Supporting Information

Detection of procalcitonin (PCT) using the double antibody sandwich method based on fluorescence resonant energy transfer between upconversion nanoparticles and quantum dots

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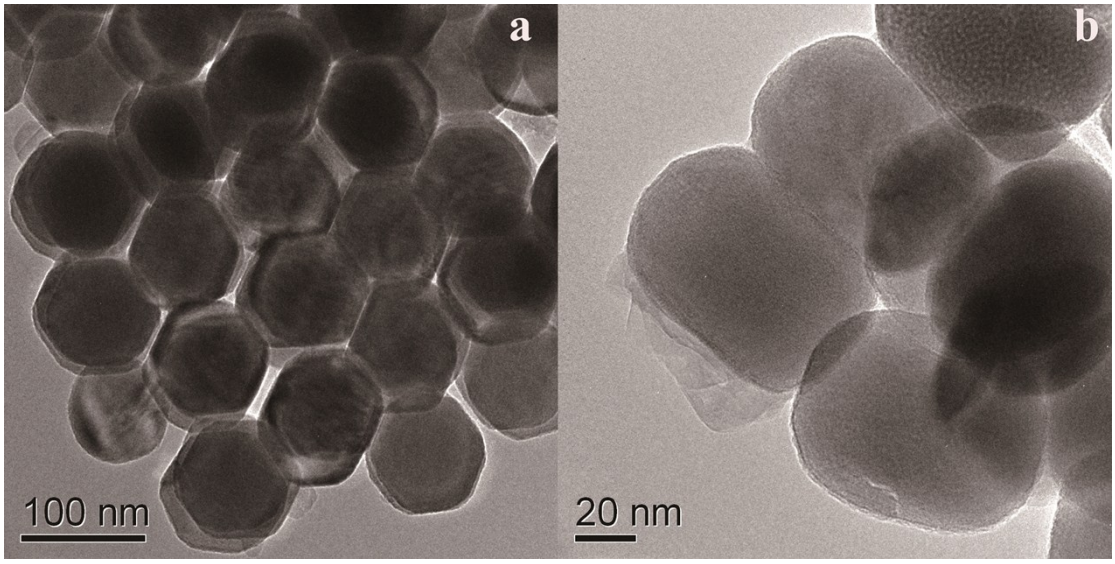

Figure S1 TEM images of $NaYF_4$:Yb, Er (a) before and (b) after hydrophilic functionalization.

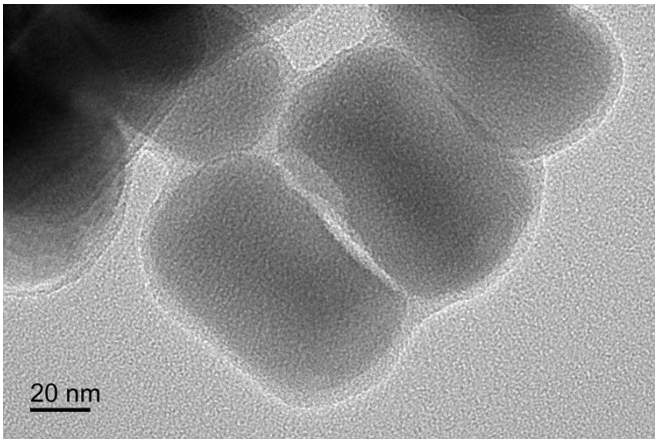

Figure S2 TEM image of protein on the $NaYF_4$:Yb, Er after protein conjugation.

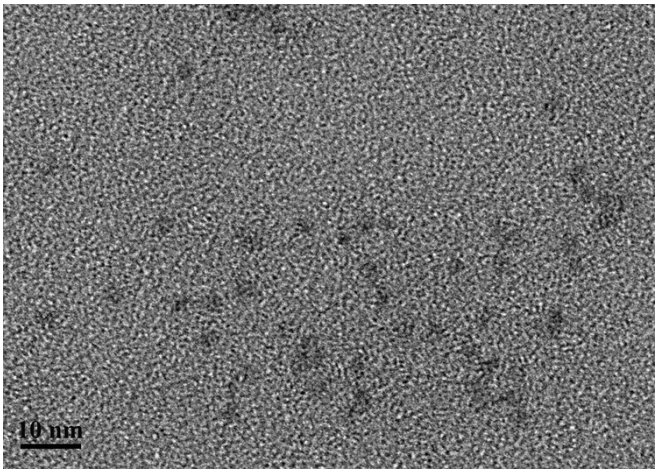

Figure S3 TEM image of CdTe QDs with MPA modification.

