Supporting Information for

High-performance Ruddlesden–Popper two-dimensional perovskite solar cells based on solution processed inorganic charge transport layers

Zhihai Liu[a], Lei Wang[b], Xiaoyin Xie[c], Chongyang Xu[d], Jianfeng Tang[*e] and Wei Li[*e]

[a]*School of Physics and Electronic Information, Yantai University, Yantai 264005, China*

[b]*School of Artificial Intelligence, Beijing Technology and Business University, Beijing, 100048, China*

[c]*School of Chemistry and Chemical Technology, Hubei Polytechnic University, Huangshi 435003, China*

[d]*Yantai Research Institute and Graduate School of HEU, Harbin Engineering University, Harbin 150001, China*

[e]*School of Chemistry and Materials Science, Hunan Agricultural University, Changsha 410128, China*

*Correspondence: weili@hunau.edu.cn (W. Li); jftang@hunau.edu.cn (J. Tang)

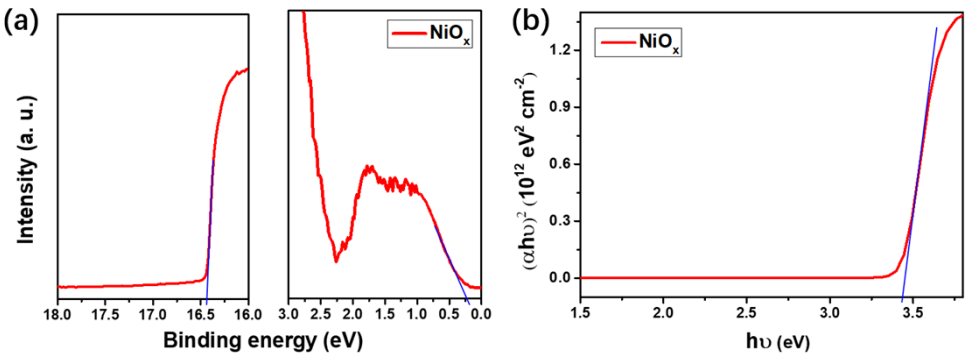

Fig. S1. (a) UPS spectrum and (b) absorption coefficient as a function of photon energy of the prepared NiO_x film.

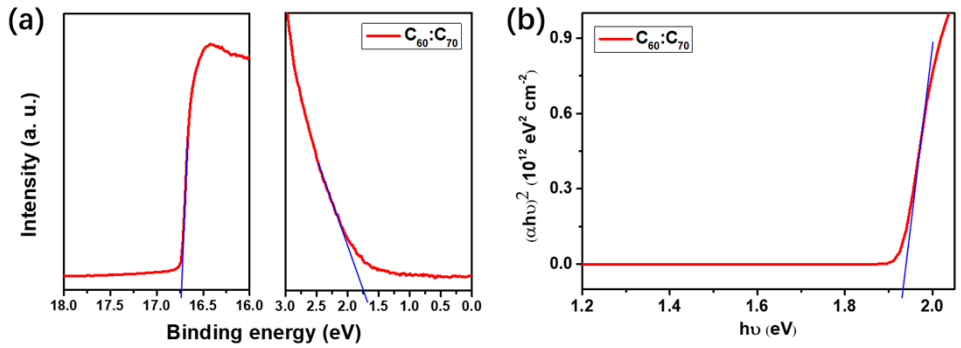

Fig. S2. (a) UPS spectrum and (b) absorption coefficient as a function of photon energy of the prepared C_{60}:C_{70} film.

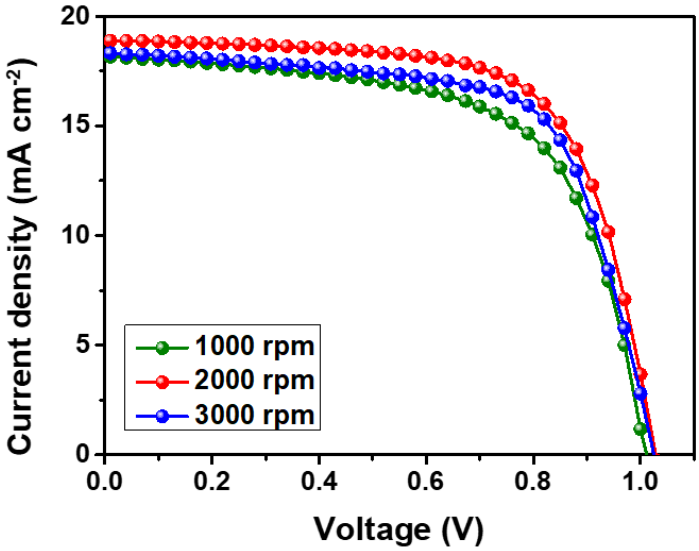

Fig. S3. *J–V* characteristics of the PSCs using NiO_x and fullerene mixture (C_{60}:C_{70} =1:1) as the HTL and ETL, respectively. The fullerene mixture was spin coated from varying the rotating speed of 1000, 2000 and 3000 rpm.

