

**Supporting information**

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**Cu<sub>2</sub>ZnSnS<sub>4</sub> Nanocrystals for Microwave Thermal and Microwave-dynamic Combination Tumor Therapy**

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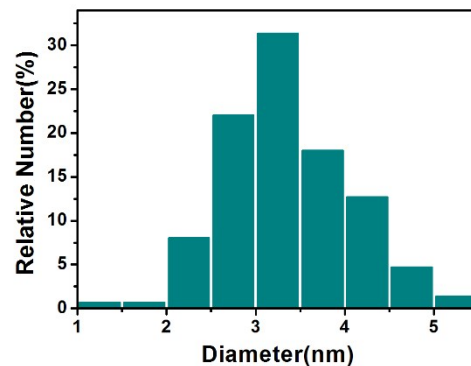
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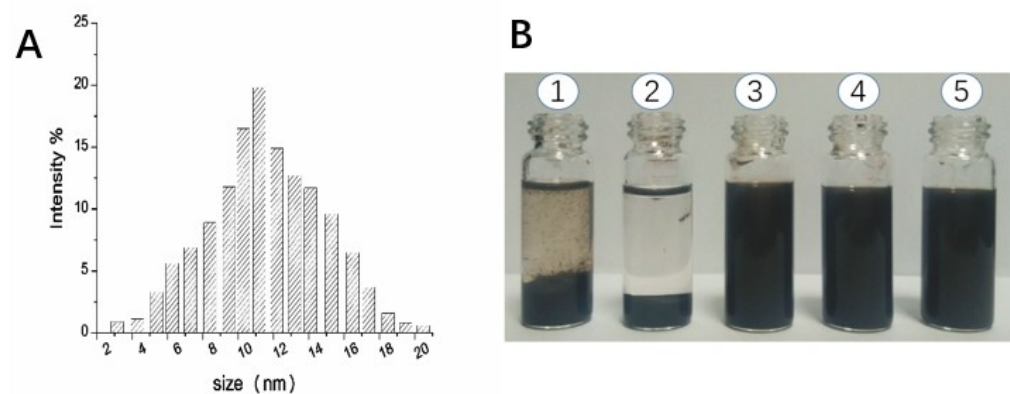
c. † These authors contributed equally.

## Preparation of CZTS NCs

Got the quantitative copper acetate, zinc acetate, four tin chloride in 150 mL three flasks, then added 50ml glycol, ultrasonic 3min and magnetic stirring 5 minutes mix evenly, got the precursor solution. The sodium-sulfur solution in methyl alcohol (15 mL) were added to the other bottle, then the mixture was under ultrasonic treatment. The three flasks solution were heated to 120°C under magnetic stirring, and then injected argon gas for vacuumizing. After 15 min, the solution were heated to 230°C and remained the temperature until the reactant was completely dissolved. Then the mixture of thiourea and ethylene glycol was injected into three bottles quickly, and the solution was immediately turned into deep black, keep the temperature of 230°C for 30 min. The obtained Cu<sub>2</sub>ZnSnS nanoparticles were collected by centrifugation and washed three times with the mixture of hexane and isopropyl alcohol.

