Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supporting Information

Exploration of Photoredox Desalination Generator

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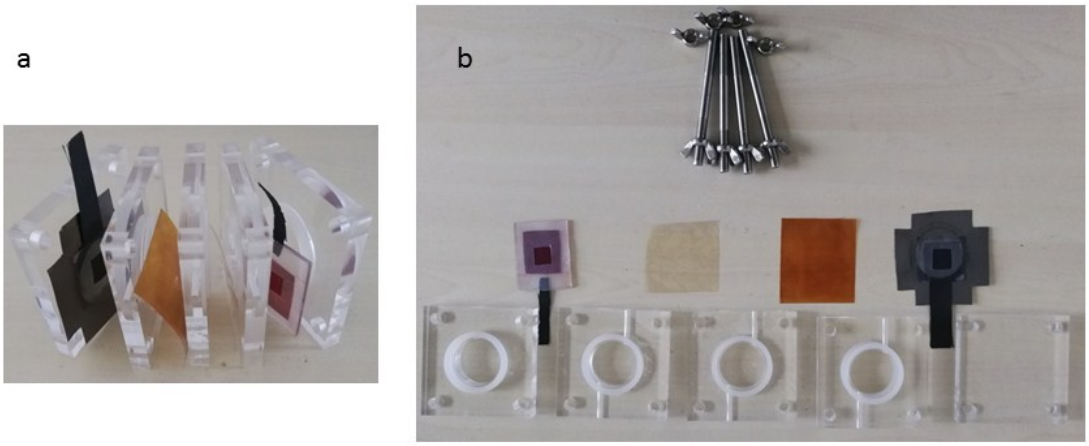


Figure S1 The detailed components of the cell in Figure 1 and Figure 2

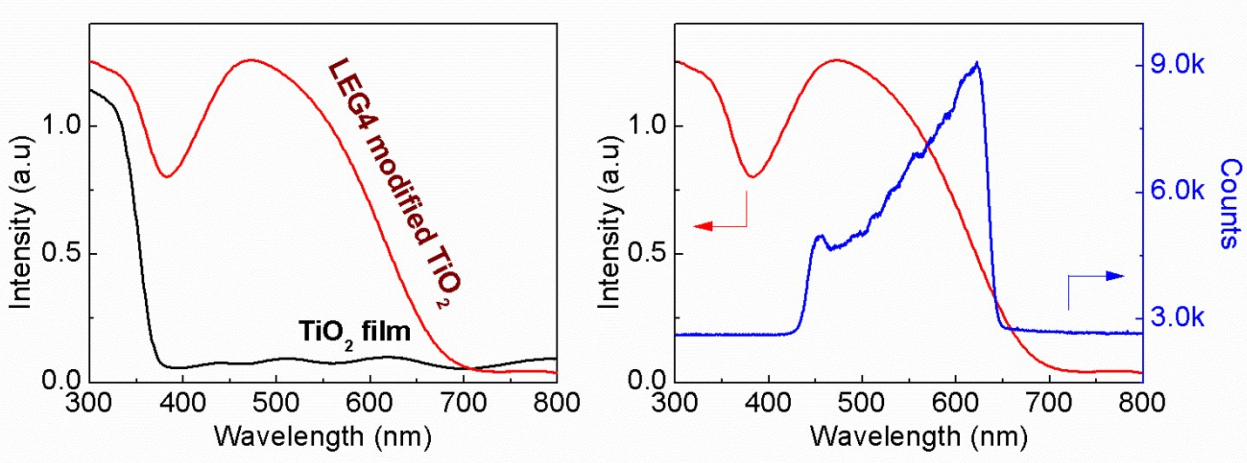


Figure S2 (a) the absorption spectra of bare TiO_2 and dye-modified TiO_2 photo-anode, (b) absorption of dye-modified TiO_2 photo-anodes matches the light source spectra well.

