


**Figure S2.** Normalized $J_{SC}$, $V_{OC}$, FF, PCE, $R_S$, and $R_{SH}$ as a function of exposure time under simulated solar light (air mass 1.5G, 100 mW/cm$^2$) for glass/ITO/ZnO/PTB7-Th:$PC_{71}BM$/$MoO_3$/Ag solar cells with and without UCF (see original values in Figure 3).

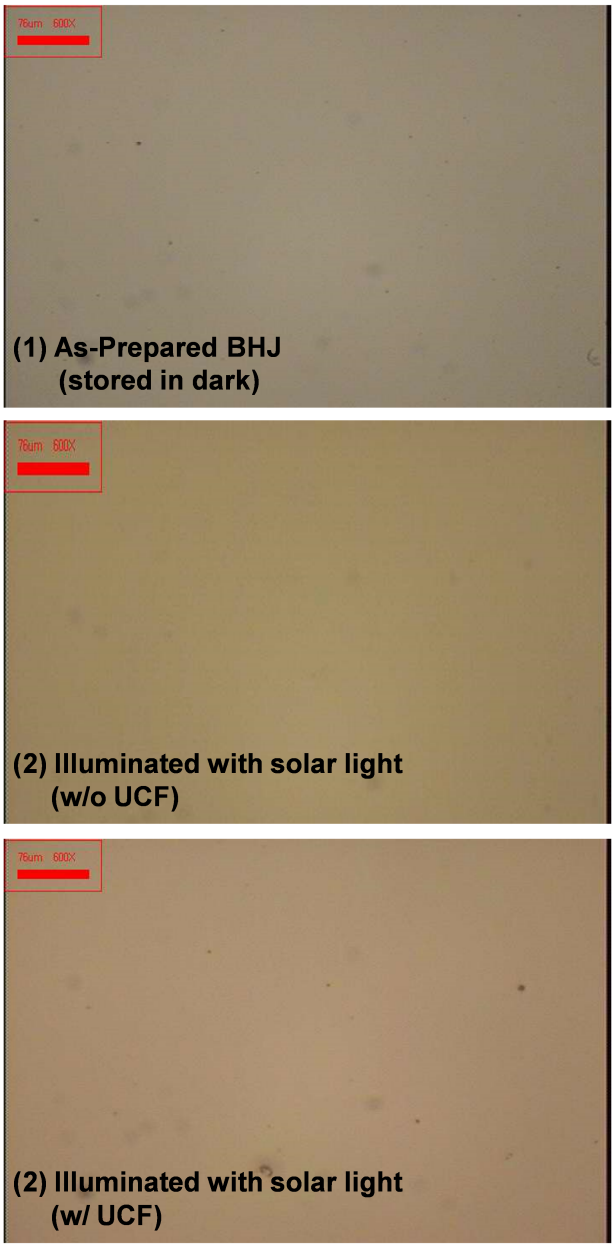


**Figure S3.** Optical microscope images for PTB7-Th:$PC_{71}BM$ BHJ films: (1) As-prepared, (2) illuminated with simulated solar light (air mass 1.5G, 100 mW/cm$^2$) without UCF for 120 min, and (3) illuminated with simulated solar light (air mass 1.5G, 100 mW/cm$^2$) with UCF for 120 min. The size of scale bar in red is 76 μm. Note that some big spots here come from defects in lenses of optical microscope.

