Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Supporting Information

Blue/Red Ratiometric pH Sensor without Background Signal Based on 808 nm-Excited Core-Triple Shells Up-Conversion Nanoparticles

Tao Wang, [a] *Fenglei Sun,* [b] *Zike Jiang,* *[a] *Jing Wang,* [a] *Yanyan Ma,* [a] *Haitao Lin,* [a] *Hongmin Lv,* [a] *Shanshan Xu,* [a] *Jinhua Li,* [a] *Guangjun Zhou* *[b]

a Institute of Oceanographic Instrumentation, Qilu University of Technology (Shandong Academy of Sciences), Shandong Provincial Key Laboratory of Marine monitoring instrument equipment technology, National Engineering and Technological Research Center of Marine Monitoring Equipment, Qingdao 266061, P. R. China

b State Key Laboratory of Crystal Materials, Shandong University, Jinan 250100, P. R. China

Corresponding author: jiangzike2011@126.com (Z. J.); gjzhou@sdu.edu.cn (G. Z.)

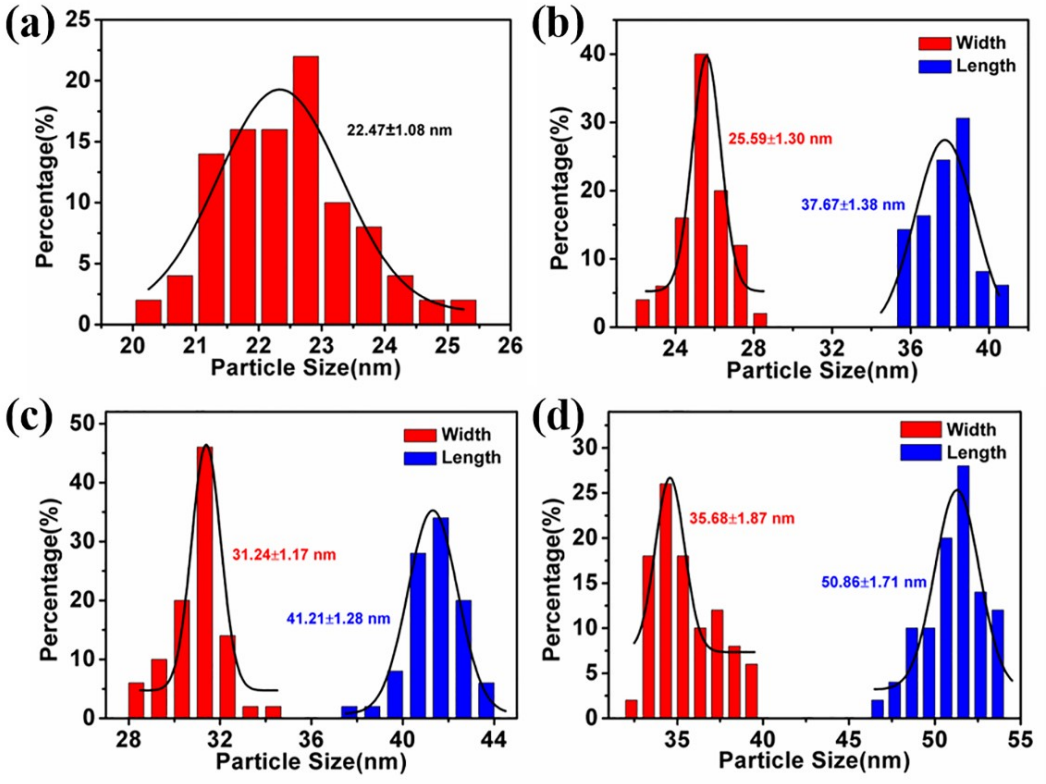

Figure S1. Size distributions of (a) core UCNPs, (b) CS UCNPs, (c) CDS UCNPs and (d) CTS UCNPs.