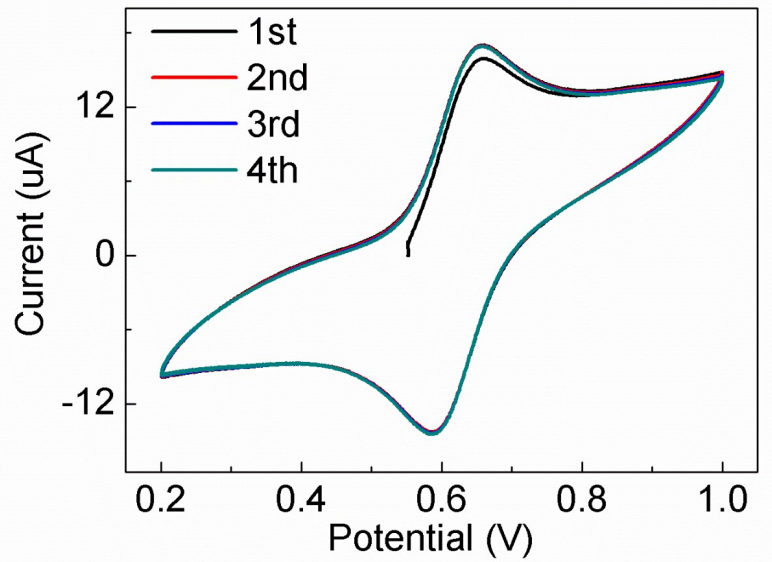


Figure S3 The three-electrode CV of TEMPO. The scanning window is from 0.2V to 1V, and the scanning rate is 10 mV/s. Glass carbon electrode was used as working electrode; Pt grid as counter electrode; standard Ag/AgCl electrode as reference electrode.

