

Electronic Supplementary Information

Bifunctional Water-Purification Materials Derived from Natural Wood
Modified TiO₂ by Photothermal Effect and Photocatalysis

Hui Zhang,^a Xiaohua Wang,^b Yao Wang,^a Zhizhi Gu^{*c} and Liyong Chen^{*a,b}

^aState Key Laboratory of Fine Chemicals Dalian University of Technology 2
Linggong RD., Dalian, 116024, China. E-mail: lychen@dlut.edu.cn

^bDepartment of Pharmaceutical Engineering, Bengbu Medical College, Bengbu,
233030, China.

^cCollege of Fisheries and Life Science, Dalian Ocean University, Dalian, Dalian
116023, China. guzhizhi@dlou.edu.cn.

Experimental Section

Materials and Chemicals

All chemical reagents were used as received. P25 and Rhodamine B (RhB) were purchased from Sinopharm Chemical Reagent Co., Ltd., China. White oak block was supplied by Shanghai Chengshen Industrial Co., Ltd., China. Seawater was taken from YellowYellow sea (Coordination: E121.58, N38.90).

Characterization Methods

Microstructural and morphological characterization was performed on a HITACHI UHR FE-SEM SU8220 to achieve Scanning electron microscopy (SEM) images. X-ray diffraction (XRD) was conducted with a Rigaku D/Max 2400 automatic powder X-ray diffractometer with Cu-K α radiation ($\lambda = 1.5418 \text{ \AA}$). The content of metal elements was measured by inductively coupled plasma atomic emission spectroscopy (ICP-AES) on Optima 2000DV. UV-Vis absorption spectroscopy was performed on U-4100 spectrophotometer. Raman spectroscopy was conducted on a Jobin Yvon LabRAM HR Evolution Raman spectrometer.

Materials Synthesis

Preparation of porous wood carbon by surficial carbonization of the semi-spherical end (wC-s-s). In a typical synthetic procedure, white oak was cut into small blocks with 3 cm in diameter and 2.5 cm in height along its radical direction. One end of wood block was firstly polished to form semi-spherical structures, and the as-made wood block with spherical shape at one end was separately treated in water, ethanol and acetone by sonication to remove pigment. The treated wood block was placed on a

conventional hot plate with a heating mantle that was filled with quartz sand, and was kept at 400 °C for 25 min. The as-made wC-s-s was sonicated for 1 h to clean its surfaces.

In the preparation process, the thickness of surficial carbonization layer can be adjusted by the carbonization time that was set to 10, 20, 25 and 30 min. Finally, these materials are defined as wC-s-s-t, wherein t is carbonization time.

Preparation of P25 nanocrystals loaded wC-s-s composites (P25/wC-s-s). The commercial P25 (5 mg) was dispersed into ethanol and sonicated to form homogeneous suspension. After that, the P25 suspension was carefully dropped onto the surfaces of wood domains of wC-s-s, and dried in vacuum at 100 °C for 6 h.

Testing solar-driven water evaporation and photo-degradation of organic pollutants

In a 100-mL beaker containing 60 mL of RhB solution in seawater that was taken from Yellow sea (Coordination: E121.58, N38.90), the P25/wC-s-s composites were floated at the air-water interface. The beaker was located at a Xe lamp (CHF-XM500, 500 W), and the variation of water weight upon illumination of simulated sunlight was measured at desirable time interval (10 min) by placing the beaker on an electronic precision balance with resolution of 0.1 mg (Mettler Toledo, ML204). By changing the distance between the Xe lamp and the evaporators, the intensity of light illuminating on the evaporators was adjusted to 1 kW m⁻², which was measured by a power meter (PL-MW2000). An IR camera (Ti400, Fluke, USA) was used to record the temperature distribution of the photothermal/photo-degradation system.

