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# A novel flower-like Z-type heterojunction $CuS/Bi_7O_9I_3$ composite catalyst prepared under mild conditions for degradation of antibiotics and sterilization under visible light

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**T1 Photocatalytic antibacterial experiment**

(1) Culture of bacteria

Preparation:

1. Mix physiological saline (0.85% Na Cl solution), solid medium solution (25 g nutrient broth and 15 g agar powder per 1 L distilled water), LB liquid medium (per 1 L distilled water) 25 g nutrient broth), pipette (1 mL, 200 μL), sampling tube (2 mL centrifuge tube, 7 mL centrifuge tube), test tube (including test tube plug) are placed in a pressure steam sterilizer at 121°C Sterilize for 30 minutes.

2. After the sterilization is completed, remove the test items and place them in an oven at 80°C for 30 minutes.

3. After the drying is completed, place the unsolidified solid medium on an ultra-clean workbench, pour it into a Petri dish, cool and solidify, and put it upside down for use. All other experimental items were cooled to room temperature before use.

Incubate overnight in a warm shaker: the culture conditions are: speed 180 rpm/min, temperature 37°C, time 16 h.

(2) Antibacterial experiment

In this paper, the gradient dilution method and plate colony counting method were used to determine the antibacterial properties of the material.

Dilute the bacterial solution in the test tube of 0.85% NaCl solution 10 times, $10^2$ times, $10^3$ times, $10^4$ times, $10^5$ times, $10^6$ times, and $10^7$ times, draw 100 μL each and evenly spread on the solid medium and cultivate. After culturing in the box for 18 h, each live bacterium can form a single colony on the solid medium. Observe and record the number of colonies obtained. When the number of colonies in the medium is around 300, it is considered to be in accordance with the experimental design.

The specific photocatalytic antibacterial experiment process is as follows:

Weigh 10 mg of the sample into a 250 mL beaker, add 49.5 mL of 0.85% NaCl solution, and sonicate for 15 min to dissolve it evenly. After diluting the bacterial solution, 0.5 mL of

the bacterial solution was added to the 0.85% NaCl solution containing the sample, and stirring was started in the dark for 15 min to allow the bacteria to fully contact the sample. Start lighting and time, after the reaction is over. Aspirate 100 μL of the mixed liquid sampled at each time point and evenly spread it on the petri dish. Then, invert the culture in a constant temperature incubator, the culture conditions are: temperature 37 ℃, time 18 h. The experimental result is the average number of colonies grown after three parallel experiments.

**T2 Light response instrument parameters:**

The reaction vessel used in this study was a multi-tube simultaneous stirring photochemical reactor. The manufacturer of the optical chemical reaction instrument is Shanghai Bilang Instrument Manufacturing Co., Ltd., and the instrument model is BL-GHX-V. At the same time, it is equipped with a 1KW single-ended long arc xenon lamp (photon flux of 22000 lm) with a 420 nm filter. During the reaction, the reaction system was maintained at 20 °C by a double-layer quartz cold trap.

**Table S1**

BET calculation results for $Bi_7O_9I_3$ and $CuS/Bi_7O_9I_3$.

| Samples | Surface area (BET) [a] $m^2g^{-1}$ | Pore volume (P/P0=0.97) [b] $cm^3g^{-1}$ | Pore size (BJH) [c] nm |
|---|---|---|---|
| $Bi_7O_9I_3$ | 51.12 | 0.196 | 14.6 |
| $CuS/Bi_7O_9I_3$ | 64.32 | 0.234 | 21.5 |

a Measured using $N_2$ adsorption with the Brunauer-Emmett-Teller (BET) method.

[b] Total pore volume determined at $P/P_0$=0.97.

[c] Pore size in diameter calculated by the desorption data using Barrett-Joyner-Halenda (BJH) method.

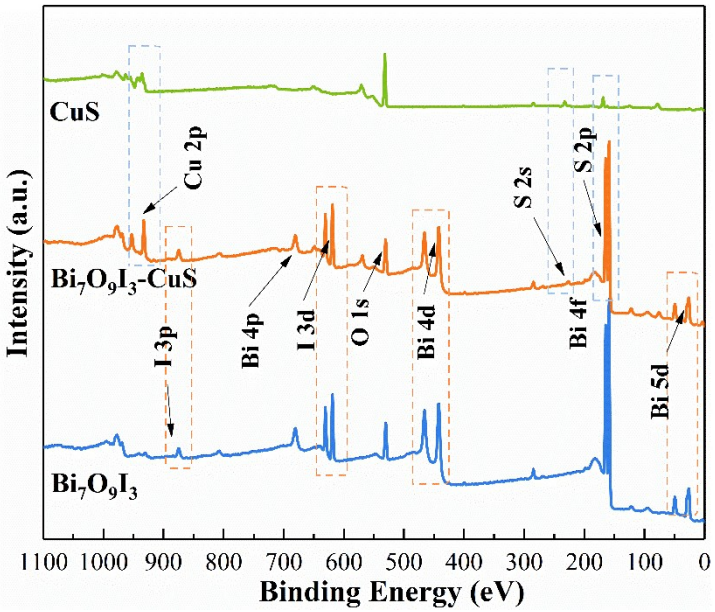
CuS
Cu 2p
Bi7O9I3-CuS
I 3p
Bi 4p
I 3d
O 1s
Bi 4d
S 2s
S 2p
Bi 4f
Bi 5d
Bi7O9I3
Intensity (a.u.)
1100 1000 900 800 700 600 500 400 300 200 100 0
Binding Energy (eV)

