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Building a near-infrared responsive upconverting nanoplatform against hypoxic tumors *via* NO-enhanced photodynamic therapy

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Supporting Figure Captions

Figure S1. X-ray diffraction patterns of $NaYF_4$:Yb core, $NaYF_4$:Yb@$NaYbF_4$:Tm/Gd core-shell and $NaYF_4$:Yb@$NaYbF_4$:Tm/Gd@$NaYF_4$ core-shell-shell nanoparticles. The standard pattern of β-$NaYF_4$ (JCPDS 16-0334) is used as a reference.

Figure S2. TEM image and size distribution (inset) of the $NaYF_4$@$NaYbF_4$:Tm@$NaYF_4$ core–shell–shell nanoparticles with varying inner shell thickness. Scale bars for all images are 100 nm.

Figure S3. Comparison of upconversion emission intensity of the core-shell $NaYF_4$:Yb/Tm@$NaYF_4$ with core-shell-shell $NaYF_4$@$NaYbF_4$:Tm@$NaYF_4$ nanoparticles.

Figure S4. Luminescence decay curves of a series of $NaYF_4$:x%Yb@$NaYbF_4$:1%Tm,30%Gd@$NaYF_4$ (x=0, 15, 30, 45) UCNPs under 980 nm excitation.

Figure S5. Zeta potential of UCNPs@$mSiO_2$ and UCNPs@$mSiO_2$-NH_2 in ethanol solution.

Figure S6. UV-Vis absorption spectra of standard curcumin **(a)** and RBS **(b)** solution with different concentrations. The calibration curve (concentration vs. absorbance) of solution at 425 nm for **(c)** curcumin and 350 nm for **(d)** RBS.

Figure S7. UV-Vis absorption spectra of supernatants of UCNPs@mSiO_2-CUR-RBS collected by centrifugation after they were soaked in deionized water, PBS buffer and cell culture medium (DMEM) for 24 hours.

Figure S8. Representative photographs of segregated tumors after 14 days of PDT treatment.

Figure S9. Standard curve of Griess assay for NO detection.

