Supporting Information

Polydopamine coated multifunctional lanthanide theranostic agent for vascular malformation and tumor vessel imaging beyond 1500 nm and imaging-guided photothermal therapy

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Figure S1. The typical TEM and XRD results of the as-prepared NaLuF₄: Yb/Er samples with/without doping Gd: (A) TEM image of NaLuF₄: Gd/Yb/Er. (B) TEM image of NaLuF₄: Yb/Er. (c) XRD patterns of the NaLuF₄: Yb/Er (blue line), and NaLuF₄: Gd/Yb/Er (red line). The inset of Figure S1B denotes the corresponding selected area electron diffraction pattern.
Figure S2. The XPS pattern of the as-prepared NaLuF$_4$: Gd/Yb/Er NRs and NRs@PDA and XPS N1s spectrum of NRs@PDA (the inset).
Figure S3. FTIR spectra of OA-NaLuF$_4$: Gd/Yb/Er NRs and NRs@PDA nanocrystals. The weak absorption peaks at 2926 and 2855 cm$^{-1}$ are attributed to the asymmetric and symmetric stretching vibrations of the -CH$_2$ bond, respectively. The broader and stronger band centered at 3435 cm$^{-1}$ is originated from the O-H group. The characteristic peaks at 1577 cm$^{-1}$ and 1496 cm$^{-1}$ are associated to the PDA.
**Figure S4.** The emission spectra of (A) IR-26 and (B) NRs@PDA and the absorption spectra of (C) IR-26 and (D) NRs@PDA. The optical density (OD) in each absorption spectrum of IR-26 and NRs@PDA presents the absorbance value at 808 nm and 980 nm, respectively.
Figure S5. Photo-stability curve and in vitro phantom imaging (the inset picture) of NaLuF$_4$ NRs@PDA in water and PBS under continuous 980 nm laser irradiation with a power density of 0.6 W cm$^{-2}$ at different time points.
Figure S6. (A) The *in vitro* phantom imaging of ICG and NRs@PDA solutions after irradiation of 808 nm and 980 nm laser with different times, respectively. (B) The corresponding NIR-II fluorescent intensity.
**Figure S7.** *In vitro* HeLa cells viability after incubated with various concentrations of NaLuF$_4$ NRs@PDA for 24 h at 37 °C under 5% CO$_2$. 
Figure S8. The time-dependent average signal intensity changes in liver and heart sites of tumor mouse.
Figure S9. The corresponding NIR-II fluorescent intensity of the liver and tumor after 60 h intravenous injection with NaLuF₄ NRs@PDA under 980 nm laser excitation.
Figure S10. Ex vivo bioimaging of the isolated organs, including heart, liver, spleen, lung, and kidney after 3 and 7 days injection with NaLuF₄ NRs@PDA.
Figure S11. (A) Time dependent NaLuF$_4$ NRs@PDA contents in blood (based on the tested fluorescence intensity). The inset presents the corresponding in vitro NIR-II imaging of blood after intravenous injection of NaLuF$_4$ NRs@PDA in 24 h under 980 nm laser excitation (100 mW/cm$^2$). (B) Digital photography, in vitro imaging of feces from un-injected and injected mouse.
**Figure S12.** (A) A time course of high-magnification tumor vascular imaging with FOV of 26 mm × 21 mm. (B) and (C) Cross-sectional intensity profiles along the colour lines marked in (A). The scale bar is 2 mm.
**Figure S13.** (A) High-magnification NIR-II vessel image of mouse abdomen under the 980 nm laser excitation (FOV: 21 mm × 26 mm, 512 × 640 pixels, 41 μm/pixel). (C) A typical abdomen vessel image taken from (A). (B) and (D) The corresponding zoom-in images of the chosen vessels. (E) and (F) Cross-sectional intensity profiles measured along the colorized lines from the images of (B) and (D), respectively. All scale bars are 2 mm.
Figure S14. *In vitro* thermal images based on NRs@PDA solution with different concentrations under the irradiation of 808 nm laser.
Figure S15. H&E stained main tissues collected from control and experiment mouse injected with NRs@PDA solution for 3 and 7 days.