Supporting

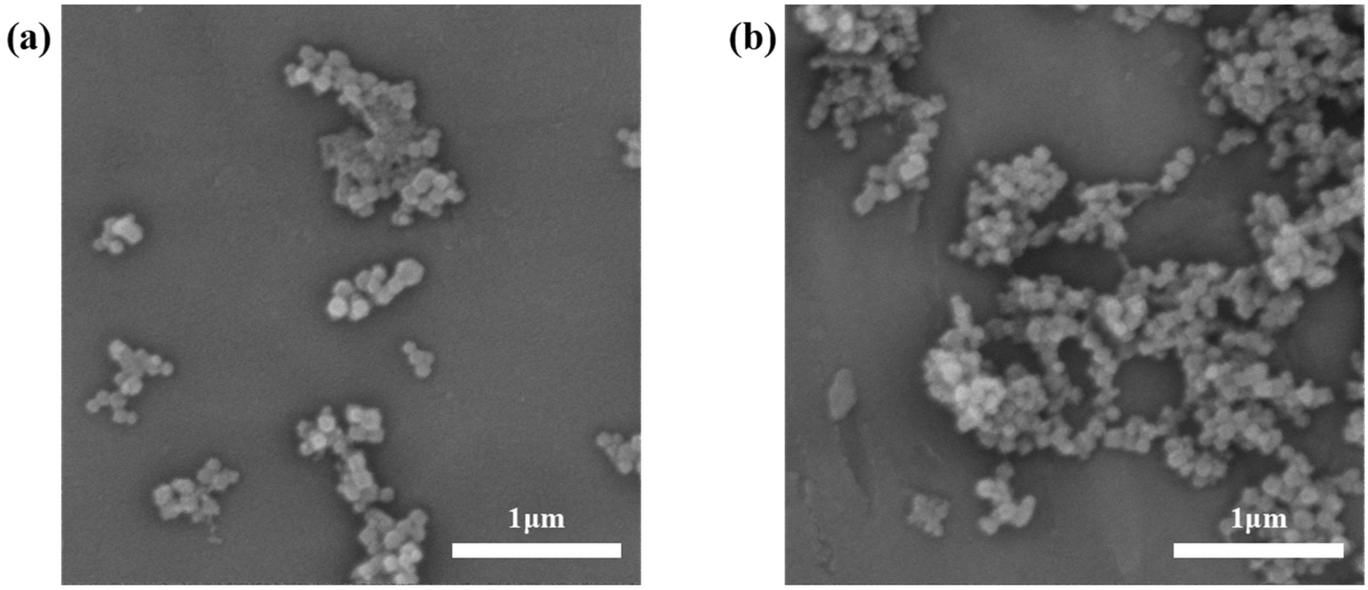

Fig. S1 SEM images of (a) ZIF-8 and (b) ZIF-8@HA.

