Electronic Supplementary Material (ESI) for Nanoscale.

Supporting Information

Efficient and Ultraviolet Durable Planar Perovskite Solar Cells via Ferrocenedicarboxylic Acid Modified Nickel Oxide Hole Transport Layer

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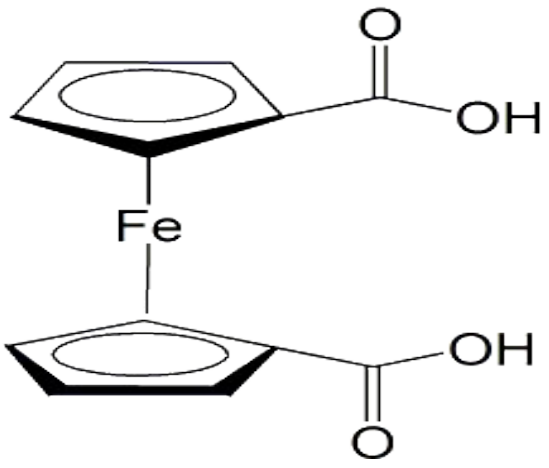

Figure S1 Chemical structure of ferrocenedicarboxylic acid (FDA).

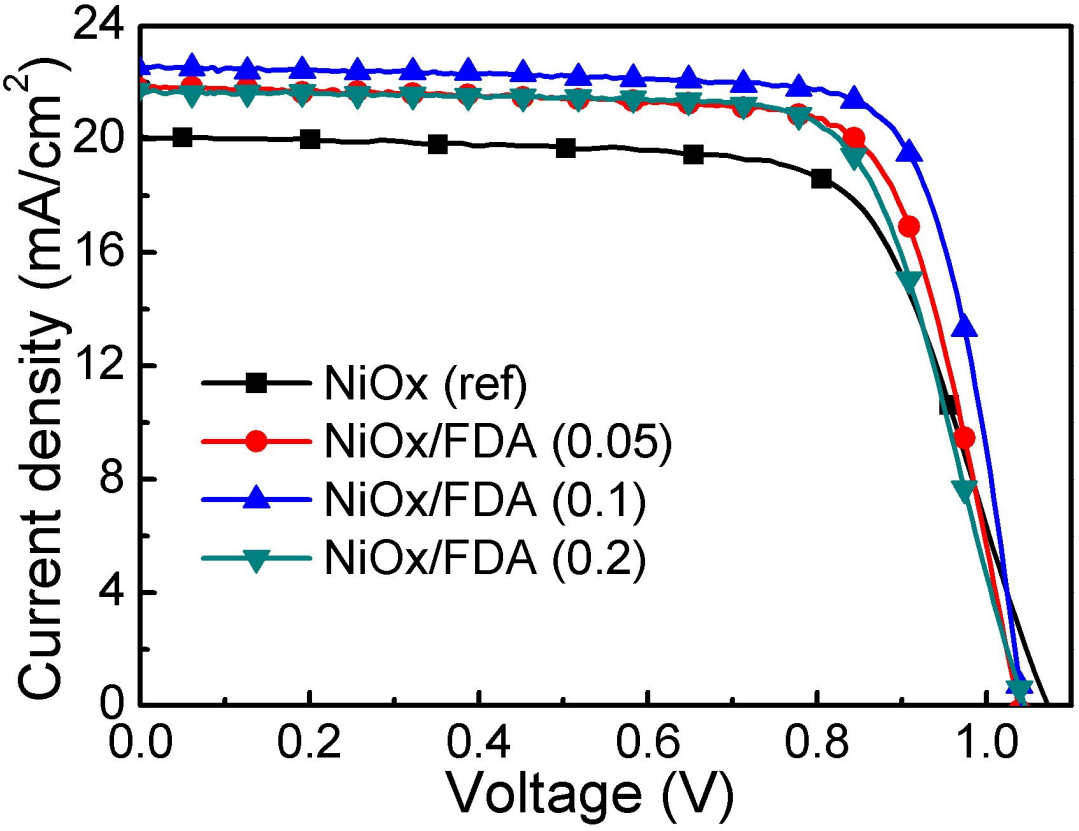

Figure S2 J−V curves of PSCs based on NiO_x modified with different FDA concentration. FDA concentration spin-coated onto NiO_x surface are 0, 0.05, 0.1 and 0.2 mg/ml, respectively.

