Supplementary Materials

Engineered rare-earth nanomaterials for fluorescence imaging and therapy

Hongru Wang [1,2], Zheng Wei [3], Yangyang Zhao [5], Shidong Wang [4,*] , Lili Cao [2,*] , Fan Wang [3], Kai Liu [3,5] and Yanfei Sun [3,*]

[1]Department of Neurology, Liaocheng People's Hospital, Liaocheng, Shandong, 252000, China
[2]Department of Neurology, Qilu Hospital of Shandong University, Jinan, Shandong, 250012, China
[3]State Key Laboratory of Rare Earth Resource Utilization, Changchun Institute of Applied Chemistry, Chinese Academy of Sciences, Changchun 130022, China
[4]Musculoskeletal Tumor Center, Peking University People's Hospital, Beijing, 100044, China
[5]Department of Chemistry, Tsinghua University, Beijing 100084, China
*Correspondence: stonewang@bjmu.edu.cn; qilucll@163.com; Sunyf90@163.com

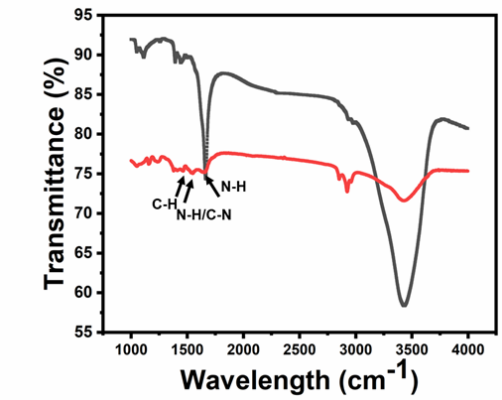

Fig. S1. The Fourier Transform Infrared (FTIR) spectroscopy of pristine UCNP (no oleate ligands capped, black) and UCNPs@Au (red) nanoparticles. The successful coating of PEI on UCNP is confirmed by the FTIR spectrum with a peak at 1502 cm^{-1}.

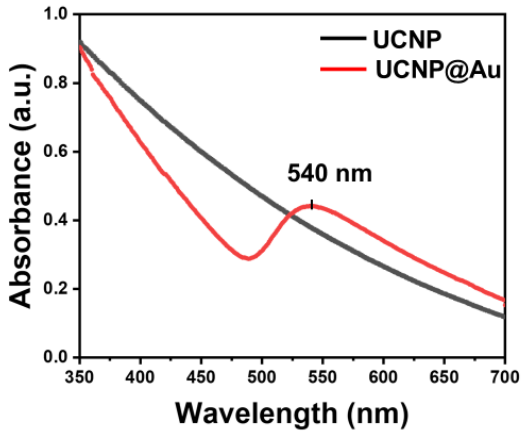

Fig. S2. Ultraviolet–Visible (UV-Vis) spectra of UCNP@PEI and UCNP@Au aqueous solution. The UV-Vis spectra of UCNP@Au nanoparticles showed a strong absorption at 540 nm, resulting from the plasma resonance absorption peak of isotropous Au nanoparticles.

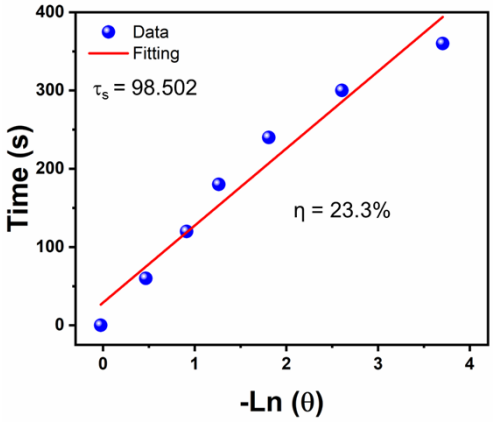

Fig. S3. The photo-thermal conversion efficiency (η) of UCNPs@Au. η was calculated as follows [1]: $\eta=hS(T_{max,NPs}-T_{max,solvent})/I(1-10^{-A980})$; $t=-\tau_s$ Lnθ; $\theta=(T-T_{surr})/(T_{max,NPs}-T_{surr})$; $hS=m_dC_d/\tau_s$. m_d=1 g, C_d=4.2 $J\cdot g^{-1}$ $T_{max,NPs}$=49.4 °C, $T_{max,solvent}$=30.8 °C, T_{surr}= 25 °C，A_{980}=0.625, I=4.458 $W\cdot cm^{-2}$.