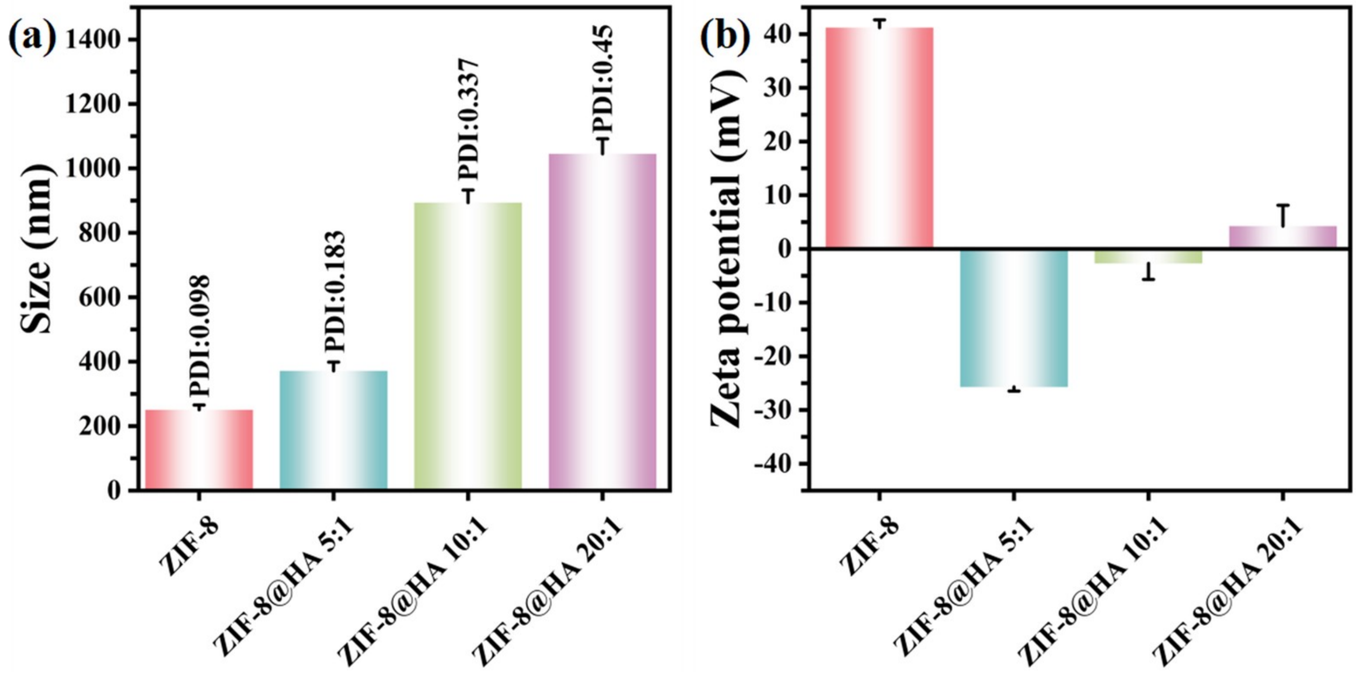

Fig. S2 (a) Hydrodynamic size and (b) zeta potential of ZIF-8@HA synthesized with different mass ratios (w/w) of ZIF-8 to HA.

Supporting Table I Parameters for calculating the MW thermal conversion efficiency η of ZIF-8 and ZIF-8@HA

	Q_{loss} (J)	Q_{heat} (J)	Q_{input} (J)	η (%)
0.9% NaCl	702.54	90.61	3600	22.03
ZIF-8	1532.02	155.33	3600	46.87
ZIF-8@HA	1518.34	154.07	3600	46.46

Microwave (MW) thermal conversion efficiency[1, 2] is used to evaluate the sensitization effect of Microwave-Thermal-Sensitive nanomaterials (MTSN). The MW thermal conversion efficiency of ZIF-8 and ZIF-8@HA is calculated based on two stages: MW heating and cooling. The MW heating stage (stage I) is the phase where temperature continuously rises under MW irradiation, while the free cooling stage (stage II) refers to the phase where temperature decreases after the MWe irradiation source is turned off. Fig. S3 shows the typical thermal curves of 10 mg mL^{-1} ZIF-8 and ZIF-8@HA dispersed in physiological saline (0.9% NaCl) solution under MW irradiation.

Based on the law of conservation of energy, when the antenna irradiates the target substance, part of the energy is absorbed and converted into thermal energy. Meanwhile, due to the temperature difference between the system and the surrounding environment, a portion of the thermal energy in the system is lost to the environment through heat conduction, convection, and other forms. Therefore, the MW thermal conversion efficiency can be calculated according to equation (1).

$$Q_{input} \cdot \eta = Q_{heat} + Q_{loss} \quad \textbf{(1)}$$

Where Q_{input} represents the energy input to the system from the MW irradiation source. η represents the nominal MW thermal conversion efficiency. Q_{heat} represents the temperature of the 0.9% NaCl mixed solution containing nanomaterials. Q_{loss} represents the heat loss from the system to the surrounding environment. Q_{input} and Q_{loss} can be calculated using equations (2) and (3):

$$Q_{input} = p \cdot s_1 \cdot (t_n - t_0) \quad \textbf{(2)}$$

$$\begin{aligned} Q_{heat} &= \sum_{t=t_0}^{t=t_n} C \\ &= C \cdot m \cdot (T_1 - T_0) + C \cdot m \cdot (T_2 - T_1) \\ &\quad + \cdots\cdots + C \cdot m \cdot (T_{n-1} - T_{n-2}) + C \cdot m \cdot (T_n - T_{n-1}) \\ &= C \cdot m \cdot (T_n - T_0) \end{aligned} \quad \textbf{(3)}$$

Where p is the output power of the MW source, s_1 is the surface area of the system heated by MW irradiation, t_n is the steady-state maximum temperature of the mixed solution, t_0 is the initial temperature before MW heating, C is the specific heat capacity of 0.9% NaCl.