Table S1 Photovoltaic parameters of NiO_x based PSCs with different modified concentration of FDA.

NiO_x/FDA (mg/ml)	Voc (V)	Jsc (mA/cm^2)	FF (%)	PCE（%）	R_S（Ω·cm^2）	R_{SH}(Ω·cm^2)
NiO_x(ref.)	1.08	20.19	69.4	15.13	12.1	1522
0.05	1.04	21.84	74.5	16.90	7.0	1477
0.1	1.04	22.56	77.43	18.20	3.7	1379
0.2	1.05	21.67	72.7	16.53	10.8	3011

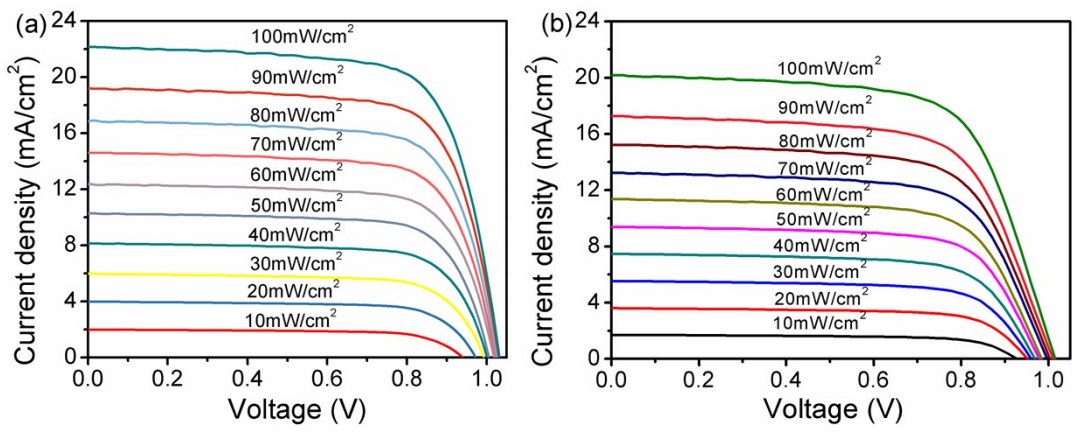

Figure S3 J-V curves of PSCs based NiO_x with (a) and without (b) FDA modification as a function of light intensity. FDA modified concentration spin-coated onto NiO_x surface is 0.1mg/ml.

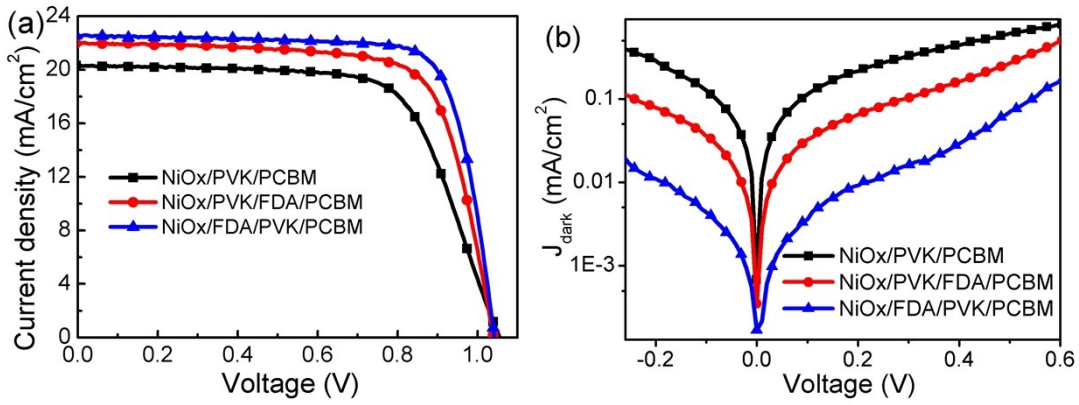

Figure S4 (a) J−V and (b) dark J−V curves of three types of PSCs. NiO_x/FDA presents that perovskite layer was spin-coated onto the surface of NiO_x modified with FDA. FDA/PCBM presents that FDA solution was firstly spin-coated onto perovskite layer before further spin-coating PCBM layer. The FDA modified concentration is 0.1 mg/ml.

