Highly oriented quasi-2D layered tin halide perovskites with 2-thiopheneethylammonium iodide for efficient and stable tin perovskite solar cells

Authors: Yanting Xu, Ke-Jian Jiang, *b Pengcheng Wang, Wei-Min Gu, Guang-Hui Yu, Xueqin Zhou* and Yanlin Song*

Affiliations:

*aSchool of Chemical Engineering and Technology, Tianjin University, Tianjin, 300072, P. R. China.

bKey Laboratory of Green Printing, Institute of Chemistry, CAS, Beijing, 100190, P. R. China.

*Corresponding author.

E-mail address: kjjiang@iccas.ac.cn, zhouxueqin@tju.edu.cn, ylsong@iccas.ac.cn
Supporting information

**Fig. S1.** The $^1$H NMR spectrum of TEAI.
**Fig. S2.** The enlarged XRD pattern of the pristine MASnI$_3$ film and the MASnI$_3$ films with different amounts of TEAI, from range 3°-15°.

**Fig. S3.** GIWAXS images of the perovskite films with 0%, 5%, 10%, 20%, and 40% TEAI, respectively.
**Fig. S4.** XRD patterns of the TH$_2$MASn$_2$I$_7$ film and the 40% TEAI film.

**Fig. S5.** Surface SEM images of the perovskite films with 0%, 5%, 10%, 20%, and 40% TEAI, respectively.
**Fig. S6.** Stabilized current and power output of the device with 10% TEAI, monitored under a constant bias of 0.41 V.

**Fig. S7.** UV-vis absorption spectra of perovskite films without (a) and with 10% TEAI (b), stored in air at 25 ~ 35 °C and 30 ~ 45% RH.
Fig. S8. XRD patterns of perovskite films without (a) and with 10% TEAI (b), stored in air at 25 ~ 35 °C and 30 ~ 45% RH.

Table S1 TRPL characteristics values of the control and 10% TEAI perovskite (the effect of IRF has been eliminated by deconvolution during the fitting process)

<table>
<thead>
<tr>
<th>Samples</th>
<th>$\tau_1$ (ns)</th>
<th>$\tau_2$ (ns)</th>
<th>$A_1$ (%)</th>
<th>$A_2$ (%)</th>
<th>$\tau_{\text{ave}}$ (ns)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.147394</td>
<td>1.126329</td>
<td>212.88935</td>
<td>370.22434</td>
<td>0.7689</td>
</tr>
<tr>
<td>With 10% TEAI</td>
<td>11.66845</td>
<td>0.65143</td>
<td>336.59982</td>
<td>488.13155</td>
<td>5.1478</td>
</tr>
</tbody>
</table>

$\tau_{\text{ave}} = (\tau_1 \times A_1 + \tau_2 \times A_2) / (A_1 + A_2)$