Q_{loss} can be calculated using equation (4):

$$\begin{aligned} Q_{loss} &= \sum_{t=t_0'}^{t=t_n'} h \cdot s_1 \cdot \Delta\left(T_{nanomaterials} - T_{Env}\right) \cdot \Delta t \\ &= \sum_{t=t_0'}^{t=t_n'} h \cdot s_1 \cdot \Delta\left(f_1(t) - f_2(t)\right) \cdot \Delta t \end{aligned} \quad \textbf{(4)}$$

Where h is the thermal conductivity coefficient, $T_{nanomaterials}$ is the temperature of the mixed solution, T_{Env} is the environmental temperature, $f_1(t)$ and $f_2(t)$ are the functional formulas of $T_{nanomaterials}$ and T_{Env} with respect to time, respectively.

Based on the definition of integration, equation (4) can be transformed into:

$$\begin{aligned} Q_{loss} &= \sum_{t=t_0'}^{t=t_n'} h \cdot s_1 \cdot \Delta\left[f_1(t) - f_2(t)\right] \cdot \Delta t \\ &= h \cdot s_1 \sum_{t=t_0'}^{t=t_n'} \left[f_1(t) - f_2(t)\right] \cdot dt \\ &= h \cdot s_1 \cdot \int_{t_0'}^{t_n'} \left[f_1(t) - f_2(t)\right] \cdot dt \\ &= h \cdot s_1 \cdot \Delta S \end{aligned} \quad \textbf{(5)}$$

As an unknown parameter, the conversion of θ follows the equation:

$$\sum_{t=t_0'}^{t=t_n'} C \cdot m \cdot \frac{dT}{dt} = -h \cdot s_1 \cdot \Delta T \quad \textbf{(6)}$$

Let:

$$\theta = \frac{\Delta T}{T_{max}} \quad \textbf{(7)}$$

Then equation (6) can be derived as:

$$\sum_{t=t_0'}^{t=t_n'} C \cdot m \cdot \frac{d\theta}{dt} = -h \cdot s_1 \cdot \theta \quad \textbf{(8)}$$

Transposing terms yields:

$$dt = -\frac{\sum_{t=t_0'}^{t=t_n'} C \cdot m}{h \cdot s_1} \cdot \frac{d\theta}{\theta} \quad \textbf{(9)}$$

Define:

$$\xi_s = -\frac{\sum_{t=t_0'}^{t=t_n'} C \cdot m}{h \cdot s_1} \quad \textbf{(10)}$$

Then equation (9) can be simplified to:

$$t = \xi_s \cdot (-\ln\theta) + b \quad \textbf{(11)}$$

Where ξ_s can be obtained by linear fitting of t, ΔT, and ΔT_{max} during the heat dissipation stage (stage II) of the mixed solution. Fig. S3 (b) and (d) show the linear models of time versus -ln θ for ZIF-8 and ZIF-8@HA physiological saline mixed solutions based on the free cooling stage.

The final calculation formula for MW thermal conversion efficiency is:

$$\eta = \frac{Q_{heat} + Q_{loss}}{Q_{input}} = \frac{C \cdot m \cdot (T_n - T_0) + \frac{\sum_{t=t_0'}^{t=t_n'} C \cdot m}{\xi_s} \cdot \int_{t_0}^{t_n} \left[f_1(t) - f_2(t) \right] \cdot dt}{p \cdot s_1 \cdot (t_n - t_0)} \quad (12)$$