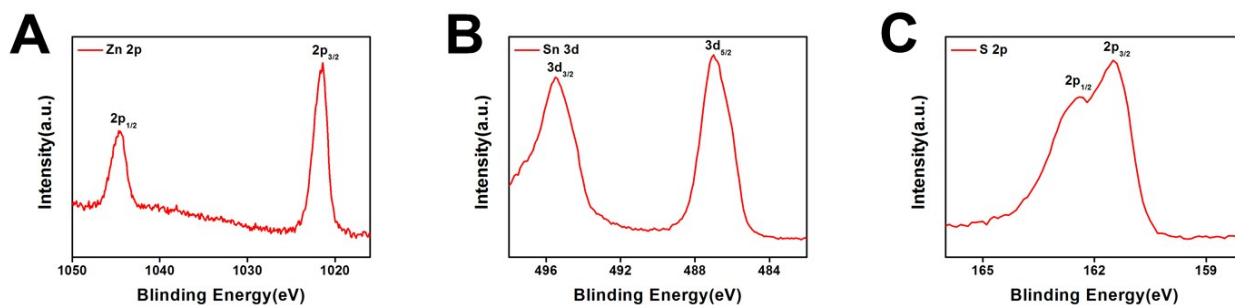


**Figure S1.** Particle size distribution of CZTS measured by statistical analysis.

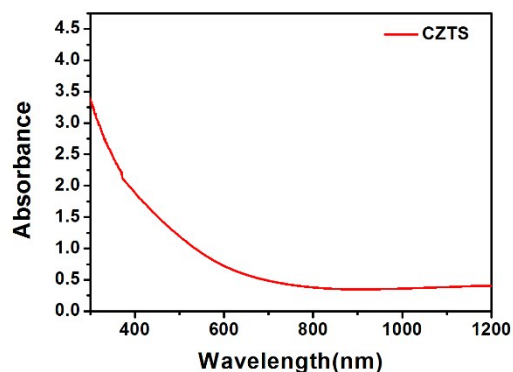


**Figure S2.** the average size of CZON by Zetasizer 3000HSA.B, Dispersity and stability

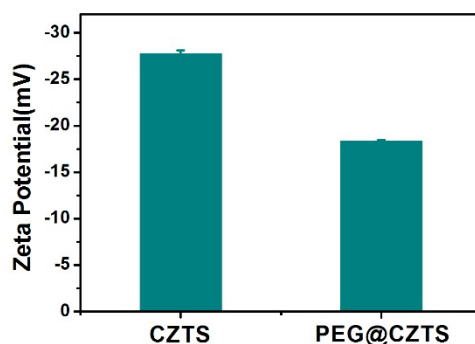
was measured by sedimentation experiments which showed that no obvious precipitation was observed for CZTS@PEG in pure water and phosphate buffer for 24 h. 1, CZTS in pure water for 24 h, 2, CZTS in phosphate buffer for 24 h, 3, CZTS modified with PEGylation in pure water for 24h, 4, CZTS modified with PEGylation in phosphate buffer for 24h, 5, CZTS modified with PEGylation in saline solution for 24h.



**Figure S3.** XPS spectra of the as-prepared CZTS: (A) Zn 2p, (B) Sn 2p, and (C) S 2p.



**Figure S4.** UV-vis absorption spectrum of CZTS nanocrystals. UV-Vis was measured on a JASCO UV-vis 570 UV-Vis spectrophotometer.



**Figure S5.** Zeta potential of CZTS and PEG @ CZTS nanocomposites. Zeta potential were measured by Zeta potential analyzer.

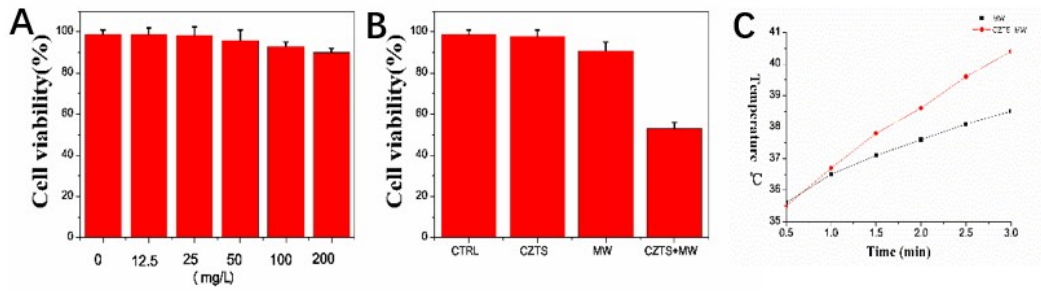


Figure S6 (A) Viability of H22 cells after incubation with CZTS NCs at various concentrations for 24 h. (B) Viabilities of H22 cells after CZTS (50 μg/mL) induced microwave thermal-ablation under microwave irradiation (0.5 W/cm<sup>2</sup>) for 3 min. (C) Temperature change of MW and CZTS+MW group received microwave irradiation (0.5 W/cm<sup>2</sup>) for 3 min.

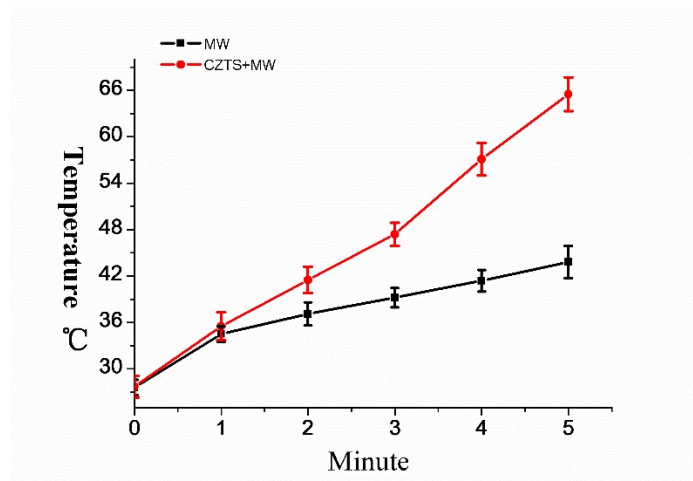


Figure S7 Temperature change of tumor detected by near-infrared thermal imaging after microwave irradiation for 5 min.

