

## Supporting Information

### **Triple activation of persulfate by a polydopamine/zerovalent iron co-functionalized sponge for synergistic solar driven photocatalytic antibiotic degradation and interfacial evaporation**

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## **1. Experimental Section**

### **1.1 Chemicals**

All commercial reagents were used directly without further purification steps unless otherwise mentioned. Haikou Tonglihang Chemical Materials Co., Ltd provided ferrous sulfate, tetracycline hydrochloride, dopamine hydrochloride, Tris buffer solution with pH=8.8, hydrochloric acid, sodium persulfate, and ethanol. The materials and reagents were all Analytical Grade (AR). Polyurethane sponges (SP) were purchased from Yongjia Sponge Products Company in Ganzhou, Jiangxi Province, and longan lids were purchased from Haikou Fruit Market. Ultrapure water was used as the water source in the experiment.

### **1.2 Polydopamine modified polyurethane sponge**

A round polyurethane sponge with a diameter of 3cm and a thickness of 0.5cm was prepared, 200ml of water was added to a 500ml beaker, 0.2g of dopamine hydrochloride and 2ml of Tris buffer solution were added, the sponge was sealed and stirred for 24 hours, and then it was taken out, washed with ultrapure water and alcohol, and dried by baking at 60°C to obtain a dopamine-modified sponge (SP@PD).

### **1.3 Loaded nano zero valent iron**

The fresh longan eyelid was dried at 60°C for 24 hours, ground into 60 mesh powder, and then 6g of the longan eyelid powder was added to 75ml of ultrapure water and 75ml of alcohol. The mixture was stirred in a 60°C water bath for 1 hour, and the supernatant was taken as a reducing agent solution for later use. A 0.6mol/L ferrous sulfate solution was prepared, and the modified sponge was immersed in the solution for 24 hours. After that, the sponge was taken out, and the extract of longan eyelid was added, and stirred for 1 hour. The sponge was then washed with ultrapure water and alcohol, and vacuum dried at 60°C for 12 hours to obtain a zero-valent iron-loaded sponge(SP@PD@Fe).

#### **1.4 Activated persulfate degradation of TC and water evaporation experiments**

In a solution of 30ml tetracycline hydrochloride with a concentration of 20mg/L, prepared in a 50ml beaker, the initial absorbance was recorded using a spectrophotometer. Next, the solution was added with 0.4mM of sodium persulfate, and the polyurethane sponges prepared in each process were floated on the upper surface of the solution. The lower surface of the sponge was brought into contact with the solution, which was stirred using a magnetic stirrer. The upper surface of the sponge was illuminated with one solar intensity of xenon light source, and the intensity of sunlight was measured using an optical power meter. The recording of time commenced, and the absorbance was measured at different intervals to determine the degradation efficiency of tetracycline. Additionally, the mass loss of the solution under this condition was measured, and the evaporation of water was monitored.

#### **1.5 Active Radical Testing and Polydopamine Reductive Validation Experiments**

The specific procedure for the capture of sulfate radical and hydroxyl radical is as follows. Add PS (0.4 mM) to 30 mL of ultrapure water. After that, prepare samples of SP@PD@Fe (diameter 3 cm), SP@PD@Fe+PS, and light+PS. Stir each sample for 2 minutes. Take 2 mL of the solution from each sample and transfer it to a centrifuge tube. Add 1.5  $\mu$ L of pure 5,5-dimethyl-1-pyrroline N-oxide (DMPO) spin trapping agent to each centrifuge tube. Mix the contents of each centrifuge tube thoroughly by stirring. The samples are then subjected to ESR measurement.

Both sulfate and hydroxyl radicals were quenched by ethanol, while hydroxyl radicals were only quenched by tert-butanol (TBA), and singlet oxygen ( $^1\text{O}_2$ ) was quenched by L-histidine. The main active free radicals during the degradation process were determined by measuring the degradation rate through the adjustment of the amount of quencher. The pink potassium permanganate was instantly faded by ferric iron, turning potassium ferricyanide indigo blue, and potassium ferricyanide appeared green when ferric iron was present. A certain concentration of  $\text{FeCl}_3$  solution was used to soak the polydopamine-loaded sponge for a period of time, and then the soaked solution was passed through the color reaction of potassium permanganate and potassium ferricyanide to determine if there was divalent iron in the solution. This verified the reducibility of the polydopamine sponge.

