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Supplementary Information

Solar-charged Photoelectrochemical Wastewater Fuel Cell for Efficient and Sustainable Hydrogen Production

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Calculation of photocarrier density

The photocarrier density was calculaed by the equation

$$\frac{1}{C^2} = \frac{2}{NDe\varepsilon\varepsilon_0}\left(E_S - E_{FB} - \frac{kT}{e}\right) \quad (1)$$

$$N_D = \frac{2}{e\varepsilon_0\varepsilon}\left(\frac{dE}{d\left(\frac{1}{c^2}\right)}\right) \quad (2)$$

where, C is the space charge capacity of the semiconductor material, e is the element charge quantity (1.6×10^{-19} C), ND is the carrier density, ε_0 is the vacuum dielectric constant (8.86×10^{-12} F m^{-1}), ε is the relative permittivity of the WO_3 nanostructures (avalue of 50 has been assumed for the WO_3), E_S is the applied potential, E_{FB} is the flat band potential, T is absolute temperature and k is Boltzmann's constant (1.38×10^{-23} J K^{-1}). Thus, the equation of ND can be described as follow:

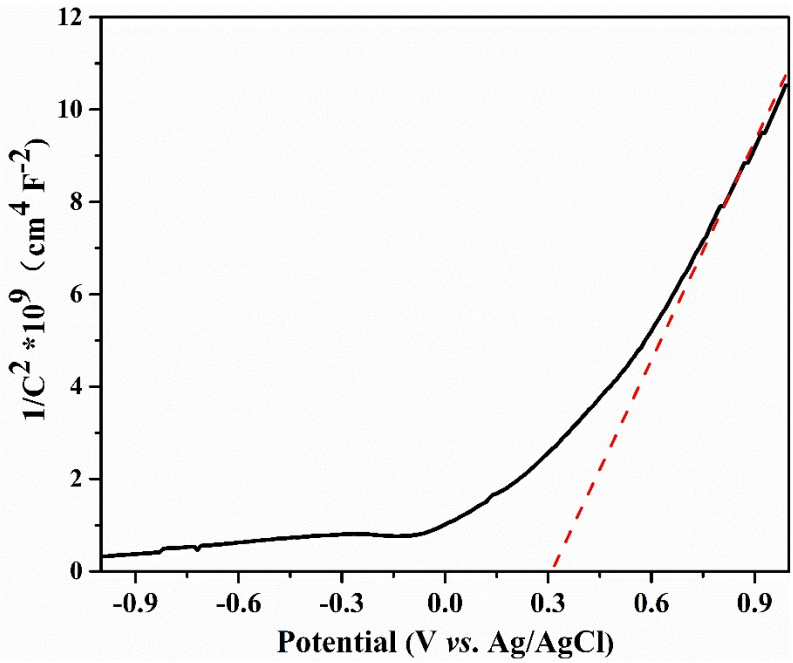

Figure.S1. Mott-Schottky plots of WO_3 NFs/W electrode measured in 0.1 mol L^{-1} Na_2SO_4 solution with a frequency of 1000 Hz and scan rate of 0.01 V·s^{-1}.

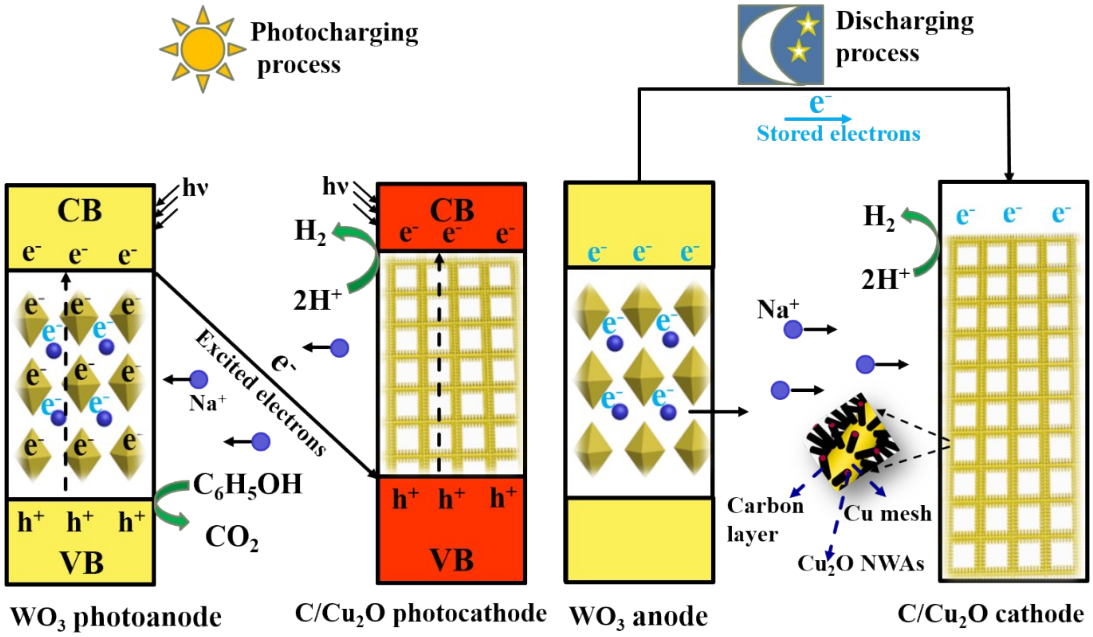

Fig.S2.The working mode diagram of scPEWFC system for simultaneous pollutant removal and hydrogen production under the photocharging-discharging process.

