

Supporting information

High efficiency hysteresis-less inverted planar heterojunction perovskite solar cell with NiO_x hole contact layer

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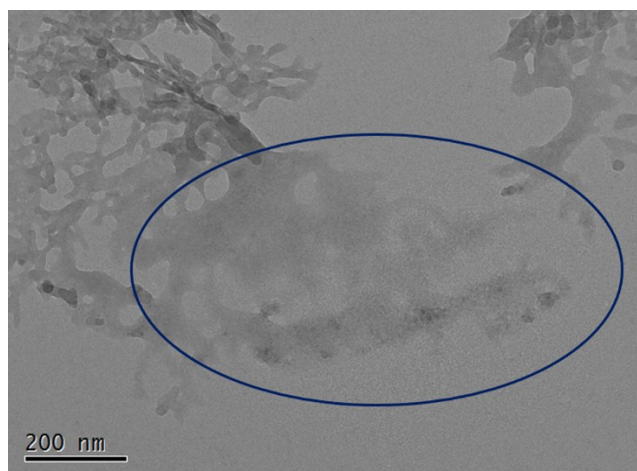


Figure S1: TEM image of the NiO_x nanoparticle precursor. The area indicated by the blue circle is irradiated by electron beams during TEM characterization. Obviously, the organic components which coat the NiO_x nanoparticles are destroyed by the electron beams.

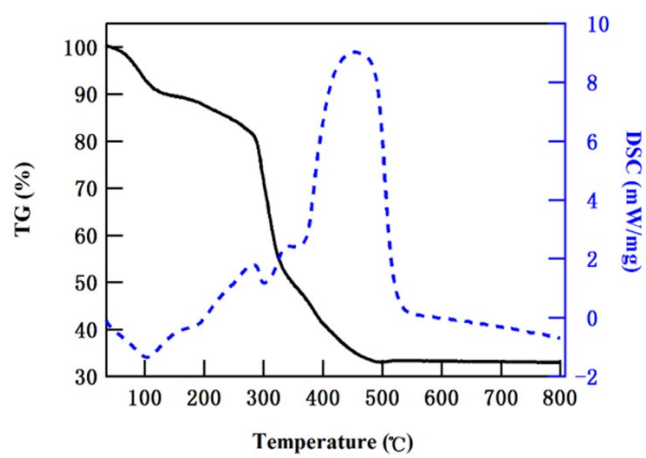


Figure S2 TGA and DSC curves of the NiO_x powder obtained by drying the precursor at 150°C for 20 min.

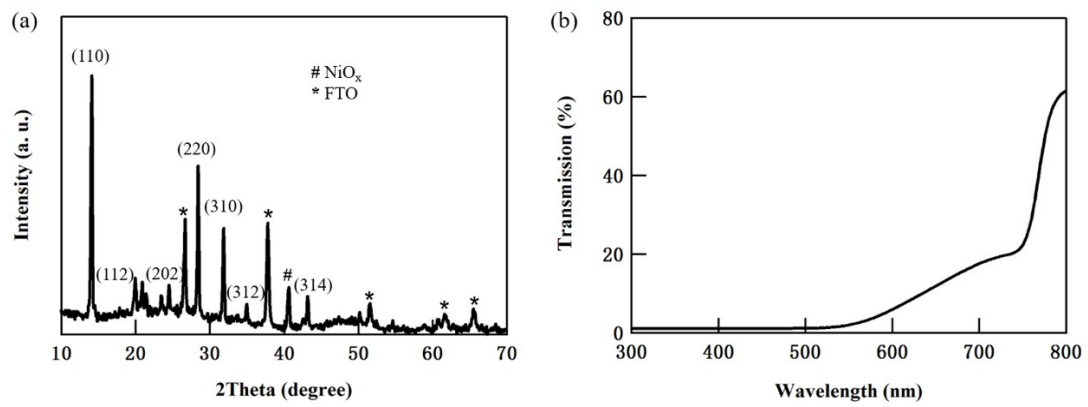


Figure S3 (a) XRD pattern (b) UV-Vis transmission spectrum of the perovskite film on the NiO_x coated FTO substrate.