## **2 Characterization Section**

The Bruker D8 instrument was used for X-ray power diffraction (XRD) characterization. A Bruker A200 spectrometer was used to record the electron spin

resonance (ESR) spectrum. The surface morphology and element distribution of the Polyurethane sponge supported nano zero valent iron catalyst were observed with a field-emission scanning electron microscope (SEM, GAIA3 TESCAN) and transmission electron microscope (JEM-1400Flash; Japan Electronics Company). The hydrophobicity of the minerals was tested using a drop shape analyzer (Germany Kruss, DSA100). UV vis diffuse reflectance spectroscopy (UV vis DRS) was tested in the wavelength range of 200-2500nm on an Agilent Cary 300. The degradation rate of tetracycline hydrochloride was measured using a Thermo Scientific 7100 visible light spectrophotometer. X-ray photoelectron spectroscopy (XPS) was recorded with an X-ray photoelectron spectroscope (15 kV, 10mA, Thermo, USA).

### 3. Supporting Figures

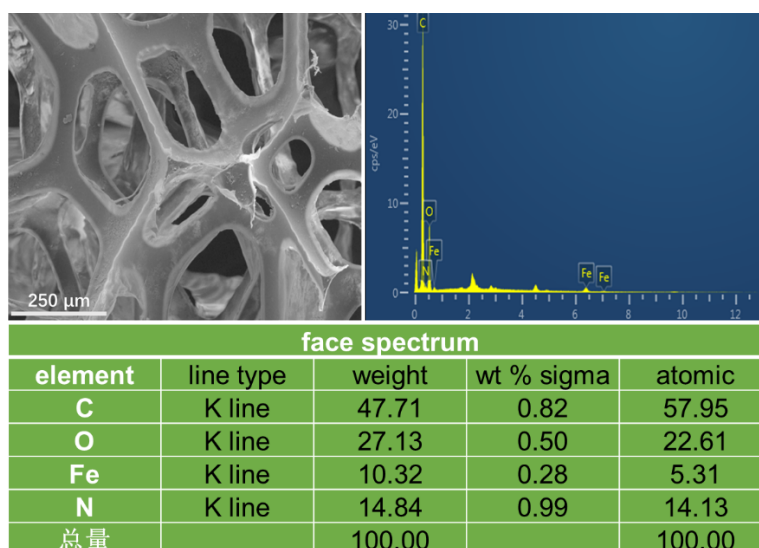


Figure S1. Element content analysis diagram

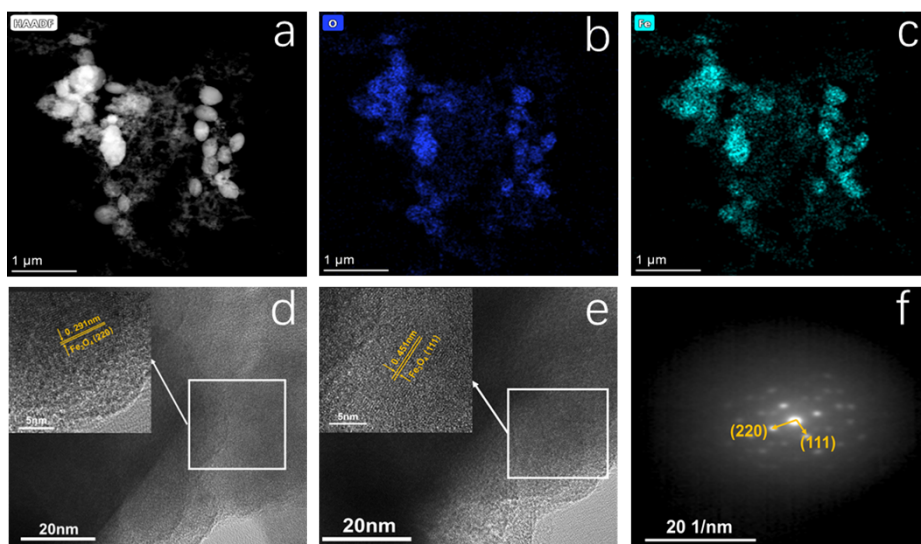


Figure S2. HRTEM images of Fe<sup>0</sup> NPs.

The lattice spacing of the diffraction peaks is measured to be 0.291 nm and 0.451 nm, corresponding to the (220) and (111) crystal planes, respectively, of Fe<sub>3</sub>O<sub>4</sub>. Reference to the PDF card (PDF26-1136) confirms that these lattice spacings correspond to the crystal planes of Fe<sub>3</sub>O<sub>4</sub> at the surface of Fe<sup>0</sup> NPs.