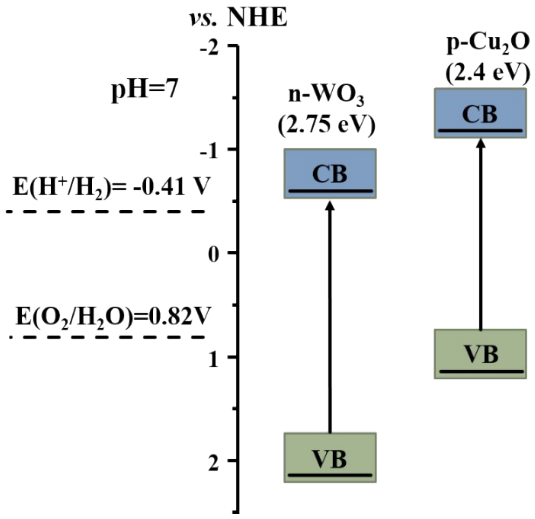

Fig. S3 The relative band positions for the WO_3 NFs-C/Cu_2O NWAs visible-light response dual-photoelectrodes

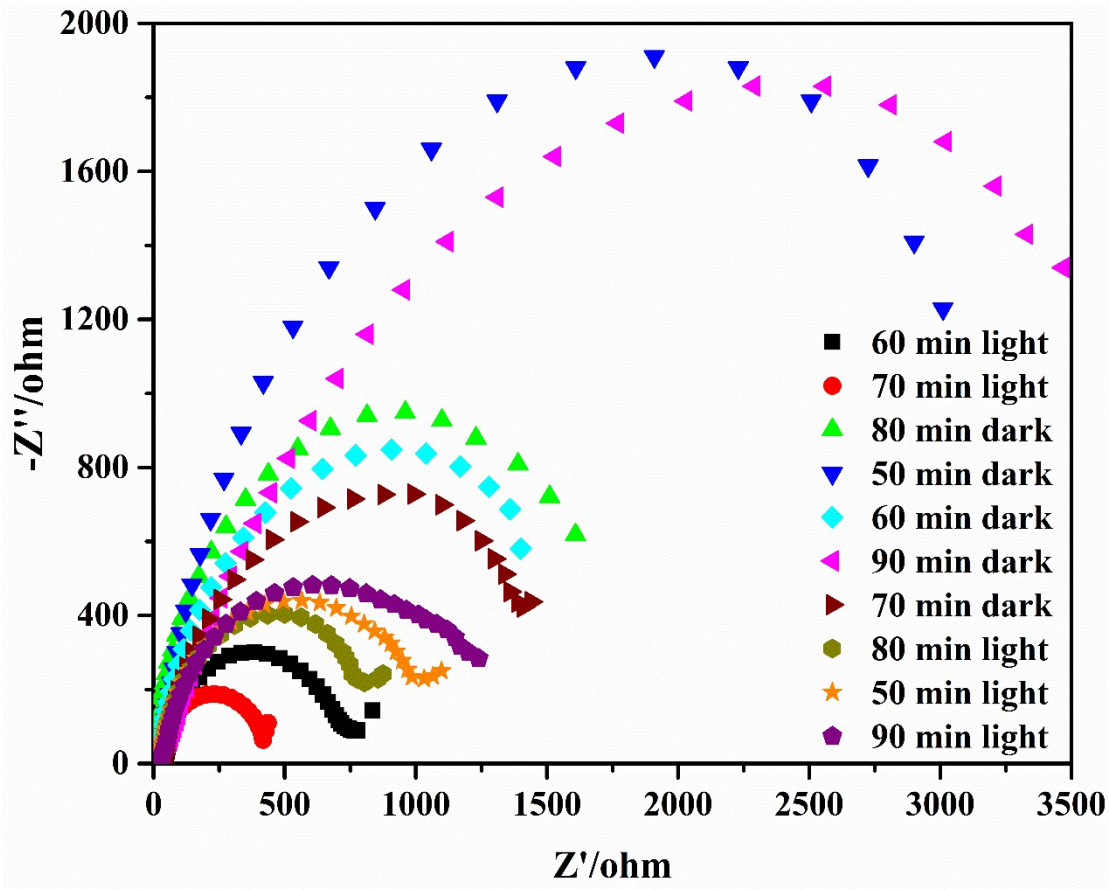

Figure.S4. The Nyquist curve of different anodizing time prepared WO_3 NFs electrode by using the two-electrode system without any bias in the 0.1 mol L^{-1} Na_2SO_4 solution containing 20 mg L^{-1} phenol.

Table S1. The photoelectrochemical performance, TOC removal and hydrogen production of scPEWFC.

Parameters	**50min**	**60min**	**70min**	**80min**	**90min**
V_{OC} (V)	0.24	0.26	0.25	0.24	0.24
J_{SC} (mA·cm^{-2})	0.33	0.42	0.44	0.40	0.36
P_{max} (mW·cm^{-2})	0.011	0.014	0.015	0.013	0.011
FF	0.139	0.128	0.136	0.135	0.127
TOC (%)	77.53	80.51	82.12	79.93	78.01
H_2 (μmol·cm^{-2})	80.67	87.15	93.08	85.65	82.41

Table S2. The WO_3 NFs/W-C/Cu_2O NWAs/Cu scPEWFC performance parameters in different concentrations of electrolyte solution.

Parameters	**0.01mol L^{-1}**	**0.05 mol L^{-1}**	**0.1 mol L^{-1}**	**0.5 mol L^{-1}**
$J_{SClight}$(mA cm^{-2})	0.482	0.488	0.523	0.589
J_{SCdark}(mA cm^{-2})	0.067	0.075	0.098	0.080
$H_{2\ light}$(μmol cm^{-2})	78.97	81.15	85.58	80.89
$H_{2\ dark}$(μmol cm^{-2})	6.23	6.71	7.50	7.15