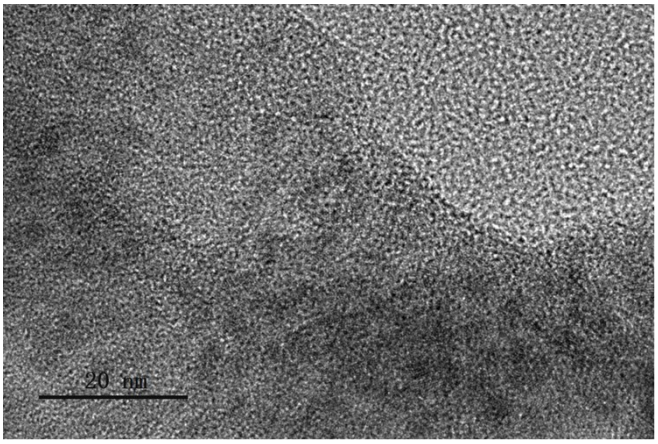

Figure S4 TEM image of QDs conjugated with antibody.

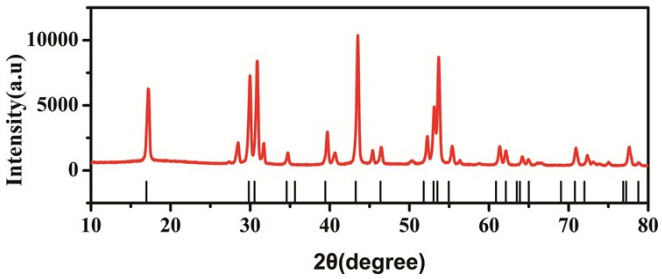

Figure S5 XRD pattern of $NaYF_4$:Yb, Er before PAA modification.

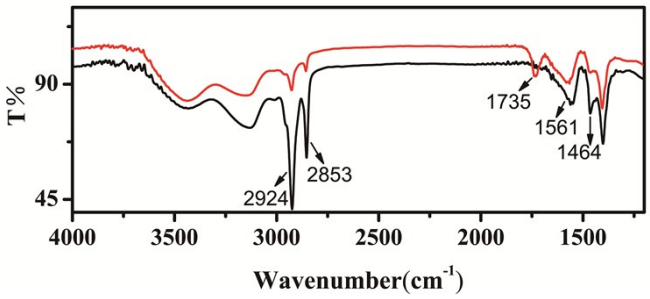

Figure S6 Infrared spectra of $NaYF_4$:Yb^{3+}, Er^{3+} before (black line) and after (red line) PAA modification.

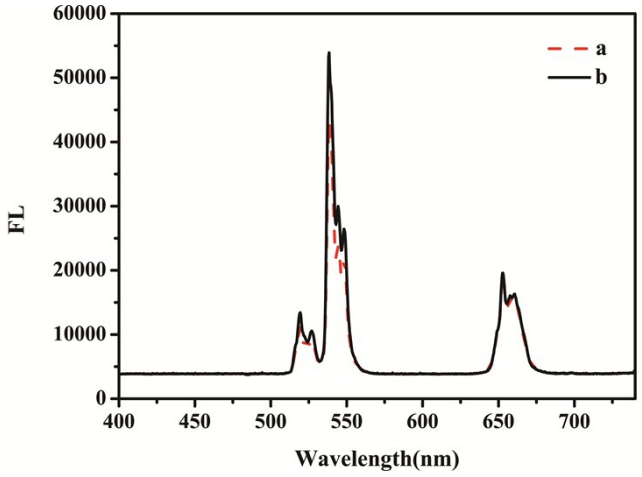

Figure S7 Room-temperature fluorescence spectra of 5.0 mg/mL $NaYF_4$: Yb, Er nanoparticles in cyclohexane (b) and after PAA modification in water (a) with a 980-nm laser.

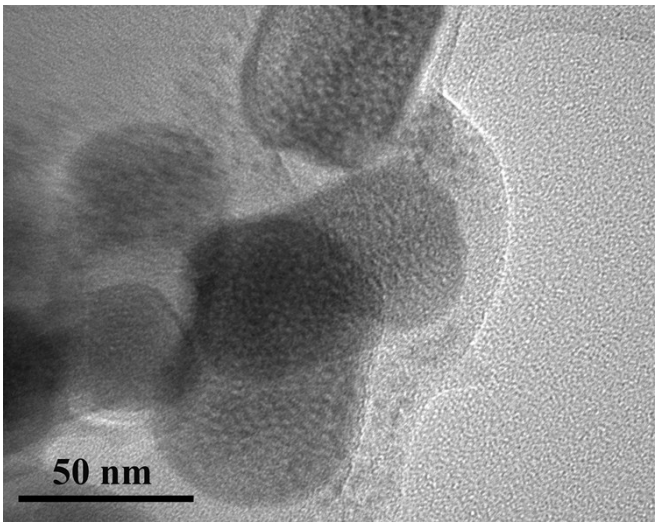

Figure S8 The TEM photo of the FRET system between $NaYF_4$ (Yb, Er) upconversion nanoparticles (UCNPs) and CdTe quantum dots (QDs).

