Supporting Information

Efficiently Improving the Stability of Inverted Perovskite Solar Cells by Employing Polyethylenimine-Modified Carbon Nanotubes as Electrodes

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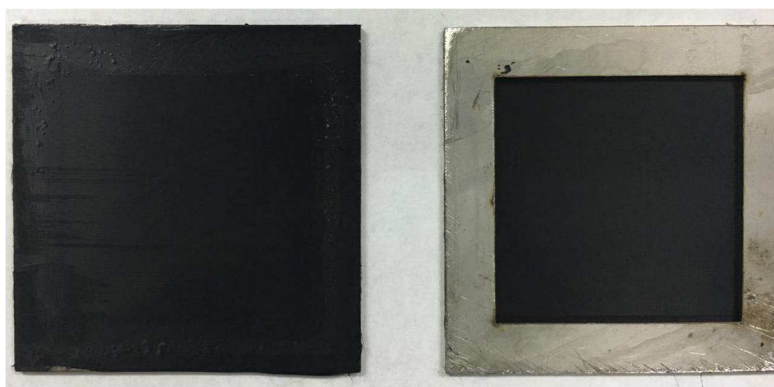*JiangKL@mail.tsinghua.edu.cn; pengliu@mail.tsinghua.edu.cn*

Figure S1. The physical photograph of CSCNT films (Left: front side; Right: back side) on the metal frame.
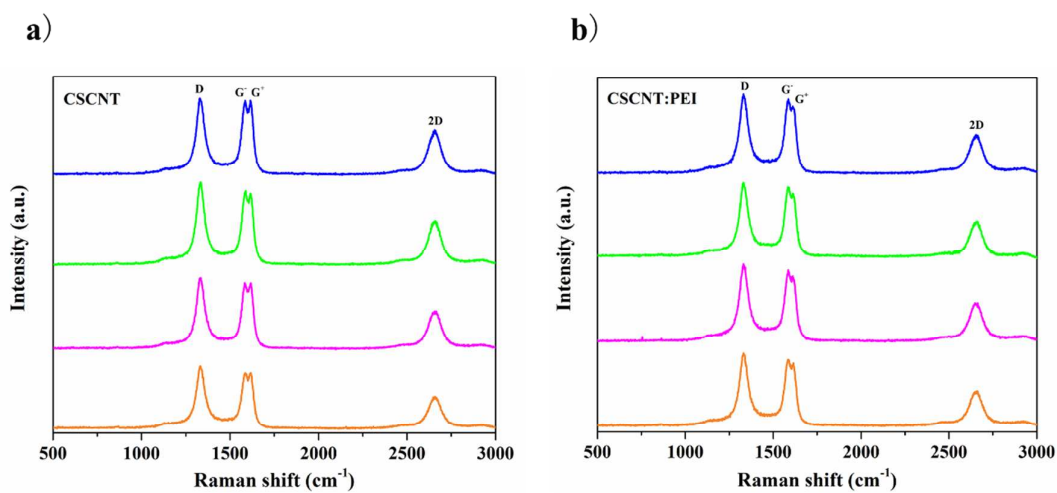

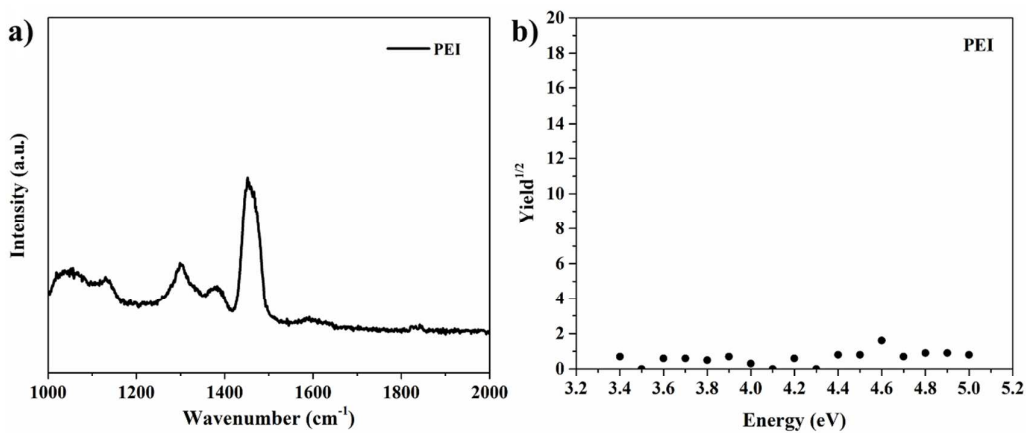**Figure S2.** Raman spectra of CSCNT a) before and b) after PEI modification.