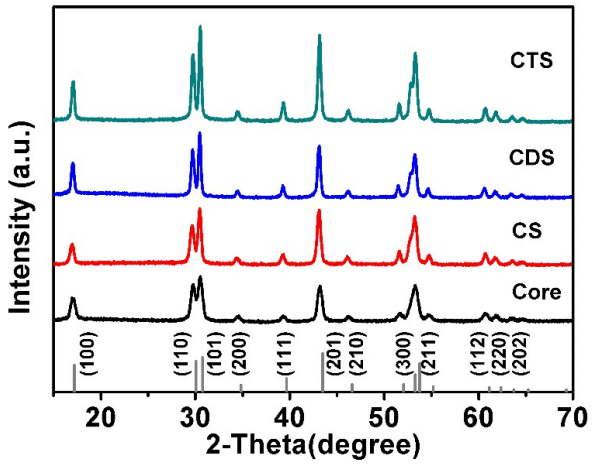

Figure S2. XRD patterns of core, CS, CDS and CTS UCNPs. Bars represent standard XRD diffraction data of hexagonal $NaYF_4$ ((JCPDS. No. 16-0334).

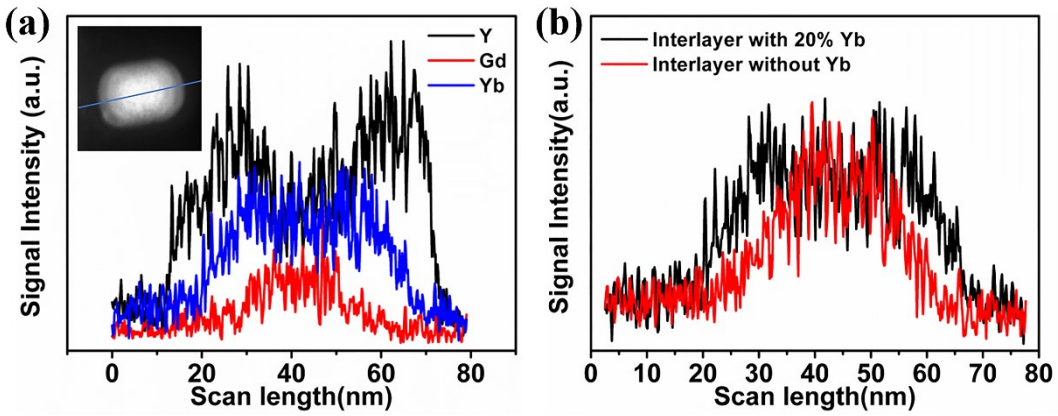

Figure S3. (a) EELS line scan for individual $NaGdF_4$:49%Yb,1%Tm@$NaYF_4$:20%Yb,15%Eu@$NaYF_4$:10%Yb,40%Nd@$NaYF_4$ CTS UCNP. (b) EELS line scan of Yb elemental for $NaGdF_4$:49%Yb,1%Tm@$NaYF_4$:χYb,15%Eu@$NaYF_4$:10%Yb,40%Nd@$NaYF_4$ CTS UCNPs (χ=0%, 20%).

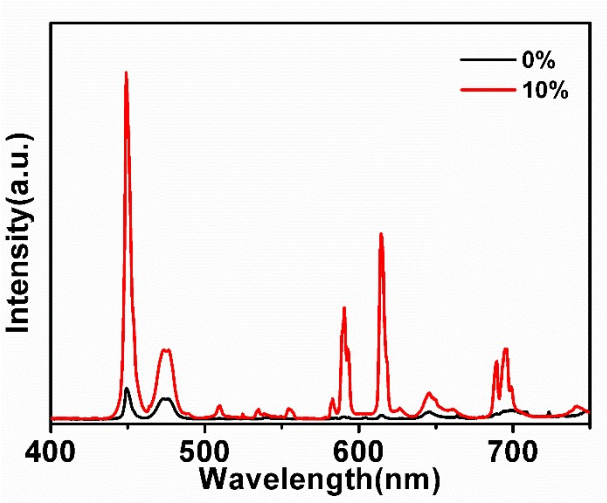

Figure S4. PL spectra of $NaGdF_4$:49%Yb,1%Tm@$NaYF_4$:χYb,15%Eu@ $NaYF_4$:10%Yb,40%Nd CDS UCNPs (χ=0%, 10%), excited by 808 nm laser at 3W power.