Table S2 Photovoltaic parameters of corresponding PSCs with and without FDA modification.

Cells Structure	V_{oc} (V)	J_{sc} (mA/cm^2)	FF (%)	PCE (%)	R_S (Ω·cm^2)	R_{SH} (Ω·cm^2)
NiO_x/PVK/PCBM	1.08	20.19	69.4	15.13	12.1	1522
NiOx/PVK/FDA/PCBM	1.04	21.99	72.6	16.62	6.0	1665
NiOx/FDA/PVK/PCBM	1.04	22.56	77.4	18.20	3.7	1379

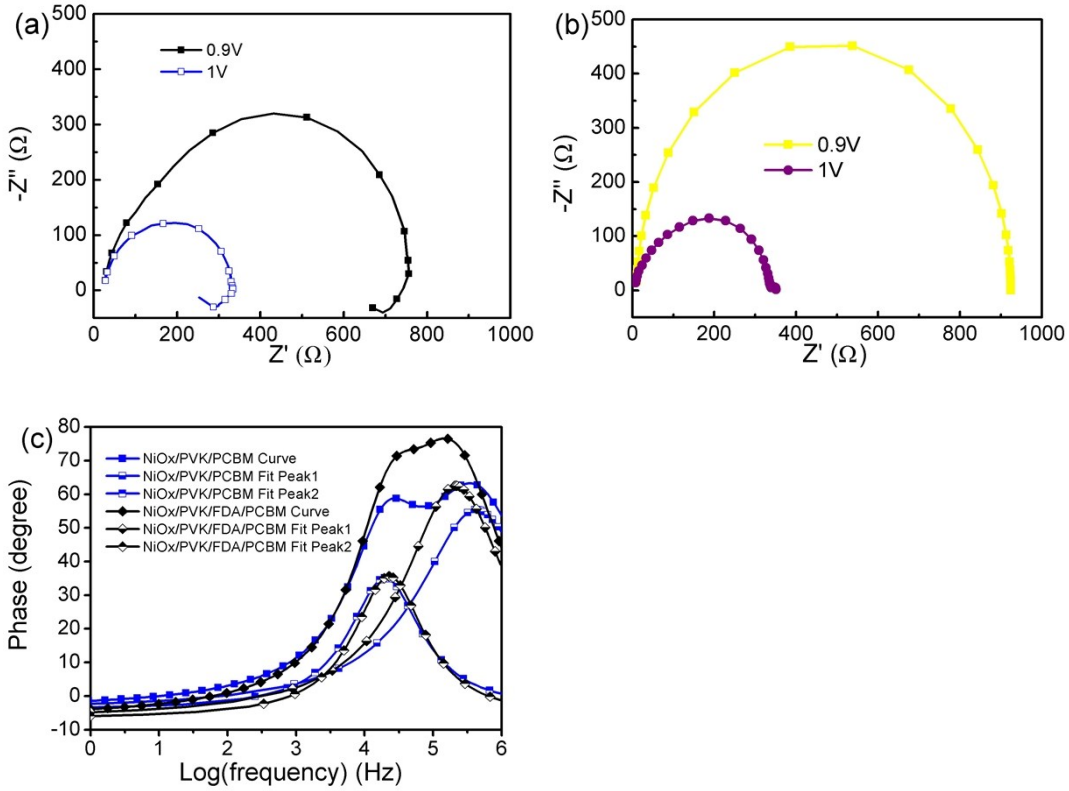

Figure S5 Nyquist plots of PSCs with (a) NiO_x/PVK/PCBM and (b) NiO_x/PVK/FDA/PCBM at the forward bias voltage of 0.9 V and 1.0 V in the dark condition. (c) Bode-phase plots of PSCs with NiO_x/PVK/PCBM and NiO_x/PVK/FDA/PCBM at the bias voltage of 0.9 V. FDA concentration spin-coated onto perovskite (PVK) layer is 0.1mg/ml.