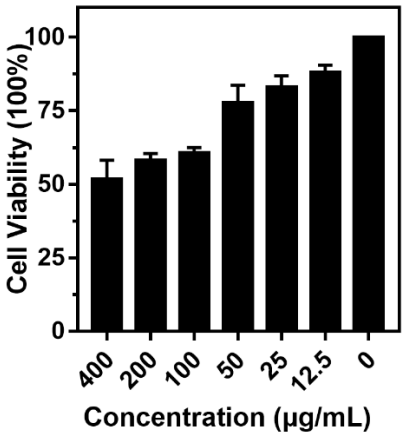

Fig. S4. Cell counting kit-8 (CCK8) assay for the cytotoxicity of UCNPs@Au nanoparticles in mouse embryonic fibroblast cell lines (NIH-3T3) cells.

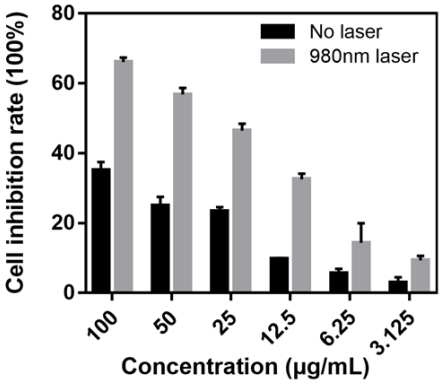

Fig. S5. CCK-8 assay to measure the anti-tumour effect of UCNPs@Au nanoparticles in mouse glioma 261 (GL261) cells. Different concentrations of UCNPs@Au nanoparticles were used under the 980 nm laser.

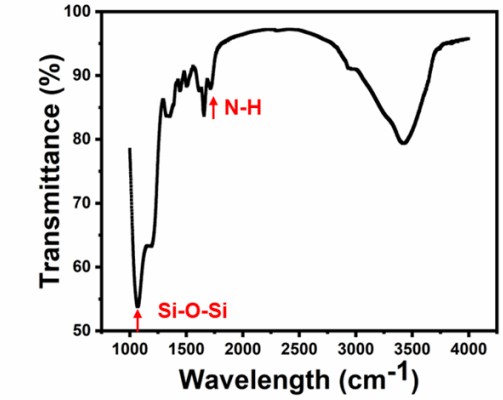

Fig. S6. The FTIR spectrum of the UCNPs@mSiO_2@TA–Al nanoparticle. The formation of the Si–O–Si framework is evidenced by the band located at 1080 cm^{-1}. The band located at 1650 cm^{-1}，which corresponds to the bending vibration –NH– group indicates the presence of amino groups in

UCNPs@mSiO$_2$-NH$_2$.

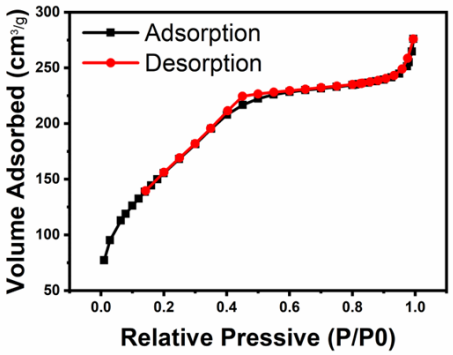

Fig. S7. Nitrogen adsorption−desorption isotherms for UCNPs@mSiO$_2$.