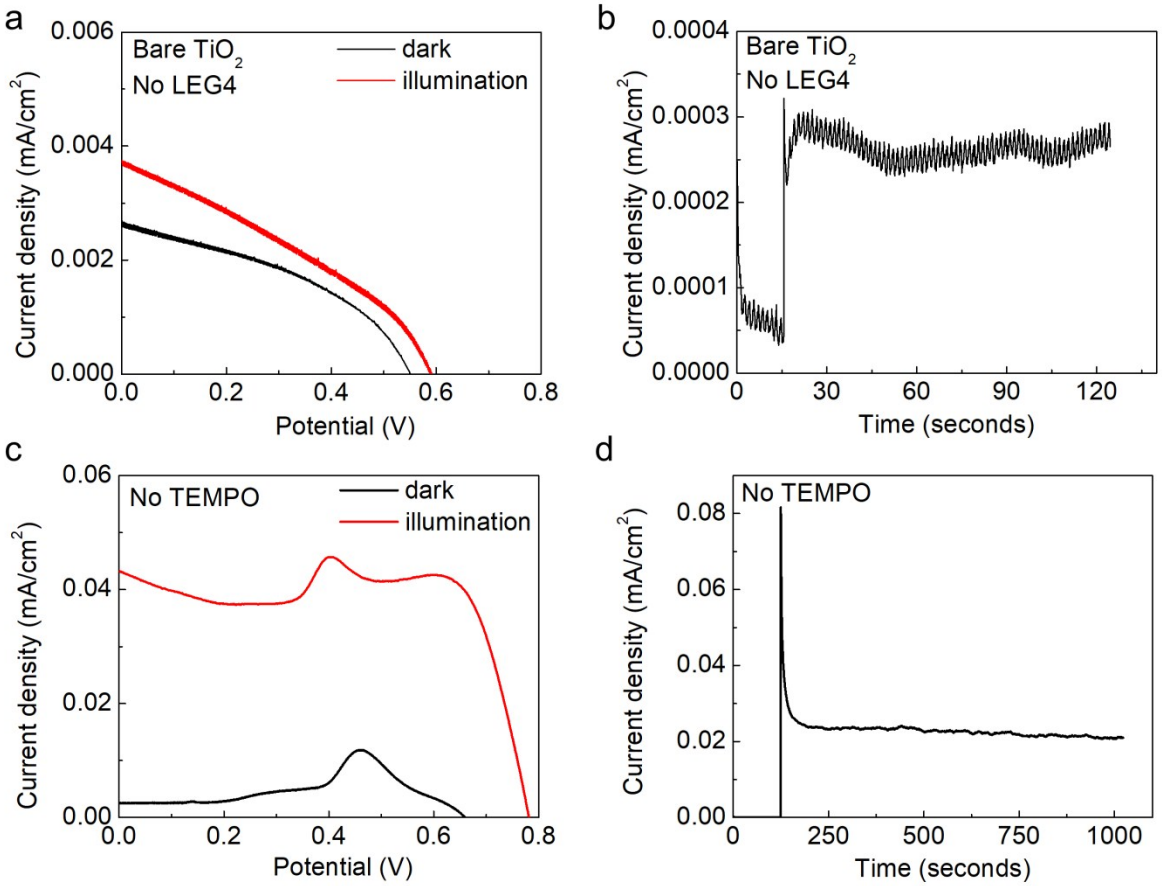


Figure S4 (a) J-V curve of bare TiO_2 (no LEG4 dye coating), (b) photo-current response of bare TiO_2 (No LEG4 coating); (c) J-V curve without TEMPO, (d) photo-current response without TEMPO

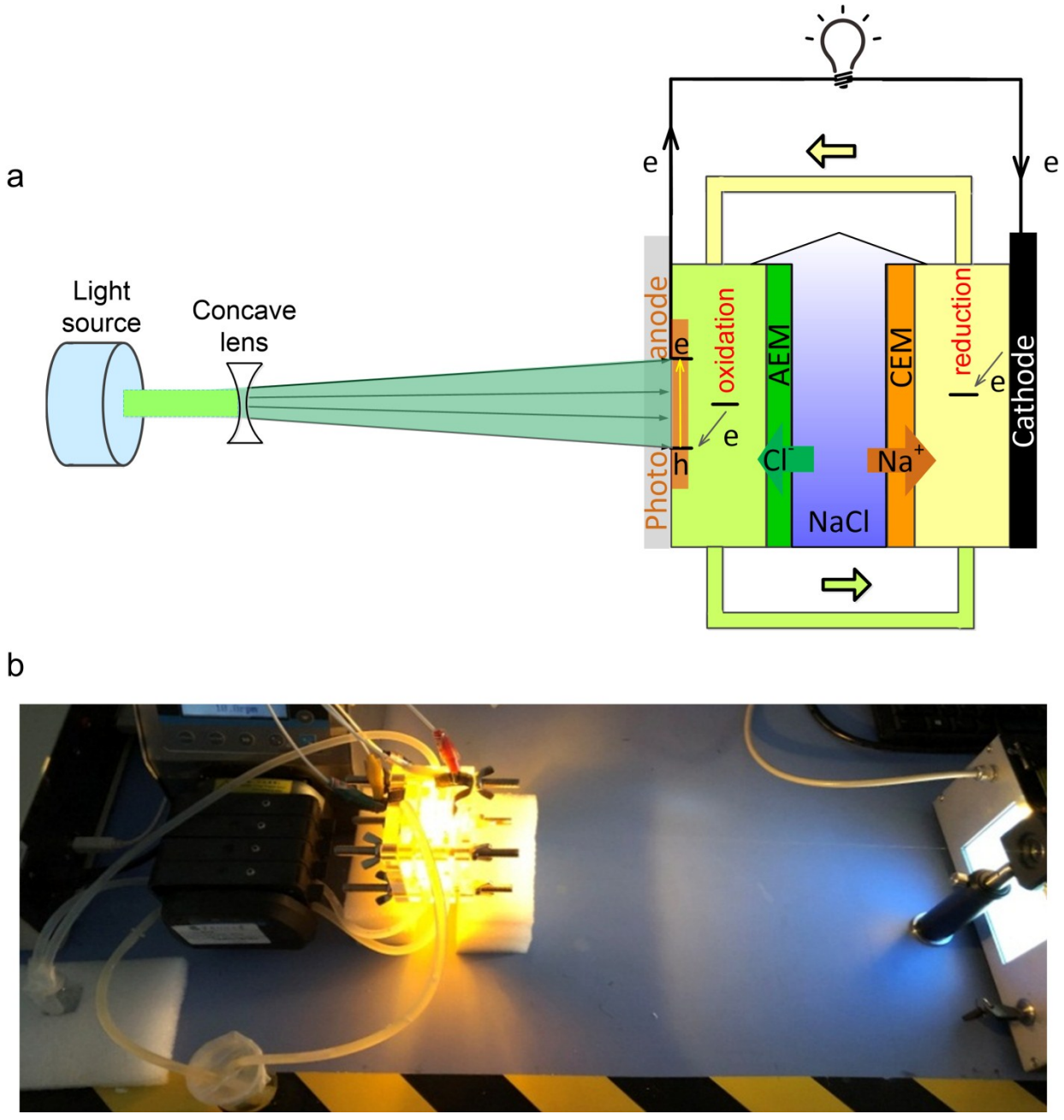


Figure S5 (a) The schematic design and (b) the experimental setting-up in Figure 1 and Figure 2.