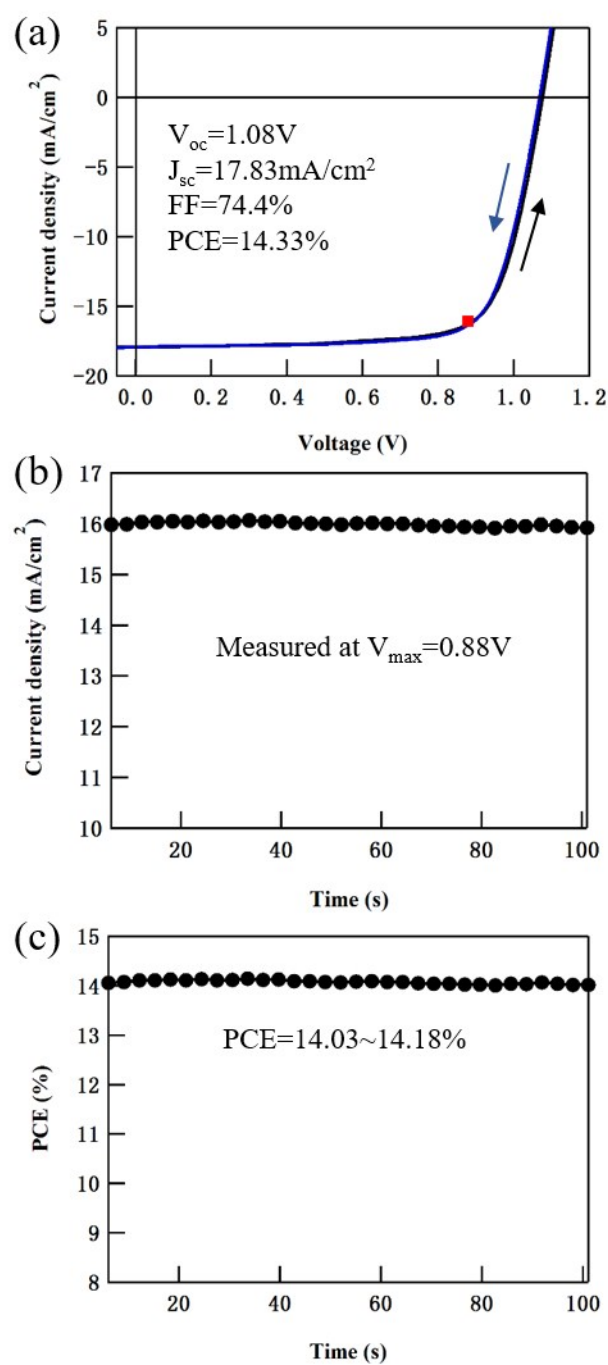


Figure S4. (a) J-V curves a device with 90 nm NiO_x film. The scan directions are indicated by the arrows and the red spot represents the maximum power point obtained from the steady state power conversion efficiency measurement. (b) The current density measured at 0.88V, which is the

voltage for the maximum power point shown in a. Clearly, the current density is stable as the time increases. (c) The steady state power conversion efficiency of the device.

Table S1 Summary on the performances of the reported NiO_x-based organic-inorganic hybrid perovskite solar cells and our devices are also included for comparison. The word “non” means the parameter was not presented in the paper.