Figure S1

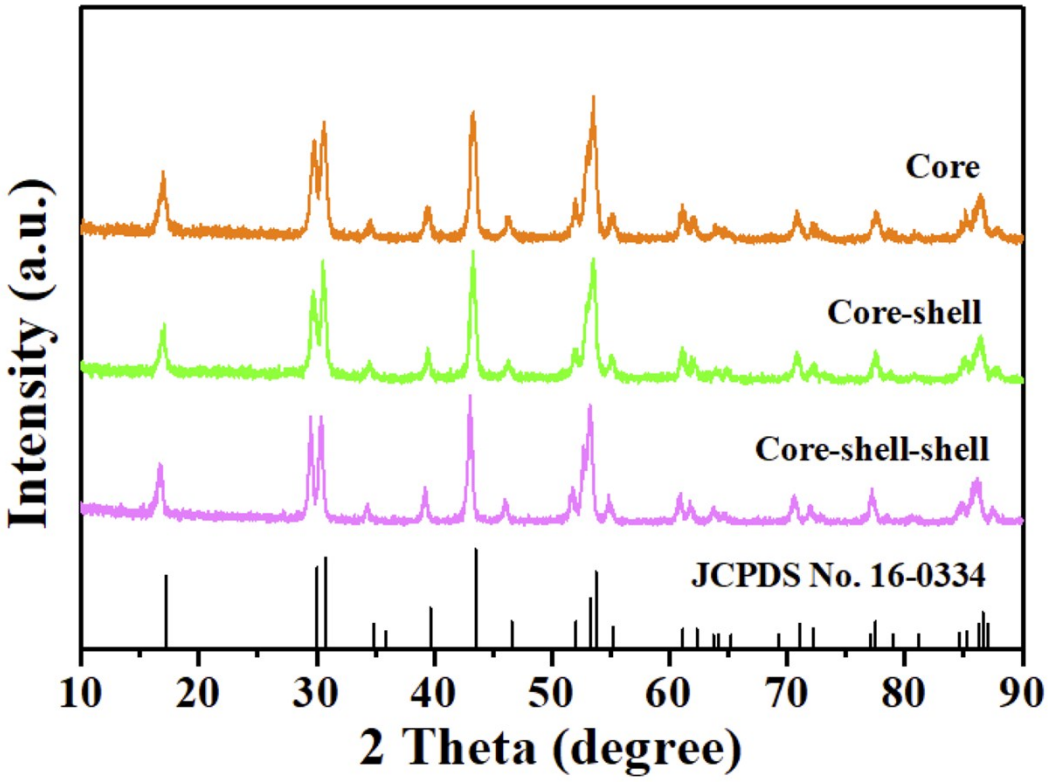

Intensity (a.u.)
Core
Core-shell
Core-shell-shell
JCPDS No. 16-0334
10
20
30
40
50
60
70
80
90
2 Theta (degree)

Figure S2

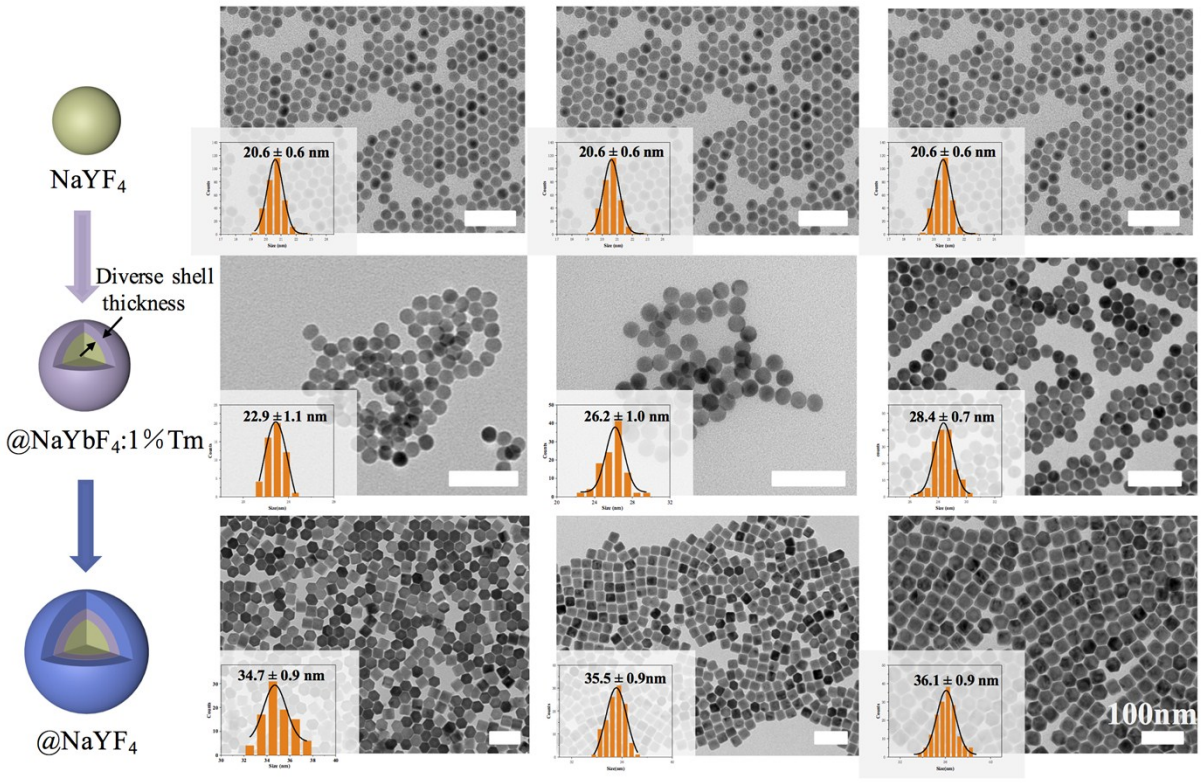

NaYF4
Diverse shell thickness
@NaYbF4:1%Tm
@NaYF4
20.6 ± 0.6 nm
20.6 ± 0.6 nm
20.6 ± 0.6 nm
22.9 ± 1.1 nm
26.2 ± 1.0 nm
28.4 ± 0.7 nm
34.7 ± 0.9 nm
35.5 ± 0.9nm
36.1 ± 0.9 nm
100nm