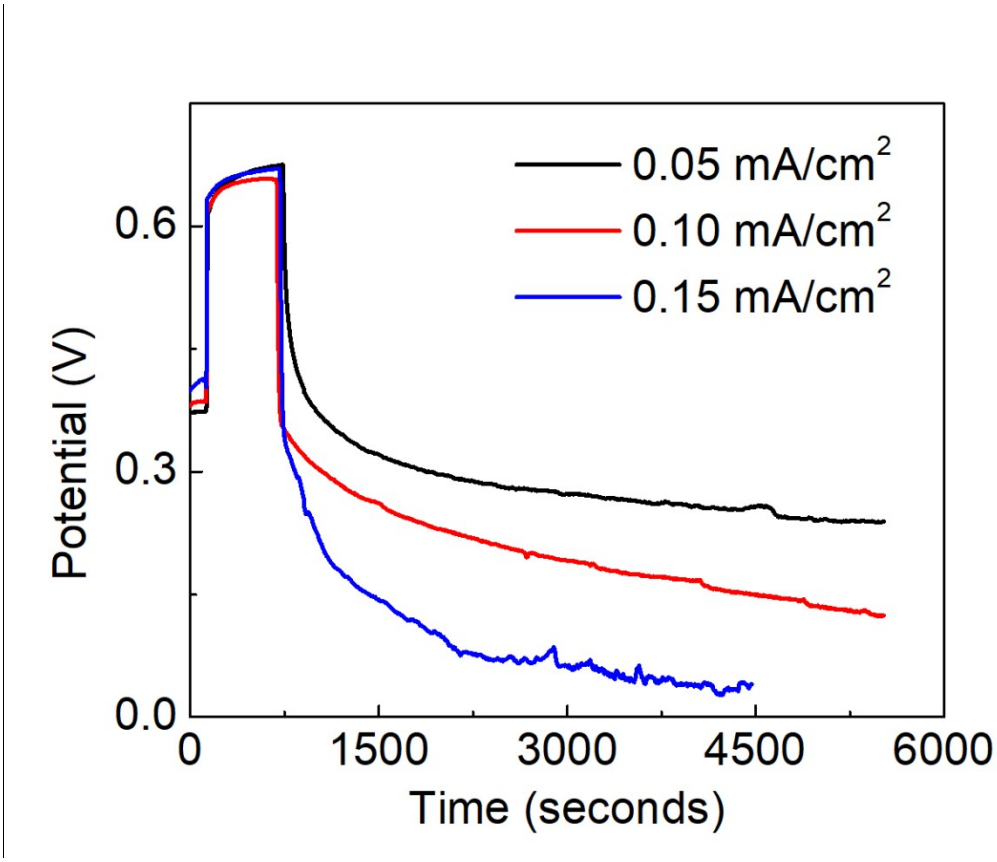


Figure S6 The discharge profile in Figure S5 at the constant discharge current density 0.05 mA/cm^2, 0.1 mA/cm^2, and 0.15 mA/cm^2