The photo-degradation experiments were performed. Prior to light irradiation, the photothermal/photo-degradation system was sealed by parafilm and kept at room temperature in the dark for 1 h to fully adsorb RhB dyes. Afterwards, the absorbance of RhB in seawater upon illumination was measured at desirable time interval (15 min) by taking out 5 mL of solution from the photo-gradation system. Notice: To eliminate the influence, the same volume of RhB solution that was originated from another photo-degradation system under otherwise identical conditions was added to the aforementioned photo-degradation system; seawater was added to the photo-degradation system according to the amount of water evaporated by the evaporator.

The experiments of solar-driven water evaporation and photo-degradation of organic pollutants were also performed outdoor (Dalian, China) under irradiation of natural sunlight.



Figure S1. (1) Natural wood blocks with one semi-spherical end treated at 400 °C with different times (2-5) 10, 20, 25, and 30 min to form wC-s-s, and (6) longitudinal section of w-C-s-s-25 to reveal the thickness of carbon layers.

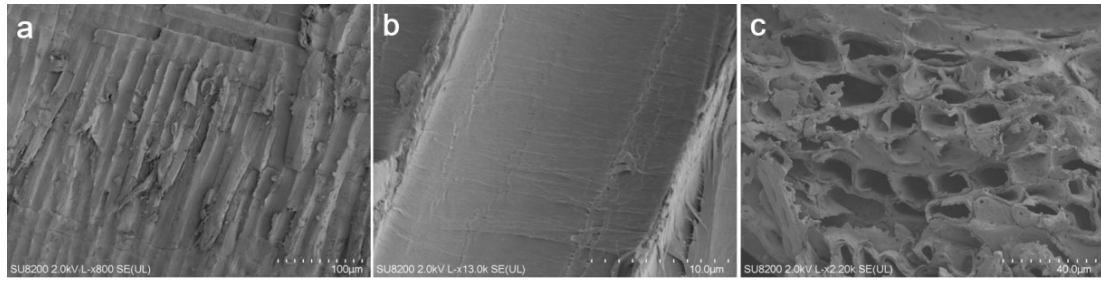


Figure S2. (a-b) Side view SEM images of microstructures of natural wood blocks with different magnification, and (c) top view SEM images of porous structures of natural wood blocks.

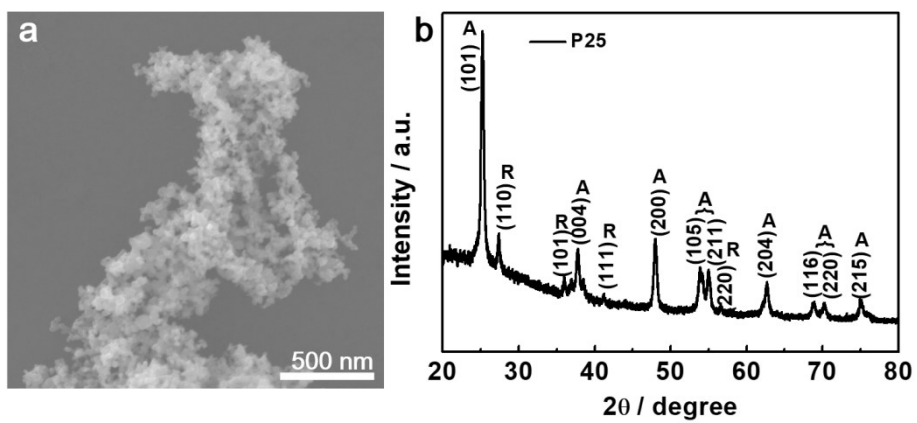


Figure S3. (a) SEM image and (b) XRD pattern of P25.