Table S1. Device parameters for the PSCs using NiO_x and fullerene mixture (C_{60}:C_{70} =1:1) as the charge transport layers. The fullerene mixture was spin coated from varying the rotating speed of 1000, 2000 and 3000 rpm.

Rotating speed	V_{oc} (V)	J_{sc} (mA cm^{-2})	FF (%)	PCE (%)
1000 rpm	1.01	18.2	71.2	13.1
2000 rpm	1.01	18.9	73.8	14.1
3000 rpm	1.00	18.4	72.7	13.4

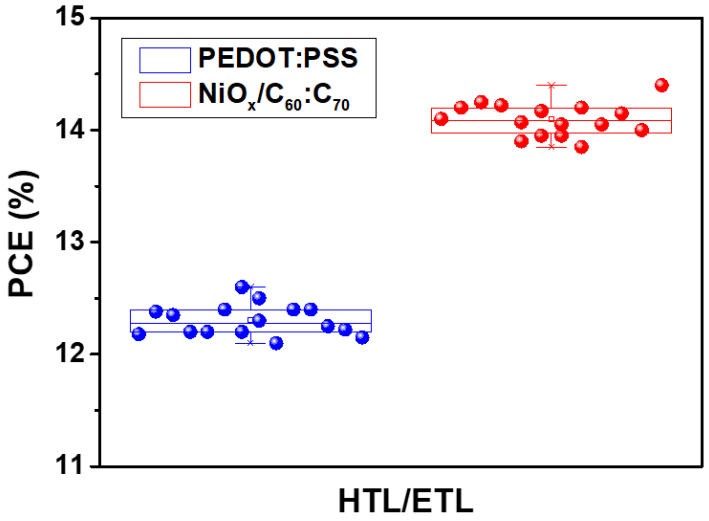

Fig. S4. PCE variations for PSCs using PEDOT:PSS/PCBM and NiO_x/C_{60}:C_{70} as the charge transport layers.

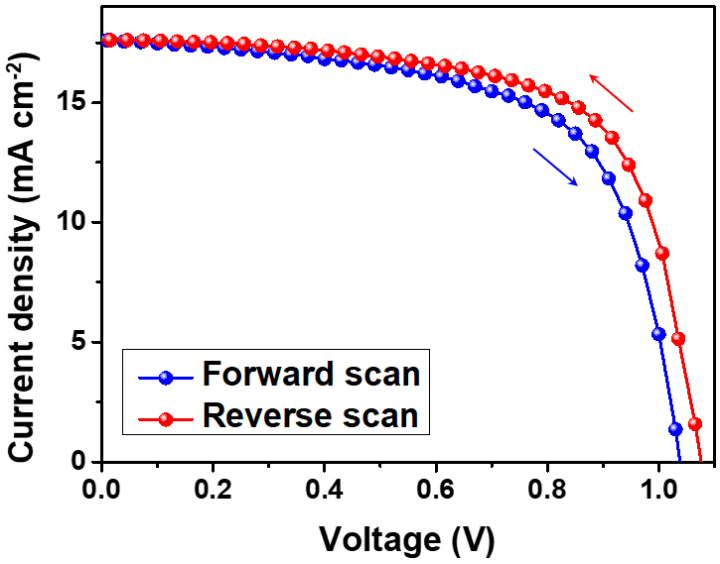

Fig. S5. *J–V* characteristics (under forward and reverse scans) of the PSCs using PEDOT:PSS and PCBM as the HTL and ETL.