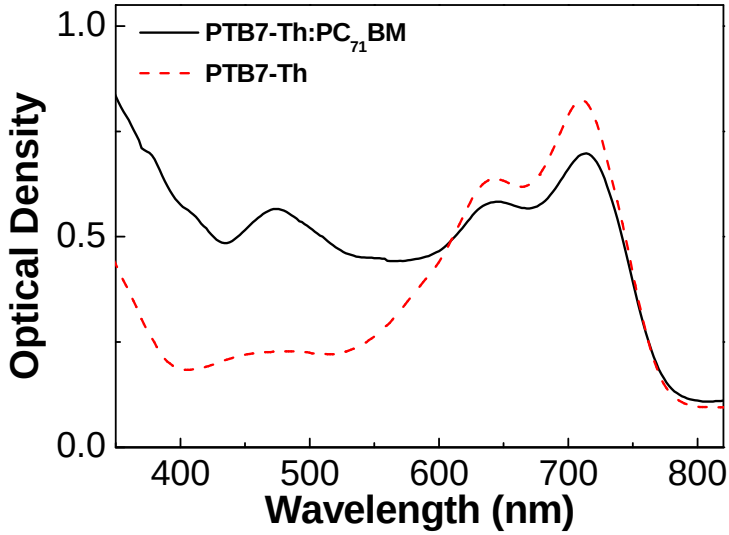


**Figure S4.** Optical absorption spectra of the pristine PTB7-Th film (red dashed line) and the PTB7-Th:$PC_{71}BM$ BHJ film (black solid line).

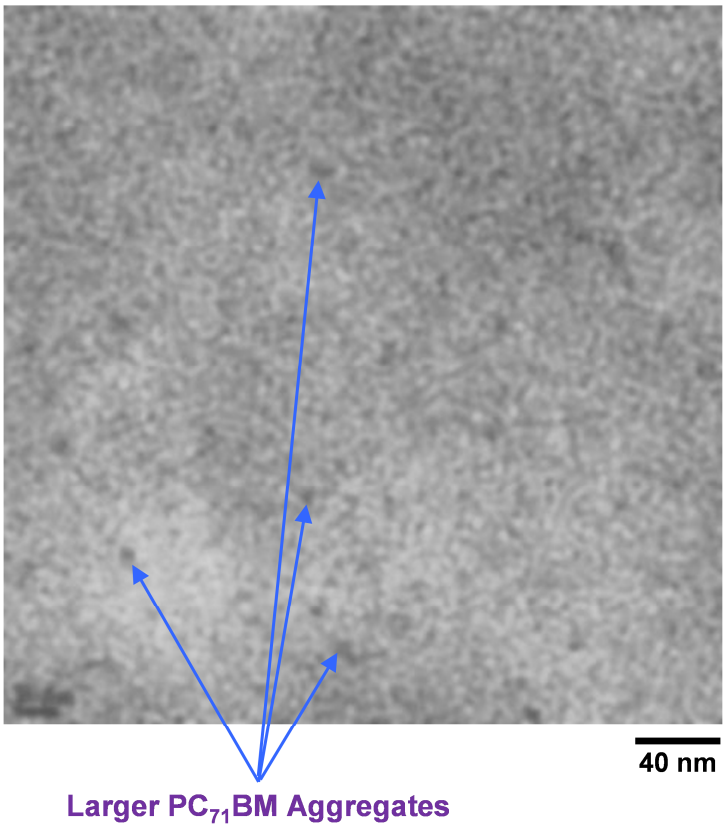


**Figure S5.** Enlarged TEM image (black & white) for the PTB7-Th:$PC_{71}BM$ BHJ film illuminated with simulated solar light (air mass 1.5G, 100 mW/$cm^2$) without UCF for 120 min. The blue arrows point the large aggregates of $PC_{71}BM$, which are considered to be formed by oxidative degradation of both components (preferably PTB7-Th) in the BHJ film.

