

# Electronic Supplementary Material

## Design and mechanism insight on SiC quantum dots sensitized inverse opal TiO<sub>2</sub> with superior photocatalytic activities under sunlight

Yingchao He<sup>1</sup>, Qiong Sun (✉)<sup>1</sup>, Likun Sun<sup>1</sup>, Zhixing Gan<sup>2</sup>, Liyan Yu (✉)<sup>1</sup>,  
Lifeng Dong (✉)<sup>1,3</sup>

1 College of Materials Science and Engineering, Qingdao University of Science and  
Technology, Qingdao 266042, China

2 Center for Future Optoelectronic Functional Materials, School of Computer and  
Electronic Information, Nanjing Normal University, Nanjing 210023, China

3 Department of Physics, Hamline University, St. Paul 55104, USA

E-mails: sunqiong@qust.edu.cn (Sun Q); liyanyu@qust.edu.cn (Yu L); donglifeng@qust.edu.cn (Dong L)

### Experimental Section

#### *Materials*

Styrene (C<sub>8</sub>H<sub>8</sub>, 99.5 %), absolute ethanol (C<sub>2</sub>H<sub>6</sub>O, 99.7%), hydrochloric acid (HCl, 99.9%), methanol (CH<sub>4</sub>O, 99.5%), nitric acid (HNO<sub>3</sub>, 99.9%), sodium hydroxide (NaOH, 99%), p-benzoquinone (C<sub>6</sub>H<sub>4</sub>O<sub>2</sub>, BZQ, 98%), and ethylenediamine tetra acetic acid disodium salt (C<sub>10</sub>H<sub>14</sub>N<sub>2</sub>Na<sub>2</sub>O<sub>8</sub>, EDTA-2Na, 99 %) were purchased from Sinopharm Chemical Reagent Co. Tetrabutyl titanate (C<sub>16</sub>H<sub>36</sub>O<sub>4</sub>Ti, TNBT, 99%), silicon carbide powder (commercial nano-SiC, 99.9%, 40nm), and Nafion solution (5 wt.%) were purchased from Shanghai Aladdin Biochemical Technology Co. Potassium persulfate (K<sub>2</sub>S<sub>2</sub>O<sub>8</sub>, 99.5%) was purchased from Fangzheng reagent factory of North Chen District. Hydrofluoric acid (HF, 40.0%) was purchased from Shanghai Macklin Biochemical Technology Co. Isopropanol (C<sub>3</sub>H<sub>8</sub>O, IPA, 99.7%) was purchased from Tianjin Bodi Chemical Co. For textile dyes, Rhodamine B (RhB) and methyl orange (MO) were purchased from Tianjin Beilian Chemical Co, reactive brilliant red X3B (98 %) was supplied by Jining dye factory, and methylene blue (MB, 98.5 %) was purchased from Tianjin Dingshengxin Chemical Co. All agents were used directly as received without further purification.

#### *Characterizations*

The phase and crystal composition of samples was characterized by X-ray diffractometer (XRD, D/MAX-2500 V, Rigaku) with Cu K $\alpha$  as radiation source. The

morphologies and microstructures of SiC QDs and SiC QDs-IO TiO<sub>2</sub> were observed by field emission scanning electron microscopy (FESEM, JSM-6700F, JEOL) and transmission electron microscopy (TEM, JEM-2100, Rigaku), while the X-ray energy spectrometer (EDS, OXFORD INCA) was used to analyze compositions and element distributions. The surface chemical composition, valence state and electronic structure of different samples were determined by X-ray photoelectron spectroscopy (XPS, ESCALAB 250XI, Thermo Fisher) under high vacuum ( $> 6 \times 10^{-9}$  mbar). The intensity of the photoluminescence (PL, FLS100, Edinburgh) spectrum can be used to compare the separation activity of photoinduced electrons and holes, using the excitation wavelength at 310 nm. The UV-Vis absorption spectra were conducted on a UV-Vis-NIR spectrophotometer (Cary 500 Scan) to study optical properties of the samples.

### ***Electrochemical measurements***

The photoelectrochemical (PEC) performances of the samples were tested on an electrochemical workstation (CHI 760E, Shanghai Chenhua, China) with a typical three-electrode configuration. The electrode slurry was prepared as following. The working electrode was prepared by dropping the homogeneous suspension that was made by ultrasonic mixing 8 mg of catalyst, 20  $\mu$ L of Nafion, 40  $\mu$ L of isopropanol and 150  $\mu$ L of deionized water onto fluorine-doped SnO<sub>2</sub> conducting glass (FTO, Yingkou OPV tech new energy Co., Ltd). The Ag/AgCl and carbon electrodes were used as the reference and counter electrodes respectively, while 1 M KOH aqueous solution was used as the electrolyte. The Mott-Schottky curves were tested to determine the conduction band positions of the photocatalysts. The photocurrent response curve was tested to evaluate the production ability of photocarriers with the lamp on/off every 20 s. The electrochemical impedance spectroscopy (EIS) was used to study the impedance information of the photocatalyst under the illumination. The photocurrent-time ( $I-t$ ) curves were recorded under the switch of light on/off at every 20 s. The active side of the photoanode facing to incident light was 1 cm  $\times$  1 cm in square shape and thus the calculated area was 1 cm<sup>2</sup>.