PCBM-blended Chlorobenzene Hybrid Anti-solvent Engineering for Efficient Planar Perovskite Solar Cells

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Fig. S1 Cross-sectional images of the perovskite light harvester film made under various secondary washing treatments of CBZ only and CBZ+PCBM hybrid (10-80 μL), analyzed by FE-SEM.
Fig. S2 Time-resolved photoluminescence (TRPL) of the perovskite films made with and without various introduction of PCBM additive solutions (from 10 μL to 80 μL).
< CBZ washing >

In grain  

Grain Boundary

(a)

< CBZ+PCBM (10 µL) washing >

In grain  

Grain Boundary

(b)
Fig. S3 EDS mapping data of perovskite films with different washing treatment using (a) CBZ only, (b) CBZ+PCBM (10 μL), (c) CBZ+PCBM (40 μL), and (d) CBZ+PCBM (80 μL).
Fig. S4. Absorption spectra of the PRV films processed with CBZ only and CBZ+PCBM hybrid washing treatments.
**Fig. S5** XRD and UV-Vis absorption spectra of the perovskite films made with CBZ/PCBM sequential washing and CBZ+PCBM hybrid washing process.
Fig. S6 Surface morphologies and phase imaging of the perovskite films made with CBZ/PCBM sequential washing process. Those are compared with the films made under CBZ+PCBM hybrid washing.
Fig. S7 A comparison of surface morphologies for the perovskite films made with CBZ+PCBM hybrid and CBZ/PCBM sequential washing process.
(a) CBZ

RMS (1 μm X 1 μm) : 17.8 nm

RMS (5 μm X 5 μm) : 17.9 nm

RMS (10 μm X 10 μm) : 20.9 nm

(b) CBZ+PCBM(1 μL)

RMS (1 μm X 1 μm) : 17.7 nm

RMS (5 μm X 5 μm) : 19.6 nm

RMS (10 μm X 10 μm) : 19.8 nm
<table>
<thead>
<tr>
<th>(c) CBZ+PCBM(5 μL)</th>
<th>(d) CBZ+PCBM(10 μL)</th>
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<tbody>
<tr>
<td>RMS (1 μm X 1 μm) : 13.3 nm</td>
<td>RMS (1 μm X 1 μm) : 12.3 nm</td>
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<tr>
<td>RMS (5 μm X 5 μm) : 14.9 nm</td>
<td>RMS (5 μm X 5 μm) : 15.0 nm</td>
</tr>
<tr>
<td>RMS (10 μm X 10 μm) : 14.6 nm</td>
<td>RMS (10 μm X 10 μm) : 19.3 nm</td>
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Fig. S8 A comparison of surface topography with various scales (1 μm × 1 μm, 5 μm × 5 μm, and 10 μm × 10 μm) for all perovskite films made with various PCBM additive concentration such as (a) No PCBM, (b) 1 μL, (c) 5 μL, (d) 10 μL, (e) 40 μL, and (f) 80 μL.
Fig. S9 Current density-voltage (J-V) characteristics of the perovskite solar cells of which absorber layers were made with solvent washing processes using CBZ only and the CBZ+PCBM hybrid solutions.