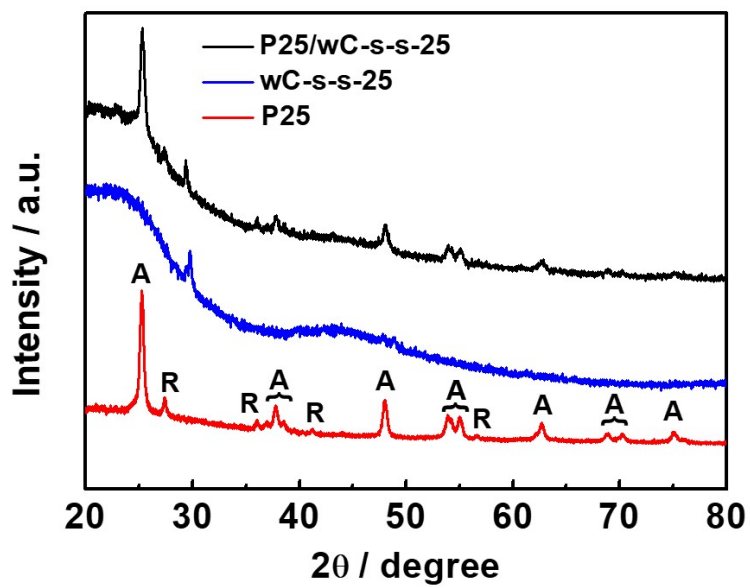


Figure S4. XRD patterns of P25, wC-s-s-25, and P25/wC-s-s-25.

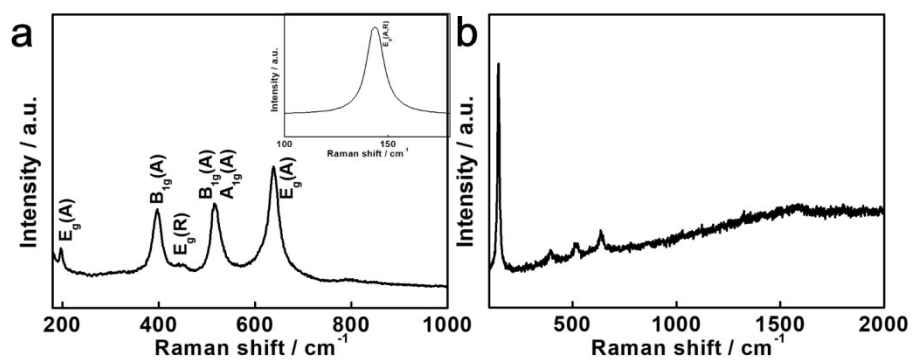


Figure S5. Raman spectra of (a) P25 and (b) P25/wC-s-s-25.

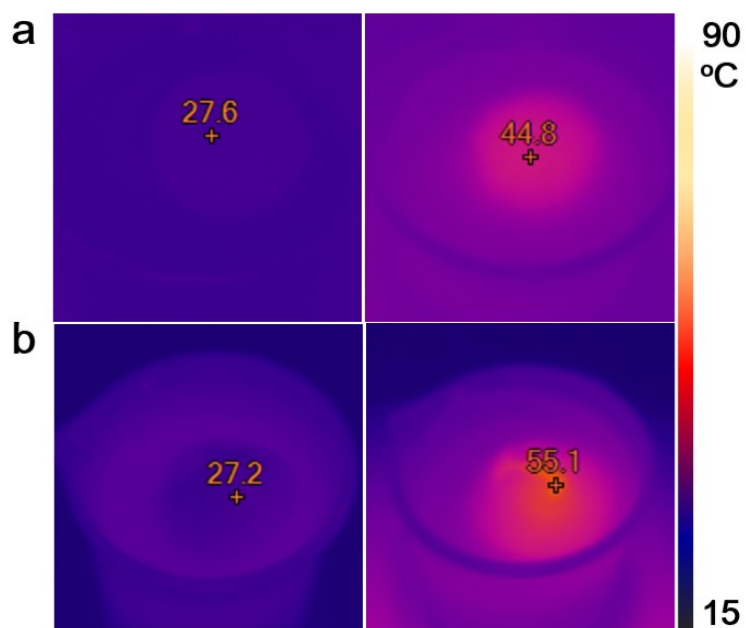


Figure S6. IR images of (a) wC-c-s and (b) P25/wC-s-s-25 floating on water upon irradiation of one simulated sunlight for 0 and 5 min (from left to right).