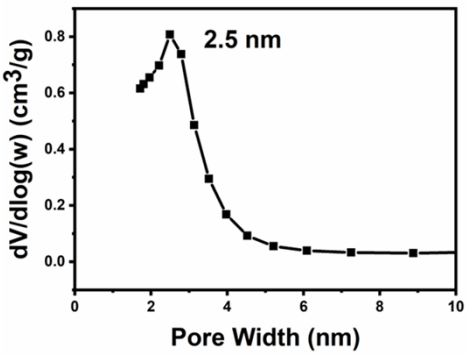

Fig. S8. Pore size analysis for UCNPs@mSiO$_2$.

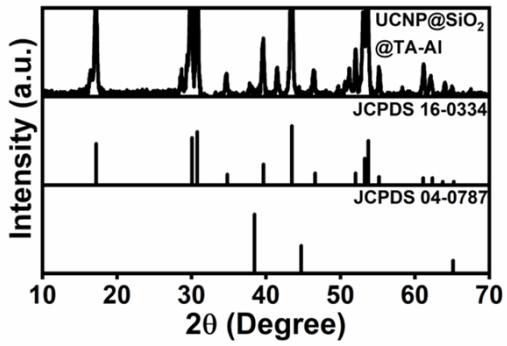

Fig. S9. Powder X-ray Diffraction (XRD) spectra of the UCNPs@mSiO$_2$@TA–Al nanoparticle. Standard card of β-NaYF$_4$ (JCPDS no. 16-0334) and Al (JCPDS 04-0787) were presented.

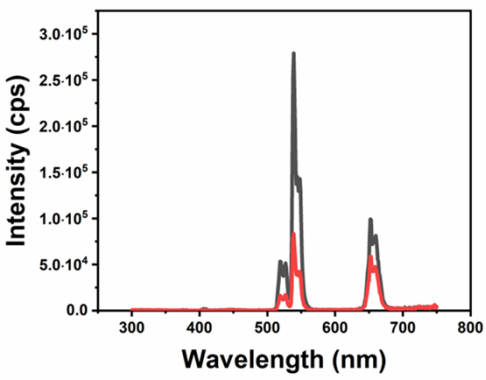

Fig. S10. Upconversion fluorescence emission spectra of UCNPs@$mSiO_2$ (black) and UCNPs@$mSiO_2$@TA–Al nanoparticle (red). They were excited with a 980 nm NIR laser.

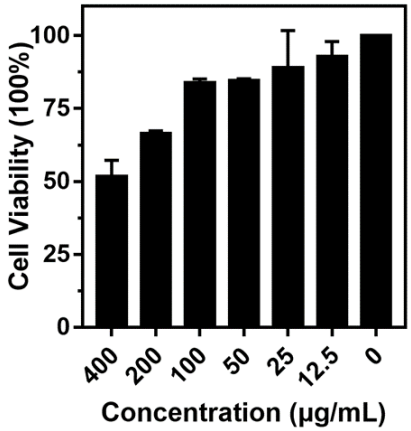

Fig. S11. CCK-8 assay to examine the cytotoxicity of UCNPs@$mSiO_2$@TA–Al in NIH-3T3 cells.

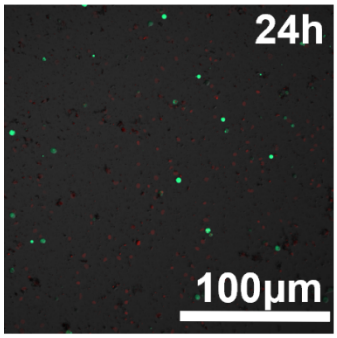

Fig. S12. GL261 cells were inhibited within 24 h by the UCNPs@$mSiO_2$–Dox@TA–Al (100 μg/mL) nanoparticles in calcein-acetoxymethyl (AM)/propidium iodide (PI) co‑staining.

References:

1. Liu, B.; Sun, J.; Zhu, J.; Li, B.; Ma, C.; Gu, X.; Liu, K.; Zhang, H.; Wang, F.; Su, J.; et al. Injectable and NIR-Responsive DNA-Inorganic Hybrid Hydrogels with Outstanding Photothermal Therapy. *Adv Mater* **2020**, *32*, e2004460, doi:10.1002/adma.202004460.