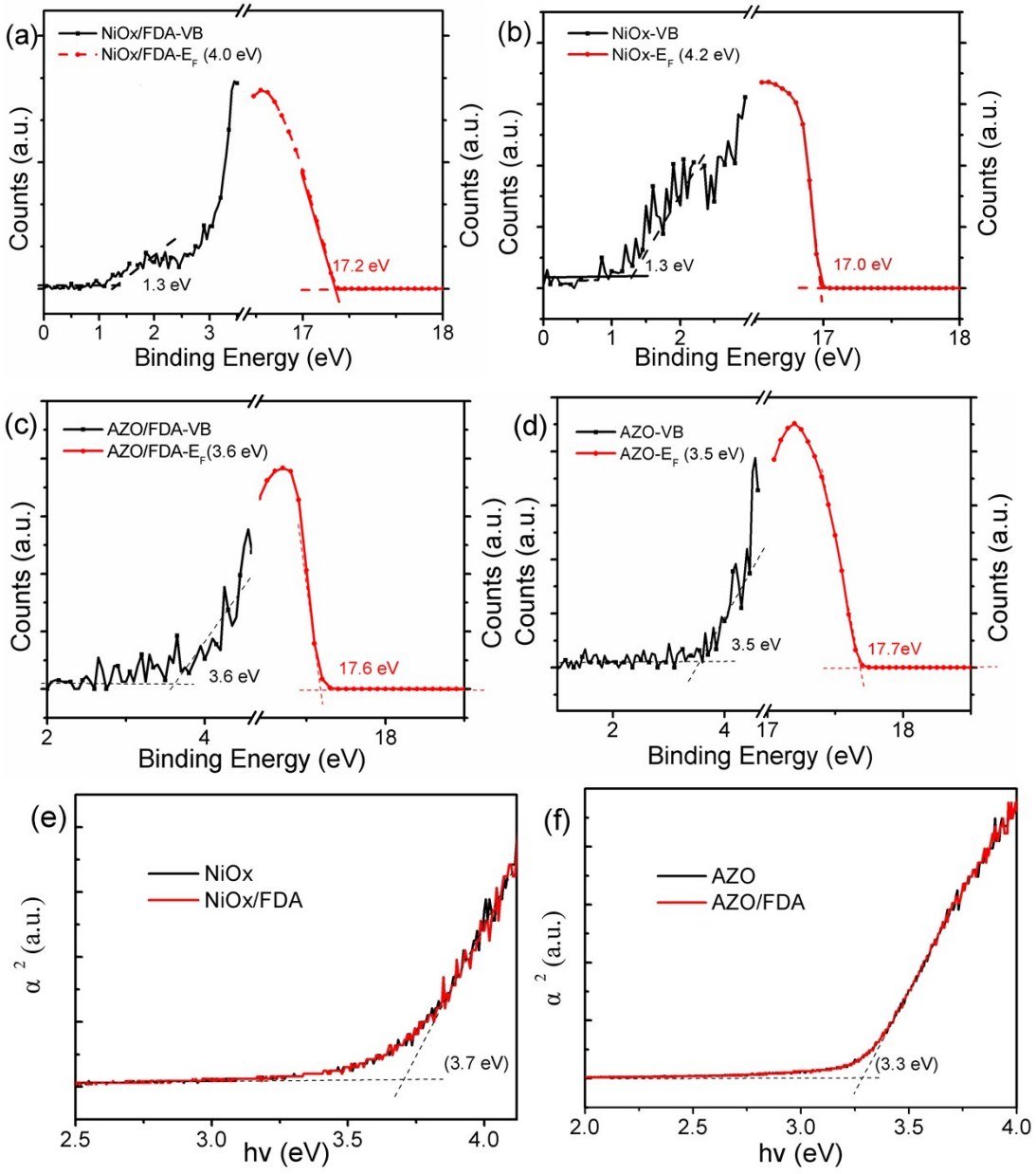

Figure S6 UPS secondary electron emission cut off and valence band edge measured for NiO_x modified with (a) and without (b) FDA layer, for AZO modified with (c) and without (d) FDA layer. Optical band gap of (e) NiO_x and (f) AZO films modified with and without FDA.