Supporting Information:

Integrated Perovskite Solar Capacitors with High Energy Conversion Efficiency and Fast Photo-Charging Rate

Jia Liang, [a#] *Guoyin Zhu,* [a#] *Zhipeng Lu,*[a] *Peiyang Zhao,*[a] *Caixing Wang,*[a] *Yue Ma,*[a] *Zhaoran Xu,*[a] *Yanrong Wang,*[a] *Yi Hu,*[a] *Lianbo Ma,*[a] *Tao Chen,*[a] *Zuoxiu Tie,*[a] *Jie Liu,*[a,b] *and Zhong Jin*[a]*

[a]Key Laboratory of Mesoscopic Chemistry of MOE, School of Chemistry and Chemical Engineering, Nanjing University, Nanjing, Jiangsu 210023, China.

[b]Department of Chemistry, Duke University, Durham, NC 27708, USA.

AUTHOR INFORMATION

Corresponding Author

*E-mail: zhongjin@nju.edu.cn

[#] These two authors contributed equally to this work.

Table S1. Performance comparison of integrated photo-powering energy devices in this study and previous literatures.

Reference	Photovoltaic unit	Energy storage unit	Architecture	Voltage plateau (V)	η (%)
This work	PSC	Supercapacitor	Integrated	0.91	7.1
[1]	DSSC	Supercapacitor	Integrated	0.70	1.8
[2]	DSSC	Supercapacitor	Integrated	0.65	1.8
[3]	DSSC	Supercapacitor	Integrated	0.63	1.2
[38]	DSSC	Supercapacitor	Integrated	0.60	1.6
[39]	DSSC	Supercapacitor	Integrated	0.62	2.1
[40]	DSSC	Supercapacitor	Integrated	0.64	2.1
[41]	DSSC	Flow battery	Integrated	--	--
[43]	PSC	Supercapacitor	Separated	1.45	10
[45]	PSC	Li-ion Battery	Separated	--	7.8
[46]	PSC	Supercapacitor	Integrated	0.70	4.7
[47]	Dual-silicon photoelectrochemical cell	Flow battery	Integrated	--	3.2
[48]	DSSC	Li-oxygen battery	Integrated	--	--
[49]	DSSC	Supercapacitor	Integrated	0.60	1.5
[50]	Polymer Solar Cell	Supercapacitor	Integrated	0.40	0.8

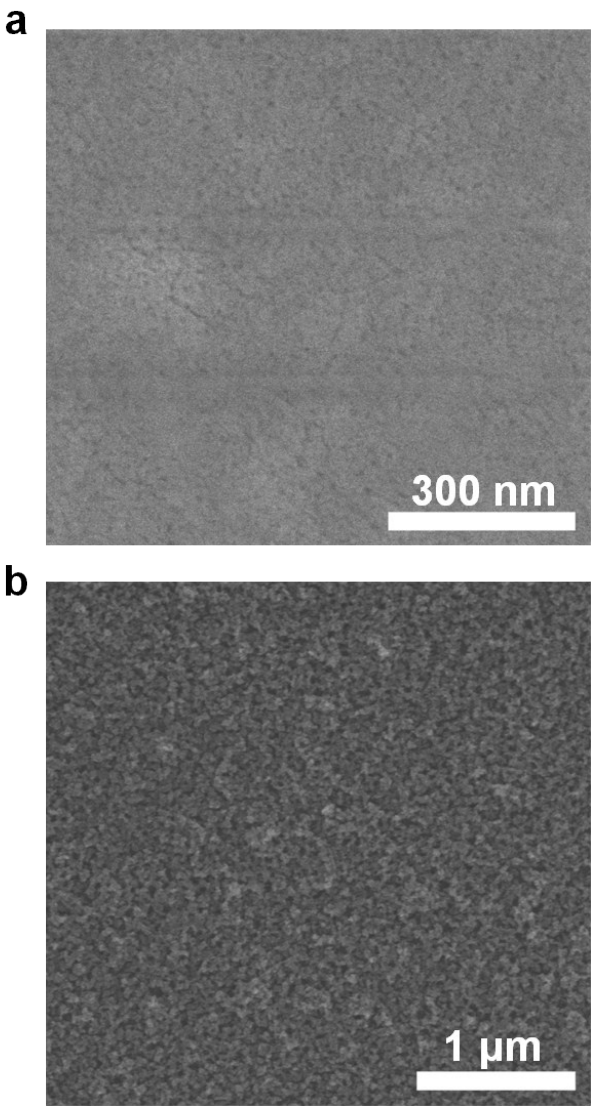

Fig. S1 SEM images of the surface morphologic features of (a) c-TiO_2 layer and (b) m-TiO_2 layer.

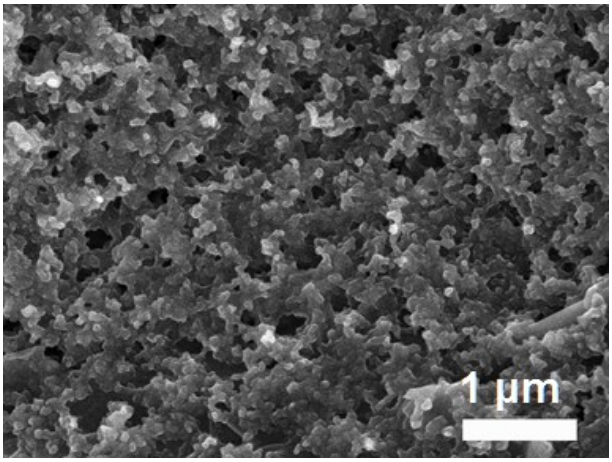

Fig. S2 SEM image of the nanocarbon electrode in IPSC.

