Supplementary Information

Multifunctional $\alpha$-Fe$_2$O$_3$@PEDOT Core-Shell Nanoplatform for Gene and Photothermal Combination Anticancer Therapy

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Fig. S1. SEM images of α-Fe$_2$O$_3$@PEDOT core-shell NPs.

Fig. S2. X-ray diffraction (XRD) patterns of α-Fe$_2$O$_3$ NPs and α-Fe$_2$O$_3$@PEDOT core-shell NPs.
Fig. S3. Particles size distribution of (a) $\alpha$-Fe$_2$O$_3$ nanocrystals, (b) $\alpha$-Fe$_2$O$_3$@PEDOT core-shell NPs measured by dynamic laser scattering.

Fig. S4. Zeta potential of $\alpha$-Fe$_2$O$_3$ NPs and Fe$_2$O$_3$@PEDOT core-shell NPs.
Fig. S5. High-resolution XPS spectra of Fe 2p of $\alpha$-Fe$_2$O$_3$ and $\alpha$-Fe$_2$O$_3$@PEDOT

Fig. S6. FT-IR spectrum of Fe$_2$O$_3$@PEDOT core-shell nanoparticles from 400 to 4000 cm$^{-1}$.
The photothermal conversion efficiency ($\eta_T$)

The photothermal conversion efficiency ($\eta_T$) was calculated according to the model described previously by Roper’s et al.$^1,^2$ In briefly, (100 μg/mL, 500 mL) of Fe$_2$O$_3$@PEDOT was irradiated in a cuvette with NIR laser (808 nm, 1.0 W/cm$^2$) for 10 min. The temperature was recorded every 30 second. Instantly, the laser was turned off and the temperature was temporally measured until it reached to the ambient temperature.

The equation below was used to calculate the photothermal conversion efficiency ($\eta_T$).

$$\eta_T = \frac{hA(T_{\text{max}} - T_{\text{amb}}) - Q_0}{I(1 - e^{-A\lambda})}$$
Where, \((T_{\text{max}}, T_{\text{amb}})\) is the maximum and ambient system temperatures, \((A)\) surface area of the container, \((h)\) is the heat transfer coefficient, \((Q_0)\) the rate of heat input due to absorption of light energy by water, \((I)\) laser power, and \((A_\lambda)\) the absorbance of the \(\text{Fe}_2\text{O}_3@\text{PEDOT}\) at 808 nm. After laser switching off, the cooling curves of \(\text{Fe}_2\text{O}_3@\text{PEDOT}\) aqueous solution and water was plotting between \(\ln(\Delta T)\) and function of time, a linear plot yielded with the slope equalling to \(-1/\tau_s\) (Fig. 8a, 8b). The \((hA)\) values of \(\text{Fe}_2\text{O}_3@\text{PEDOT}\) and water were calculated by the equation below.

\[
\tau_s = \frac{m_i C_i}{hA}
\]

Where \((C_i, m_i)\) are the heat capacity and the mass multiplied for the sample, at that point \(Q_0\) was calculated by water by using the equation below.

\[
Q_0 = hA(T_{\text{water max}} - T_{\text{water amb}})
\]

Finally, we calculate photothermal conversion efficiency \((\eta = 54.3\%)\) of our \(\text{Fe}_2\text{O}_3@\text{PEDOT}\) core-shell NPs.

**Fig. S8.** (a) Heating and cooling curves of \(\alpha\text{-Fe}_2\text{O}_3@\text{PEDOT}\) and water irradiated by an 808 nm NIR laser \((1.0\ \text{W/cm}^2)\). (b) The cooling curves with the fitting of \(\alpha\text{-Fe}_2\text{O}_3@\text{PEDOT}\) and water.
**Fig. S9.** The mice tumor images of the Fe$_2$O$_3$@PEDOT treatment group.

**References**