Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

Electronic Supplementary Information

pH-responsive drug release and NIR-triggered singlet oxygen generation based on multifunctional core-shell-shell structure

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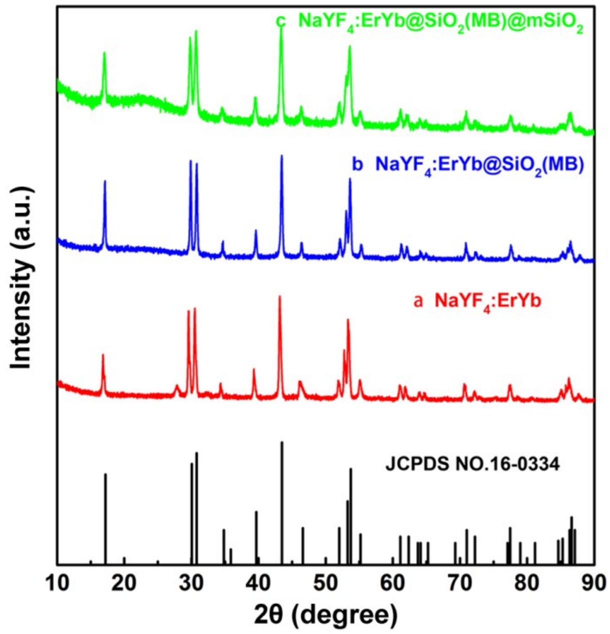

Fig. S1 Powder X-ray diffraction (XRD) patterns for $NaYF_4$:ErYb (a), $NaYF_4$:ErYb@SiO_2(MB) (b) and $NaYF_4$:ErYb@SiO_2(MB)@mSiO_2 (c). The standard card of β-NaYF4 (JCPDS: 16-0334) was given as a reference.

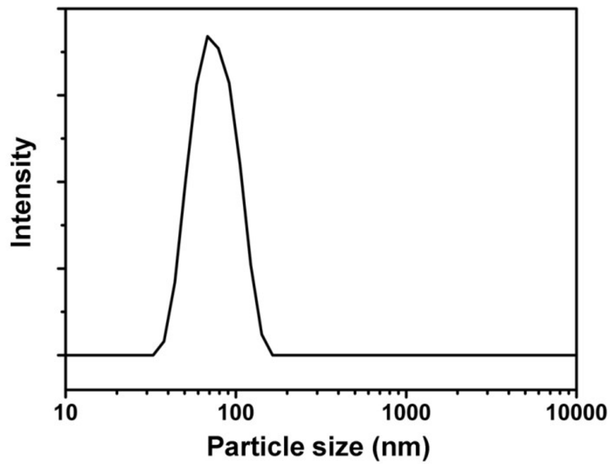

Fig. S2 Particle size distribution of UCNP@SiO_2(MB)@mSiO_2 nanoparticles obtained by DLS. The diameter of final core-shell-shell structure measured with DLS was 70 nm and larger than that obtained from TEM (Fig. S2), which would be attributed to the dynamic sizes of the nanoparticles. [1,2]

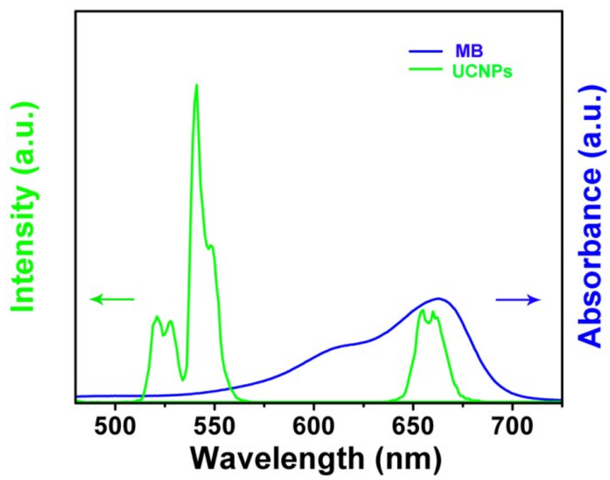

Fig. S3 Upconversion fluorescent spectrum of UCNP@SiO_2@$mSiO_2$ solid powder under NIR laser excitation (λ= 980 nm, 0.5 W cm^{-2}) and UV/Vis absorbance spectrum of MB.

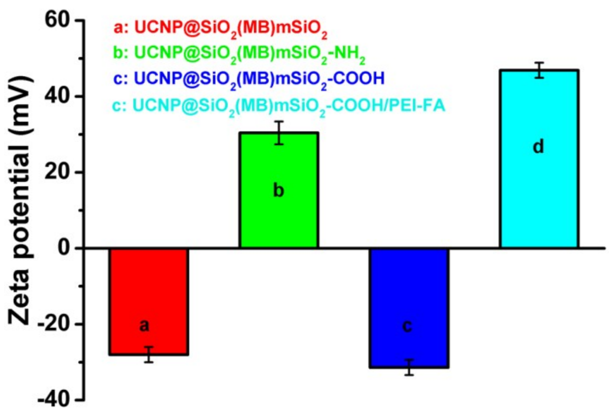

Fig. S4 Zeta potentials of UCNP@SiO_2(MB)@$mSiO_2$ (a), UCNP@SiO_2(MB)@$mSiO_2$-NH_2 (b), UCNP@SiO_2(MB)@$mSiO_2$-COOH (c), and UCNP@SiO_2(MB)@$mSiO_2$-COOH/PEI-FA (d).

