Supporting Information

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

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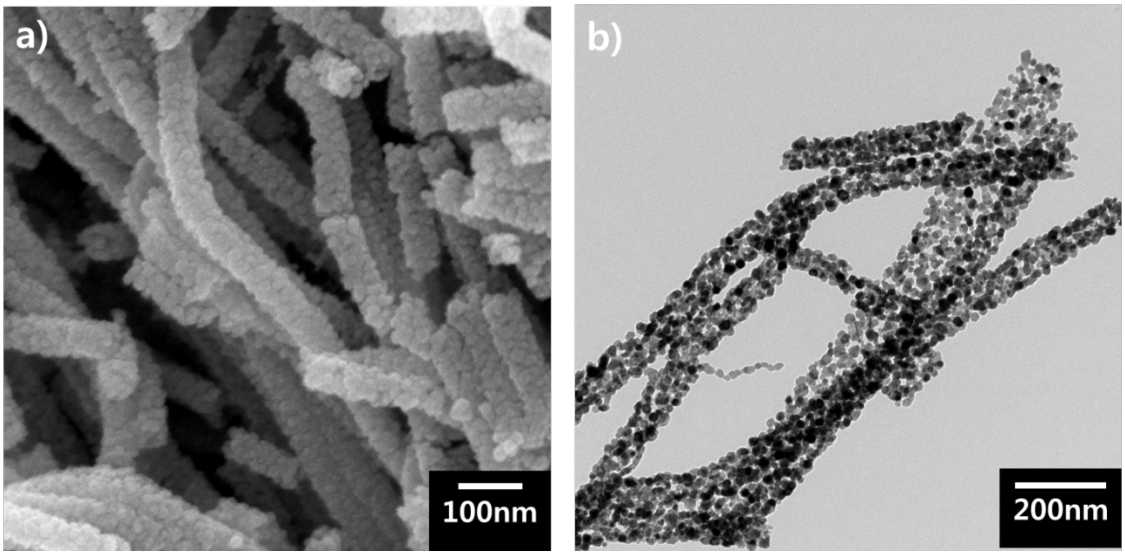


Figure S1. a) FE-SEM and b) TEM images of NiO NTs

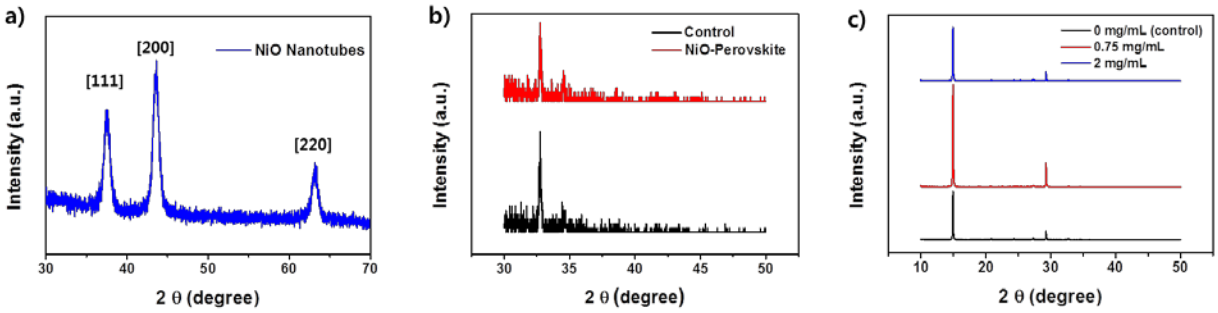


Figure S2. XRD spectra of a) NiO NTs and b) NiO NTs incorporated perovskite film with respect to concentration.