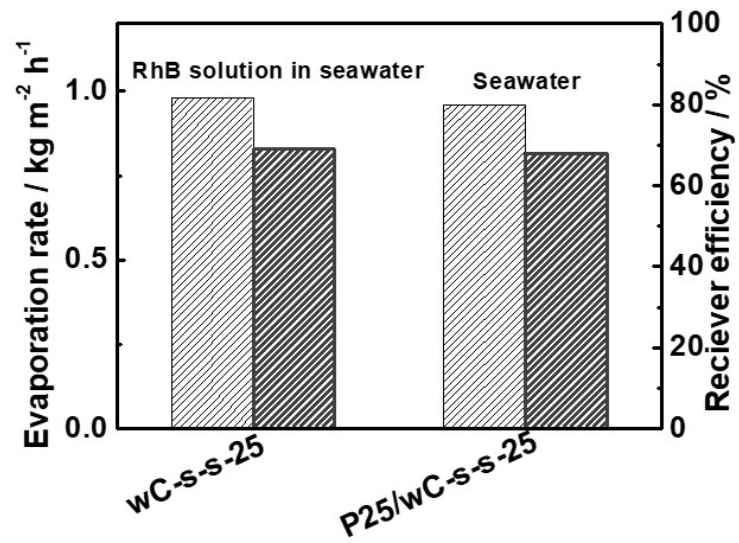


Figure S7. Evaporation rate and solar thermal receiver efficiency of wC-s-s-25 in RhB solution of seawater and P25/wC-s-s-25 in seawater under irradiation of one simulated sunlight for 90 min.

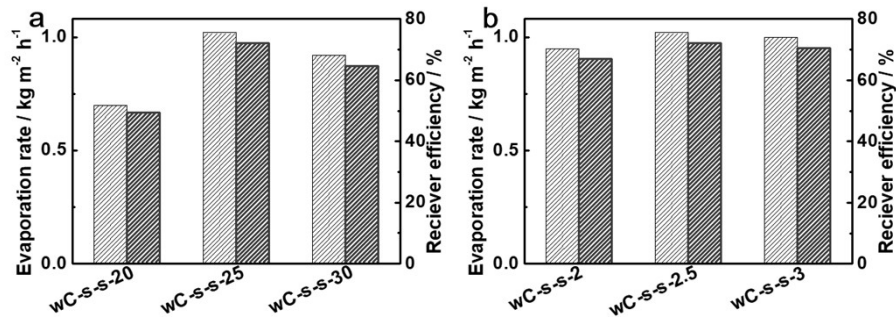


Figure S8. Evaporation rate and solar thermal receiver efficiency of (a) wC-s-s with different carbonization times and (b) wC-s-s with different thickness and the same carbonization time (25 min) under irradiation of one simulated sunlight for 90 min.

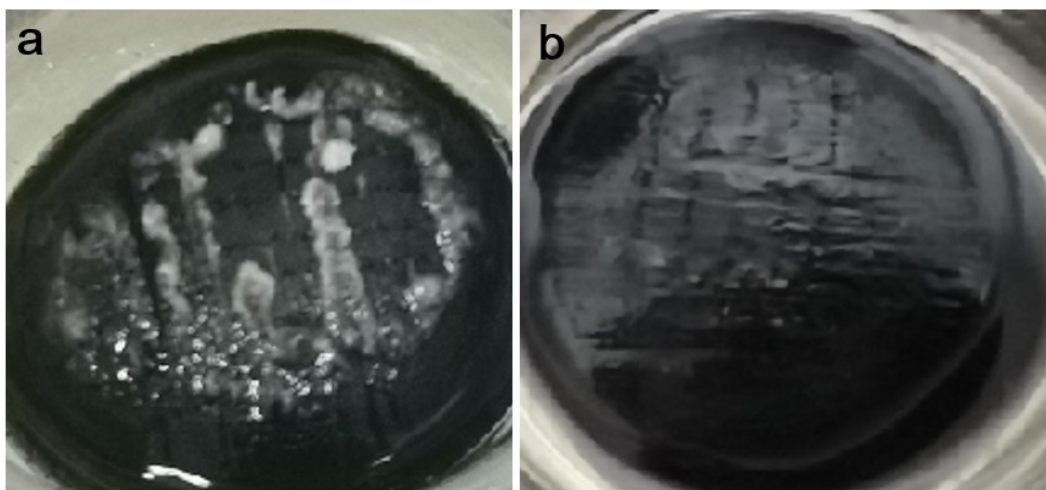


Figure S9. (a) Salting-out phenomenon of wC-s-s-25 after under irradiation of one simulated sunlight for 24 h, and (b) spontaneous removal of salt crystals from wC-s-s-25 kept in the seawater overnight.

