Supporting Information

Highly Efficient Perovskite Solar Cells Incorporating NiO Nanotubes: Increased Grain Size and Enhanced Charge Extraction

Juyoung Yun, Jaemoon Jun, Haejun Yu, Kisu Lee, Jaehoon Ryu, Jungsup Lee, and Jyongsik Jang*

[*] Prof. Jyongsik Jang

School of Chemical and Biological Engineering, Seoul National University, 599 Gwanangno, Gwanakgu, Seoul 151-742, Korea
E-mail: jsjang@plaza.snu.ac.kr
Tel.: +82-2-880-7069
Fax: +82-2-880-1604
**Figure S1.** a) FE-SEM and b) TEM images of NiO NTs
Figure S2. XRD spectra of a) NiO NTs and b) NiO NTs incorporated perovskite film with respect to concentration.
Figure S3. Cross-sectional SEM-EPMA elemental mapping images of a) O, b) Pb, c) I, d) Ni in NiO-perovskite film, e) the corresponding SEM image, and f) back scatter electron (BSE) image.
Figure S4. FE-SEM images of NiO NTs incorporated perovskite film with a) 0.75 mg/mL and b) 1.5 mg/mL concentration
Figure S5. SEM-EPMA elemental mapping images of a) O, b) Pb, c) I, d) Ni in NiO-perovskite film, e) the corresponding SEM image, and f) back scatter electron (BSE) image.
Figure S6. Current density-voltage curve of NiO NTs based perovskite solar cells with respect to concentration. (0.5-1.25 mg/mL)
Figure S7. Long-term stability of PSCs with and without NiO NTs
Figure S8. Time-resolved photoluminescence (PL) measurements of perovskite films (glass/pristine and NiO NTs-perovskite/Spiro-OMeTAD)
Figure S9. Cross-sectional a) FE-SEM and b) magnified FE-SEM images of carbon based PSCs.