Supporting Information

**Iodine-doped ZnO Nanopillar Arrays for Planar Perovskite Solar Cells with High-Efficiency up to 18.24%**

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Fig. S1 Cross-sectional SEM image of ZnO NR film hydrothermally grown for 2 h.
Fig. S2 Surface potential mapping of Au reference.

The work function of the ZnO NR and ZnO:I nanopillar films is measured by KPFM though probing the contact potential difference (CPD) between Antimony(n) doped Si tip and the samples. The \( WF_{\text{sample}} \) is defined as the following equation:

\[
WF_{\text{Sample}} = WF_{\text{tip}} - eV_{\text{CPD}}
\]

where \( e \) is the elementary charge of electron, \( WF_{\text{tip}} \) is the work function of Antimony(n) doped Si tip, and \( WF_{\text{sample}} \) is the work function of sample surface. The 1.5 × 1.5 \( \mu \text{m}^2 \) scan area is measured on Au, ZnO NR and ZnO:I nanopillar films, and the mean distribution of surface potential is employed as \( V_{\text{CPD}} \). The constant work function of Au is 5.10 eV. The \( V_{\text{CPD}} \) between Antimony(n) doped Si tip and the Au, ZnO NR and ZnO:I nanopillar films are –762 mV, –449 mV and –368 mV, respectively, as shown in Fig. 4. Therefore, the work function of the ZnO NR and ZnO:I nanopillar are 4.79 and 4.71 eV, respectively.
Fig. S3 Cross-sectional SEM images of perovskite deposition on the ZnO:I nanopillar (a) and ZnO NR (b) ETLs using one-step spin-coating process.

Table S1 Comprehensive comparison of 1D ETL structure, photovoltaic performance, perovskite processing method together with perovskite coverage between our work and other reported 1D ETL based PSCs.

<table>
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<tr>
<th>1D ETL</th>
<th>Length (nm)</th>
<th>Diameter (nm)</th>
<th>PCE (%)</th>
<th>Perovskite processing method</th>
<th>Perovskite coverage</th>
<th>Ref.</th>
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<td>Our work</td>
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<td>TiO\textsubscript{2} NRs</td>
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Fig. S4 XRD patterns of CH$_3$NH$_3$PbI$_3$ films deposited on ZnO NR ETL/ITO, and ZnO:I nanopillar ETL/ITO substrates, respectively.
Table S2 Photovoltaic parameters of a batch of 30 devices with ZnO NR as ETLs measured under AM 1.5G illumination at 100 mW cm$^{-2}$ using reverse scan direction with a scan rate of 0.2 V s$^{-1}$.

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<th>$J_{sc}$ (mA/cm$^2$)</th>
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Average 1.04±0.02 17.21±0.69 54.40±1.51 9.73±0.75
Table S3 Photovoltaic parameters of a batch of 30 devices with ZnO:I nanopillar as ETLs measured under AM 1.5G illumination at 100 mW cm\(^{-2}\) using reverse scan direction with a scan rate of 0.2 V s\(^{-1}\).

<table>
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<th>Cell</th>
<th>(V_{oc}) (V)</th>
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Average: 1.11±0.02 21.83±0.41 70.22±1.44 17.04±0.50
Fig. S5 UV-vis absorption spectra of CH$_3$NH$_3$PbI$_3$ films deposited on ZnO NR ETL/ITO, and ZnO:I nanopillar ETL/ITO substrates, respectively.
Fig. S6 Long term stability testing results for the unsealed PSC device based on ZnO:I nanopillar ETL.