Supporting Information

Hydrophobic Cu_{12}Sb_{4}S_{13}-Deposited Photothermal Film for Interfacial Water Evaporation and Thermal Antibacterial

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Experimental details:

1. Synthesis of Cu$_{12}$Sb$_4$S$_{13}$ nanoparticles

We synthesized Cu$_{12}$Sb$_4$S$_{13}$ nanoparticles via X. Qiu’s method. Briefly, 0.6 CuCl, 0.456 SbCl$_3$, 50 ml oleylamine and 50 ml glycerol were added into 250 ml three-neck flask and purged off air and water with Ar. Then, the mixture was heated up to 90 °C and held at this temperature for half hour. After that, the temperature was increased to 140 °C, followed by introduction of 0.192g S powders. After 1h, the temperature was finally heated up to 240 °C and kept at this temperature for another 1h. After the reaction, the mixture was allowed to cool down to ambient temperature naturally. The Cu$_{12}$Sb$_4$S$_{13}$ nanoparticles were obtained by centrifugation with ethanol. The final sample was dispersed in tetrachlorethylene.

2. Fabrication of Cu$_{12}$Sb$_4$S$_{13}$ photothermal film

Cu$_{12}$Sb$_4$S$_{13}$ film was prepared by filtering 3 ml Cu$_{12}$Sb$_4$S$_{13}$ solution (0.04g/ml) through the cellulose acetate filter (CA). Deposition amount of Cu$_{12}$Sb$_4$S$_{13}$ nanoparticles was calculated by weighting the dried mass change before and after Cu$_{12}$Sb$_4$S$_{13}$ deposition.

3. Characterization

TEM images were obtained on a FEI Tecnai G2 F30 microscope at an acceleration voltage of 200 kV. The crystal characters of the sample were determined by X-ray diffraction analysis (XRD, Shimadzu XD-D1) using graphite-monochromized CuKα radiation. The chemical valence of elements was determined by X-ray photoelectron spectroscopy (XPS, Perkin Elmer PHI 5600). The optical properties were measured using a spectrophotometer (U-4100. Hitachi). Contact angles were measured on a commercial contact angle system (JC2000D2). The temperature changes and thermal distribution images were obtained by a thermographicmeter (FLIR System i7). A 300 W Xe lamp (HSX-UV300) was used for the water evaporation measurement.

4. Water evaporation performance measurement

The performance of water evaporation was monitored by the weight loss of the water using an analytical balance (XS 105 DualRange). Firstly, the photothermal membrane with a diameter of 4.4 cm was placed on the surface of the water in a 50 mL beaker. Then, it was irradiated by the Xe light from the top. The power density of the Xe lamp was 5000 W m$^{-2}$. Then, the temperature and mass changes of water was monitored. The seawater was collected from the Bohai bay in the city of Yingkou, China.
5. Photothermal antibacterial test

*E. coli* O157:H7 strain (ATCC 43889) was routinely incubated with shaking at 180 rpm for 12 h in nutrient broth medium at 37 °C. Viable cell counts were determined to make sure the concentration of bacteria by plating on MacConkey agar. After overnight incubation, the concentration of bacteria was counted as $2.9 \times 10^9 \text{ CFU mL}^{-1}$ in 0.01 mol L$^{-1}$ PBS buffer (pH =7.4). The Cu$_{12}$Sb$_4$S$_{13}$ membrane was placed on the surface of 10 mL bacteria solution in the beaker, then the xenon lamp was used to irradiate the membrane for 2 min, 4 min, 6 min, 10 min, respectively. After irradiation, 1 mL extracted bacteria sample was firstly centrifuged at 3000 rpm for 10 min to discard the culture medium, then washed two times with PBS buffer solution and resuspended in SYTO 9 and propidium iodide(PI), which were used to stain live/dead bacteria. The final dye concentrations were 0.39 μM SYTO 9 and 2.35 μM PI. The suspension was incubated for 15 min in the dark at room temperature and then 100 μL stained bacteria was dropped in the glass slide and observed by fluorescence microscope. SYTO 9 and PI staining generated green and red fluorescence respectively. According to count method, the antibacterial activity was tested.

6. SEM observation of *E. coli* integrality

*E. coli* without and with photothermal heating treatment was collected by centrifugation. Then, the collected *E. coli* cells were fixed in 2.5% glutaraldehyde for approximately 30 min at room temperature, and then the samples were dehydrated by successive soakings in 30 %, 50 %, 70 %, 85 %, 95 % and 100 % ethanol each for 5 min. Finally, the resultant samples were dried naturally at room temperature. The morphologies of the *E. coli* cells were observed using a scanning electron microscope.
Figure S1. Schematic diagram of crystal structure of Cu$_{12}$Sb$_4$S$_{13}$. 

[Image of a schematic diagram of the crystal structure of Cu$_{12}$Sb$_4$S$_{13}$]
Figure S2 (a) Full-range XPS spectrum, (b) XPS Cu2p spectrum, (c) XPS S2p spectrum, (d) XPS Sb3d spectrum of Cu$_{12}$Sb$_4$S$_{13}$
Figure S3 SEM image of (a) Cu$_{12}$Sb$_4$S$_{13}$ coated CA film (Cu$_{12}$Sb$_4$S$_{13}$ particle density is 1.9 g/cm$^2$), (b) Cu$_{12}$Sb$_4$S$_{13}$ coated CA film (Cu$_{12}$Sb$_4$S$_{13}$ particle density is 5.7 mg/cm$^2$), (c) sectional view of Cu$_{12}$Sb$_4$S$_{13}$ coated CA film (Cu$_{12}$Sb$_4$S$_{13}$ particle density is 5.7 mg/cm$^2$).
Figure S4 2D and 3D AFM image of Cu$_{12}$Sb$_4$S$_{13}$ coated CA film.
Figure S5 The absorbance of water before and after Cu$_{12}$Sb$_3$S$_{13}$ film mediated 60 min photothermal treatment.
Figure S6 The cyclic test of evaporative capacity on pure water.
Figure S7 Time course of seawater evaporation with different dilution ratio.
Figure S8 Photographs of saturated NaCl solution before and after light irradiation.

Figure S9 Fluorescence images of E.coli incubated with Cu$_{12}$Sb$_3$S$_{13}$ film without light.