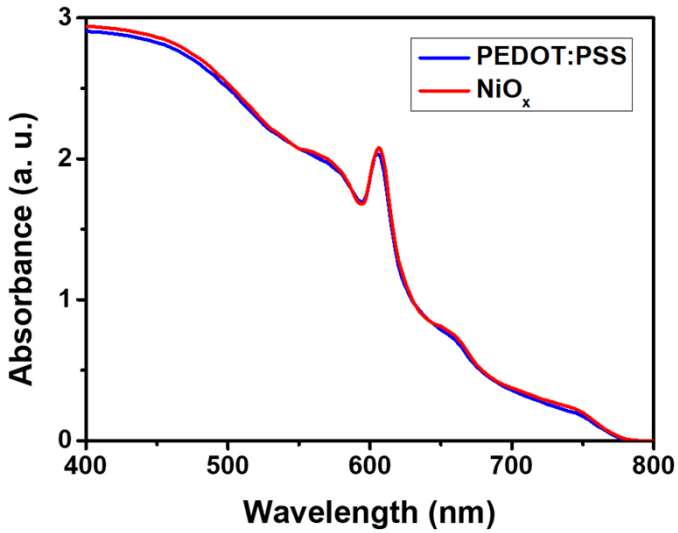

Fig. S6. Absorption spectra of the perovskite films formed on PEDOT:PSS and NiO_x.

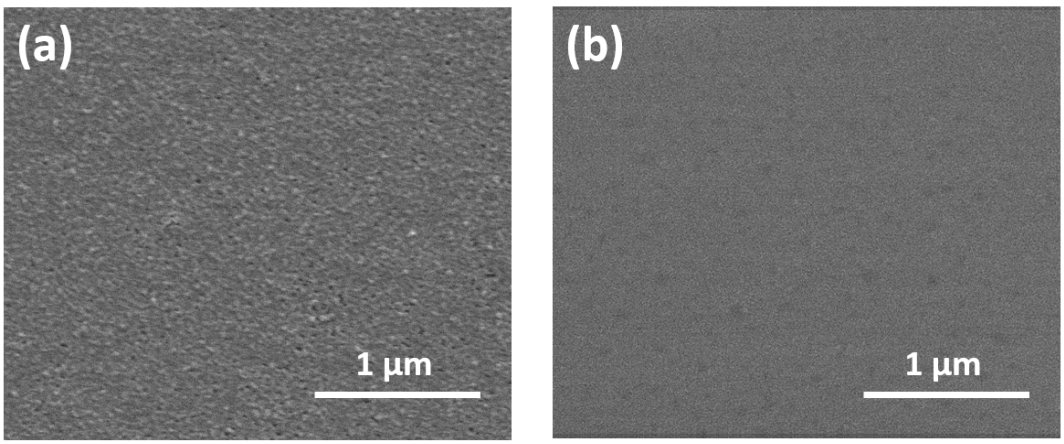

Fig. S7. Top-view SEM images of (a) underlying NiO_x HTL and (b) fullerene mixture (C_{60}:C_{70} =1:1) ETL.

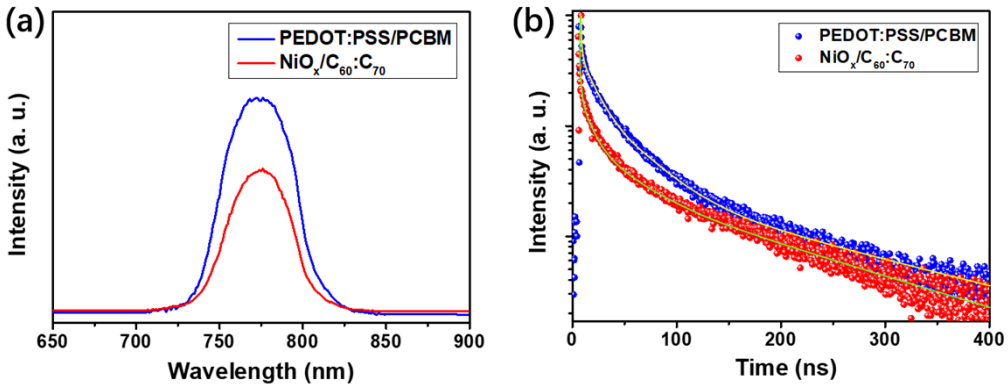

Fig. S8. PL (a) and TR-PL (b) spectra of NiO_x/perovskite/C_{60}:C_{70} and PEDOT:PSS/perovskite/PCBM on glass.

Table S2. Fast decay component (τ_1) and slow decay component (τ_2) for the films of perovskite, NiO_x/perovskite, NiO_x/perovskite/C_{60}:C_{70} and PEDOT:PSS/perovskite/PCBM, which are obtained by fitting the TR-PL spectra.

Configuration	τ_1 (ns)	τ_2 (ns)
Peorvskite	32.3	304.8
NiO_x/perovskite	11.2	82.6
NiO_x/perovskite/C_{60}:C_{70}	6.8	38.2
PEDOT:PSS/perovskite/PCBM	10.5	47.7