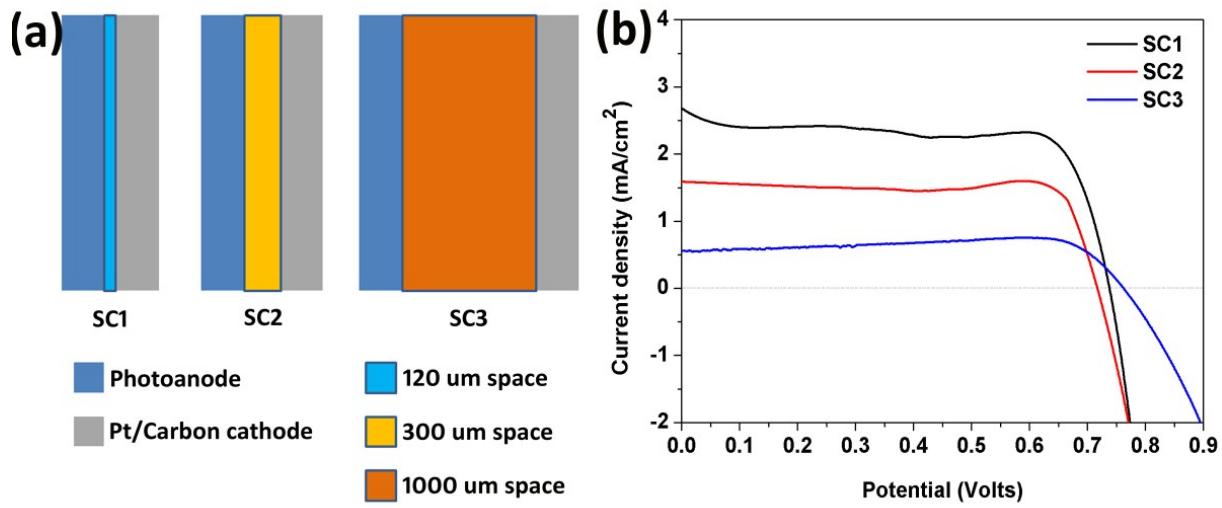


Figure S7 (a) Schematic of different solar cell architecture and (b) its corresponding J-V curve of solar cells.

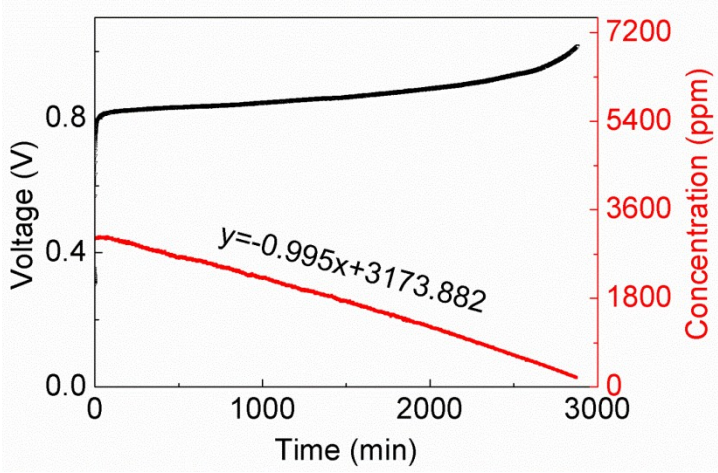


Figure S8 In the electrochemical driven desalination process at the 0.5mA current supplied by battery tester (active area: 3 cm * 3 cm), the salt can be removed to drinking water level. The middle feed is 25ml salt with the concentration of 3000 ppm; the electrolyte is 4mM TEMPO with 3000ppm salt addition.

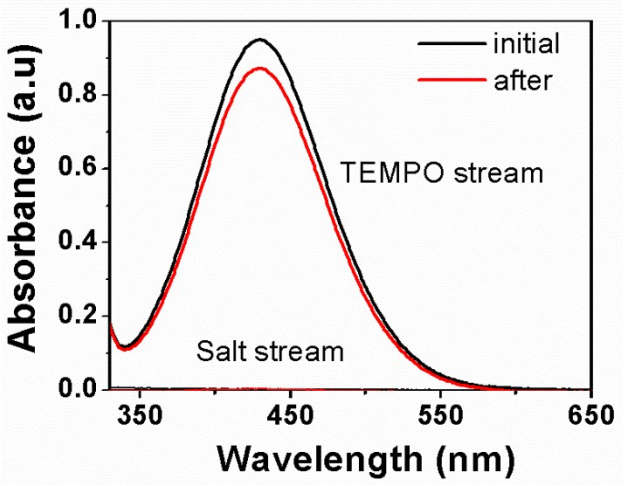


Figure S9 UV-Vis spectra of both TEMPO and salt stream at the initial and after desalination in the electrochemical desalination process.