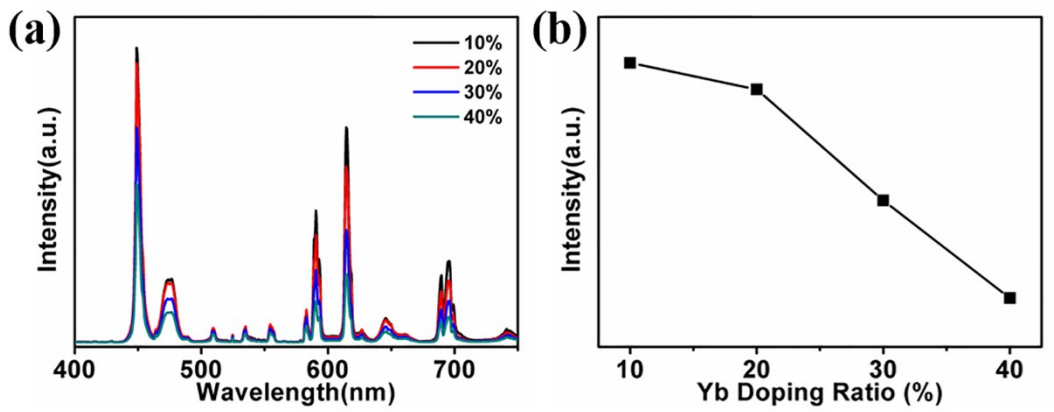

Figure S5. (a) PL spectra and (b) corresponding emission intensity variation tendency of $NaGdF_4$:49%Yb,1%Tm@$NaYF_4$:χYb,15%Eu CS UCNPs (χ=10-40%), excited by 980 nm laser at 3W power.

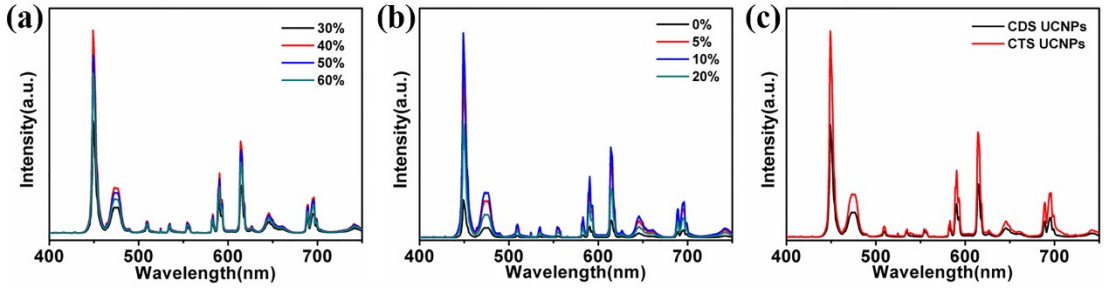

Figure S6. PL Spectra of $NaGdF_4$:49%Yb,1%Tm@$NaYF_4$:20%Yb,15%Eu@$NaYF_4$:Yb,Nd CDS UCNPs with (a) different Nd^{3+} doping concentrations (30-60%, the content of Yb^{3+} is fixed at 10%) and (b) different Yb^{3+} doping concentrations (0-20%, the content of Nd^{3+} is fixed at 40%). (c) PL Spectra of $NaGdF_4$:49%Yb,1%Tm@$NaYF_4$:20%Yb,15%Eu@$NaYF_4$:10%Yb,40%Nd CDS UCNPs and the particles after $NaYF_4$ outer layer coating. These sample at 808 nm excitation with power of 3 W.

