

Supplementary Information

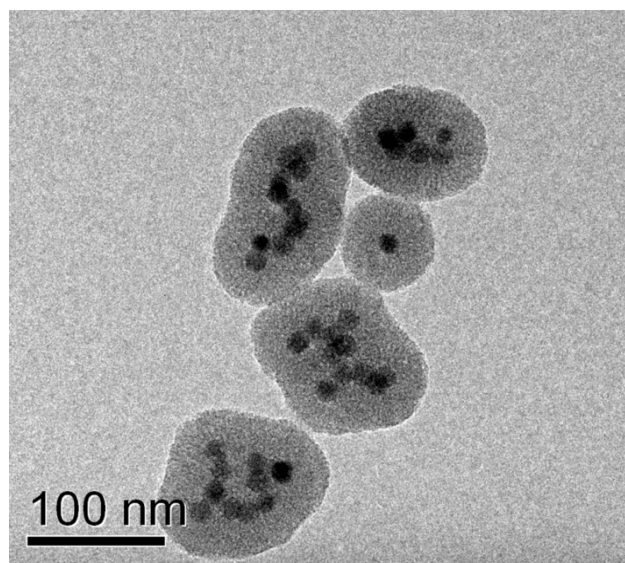


Figure S1. TEM image of the mesoporous silica nanoparticles encapsulating multiple UCNPs when the transfer of UCNPs from organic phase into water was not properly done.

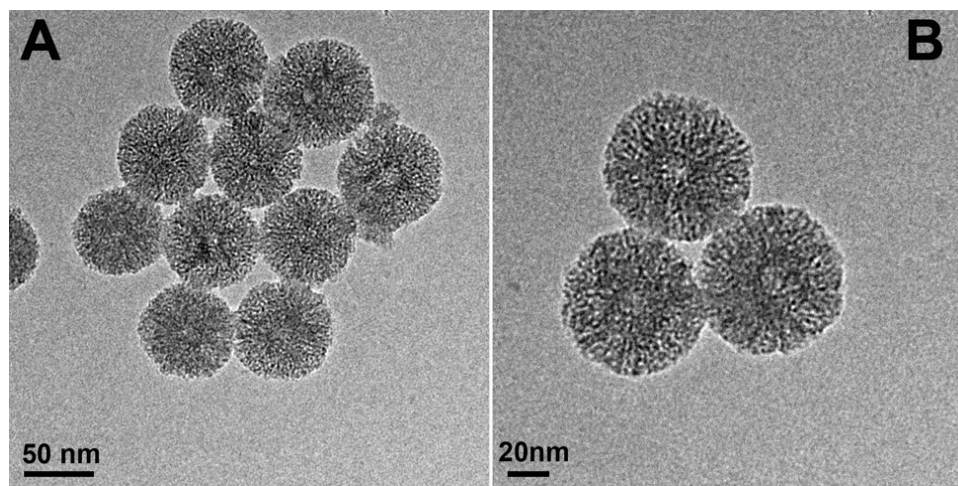


Figure S2. TEM images of the hollow mesoporous silica nanoparticles after removing both CTAB and UCNPs by using HCl and methanol solution (pH 1.0).