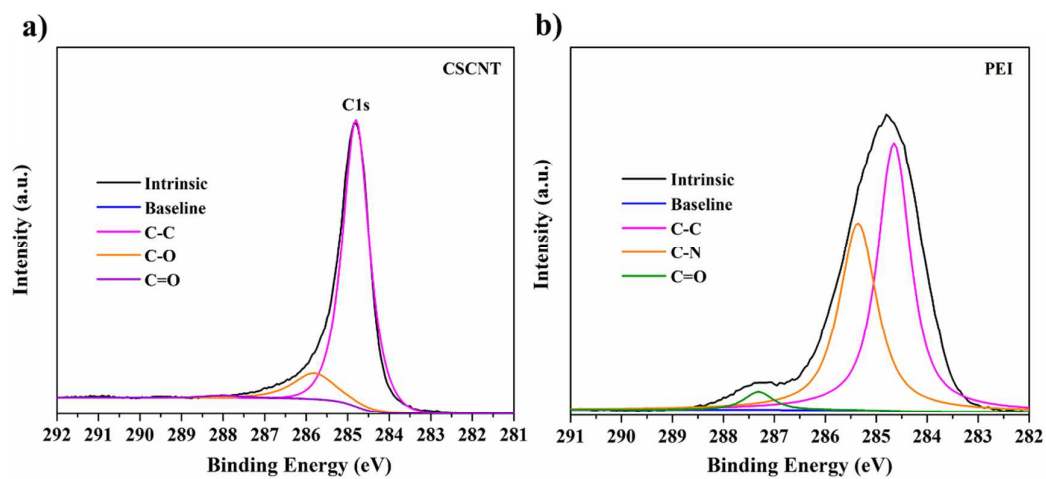**Figure S3.** a) Raman spectra and b) PESA spectra of PEI.

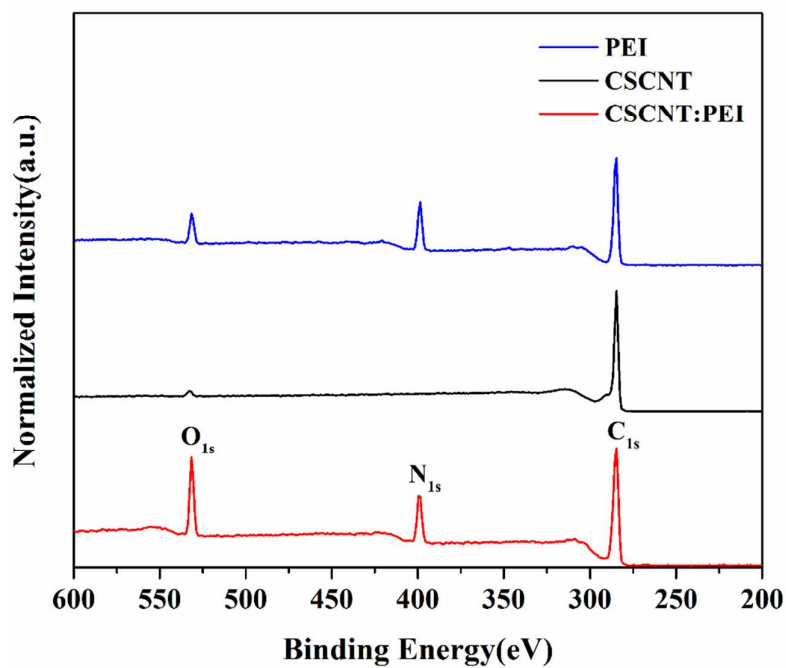**Figure S4.** Deconvolution of C1s XPS spectra of a) CSCNT and b) PEI.