Figure S3

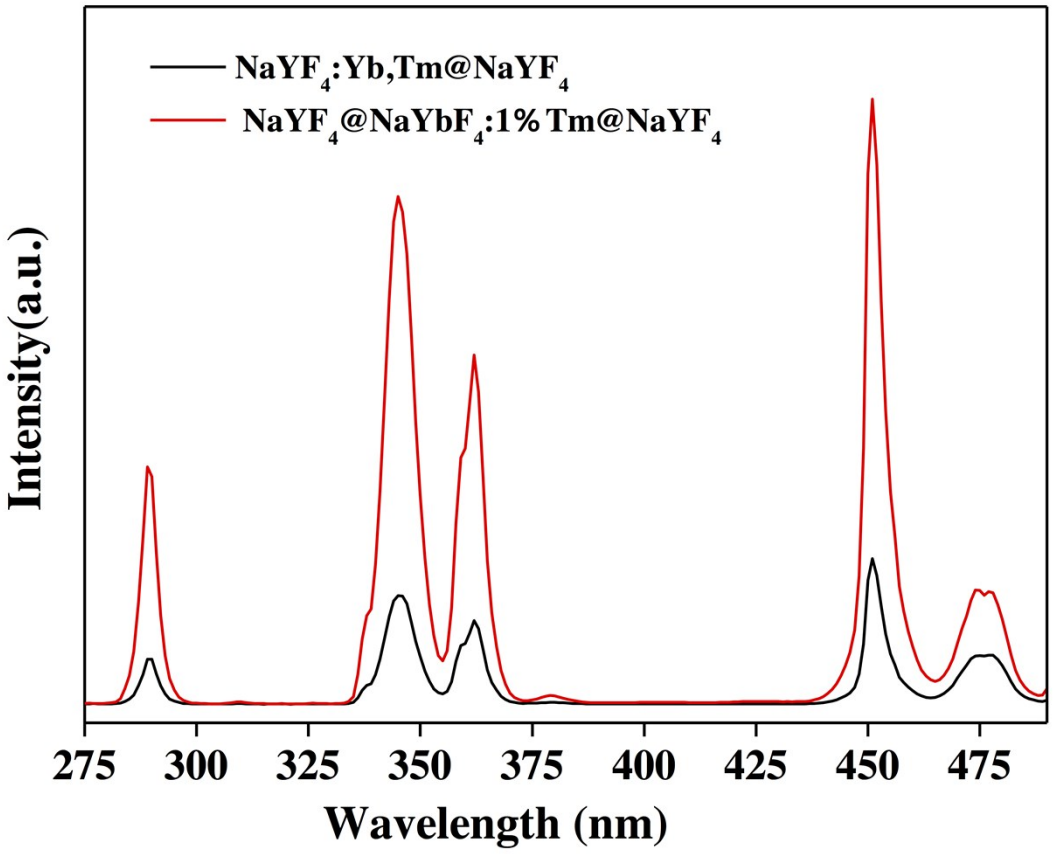

NaYF4:Yb,Tm@NaYF4
NaYF4@NaYbF4:1% Tm@NaYF4
Intensity(a.u.)
275
300
325
350
375
400
425
450
475
Wavelength (nm)