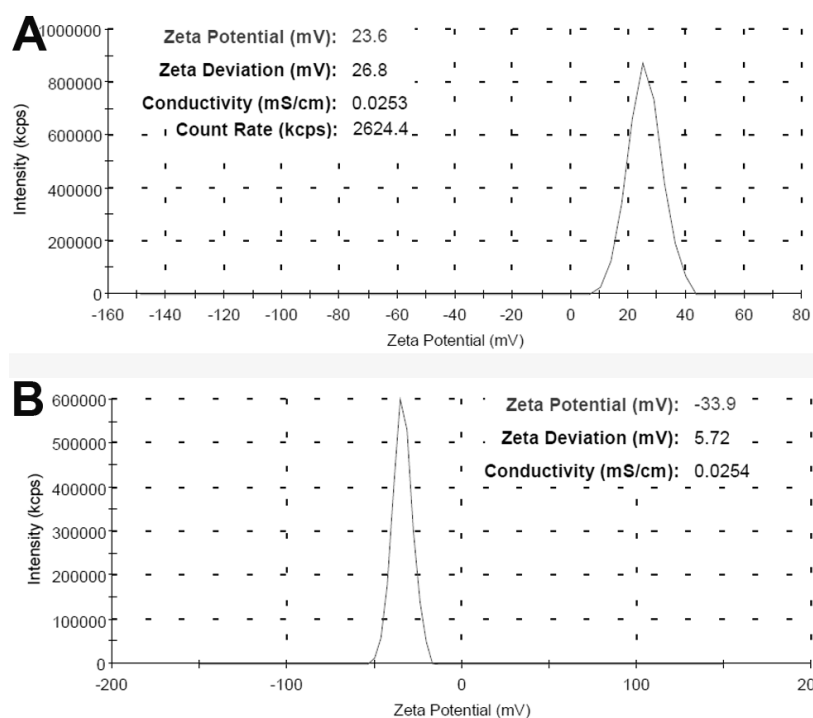


Figure S3 Zeta potential of the UCNPs@mSiO₂ nanoparticles before (A) and after (B) removal of CTAB molecules.

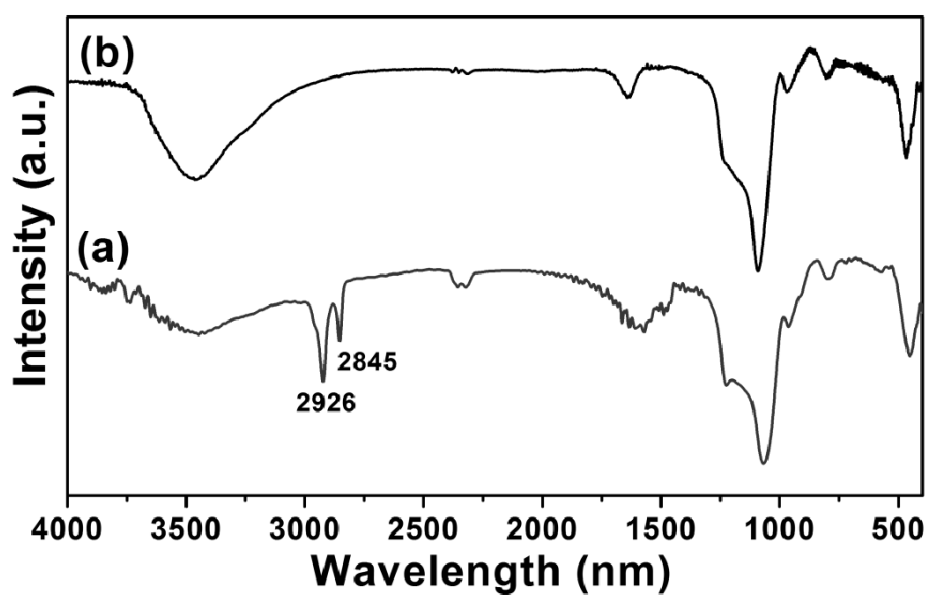


Figure S4 FT-IR spectra of the UCNPs@mSiO₂ nanoparticles before (a) and after (b) the removal of CTAB molecules.

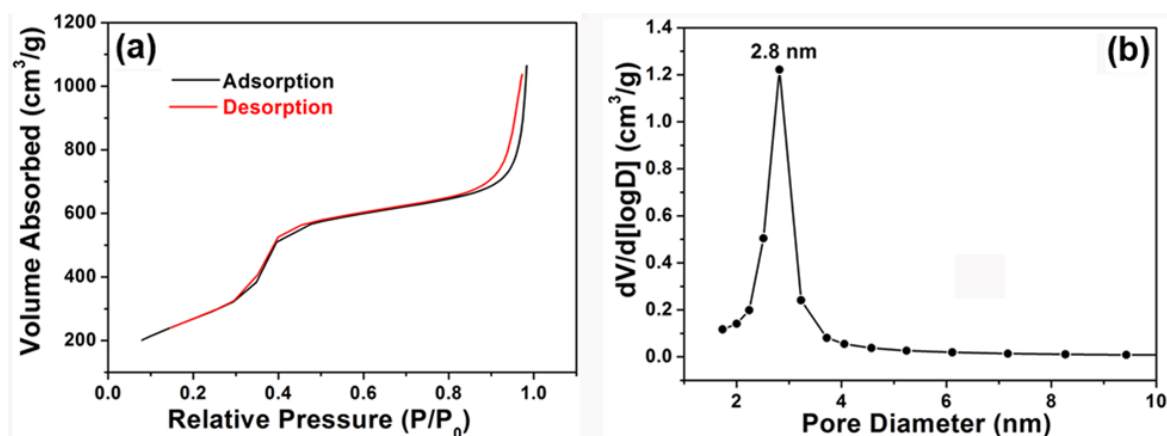


Figure S5 The nitrogen adsorption/desorption isotherm (a) and pore size distribution (b) of the UCNPs@mSiO₂ mesoporous nanoparticles.