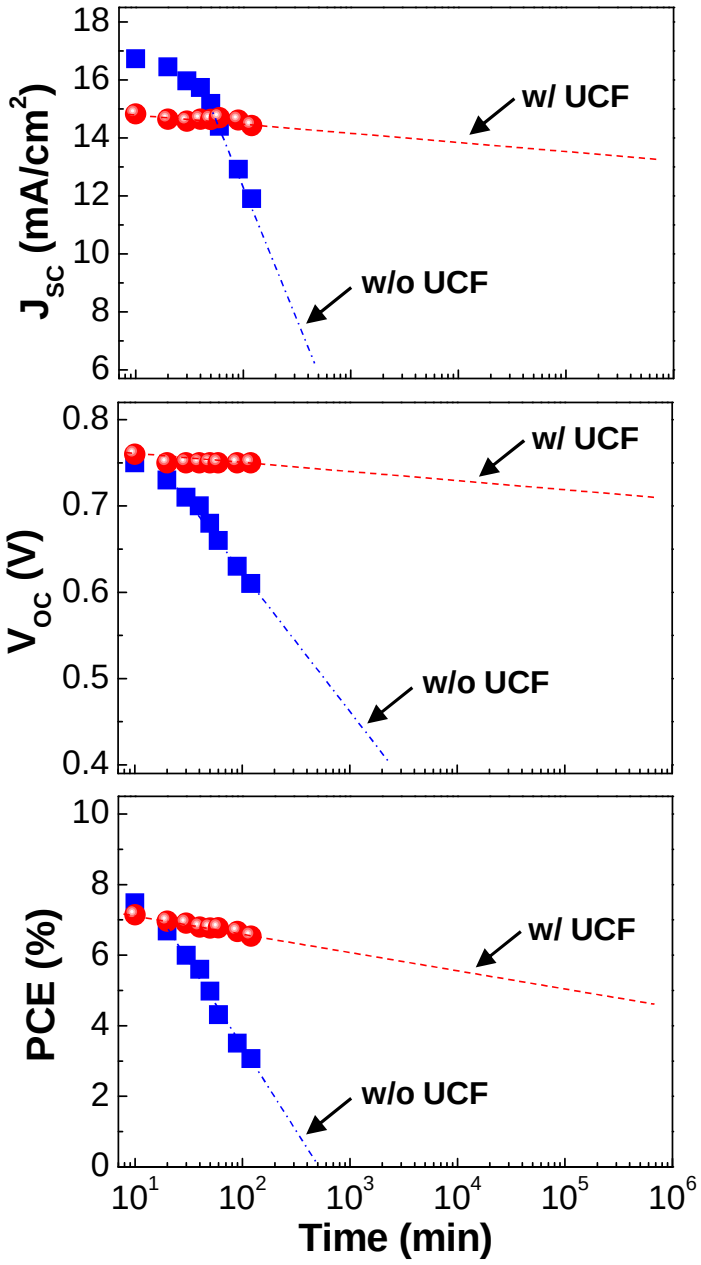


**Figure S6.** Projected $J_{SC}$, $V_{OC}$, and PCE as a function of exposure time under simulated solar light (air mass 1.5G, 100 mW/cm$^2$) for glass/ITO/ZnO/PTB7-Th:$PC_{71}BM$/$MoO_3$/Ag solar cells with and without UCF.