Figure S4

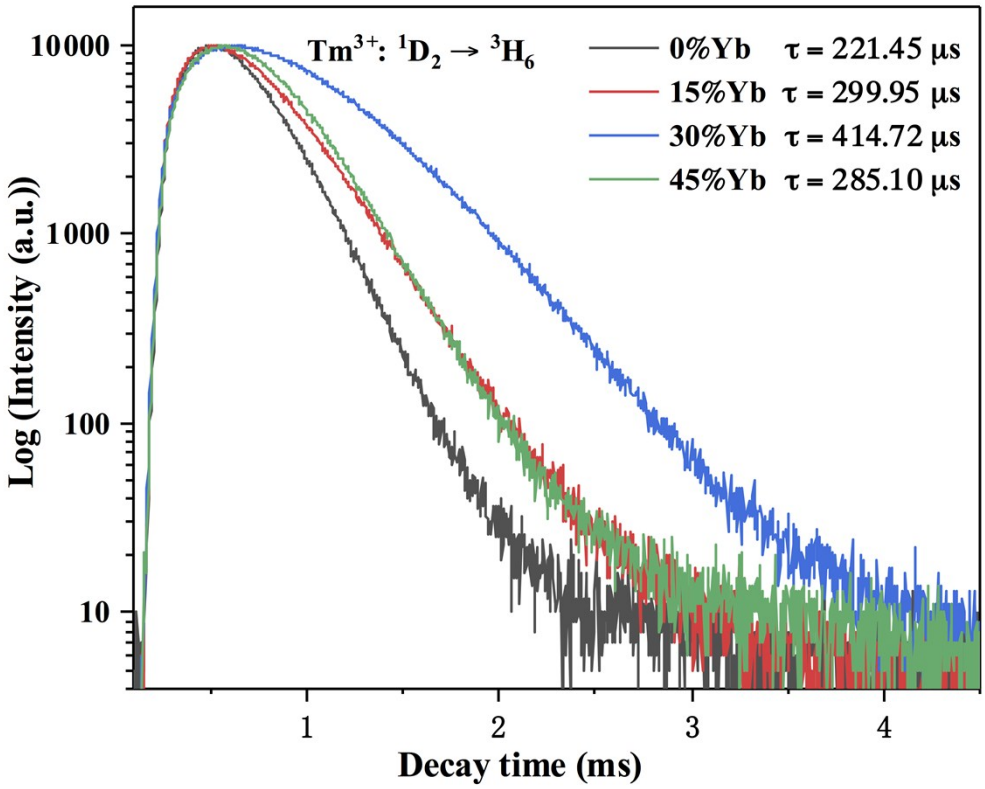

Tm3+: 1D2 → 3H6
0%Yb τ = 221.45 μs
15%Yb τ = 299.95 μs
30%Yb τ = 414.72 μs
45%Yb τ = 285.10 μs
Log (Intensity (a.u.))
10000
1000
100
10
1
2
3
4
Decay time (ms)