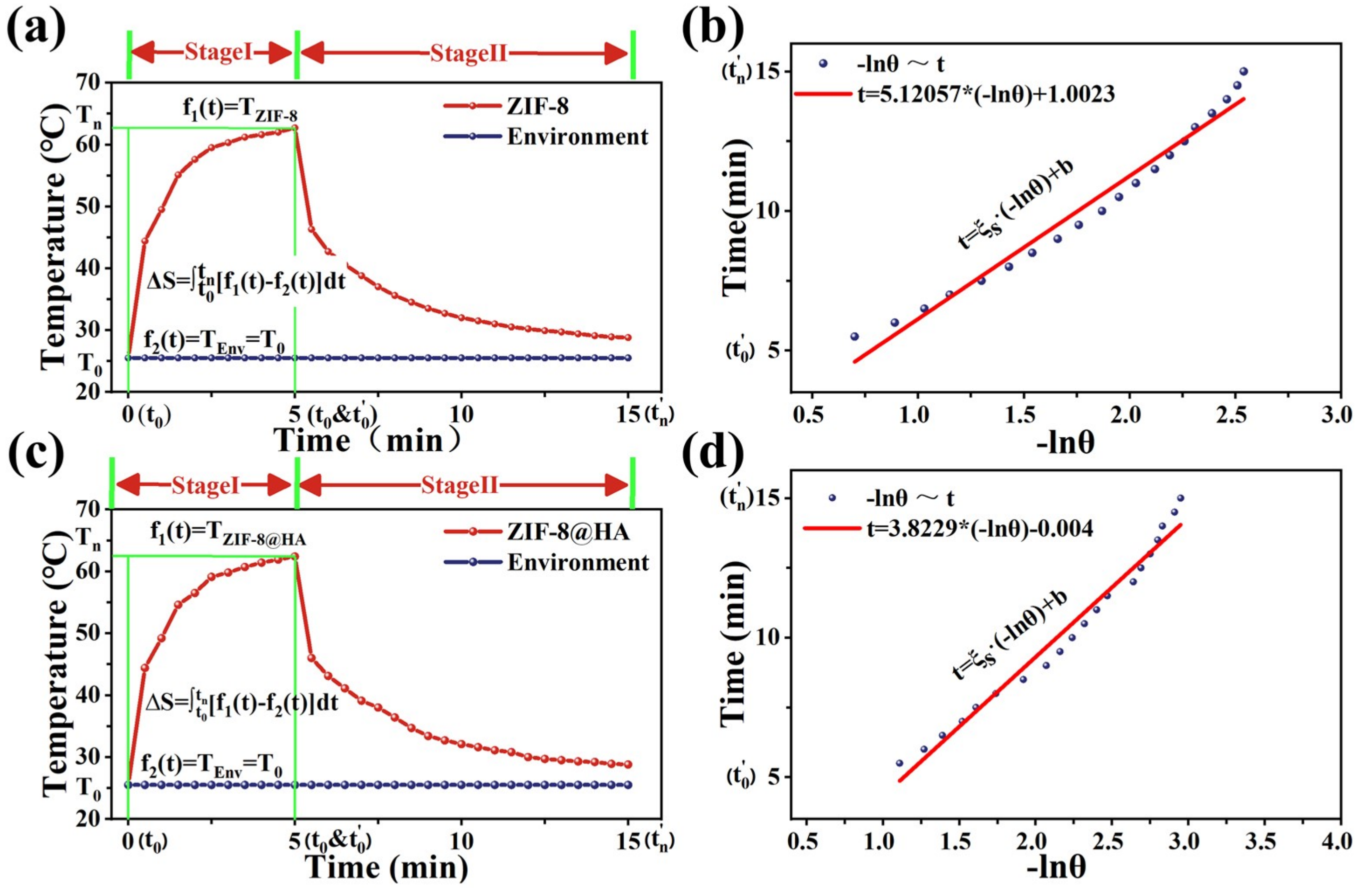

Fig. S3 (a) Temperature change curves of 10 mg mL^{-1} ZIF-8 nanomaterials dispersed in physiological saline solution before and after MW irradiation. (b) Linear model of time and -ln θ during the free cooling stage in (a) (where ξ_s is 5.12057). (c) Temperature change curves of 10 mg mL^{-1} ZIF-8@HA nanomaterials dispersed in physiological saline solution before and after MW irradiation. (d) Linear model of time and -ln θ during the free cooling stage in (c) (where ξ_s is 3.8229).

References

1. C. Fu, H. Zhou, L. Tan, Z. Huang, Q. Wu, X. Ren, J. Ren and X. Meng, *Acs Nano*, 2017, **12**, 2201-2210.
2. T. Li, Q. Wu, W. Wang, Z. Chen, L. Tan, J. Yu, C. Fu, X. Ren, P. Liang and J. Ren, *Biomaterials*, 2020, **234**, 119773.