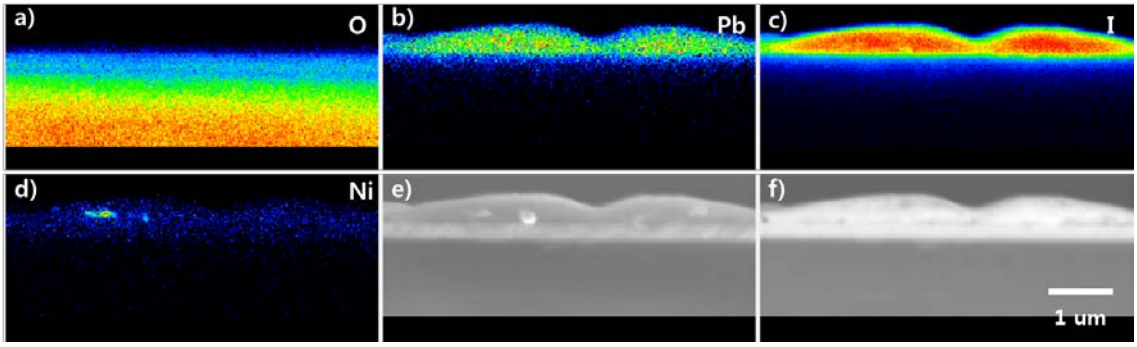


Figure S3. Cross-sectional SEM-EPMA elemental mapping images of a) O, b) Pb, c) I, d) Ni in NiO-perovskite film, e) the corresponding SEM image, and f) back scatter electron (BSE) image.

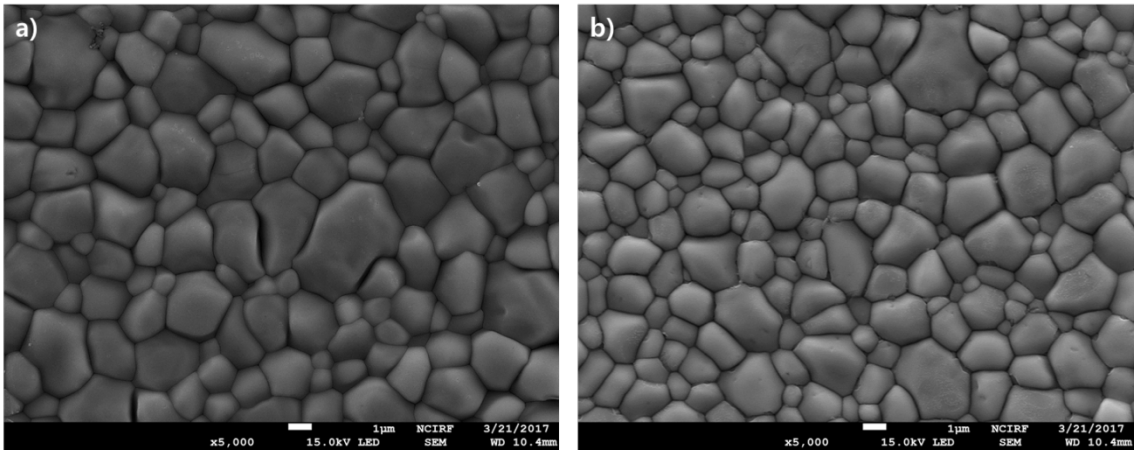


Figure S4. FE-SEM images of NiO NTs incorporated perovskite film with a) 0.75 mg/mL and b) 1.5 mg/mL concentration