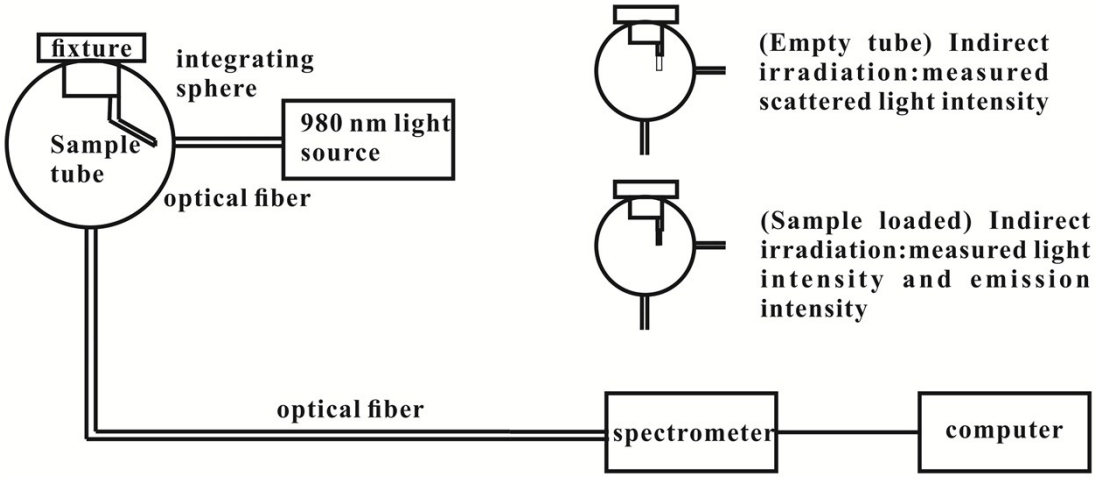

Figure S9 Schematic representation of the system for UCNPs quantum yield determination.

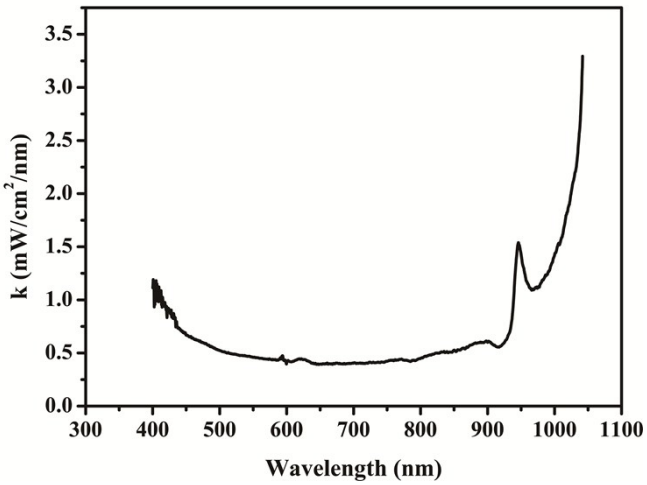

Figure S10 Response curve of the fluorescence spectrometer using a standard light source (iD2000 Deuterium halogen combo light source).

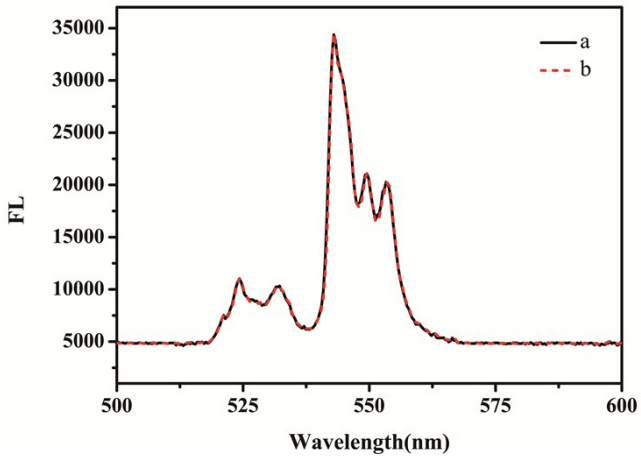

Figure S11 Fluorescence spectra of PAA (40μL, 5.0 mg/mL) functionalized $NaYF_4$: Yb, Er nanoparticles at 37 ℃ before (a) and after one hour (b) in serum samples (160μL of 0.02ng/mL negative sample) with a 980nm laser.

1. Calculation of the Förster distance R_0:

The Förster distance was defined by Eq. (3):

$$R_0 = 0.02108(\kappa^2 \varphi n^{-4} J)^{1/6} \text{ nm} \qquad \text{Eq. (3)}$$

where φ is the quantum yield of the donor, $\kappa^2 = 0.67$ (dynamic averaging) is the dipole orientation factor, n= 1.35 is the refractive index of the medium, and J (in M^{-1} cm^{-1} nm^4) defines the spectral overlap between donor (Er^{3+} in the UCNPs) PL and acceptor (QD) absorption as a function in Eq. (4). According to the literature,[1] the calculation of J was 6.04×10^{16} nm^4 M^{-1} cm^{-1}.

$$J = \int_{500nm}^{575nm} F(Er^{3+})\varepsilon_{QD}\lambda^4 d\lambda \qquad \text{Eq. (4)}$$

References

1 FRET – Förster Resonance Energy Transfer, ed. I. L. Medintz and N. Hildebrandt, WileyVCH, Weinheim, Germany, **2014**