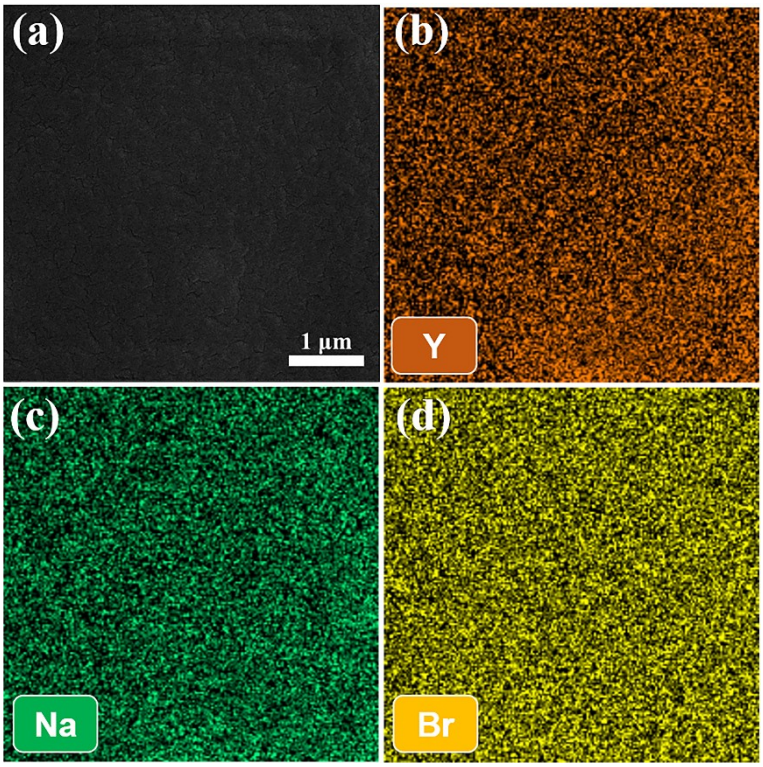

Figure S7. (a) SEM image of CTS sensor film. EDS elemental mappings of (b)Y, (c)Na and (d) Br elementals of CTS sensor film. Y, Na are the characteristic elementals of CTS UCNPs, Br is the characteristic elemental of BCG.

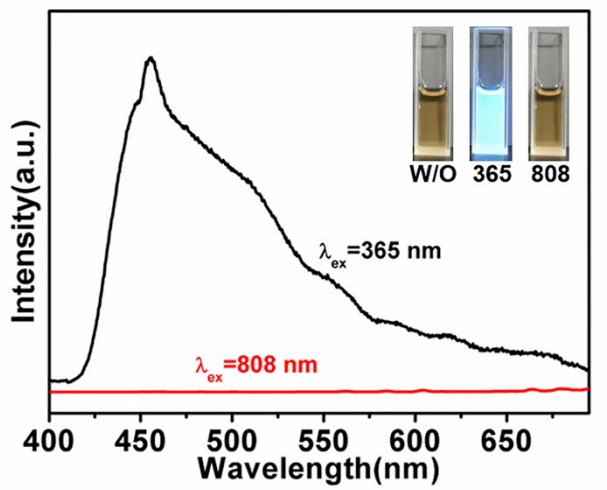

Figure S8. PL spectra of serum excited by xenon lamp with excitation wavelength of 365 nm and 808 nm laser at 3W power. Insets show the photographs of serum without excitation source, under 365 nm and 808 nm excitation.

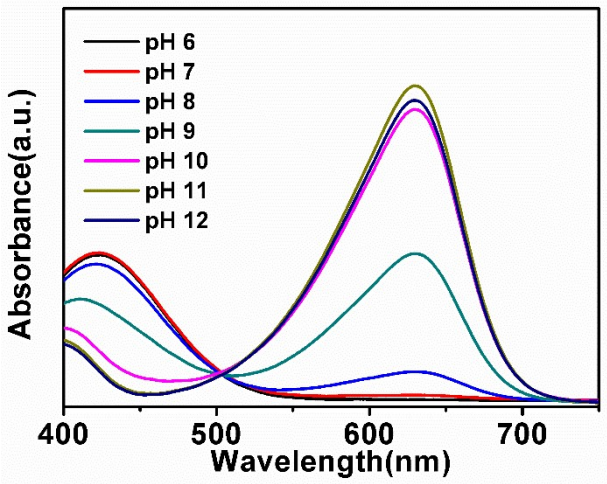

Figure S9. Absorption spectra of BTB in buffer solutions with different pH value from 6 to 12.