**Fig.S1**

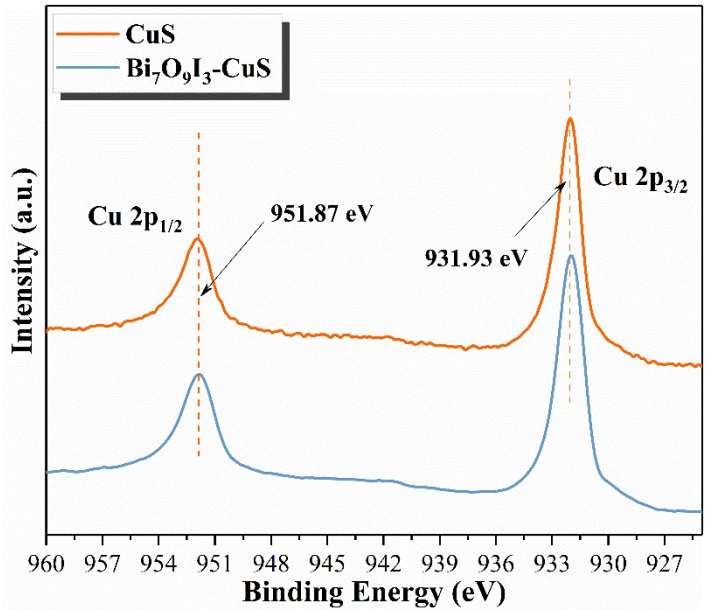
CuS
Bi7O9I3-CuS
Cu 2p1/2
951.87 eV
931.93 eV
Cu 2p3/2
Intensity (a.u.)
960 957 954 951 948 945 942 939 936 933 930 927
Binding Energy (eV)

**Fig.S2**

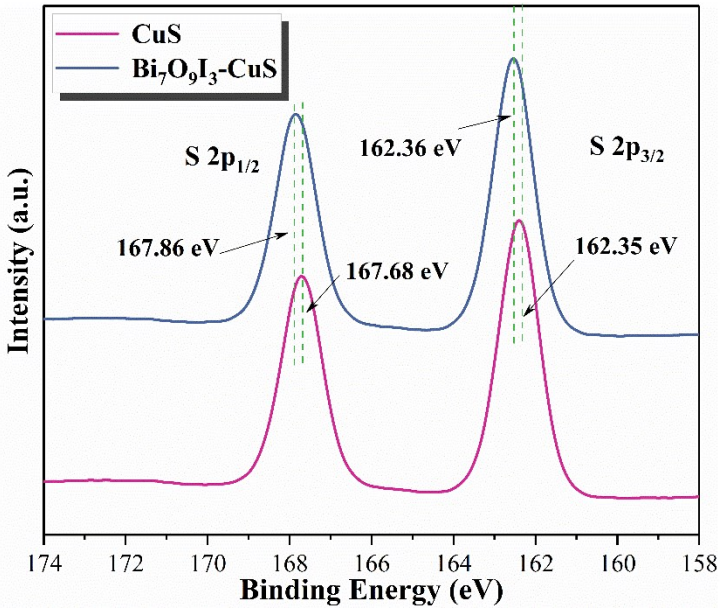
CuS
Bi7O9I3-CuS
S 2p1/2
S 2p3/2
162.36 eV
167.86 eV
167.68 eV
162.35 eV
Intensity (a.u.)
174
172
170
168
166
164
162
160
158
Binding Energy (eV)

**Fig.S3**

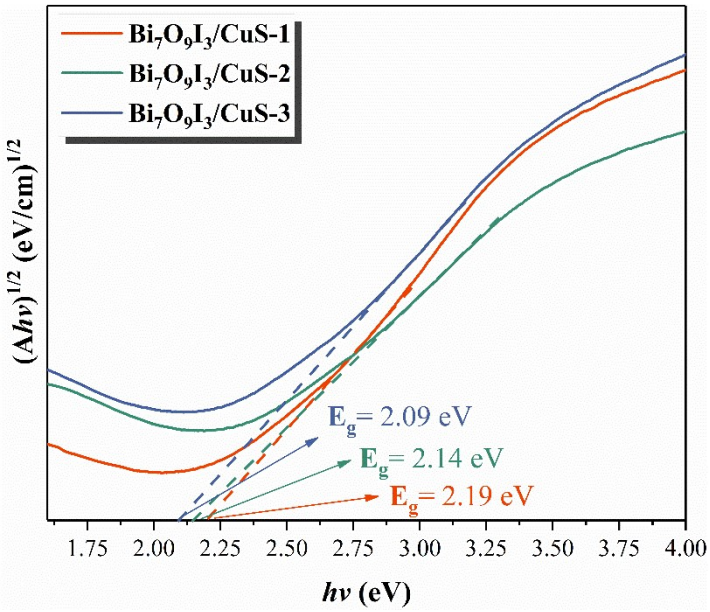
Bi7O9I3/CuS-1
Bi7O9I3/CuS-2
Bi7O9I3/CuS-3
(Ahν)1/2 (eV/cm)1/2
Eg= 2.09 eV
Eg= 2.14 eV
Eg= 2.19 eV
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
4.00
hν (eV)