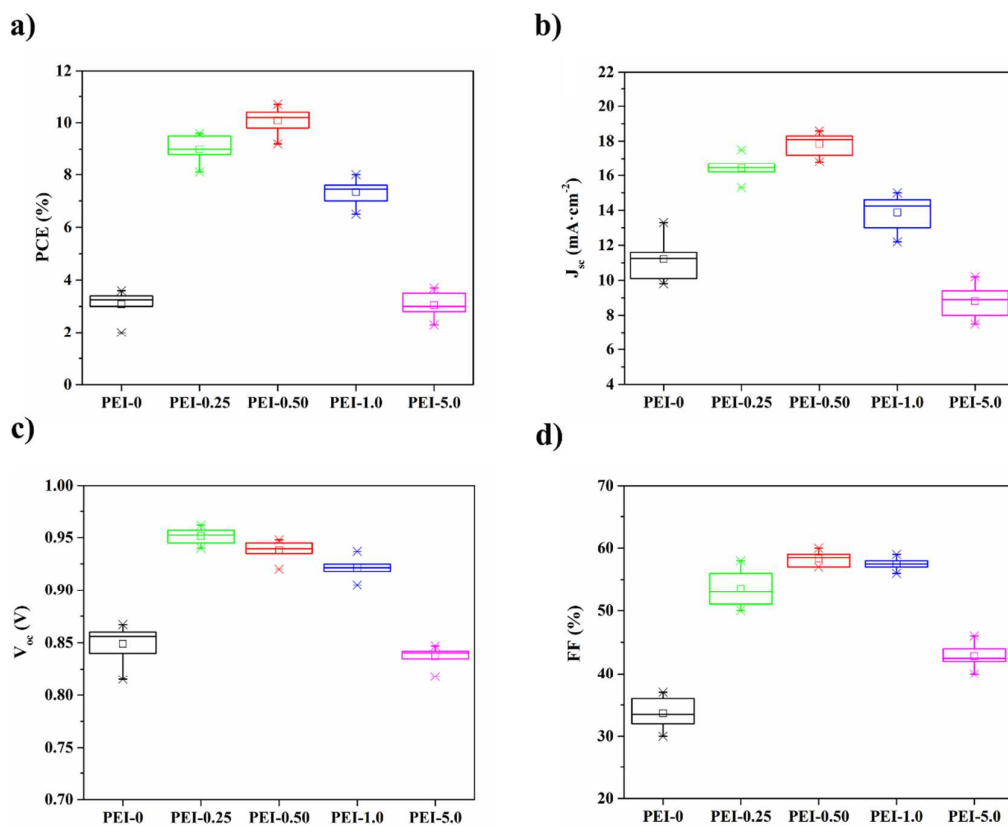**Figure S5.** XPS wide scan survey spectra of PEI, CSCNT and CSCNT:PEI.

Figure S6. Photovoltaic parameters of PSCs based on CSCNT electrodes with different PEI modification concentration: a) PCE b) J_{sc} c) V_{oc} d) FF. The device parameters were selected randomly from 10 devices fabricated on 10 different FTO substrates.
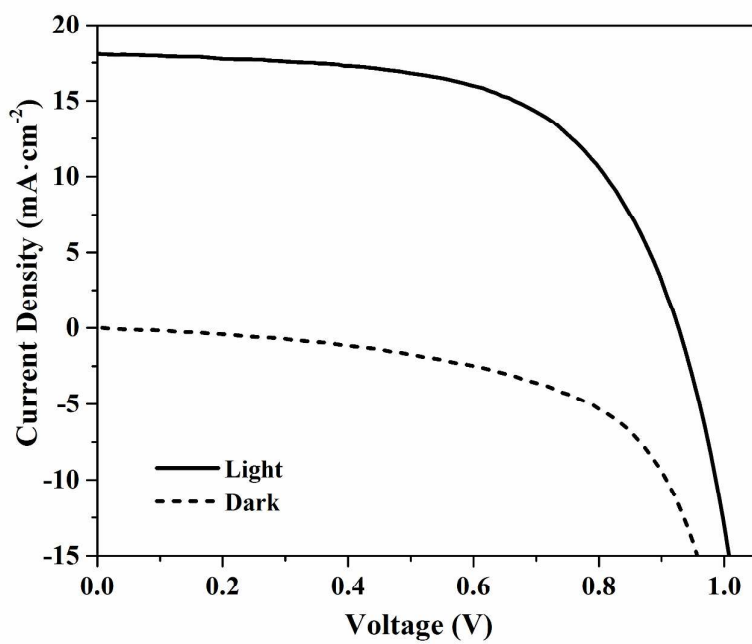
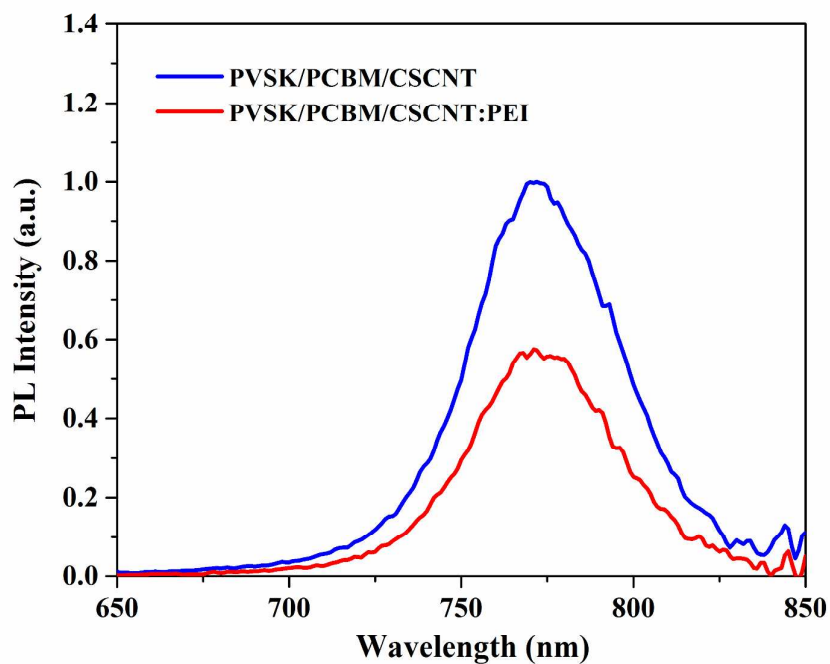**Figure S7.** *J-V* curves of CSCNT:PEI based solar cells under light (solid line) and dark (dashed line).