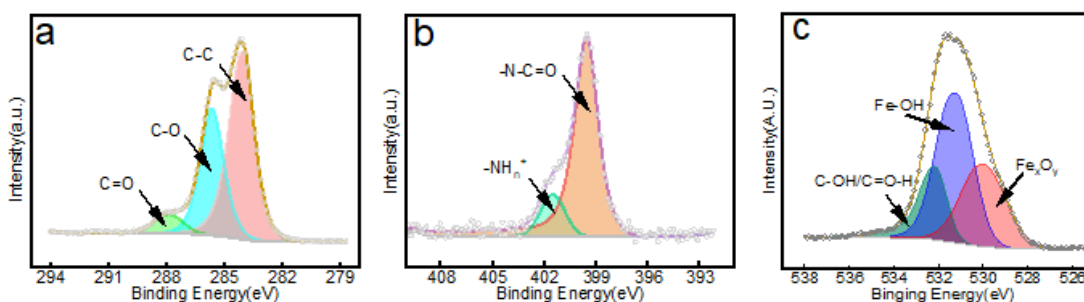


Figure S3. XPS image. (a) is the C 1s diagram of SP@PD@0.9Fe, (b) is the N 1s diagram, (c) is the O 1s diagram.

In Figure S3(a), characteristic peaks of C1s at binding energies of 284.1eV, 286.2eV, and 288.1eV correspond to the absorption peaks of C-C, C-O, and C=O, respectively, in the SP@PD@0.9 Fe material. Figure S3(b) shows N1s with characteristic peaks at binding energies of 400.1eV and 401.3eV, corresponding to the absorption peaks of -N-C=O and -NH<sub>n</sub><sup>+</sup>, respectively. The characteristic peaks in Figure 3a and b are attributed to the loaded polydopamine, and the polyurethane sponge itself is a polymer structure with a surface containing numerous functional groups that can be easily detected to provide a stable photothermal reaction platform and contribute to the adsorption of iron. Figure S3(c) displays characteristic peaks

of O1s with binding energies of 530.7eV, 531.8eV, and 532.8eV, corresponding to the absorption peaks of  $\text{Fe}_x\text{O}_y$ , Fe-OH, and C-OH/C=O-H, respectively. The oxygen-containing functional groups on the surface of the sponge produce ferrite functional groups due to the adsorption of iron in addition to the characteristic peaks of the sponge itself.

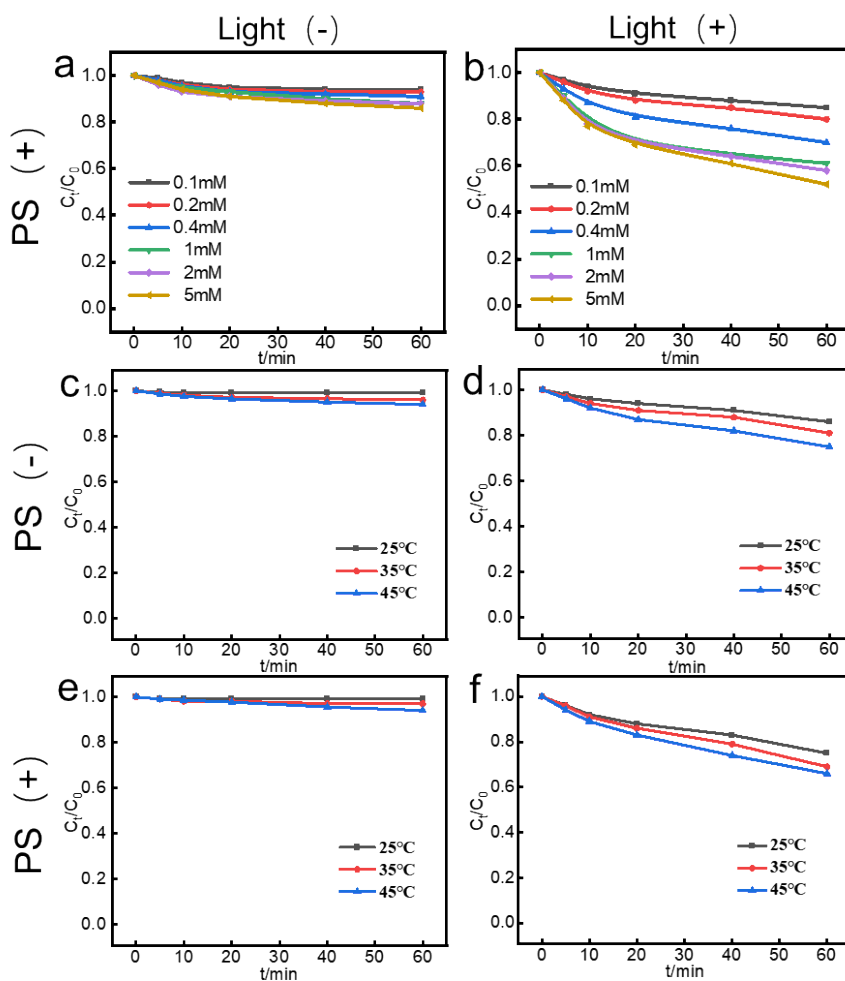


Figure S4. TC degradation under different conditions. PS were applied for TC degradation. Light (-)/(+) indicated the Xenon lamp was turned off/on during experiment. Similarly, PS(-)/(+) meant the degradation was performed in the without/with the addition of PS.