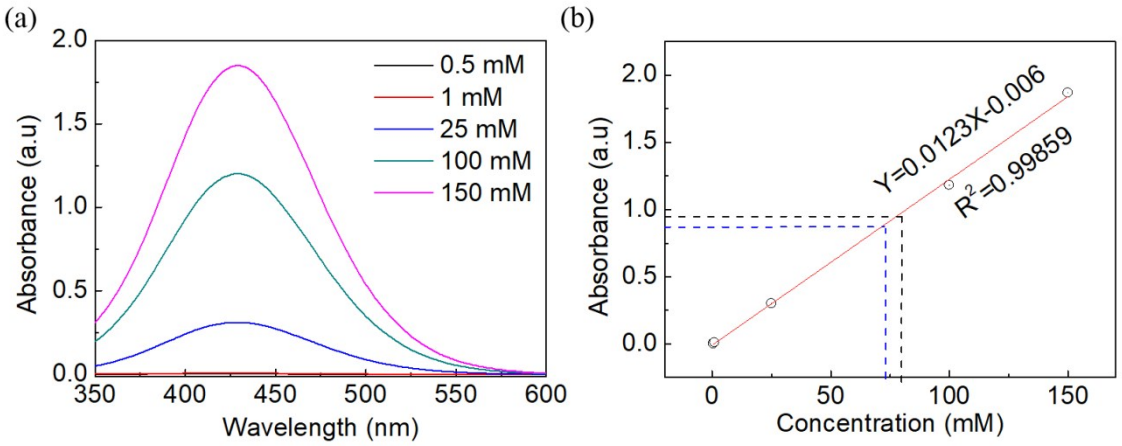
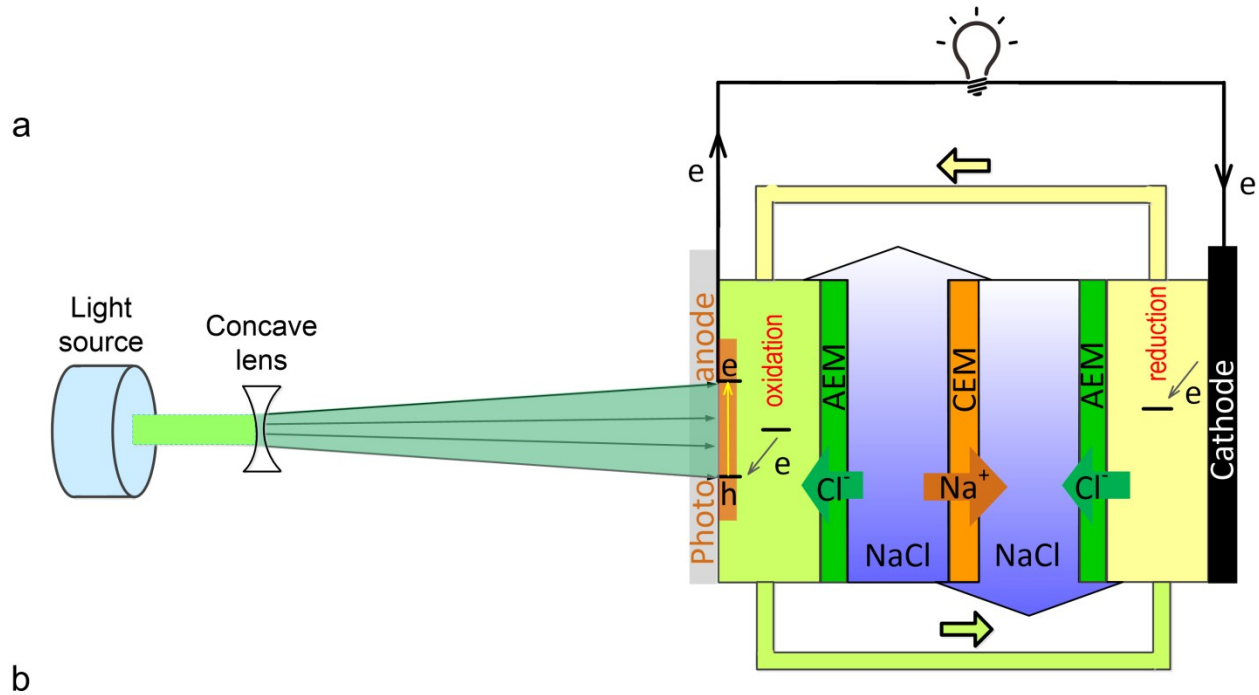


