Electronic Supplementary Information for

Perovskite Solar Cells Based on Bottom-Fused TiO$_2$ Nanocones

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**TiO$_2$ nanoparticle photoanode preparation**

The 30 nm-thick compact TiO$_2$ layer, acting as blocking layer, was deposited onto FTO glass by spray-pyrolyzing a solution of titanium (IV) isopropoxide in ethanol and acetylacetone at 450 °C. Afterwards, TiO$_2$ nanoparticle layer was prepared by the doctor-blade method using the commercial TiO$_2$ paste (18NR-T), and then cacinated at 500 °C in air for 30 min before use.

**Sequential deposition process**

Firstly, PbI$_2$ in DMF (462 mg/mL) was spin-coated onto the photoanode and was heated at 70 °C to dry over. Afterwards, the TiO$_2$/PbI$_2$ film was dipped into a 10 mg/mL CH$_3$NH$_3$I IPA solution for 20 seconds and rinsed with IPA. After drying, the HTM filtration and Au electrode deposition methods were the same as illustrated in the main text.

**Equations for Voc decay curve fitting**

SNC-Device:

\[
V_{oc} = 0.3125 + 1.04028 e^{\frac{(t - 59.9835)}{0.01038}} + 0.07309 e^{\frac{(t - 59.9835)}{0.11218}}
\]

SNR-Device:

\[
V_{oc} = 0.30592 + 0.07266 e^{\frac{(t - 59.98308)}{0.10858}} + 0.93873 e^{\frac{(t - 59.98308)}{0.01131}}
\]

SNP-Device:

\[
V_{oc} = 0.27956 + 0.02549 e^{\frac{(t - 59.98703)}{0.07442}} + 0.71788 e^{\frac{(t - 59.98703)}{0.00858}}
\]
Figure S1. SEM images of TiO$_2$ nanostructures on FTO synthesized with (a) 0.1 ml, (b) 0.2 ml, (c-d) 0.3 ml TBO using methanol as solvent. (c) Cross-sectional image. (d) Top-view image. For (a-b), bottom right insets are the top-view images. The circled area in (a) is the substrate where there are no nanocones.
Figure S2. TiO$_2$ spheres synthesized without placing FTO substrate in the reactor.

Figure S3. SEM images of TiO$_2$ nanorods on FTO synthesized with 0.15 ml TBO using isopropanol as solvent. (a) Cross-sectional image. (b) Top-view image.
**Figure S4.** 2 M CH$_3$NH$_3$PbI$_3$ coated seeded-NCs.

**Figure S5.** 1.25 M CH$_3$NH$_3$PbI$_3$ coated seeded-NCs.
Figure S6. Schematic illustratons of the devices and nanostructures. (a) SNC-Device. (b) SNR-Device. (c) An individual TiO$_2$ nanocone and a rectangular nanorod.

Figure S7. (a) Top-view SEM image of CH$_3$NH$_3$PbI$_3$/NCs obtained by sequential deposition method. (b) $J$-$V$ characteristic of the device fabricated following the sequential deposition method.
Figure S8. (a) Cross-sectional SEM image of seeding spin-coated nanoparticle device (SNP-Device). (b) J-V characteristic of the SNP-Device.

Figure S9. Digital photos of CH$_3$NH$_3$PbI$_3$ sensitized NCs.