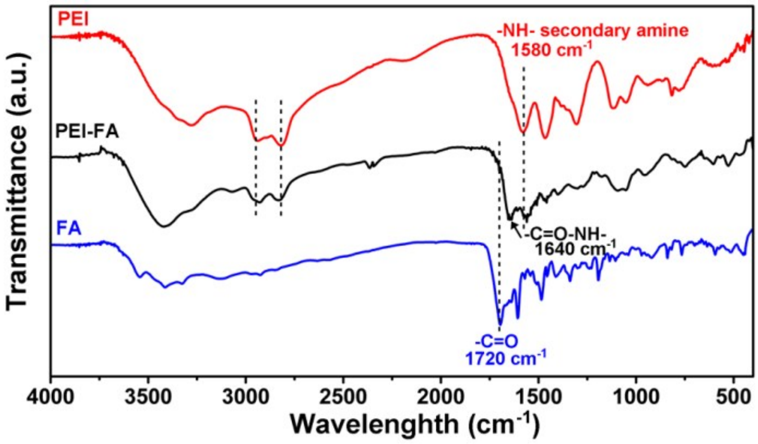

Fig. S5 FTIR spectra of PEI (red) , PEI-FA (black) and FA (blue).

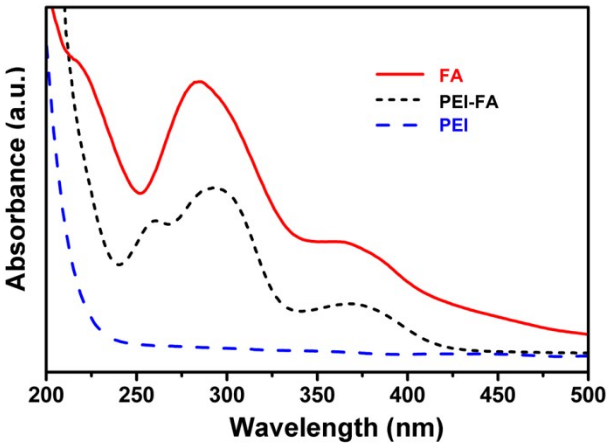

Fig. S6 UV/Vis absorption spectra of FA (red), PEI-FA (black) and PEI (blue). All the samples were dissolved in DMSO.