Figure S10 (a) the UV-Vis absorption spectra of various concentration of TEMPO in salt solution, (b) the calibration curve of absorbance vs. concentration at 428 nm.



b

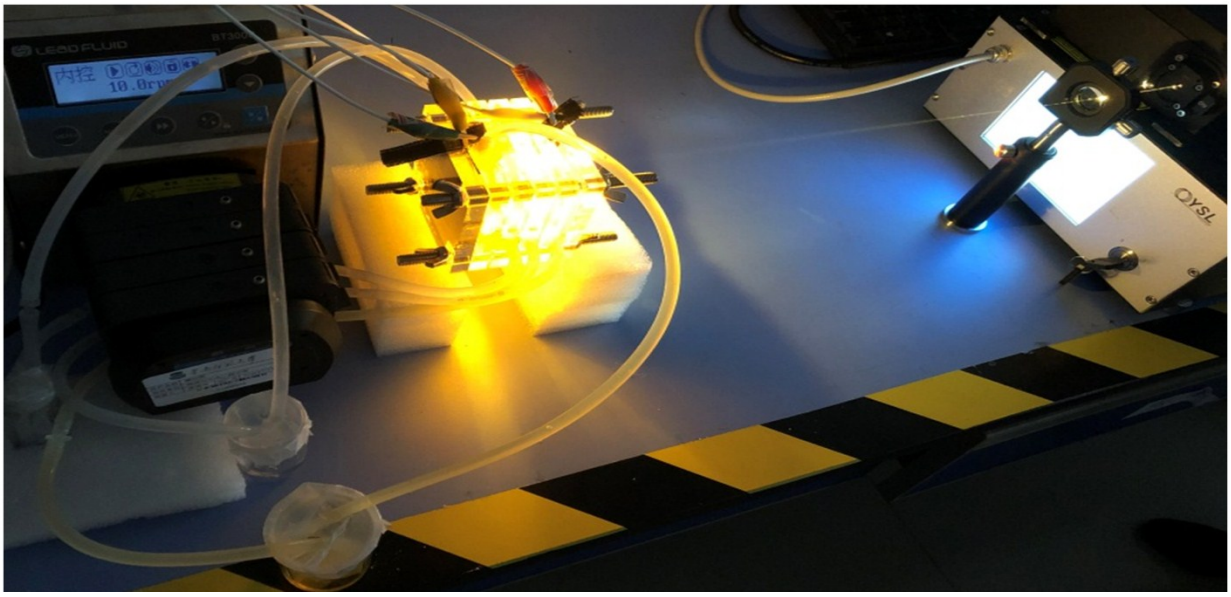


Figure S11 (a) The schematic design with the condenser stream for TEMPO regeneration (b) the experimental setting-up.