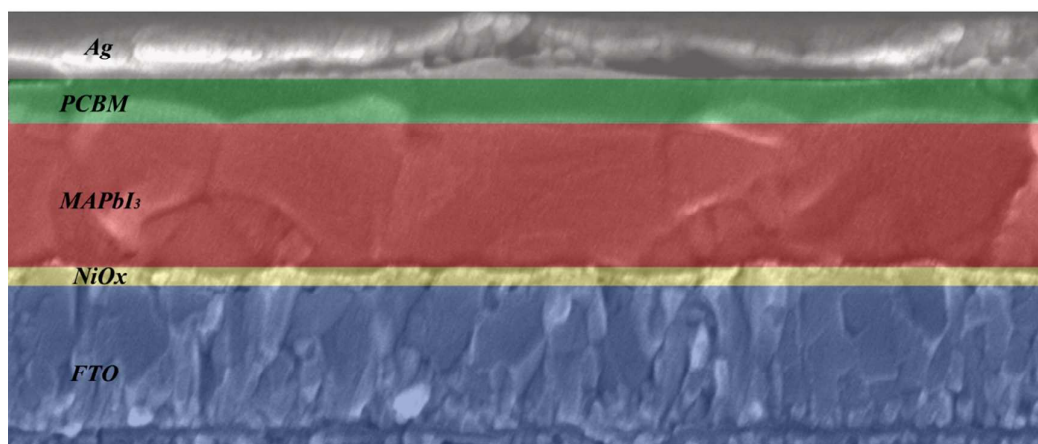**Figure S8.** Steady-state PL spectra of the perovskite/PCBM/CSCNT (blue line) and perovskite/PCBM/CSCNT:PEI (red line).

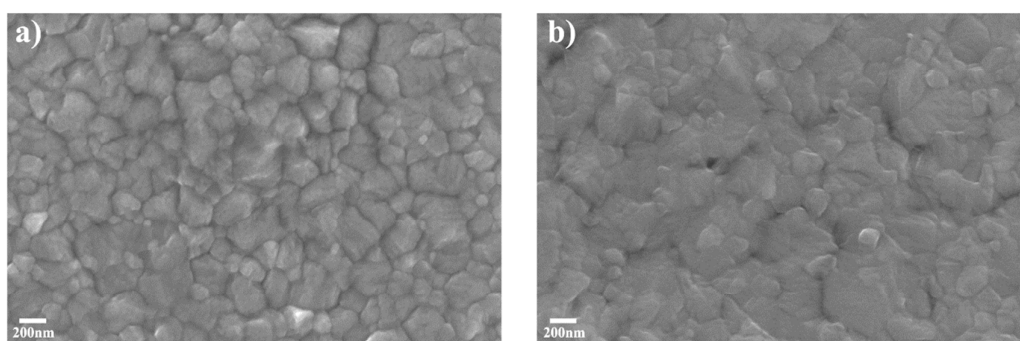**Figure S9.** Typical cross-sectional SEM image of the PSC based on Ag electrode.