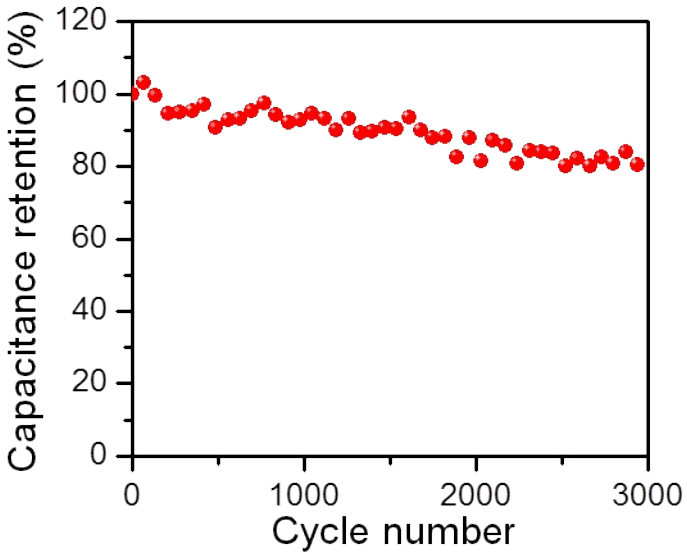

Fig. S3 Long-term cycling stability of the supercapacitor unit in IPSC upon galvanostatic-charging/galvanostatic-discharging mode at a current density of 0.4 mA/cm^2.

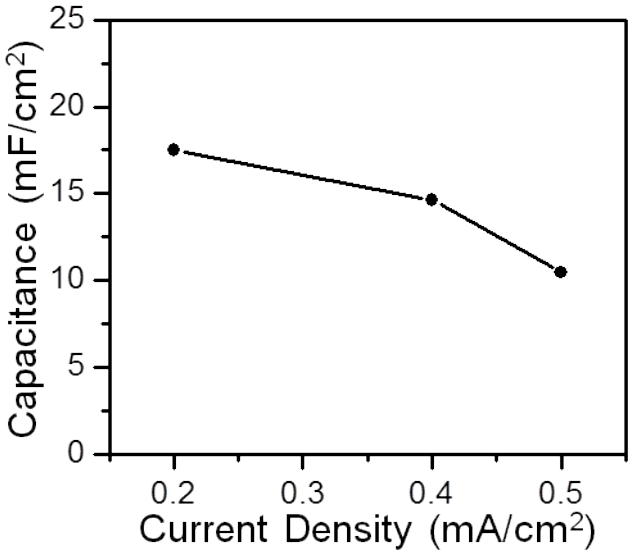

Fig. S4 Photo-charging capacitances of the IPSC at different discharging current densities (0.2, 0.4 and 0.5 mA/cm^2, respectively).

Table S2. Photovoltaic parameters of the PSC unit in IPSC under AM1.5G simulated solar illumination with different light intensities (45–100 mW/cm^2).

Light intensity (mW/cm^2)	J_{SC} (mA/cm^2)	V_{OC} (V)	*FF*	PCE (%)
100	20.0	0.92	0.48	8.9
85	18.0	0.90	0.48	9.1
75	15.7	0.90	0.49	9.2
65	13.6	0.89	0.50	9.2
55	11.4	0.88	0.51	9.3
45	9.5	0.87	0.52	9.6

Table S3. Performances of the supercapacitor unit of the IPSC in this work compared with other photo-charging devices in the literature.

Reference	Electrode materials	Work voltages	Rate performance	Cycle life
This work	Carbon	0-1.0 V	15.3 mF/cm^2 at 0.1 mA/cm^2; 10.7 mF/cm^2 at 0.5 mA/cm^2	85% for 3000 cycles
[1] (our previous work)	CF@TiO_2@MoS_2	0-0.8 V	18.51 mF/cm^2 at 0.02 mA; 13.51 mF/cm^2 at 0.1 mA	81% for 3000 cycles
[2]	Carbon nanotubes	0-0.8 V	21.7 F/g at 0.05 A/g; 18.6 F/g at 0.6 A/g	--
[3]	Carbon nanotubes	0-0.7 V	4.11 mF/cm^2 at 2×10^{-7} A; 3.32 mF/cm^2 at 1×10^{-5} A	100% for 8000 cycles
[38]	TiO_2	0-0.63 V	1.072 mF/cm^2 at 0.1 mA/cm^2; 0.8 mF/cm^2 at 2 mA/cm^2	98.8% for 3000 cycles
[39]	PANI	0-0.6 V	19.2 mF/cm^2 at 0.32 mA/cm^2; 19 mF/cm^2 at 12.8 mA/cm^2	100% for 10000 cycles
[40]	Silicon	0-0.64 V	3.5 mF/cm^2 at 0.05 mA/cm^2	105% for 3000 cycles
[43]	TiO_2	0-0.8 V	572 mF/cm^2 at 1 mA/cm^2; 486.2 mF/cm^2 at 15 mA/cm^2	--
[46]	PEDOT-carbon	0-0.7 V	12.8 mF/cm^2 at 0.25 mA/cm^2; 10.8 mF/cm^2 at 1.5 mA/cm^2	95% for 2000 cycles
[49]	Carbon nanotube fiber	0-0.8 V	0.6 mF/cm^2 at 0.25 μA;	--
[50]	Carbon nanotubes	0-0.6 V	0.077 mF/cm at 0.1 μA	--