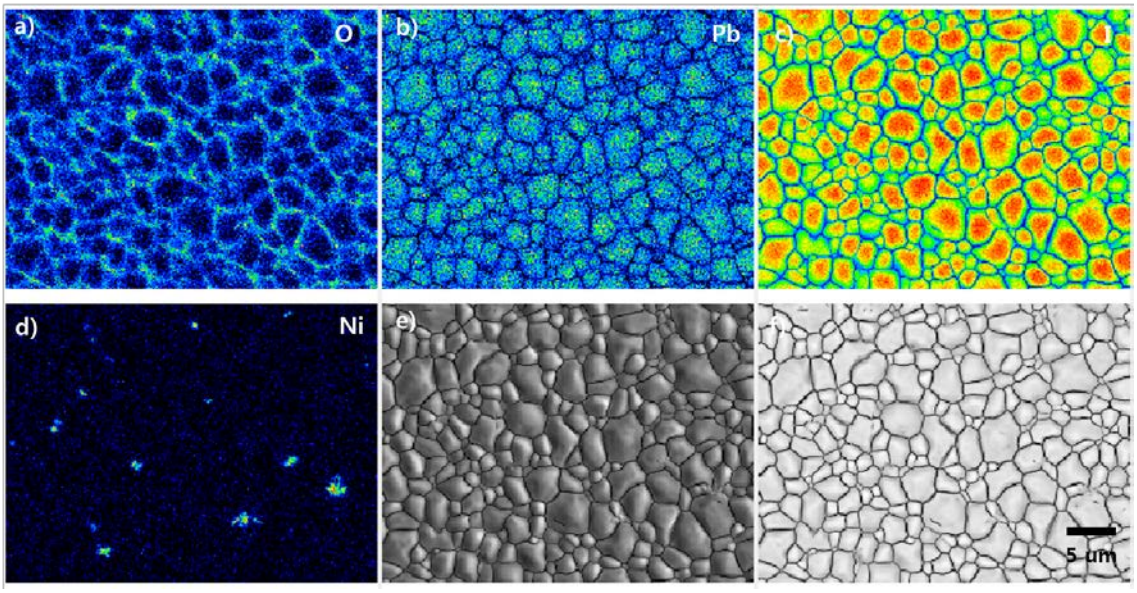
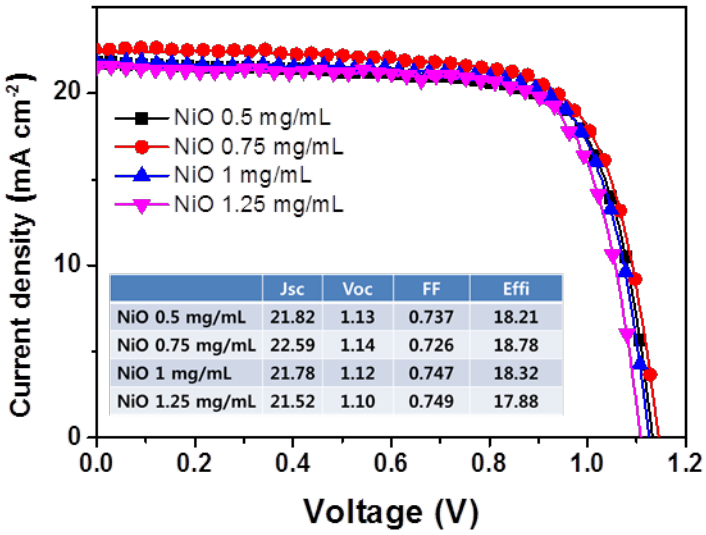


Figure S5. SEM-EPMA elemental mapping images of a) O, b) Pb, c) I, d) Ni in NiO-perovskite film, e) the corresponding SEM image, and f) back scatter electron (BSE) image.



	Jsc	Voc	FF	Effi
NiO 0.5 mg/mL	21.82	1.13	0.737	18.21
NiO 0.75 mg/mL	22.59	1.14	0.726	18.78
NiO 1 mg/mL	21.78	1.12	0.747	18.32
NiO 1.25 mg/mL	21.52	1.10	0.749	17.88

Figure S6. Current density-voltage curve of NiO NTs based perovskite solar cells with respect to concentration. (0.5-1.25 mg/mL)