**Fig.S4**

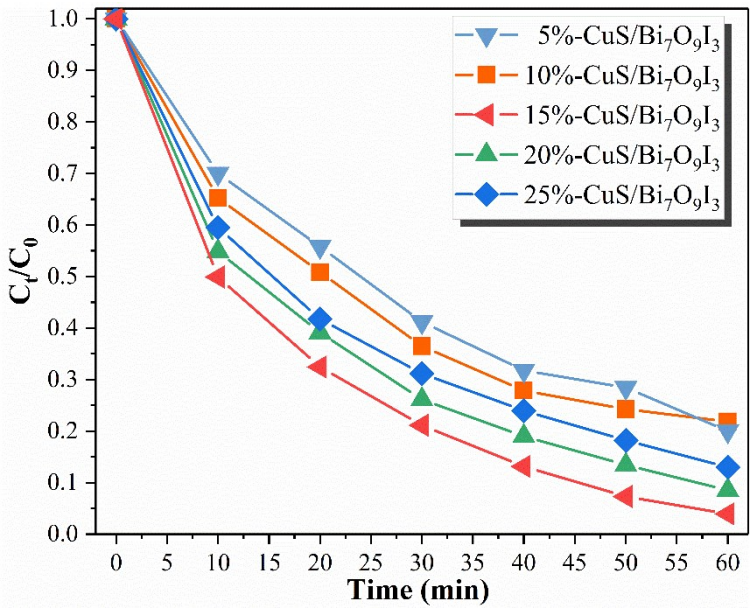
5%-CuS/Bi7O9I3
10%-CuS/Bi7O9I3
15%-CuS/Bi7O9I3
20%-CuS/Bi7O9I3
25%-CuS/Bi7O9I3
C_t/C_0
Time (min)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
0
5
10
15
20
25
30
35
40
45
50
55
60

**Fig.S5**

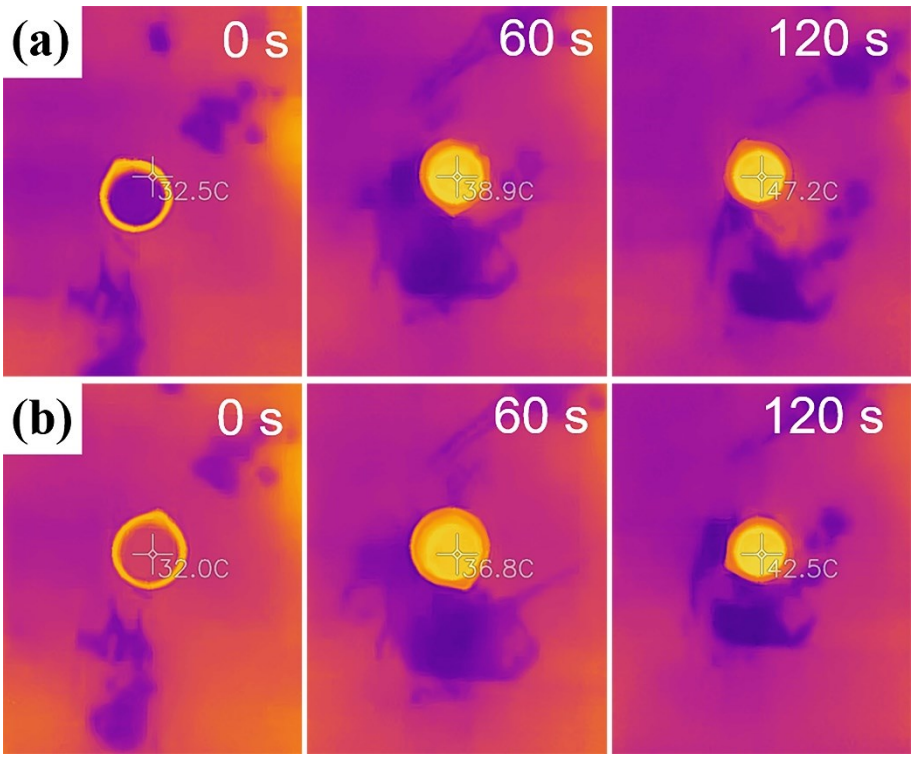
(a)
0 s
32.5C
60 s
38.9C
120 s
47.2C
(b)
0 s
32.0C
60 s
36.8C
120 s
42.5C

**Fig.S6**