Figure S5

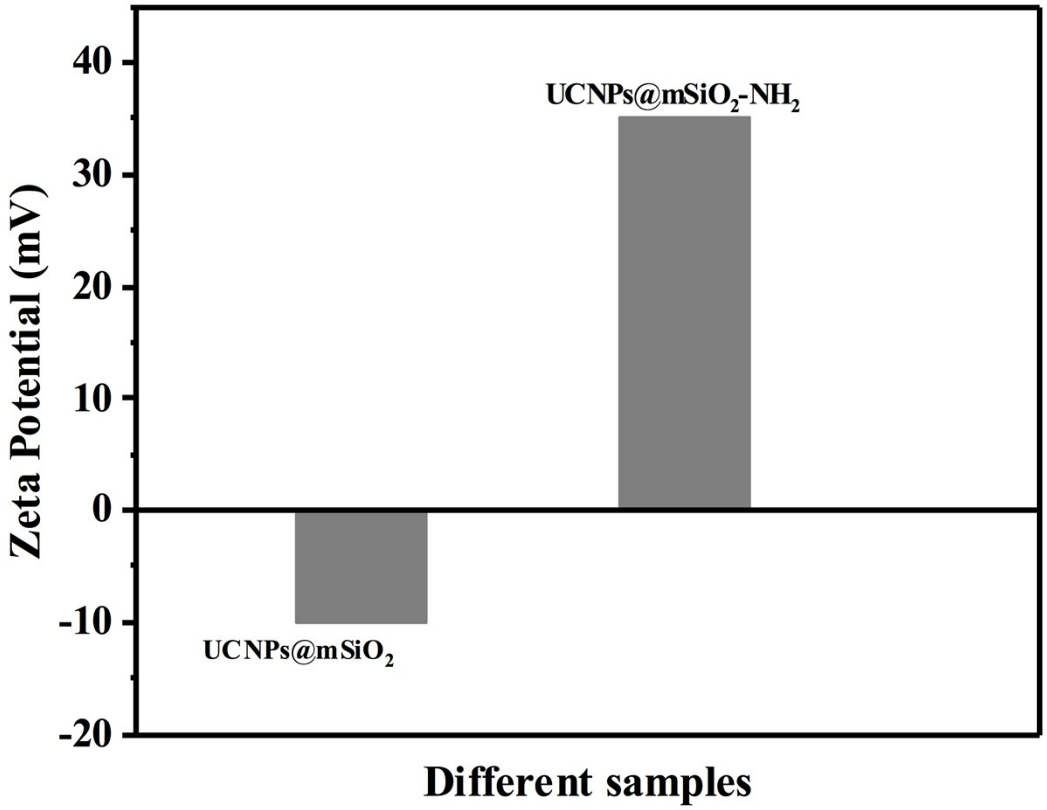

40
30
20
10
0
-10
-20
Zeta Potential (mV)
UCNPs@mSiO2-NH2
UCNPs@mSiO2
Different samples

Figure S6

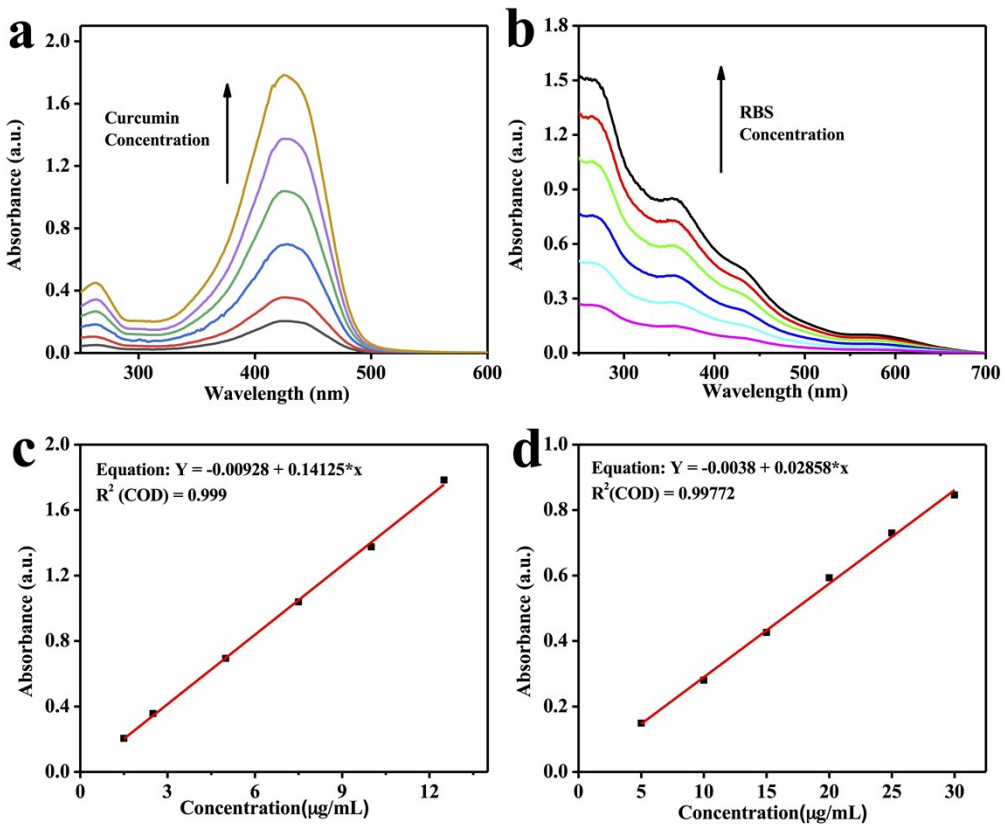

a
Curcumin
Concentration
Absorbance (a.u.)
Wavelength (nm)
b
RBS
Concentration
Absorbance (a.u.)
Wavelength (nm)
c
Equation: Y = -0.00928 + 0.14125*x
R2 (COD) = 0.999
Absorbance (a.u.)
Concentration(μg/mL)
d
Equation: Y = -0.0038 + 0.02858*x
R2(COD) = 0.99772
Absorbance (a.u.)
Concentration(μg/mL)