Device configuration	V _{oc} (V)	J _{sc} (mA/cm ²)	FF (%)	PCE (%)	Area (cm ²)	Hysteresis (PCE _r -PCE _f) %	Reference
ITO/PLD-NiO/CH ₃ NH ₃ PbI ₃ /PCBM/LiF/Al	1.06	20.2	0.813	17.3	Non	Non	1
FTO/Cu:NiO/CH ₃ NH ₃ PbI ₃ /PCBM/Ag	1.11±0.01	18.75±0.42	0.72±0.01	15.40±0.3 3	Non	obvious	2
FTO/TiO ₂ /ZrO ₂ /NiO/carbon-(CH ₃ NH ₃ PbI ₃)	0.917	21.36	0.76	14.9	Non	Non	3
FTO/NiO_x/CH₃NH₃PbI₃/PCBM/Ag	1.09	17.93	73.8	14.42	0.07	0.06	This work
FTO/NiO/Meso-Al ₂ O ₃ /CH ₃ NH ₃ PbI ₃ /PCBM/BCP/Ag	1.04	18.0	72	13.5	0.09	0.66	4
ITO/ NiO/meso-NiO/CH ₃ NH ₃ PbI ₃ /BCP/Al	0.96	19.8	61	11.6	Non	Non	5
FTO/ NiO NCs/CH ₃ NH ₃ PbCl _{3-x} I _x /PCBM (1.5 wt% PS)/Al	1.07	15.62	0.64	10.68	Non	Obvious	6
FTO/NiO/CH ₃ NH ₃ PbI ₃ /PCBM/Ag	1.10	15.17	0.59	9.84	Non	Non	7
FTO/NiO NCs/CH ₃ NH ₃ PbI ₃ /PCBM/Au	0.882	16.27	63.5	9.11	Non	Non	8
ITO/NiO/meso-NiO/CH ₃ NH ₃ PbI ₃ /BCP/Al	1.04	13.24	69	9.51	0.06	Non	9
ITO/NiO/CH ₃ NH ₃ PbI _{3-x} Cl _x /PCBM/BCP/Al	0.92	12.43	68	7.8	0.06	Non	10
ITO/NiO/CH ₃ NH ₃ PbI ₃ /PCBM/Al	1.05	15.4	48	7.6	0.0725	Non	11
ITO/NiO/CH ₃ NH ₃ PbI ₃ /PCBM/BCP/Al	0.901	13.16	65.38	7.75	0.06	Non	12
FTO/NiO /CH ₃ NH ₃ PbI _{3-x} Cl _x /PCBM/Ag	0.786	14.2	0.65	7.26	0.07	Non	13

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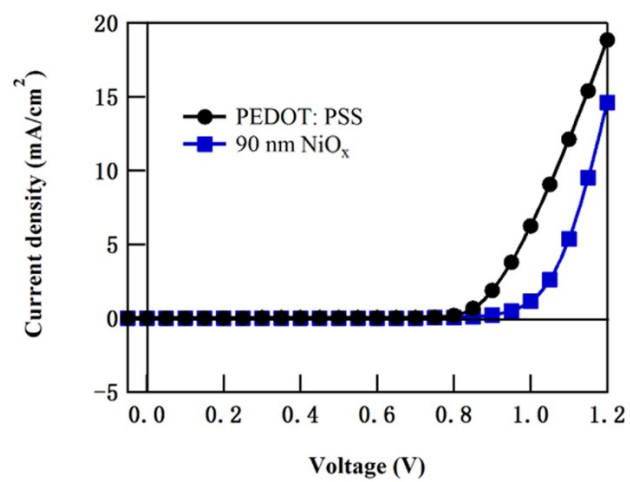


Figure S5 J-V curves for the perovskite solar cells based on the PEDOT:PSS contact and 90 nm NiO_x contact.

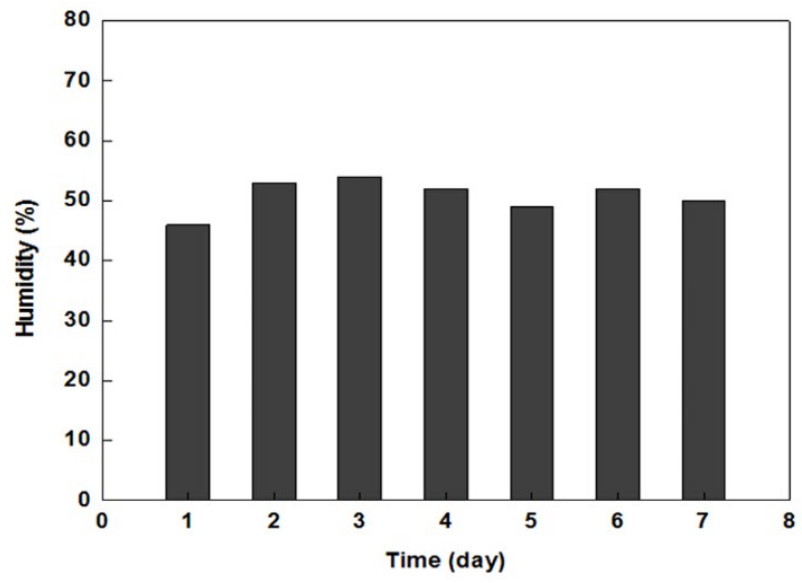


Figure S6 Ambient air humidity for the stability study.