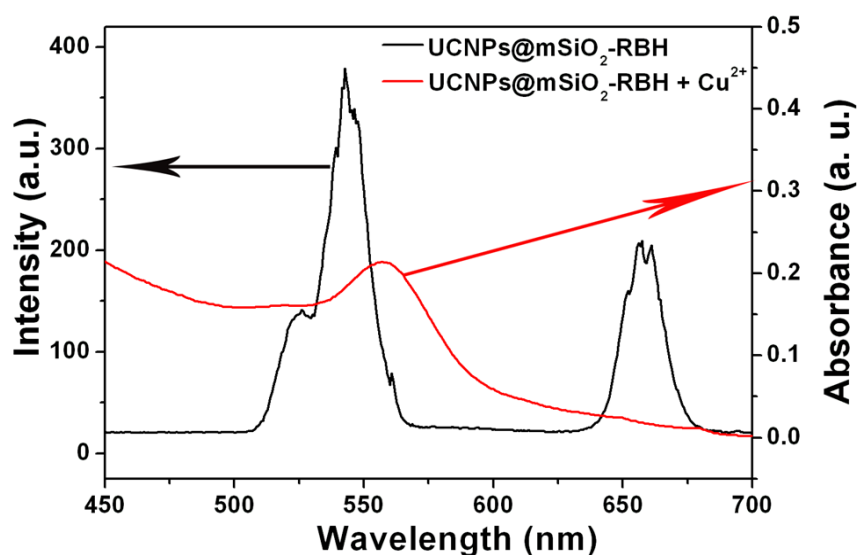


Figure S6 Upconversion fluorescence spectrum of the UCNPs@mSiO₂-RBH nanoparticles (black line) under the excitation of 980 nm laser and absorbance spectrum (red line) of the nanoparticles in DMSO/H₂O upon the addition of Cu²⁺ ions. There is a spectra overlap at about 542 nm.

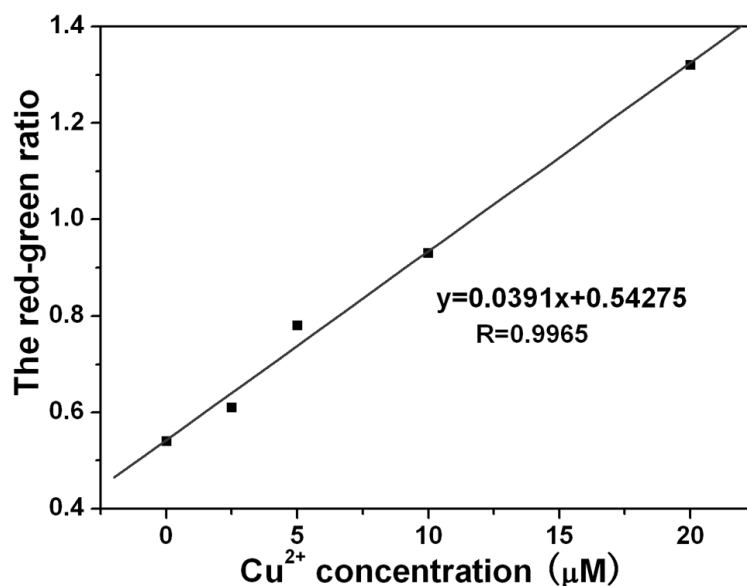


Figure S7 The sensitivity test of UCNPs@mSiO₂-RBH towards Cu²⁺ using upconversion luminescence emission technique. The detection limit (LOD) was given by the equation $LOD = 3S_0/S$,¹ where 3 is the factor at the 99% confidence level, S_0 the standard deviation of the blank measurements ($n = 10$), and S is the slope of the calibration curve. The limit of detection (LOD) was determined to be 4.6 ppb of Cu²⁺.

Reference

1. Q. Liu, J. J. Peng, L. N. Sun and F. Y. Li, *ACS Nano*, 2011, **5**, 8040-8048.