Figure S7

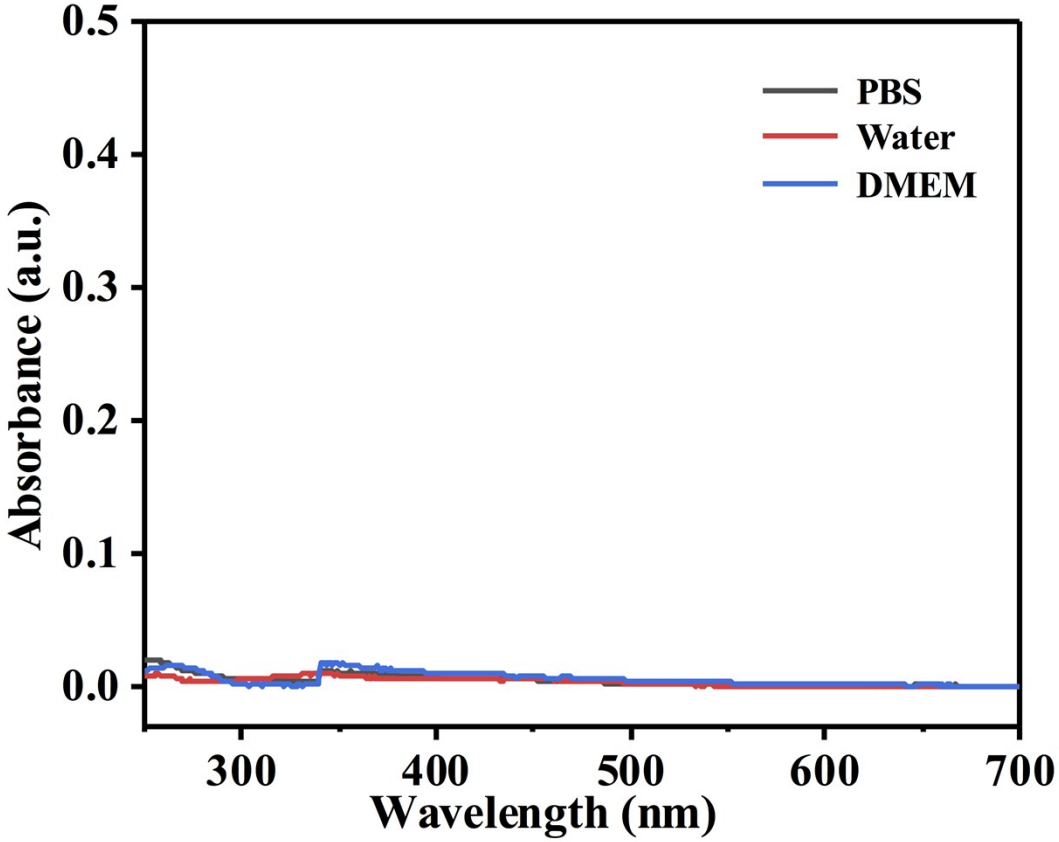

0.5
0.4
0.3
0.2
0.1
0.0
Absorbance (a.u.)
300
400
500
600
700
Wavelength (nm)
PBS
Water
DMEM