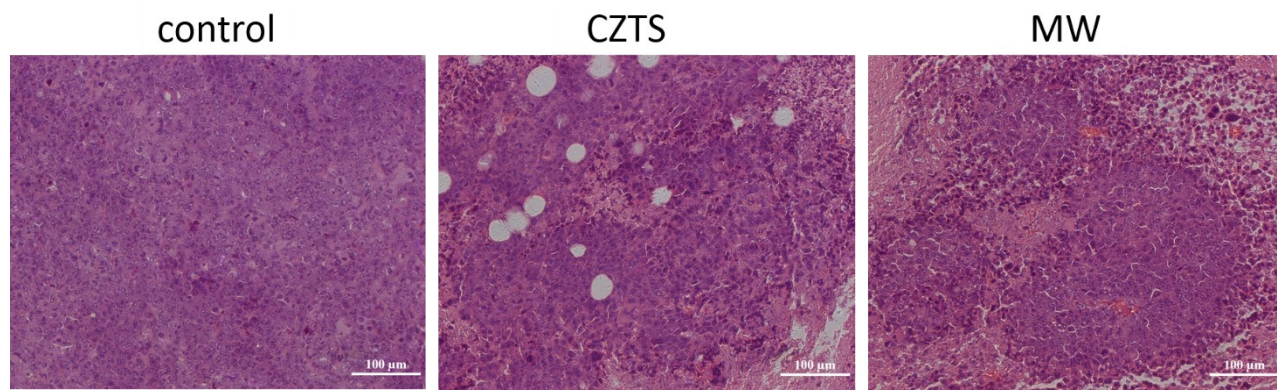


Figure S8 H&E staining of tumor tissues collected from mice in the different groups at the end of treatment. Scale bar= 100  $\mu\text{m}$ .

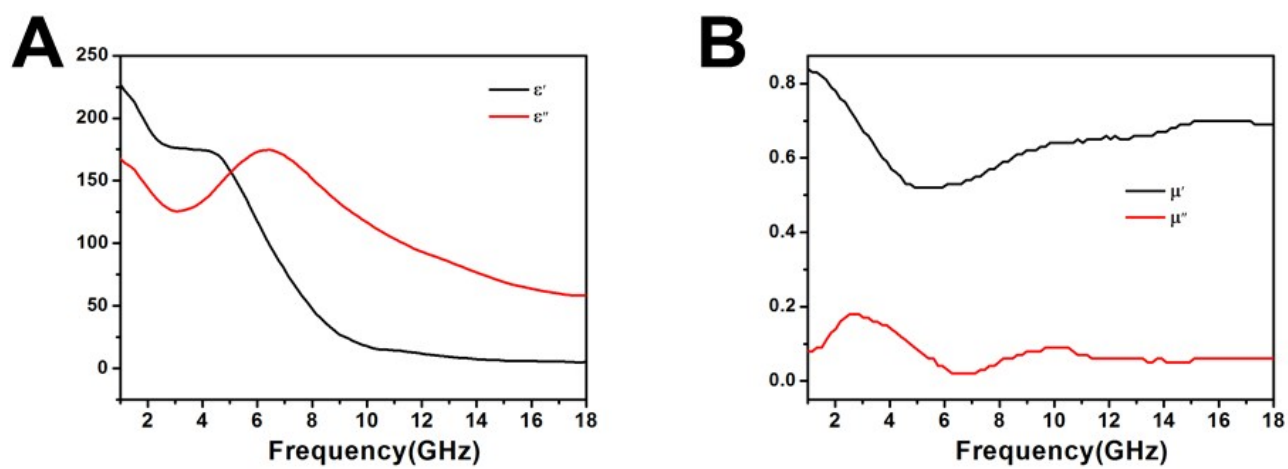


Figure S9 parameters of microwave absorption of CZTS.

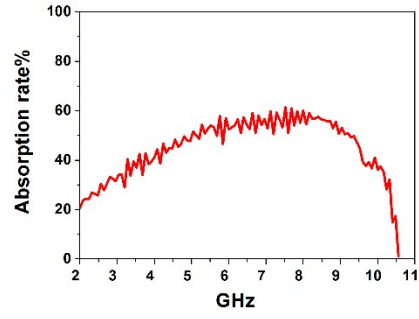


Figure S10 Absorption rate of CZTS with frequency from 2 to 10 GHz.

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