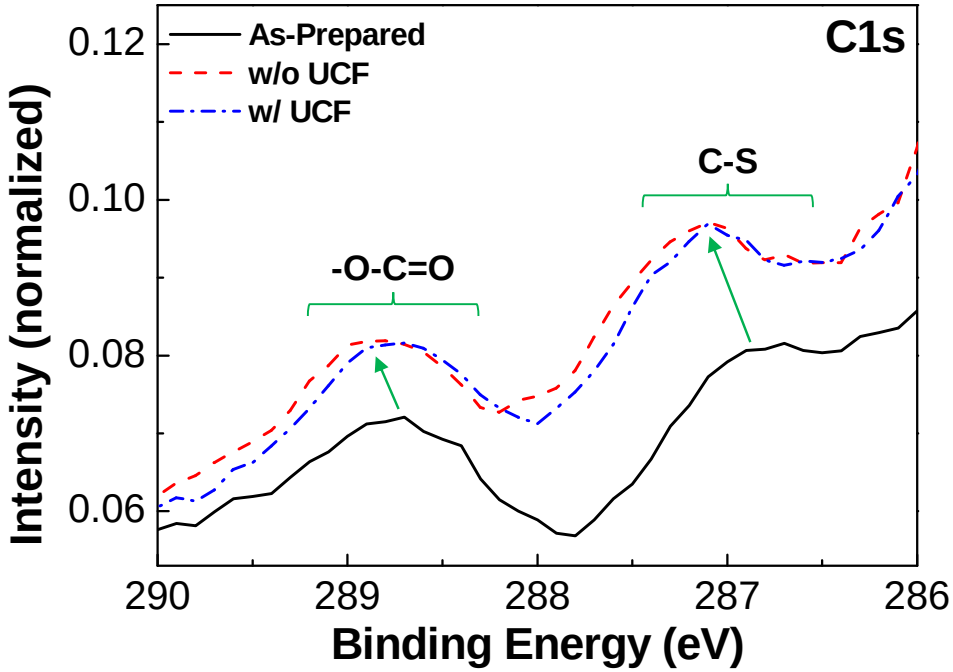


**Figure S7.** Enlarged C1s XPS spectra for –O-C=O and C-S groups in the PTB7-Th:$PC_{71}BM$ BHJ films: (1) As-prepared (black solid line), (2) illuminated with simulated solar light (air mass 1.5G, 100 mW/cm$^2$) without UCF for 120 min (red dashed line), and (3) illuminated with simulated solar light (air mass 1.5G, 100 mW/cm$^2$) with UCF for 120 min (blue dash-dot line). Green arrows denote the shift of C1s peaks in the as-coated film (1) after illumination, indicating the environmental change of carbon atoms in the –O-C=O and C-S groups of the BHJ films after illumination.

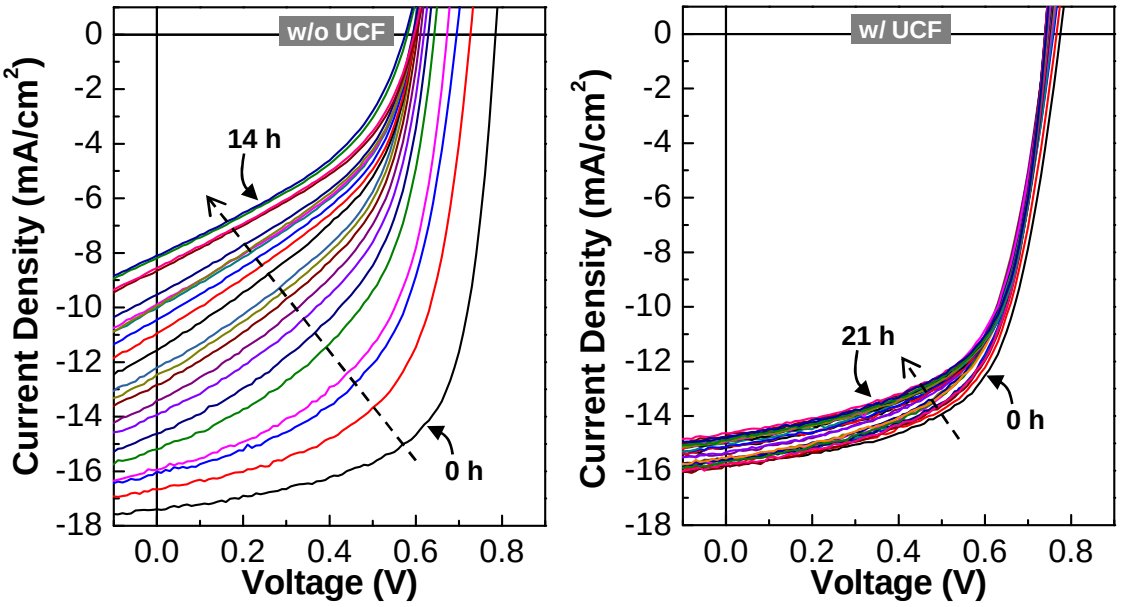


**Figure S8.** Current density – voltage (J-V) curves of glass/ITO/ZnO/PTB7-Th:$PC_{71}BM$/$MoO_3$/Ag solar cells under continuous illumination with simulated solar light (air mass 1.5G, 100 mW/cm$^2$): (left) without UCF for 14 h and (right) with UCF for 21 h. Note that the sorted J-V curves appear in Figure 7.