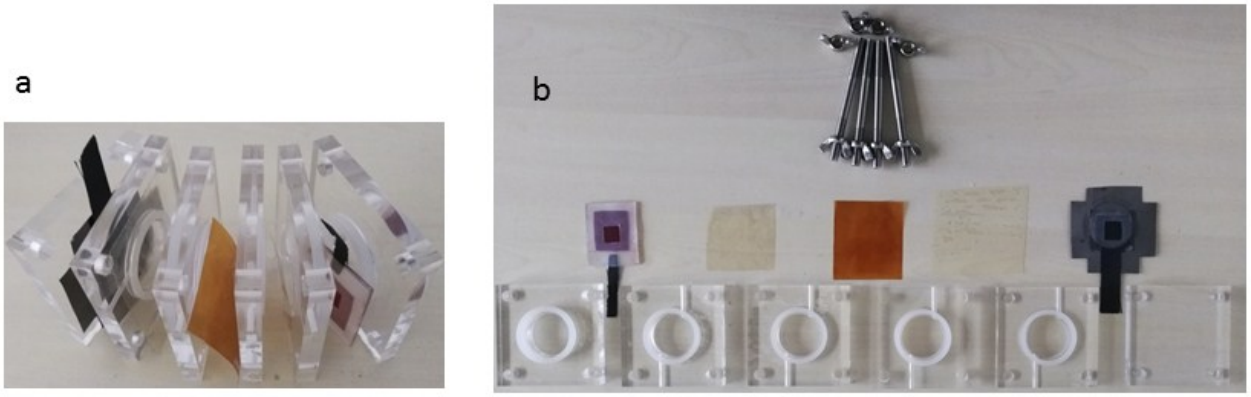


Figure S12 The detailed components with the condenser stream for TEMPO regeneration

Table S1 Solar cell performance from current–voltage measurements with the different light source intensity in this study

Input Power (mW/cm^2)	**Voc (Volts)**	**Jsc (mA/cm^2)**	**FF %**	**Efficiency %**	**Maximum Power (mW)**
50	0.726	0.24	44	0.15	0.07
100	0.757	0.28	45	0.09	0.09
150	0.773	0.31	44	0.07	0.1

Table S2 Conductivity of Figure 2(b)

	Conductivity (uS/cm)
Initial State	7350
Final State	7308

Table S3 Solar cell performance of different architecture measured at 100 mW/cm^2 of Figure S7.

Device	**Voc (Volts)**	**Jsc (mA/cm^2)**	**FF %**	**Efficiency %**	**Maximum Power (mW)**
SC1	0.739	2.68	71	1.4	1.4
SC2	0.715	1.58	80	0.9	0.9
SC3	0.763	0.54	90	0.37	0.4

Table S4: Mechanism of photo-redox desalination generator in Figure 1 and Figure 2

Mechanism of Dye regeneration by TEMPO redox species	**Mechanism of cell at components**
$TiO_2/P + hv \rightarrow TiO_2/P^*$ $TiO_2/P^* \rightarrow TiO_2/P^+ + e$ $TiO_2/P^+ + TEMPO + Cl^-$ $\rightarrow TEMPO^+Cl^- + TiO_2/P$ $TEMPO^+Cl^- + e + Na^+ \rightarrow TEMPO + NaCl$	**At Photo-anode:** $TEMPO + Cl^- \overset{oxidation}{\rightarrow} TEMPO^+Cl^- + e$ **At Salt stream:** $NaCl \overset{AEM}{\rightarrow} Cl^-\ (towards\ photoanode)$ $\overset{CEM}{\rightarrow} Na^+\ (towards\ cathode)$ **At Cathode:** $TEMPO^+Cl^- + e + Na^+ \overset{reduction}{\rightarrow} TEMPO + NaCl$

P: Photo-sensitized material, LEG4 dye

P*: excited state

P^+: oxidized state

Table S5 Conductivity of Figure 3(b)

	Conductivity of Stream 1 (uS/cm)	**Conductivity of Stream 2 (uS/cm)**
Initial State	7282	7280
Final State	7242	7321

Table S6: Mechanism of photo-redox desalination generator in Figure 3

Mechanism of Dye regeneration by TEMPO redox species	**Mechanism of cell at electrodes**
$TiO_2/P + hv \rightarrow TiO_2/P^*$ $TiO_2/P^* \rightarrow TiO_2/P^+ + e$ $TiO_2/P^+ + TEMPO + Cl^-$ $\rightarrow TEMPO^+Cl^- + TiO_2/P$ $TEMPO^+Cl^- + e \rightarrow TEMPO + Cl^-$	**At photo-anode:** $TEMPO + Cl^- \xrightarrow{oxidation} TEMPO^+Cl^- + e$ **Salt stream 1:** $NaCl\ (stream\ 1) \xrightarrow{AEM} Cl^-\ (towards\ anolyte)$ $\xrightarrow{CEM} Na^+\ (towards\ salt\ stream\ 2)$ **Salt stream 2:** $Cl^-\ (from\ catholyte) \xrightarrow{AEM}$ $Na^+\ (from\ salt\ stream\ 1) \xrightarrow{CEM} NaCl$ (stream 2) **At Cathode:** $TEMPO^+Cl^- + e \xrightarrow{reduction} TEMPO + Cl^-$