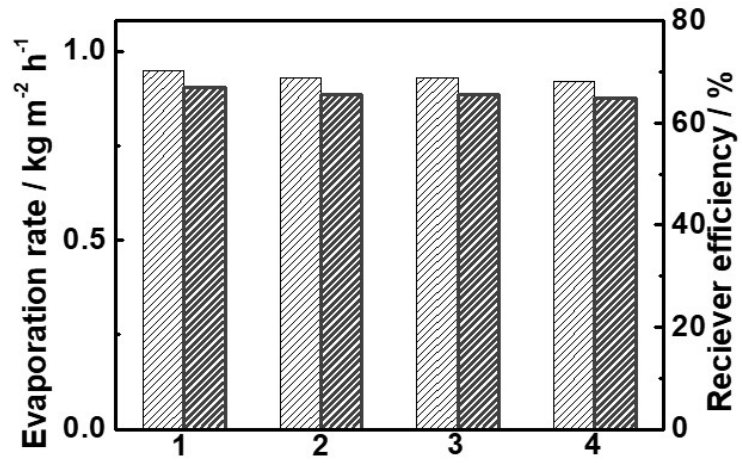


Figure S10. Solar water generation performance of wC-s-s-25 by alternate irradiation by simulated sunlight with 12 h intervals.



Figure S11. Optical image of RhB solution in seawater before and after irradiation of simulated light at 1 kW cm^{-2} for 3 h in the presence of P25/wC-s-s-25.

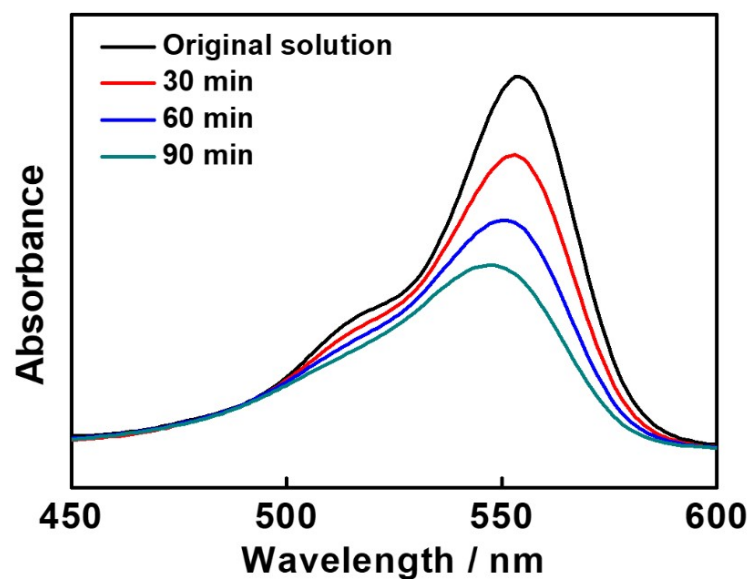


Figure S12. UV-visible absorption spectra of RhB solution (60 mL) after irradiation by the simulated sunlight with different times in the presence of P25 (5 mg) and tert-butanol (5 mL).