Figure S10. SEM images of the MAPbI$_3$ films in FTO/NiO$_x$/MAPbI$_3$/PCBM/Ag a) before and b) after thermal treatment at 60 °C for 96 h.
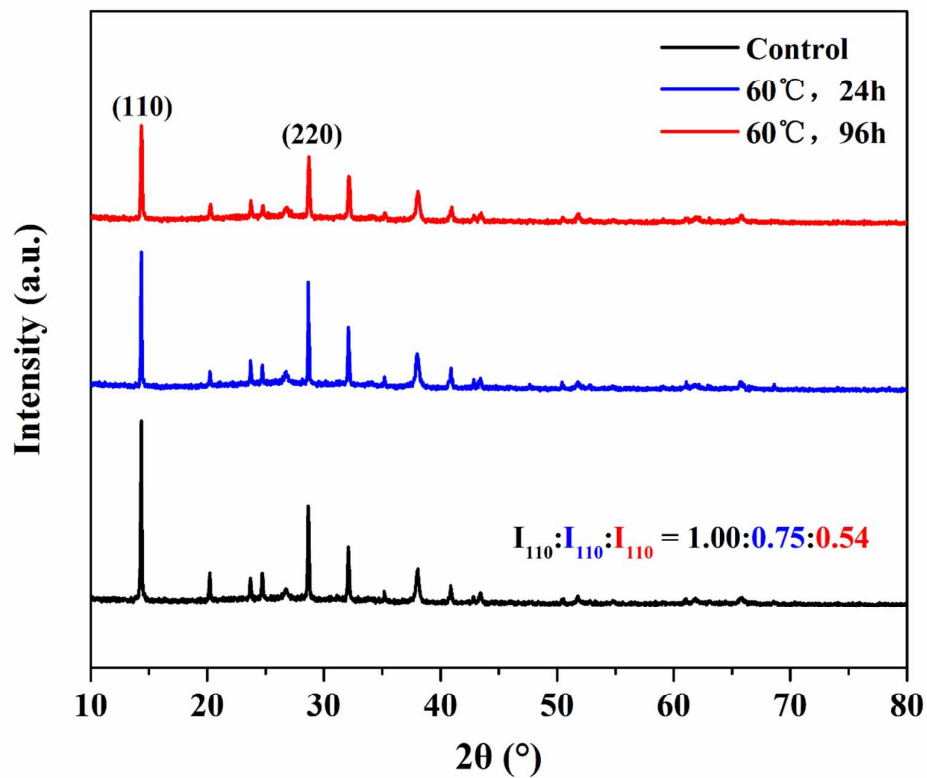
Figure S11. XRD spectra of MAPbI$_3$ films in FTO/NiO$_x$/MAPbI$_3$/PCBM/Ag with different ageing condition.
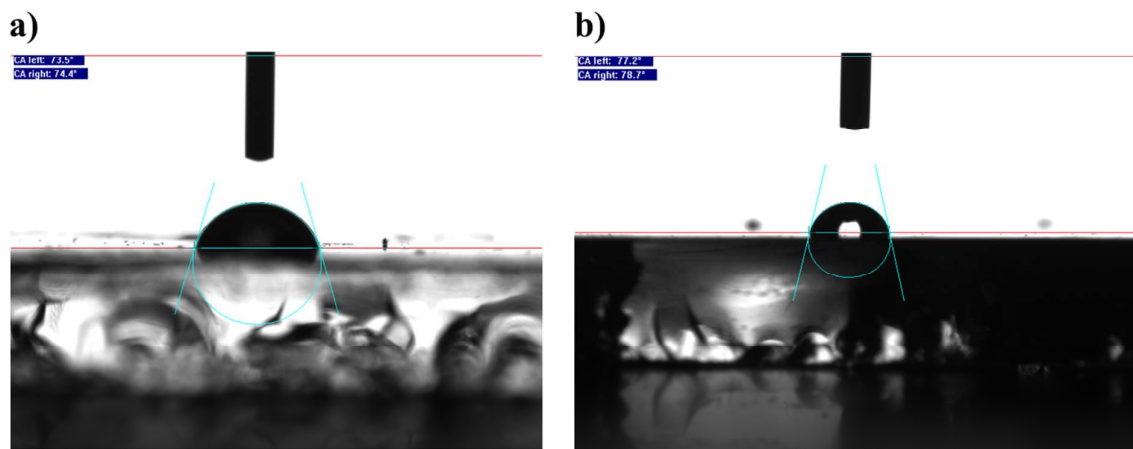

Figure S12. Contact angle image of water droplet on the surface of a) CSCNT:PEI and b) Ag.

Table S1. R_s and R_{sh} from the slop of *J-V* curves of the cells at V_{oc} and J_{sc} point

PEI concentration (wt %)	R_s ($\Omega \cdot cm^2$)	R_{sh} ($\Omega \cdot cm^2$)
0	25.7	173.1
0.25	12.2	861.3
0.5	6.1	655.4
1.0	15.64	242.1
5.0	24.6	241.5

R_s: series resistance; R_{sh}: shunt resistance.