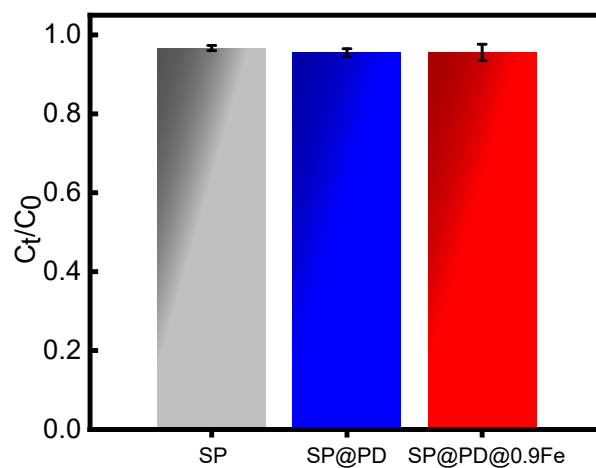


Figure S5. TC removal by surface adsorption in the absence of light and PS. The time for adsorption is 60 min.

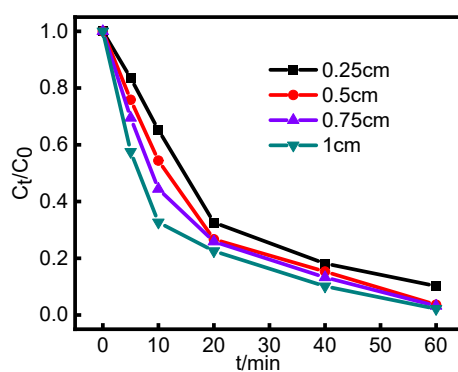


Figure S6. The degradation rate of SP@PD@0.9Fe at different thicknesses.

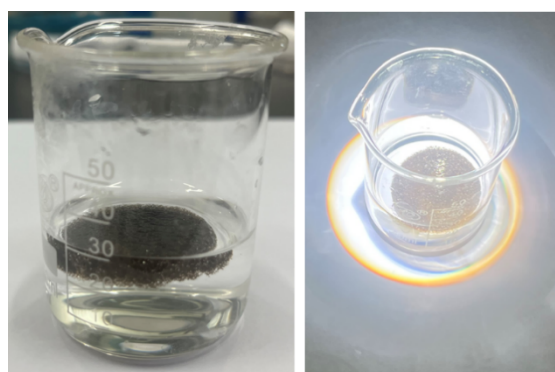


Figure S7. Photograph of the photothermal experiment.

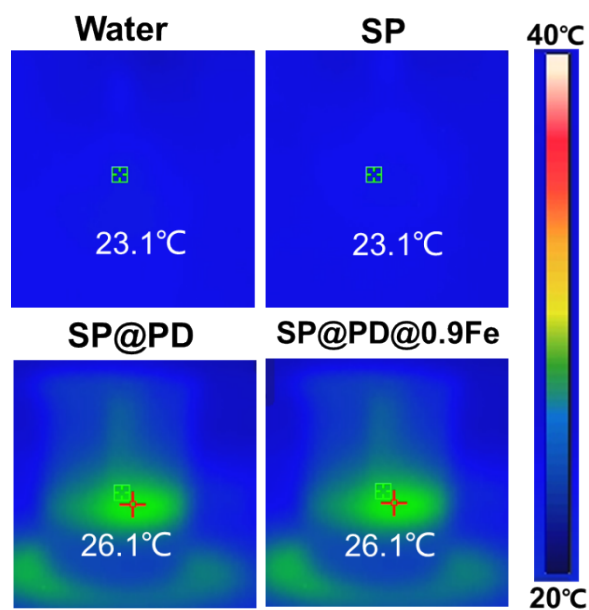


Figure S8. IR images of water, SP, SP@PD, and SP@PD@0.9Fe without illumination. The green region in SP@PD and SP@PD@0.9Fe indicated the position of the sponge.