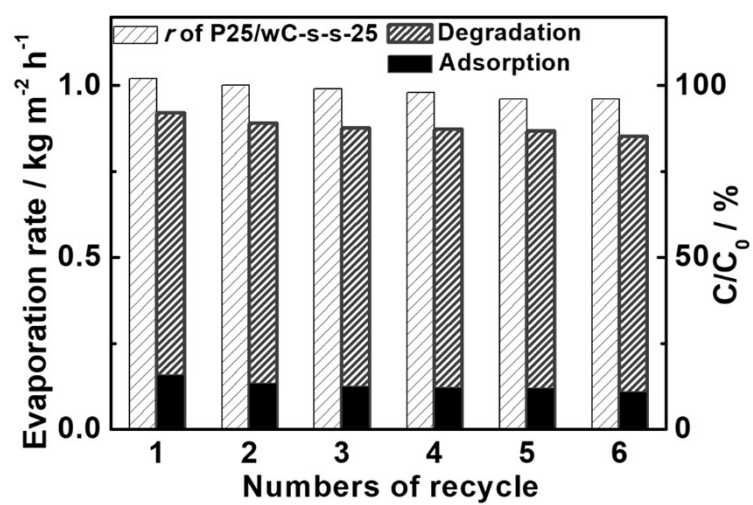


Figure S13. Recyclability of P25/wC-s-s-25 against removal of RhB and towards solar water evaporation under irradiation of simulated sunlight at 1 kW cm⁻² for 1.5 h for each run.

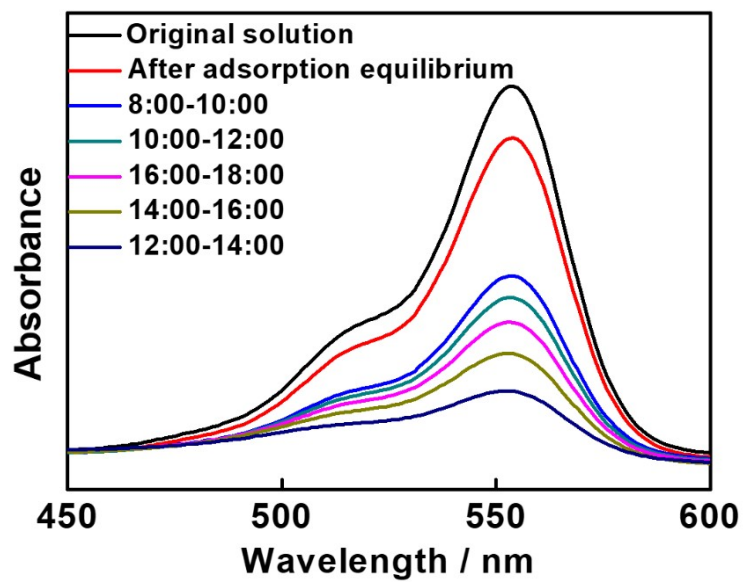


Figure S14. UV-visible absorption spectra of RhB solution in the presence of P25/wC-s-s-25 upon irradiation of natural sunlight with different time range.

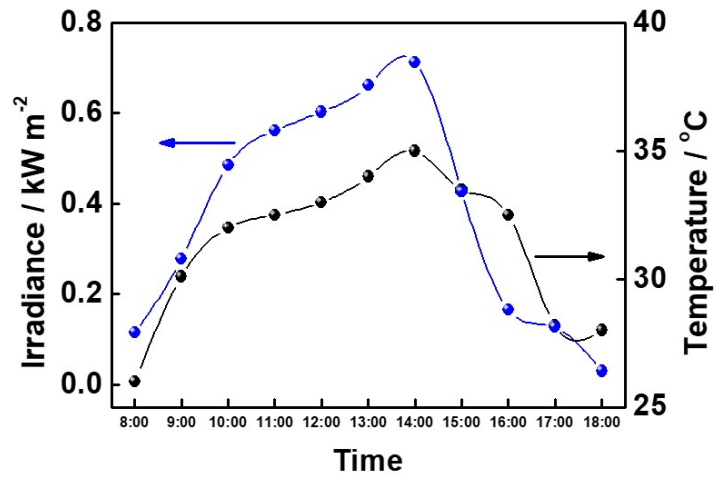


Figure S15. Irradiance intensity of natural sunlight and temperature in outdoor at different time.