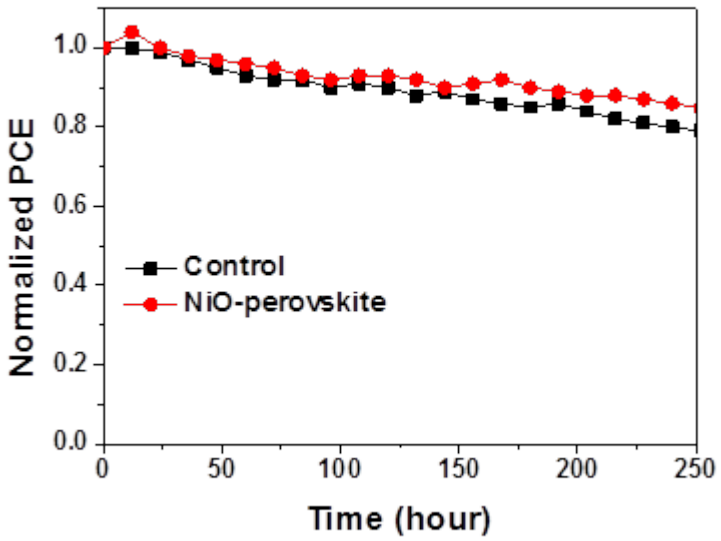


Figure S7. Long-term stability of PSCs with and without NiO NTs

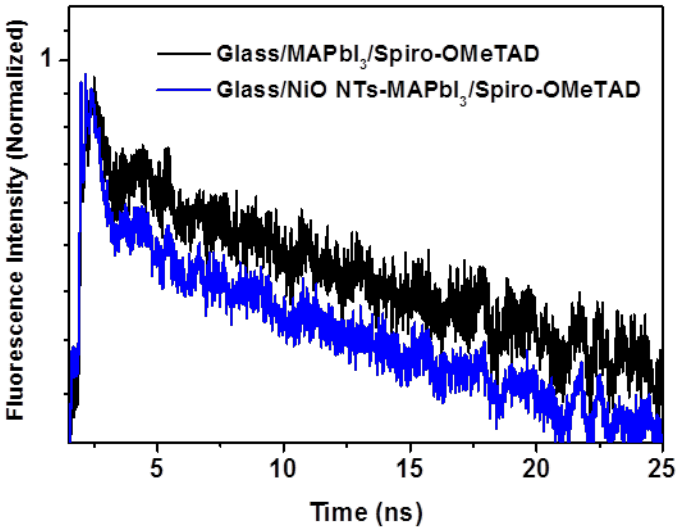


Figure S8. Time-resolved photoluminescence (PL) measurements of perovskite films (glass/pristine and NiO NTs-perovskite/Spiro-OMeTAD)

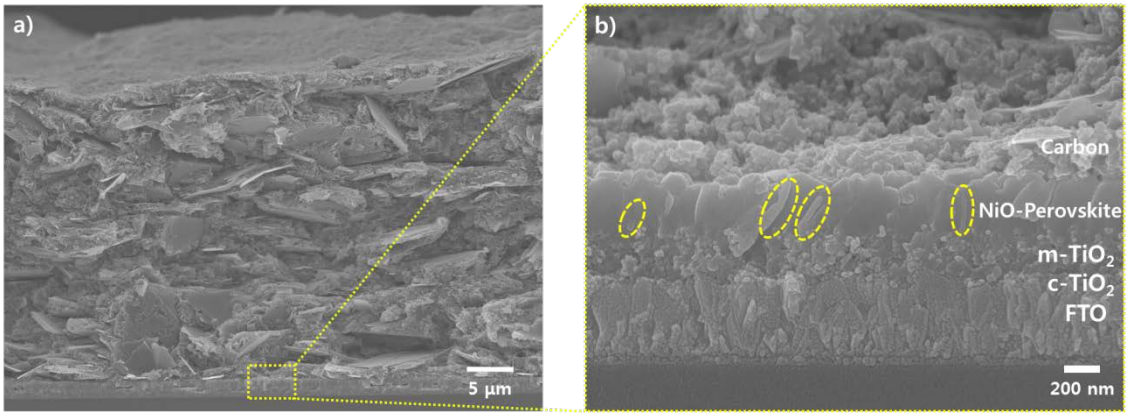


Figure S9. Cross-sectional a) FE-SEM and b) magnified FE-SEM images of carbon based PSCs