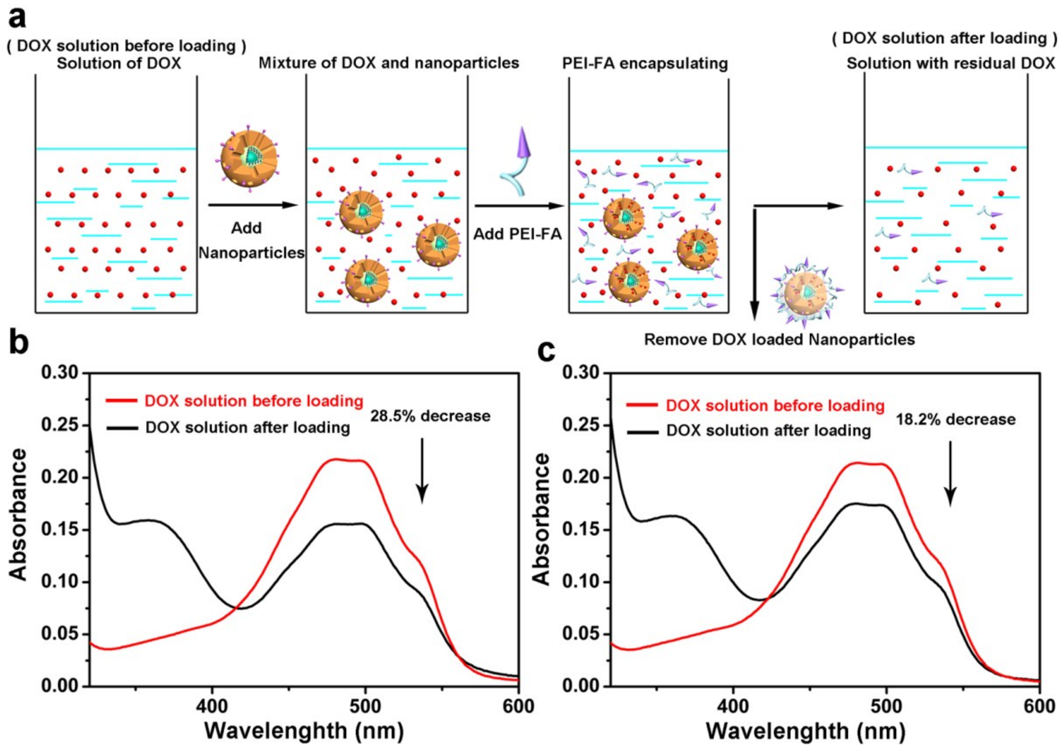

Fig. S7 (a) Schematic illustration of the procedure to determine the DOX loading efficiency in as-prepared nanoparticles. (b) UV/Vis absorption spectra of DOX solution before and after loading for UCNP@SiO_2(MB)@mSiO_2-COOH. (c) UV/Vis absorption spectra of DOX solution before and after loading for UCNP@SiO_2(MB)@mSiO_2. Using Beer's Law, it can be calculated the DOX loading efficacy is 1.7 % (17 μg DOX in 1 mg nanoparticles) for UCNP@SiO_2(MB)@mSiO_2-COOH and 1.07 % (10.7 μg DOX in 1 mg nanoparticles) for UCNP@SiO_2(MB)@mSiO_2 , respectively. [3]

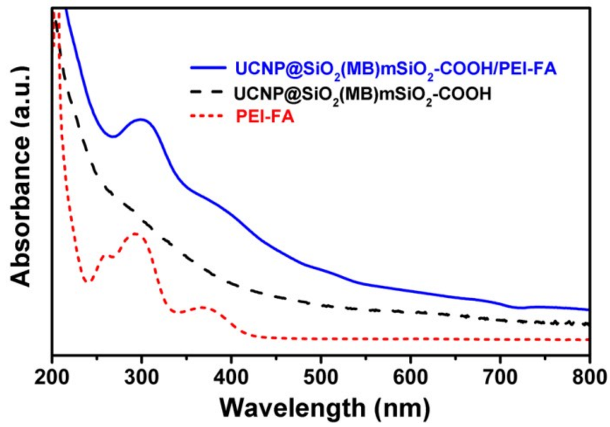

Fig. S8 UV/Vis absorption spectra of UCNP@SiO_2(MB)@mSiO_2-COOH/PEI-FA (blue), UCNP@SiO_2(MB)@mSiO_2-COOH (black) and PEI-FA (red). All the samples were suspended or dissolved in deionized water.

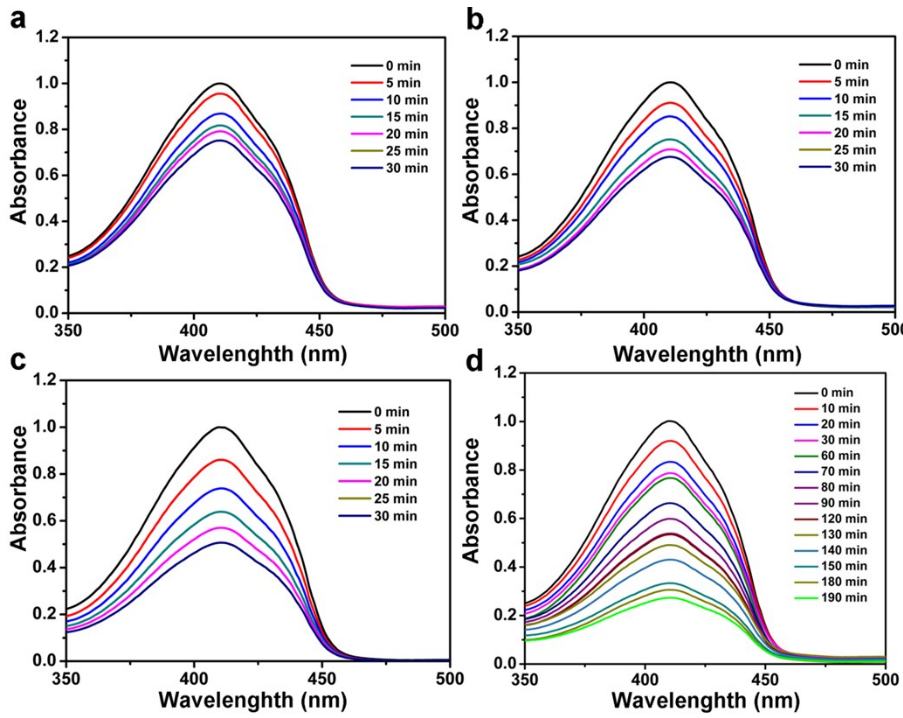

Fig. S9 Original UV/Vis spectra of DPBF upon continuous 980 nm laser irradiation at a power density of 1.0 W cm^{-2} (a), 2.0 W cm^{-2} (b), and 3.5 W cm^{-2} (c) for UCNP@SiO_2(MB)@mSiO_2 nanoparticles in Fig. 6a. (d) Original UV-Vis spectrum of DPBF upon 980 nm laser ON/OFF irradiation at a power density of 0.6 W cm^{-2} for UCNP@SiO_2(MB)@mSiO_2 nanoparticles in Fig. 6b.

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2 X. Ma, S. Sreejith and Y. Zhao, *ACS Appl. Mater. Interfaces*, 2013, **5,** 12860.

3 He, K. Krippes, S. Ritz, Z. Chen, A. Best, H. J. Butt, V. Mailander and S. Wu, *Chem*, *Commun*., 2015, **51**, 431.