## Efficient Perovskite/Organic Integrated Solar Cells with Extended Photoresponse to 930 nm and Enhanced Near-Infrared External Quantum Efficiency Over 50%

Qiang Guo<sup>a</sup>, Hao Liu<sup>a</sup>, Zhenzhen shi<sup>a</sup>, Fuzhi Wang<sup>a</sup>, Erjun Zhou<sup>b</sup>, Xingming Bian<sup>a</sup>, Bing Zhang<sup>a</sup>, Ahmed Alsaedi<sup>c</sup>, Tasawar Hayat<sup>c,d</sup> and Zhan'ao Tan<sup>a,\*</sup>

<sup>a</sup> State Key Laboratory of Alternate Electrical Power System with Renewable Energy Sources, Beijing Key Laboratory of Novel Thin Film Solar Cells, North China Electric Power University, Beijing 102206, China.

<sup>b</sup> CAS Key Laboratory of Nanosystem and Hierarchical Fabrication, National Center for Nanoscience and Technology, Beijing 100190, China.

<sup>c</sup> NAAM Research Group, Faculty of Science, King Abdulaziz University, Jeddah 21589, Saudi Arabia.

<sup>d</sup> Department of Mathematics, Quiad-I-Azam University, Islamabad 44000, Pakistan.

Corresponding authors: E-mail: <u>tanzhanao@ncepu.edu.cn</u> (Z. A. Tan)



Figure S1. J-V and EQE curves of the devices using only PBDTTT-E-T or IEICO as

HTL.



Figure S2. EQE and  $J_{int}$  curves of ISCs with different thickness of BHJ active layer.



**Figure S3.** EQE and *J<sub>int</sub>* curves of ISCs with BHJ active layer have a D:A ratio 1:0.8, 1:1, 1:1.25, 1:1.5, and 1:2.



Figure S4. (a) J-V curves, (b) EQE and  $J_{int}$  curves of FTO/c-TiO<sub>2</sub>/PBDTTT-E-

T:IEICO /Ag device.



**Figure S5**. Normalized PCEs of unencapsulated PSC and ISC after aging for 240 hours, (a) in nitrogen-filled glove-box and (b) in ambient environment with relative humidity of about 30%.

Table S1. TRPL decay	detail fitting parameters	s of samples
----------------------	---------------------------	--------------

samples	A <sub>1</sub> (%)	$\tau_1(ns)$	A <sub>2</sub> (%)	$\tau_2(ns)$	$\tau_{avg}(ns)$
MAPbI3	9.567	0.337	90.433	39.791	36.02
PBDTTT-E-T:IEICO	93.729	0.483	6.271	3.678	0.68
MAPbI3/PBDTTT-E-	93.567	0.460	( 122	4 229	0.70
T:IEICO		0.400	0.435	4.228	0.70
	$\tau_{avg} = \sum_{i} A_i \tau_i$ , where $\sum_{i} A_i = 1$				

**Table S2**. Photovoltaic performance parameters of devices using only PBDTTT-E-Tor IEICO as HTL (reverse scan).

HTL	$J_{sc}$ (mA/cm <sup>2</sup> )	$V_{oc}\left(\mathbf{V} ight)$	FF (%)	PCE (%)
PBDTTT-E-T	20.21	0.973	53.19	10.46
IEICO	15.95	1.01	54.92	8.85