Figure S8

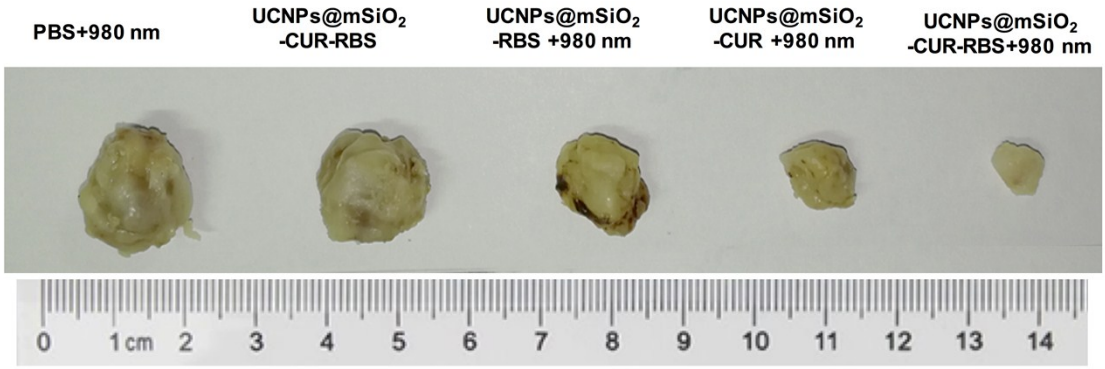
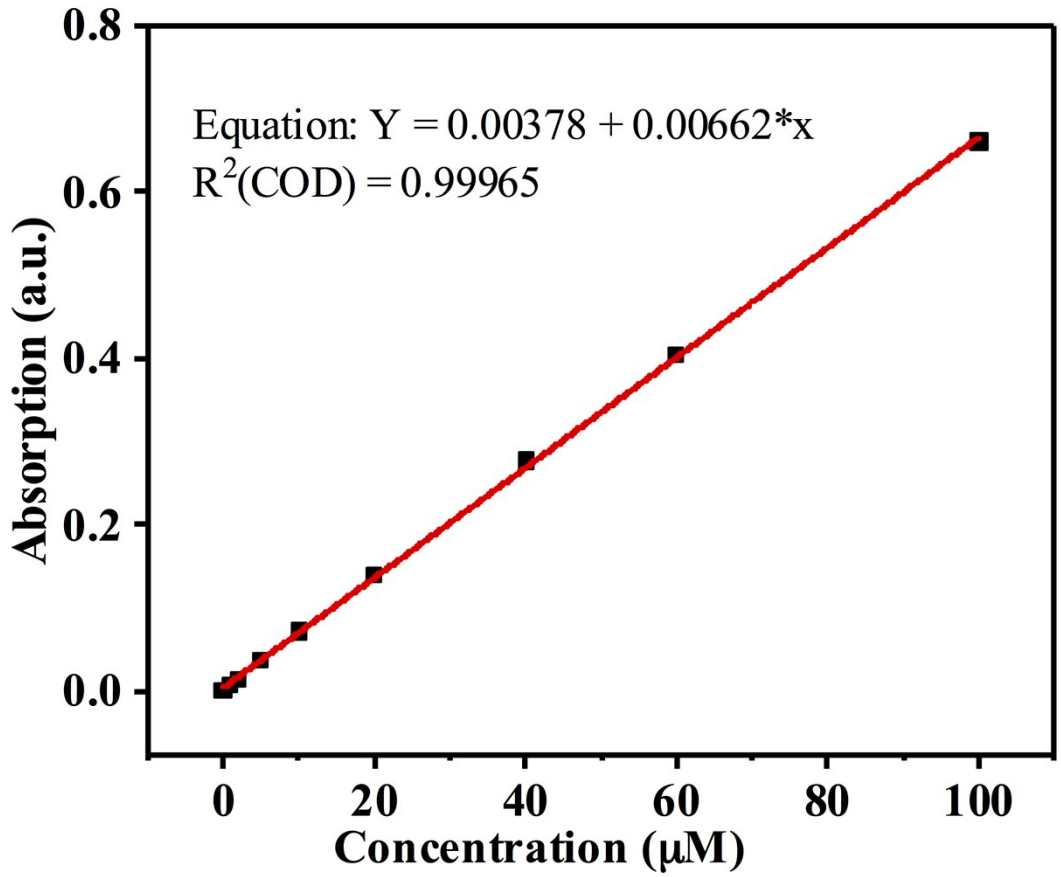

PBS+980 nm
UCNPs@mSiO2 -CUR-RBS
UCNPs@mSiO2 -RBS +980 nm
UCNPs@mSiO2 -CUR +980 nm
UCNPs@mSiO2 -CUR-RBS+980 nm
0
1cm
2
3
4
5
6
7
8
9
10
11
12
13
14

Figure S9


Equation: Y = 0.00378 + 0.00662*x
R2(COD) = 0.99965
Absorption (a.u.)
0.0
0.2
0.4
0.6
0.8
0
20
40
60
80
100
Concentration (μM)