Supporting Information

Solvent engineering for forming Stonehenge-like PbI$_2$ nanostructure

towards efficient perovskite solar cells

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Fig. S1 ~ Fig. S7

![XRD patterns of PbI$_2$ films prepared by high-vacuum treatment and IPA substitution.](image)

Fig. S1 XRD patterns of PbI$_2$ films prepared by high-vacuum treatment and IPA substitution.

![UV–Vis absorption spectra of the PbI$_2$ films prepared by different approaches.](image)

Fig. S2 UV–Vis absorption spectra of the PbI$_2$ films prepared by different approaches.

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Fig. S3 PbI$_2$ film photographs. Prepared by a, anneal treatment; b, IPA substitution for 60 sec.

Fig. S4 a, Top-view SEM images of CH$_3$NH$_3$PbI$_3$ films; b, Cross-view SEM images of CH$_3$NH$_3$PbI$_3$ films (red region).

Fig. S5 Photographs of CH$_3$NH$_3$PbI$_3$ films prepared by IPA substitution.
Fig. S6 J-V curves of the perovskite solar cell based on IPA substitution for 60 s measured by reverse (open circuit → short circuit) and forward (short circuit → open circuit) scans under one sun illumination.

Fig. S7 The steady-state photocurrent and output PCE of the devices at the maximum power points.

Fig. S8 Distribution of the efficiencies from for perovskite solar cell based on anneal-treatment and IPA-60s (Each team is calculated from a batch of 50 cells).
Table S1 Fitting parameters for the time-resolved PL measurements shown in Fig. 6b.

<table>
<thead>
<tr>
<th>Sample</th>
<th>$A_1$</th>
<th>$\tau_1$/ns</th>
<th>$A_2$</th>
<th>$\tau_2$/ns</th>
<th>Average $\tau$/ns</th>
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<tbody>
<tr>
<td>Anneal</td>
<td>0.68</td>
<td>31.26</td>
<td>0.32</td>
<td>6.20</td>
<td>23.24</td>
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<tr>
<td>IPA-5s</td>
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<td>26.68</td>
<td>0.47</td>
<td>8.48</td>
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<td>IPA-20s</td>
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<td>14.77</td>
<td>0.44</td>
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<td>IPA-60s</td>
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<td>0.33</td>
<td>3.38</td>
<td>9.66</td>
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<tr>
<td>IPA-100s</td>
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<td>23.36</td>
<td>0.53</td>
<td>5.31</td>
<td>13.79</td>
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