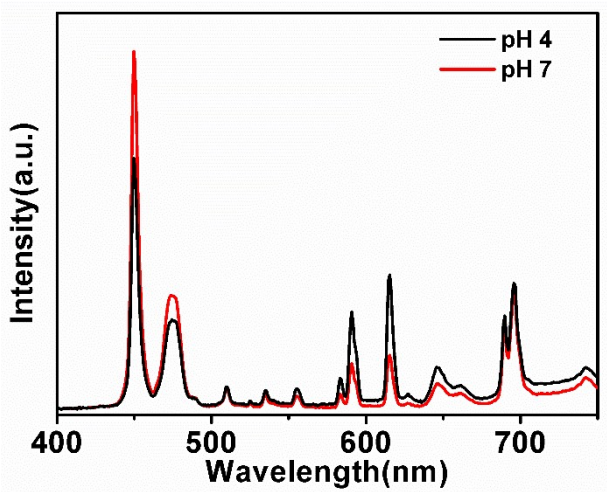

Figure S10. PL spectra of CTS UCNPs mixing with BCG in buffer solution with pH values of 4 and 7.

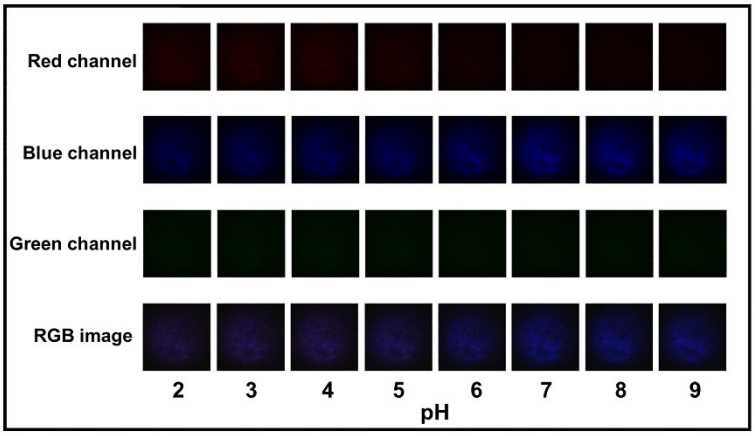

Figure S11. Bottom row shows the RGB images of core sensor film in buffer solutions with different pH values from 2 to 9 under 980 nm excitation at 3 W power. Top three rows severally show the red, blue and green split signals from red-green-blue channels.

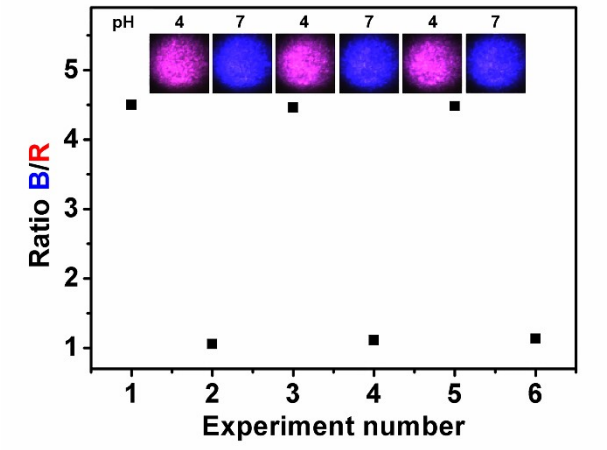

Figure S12. The B/R ratio of CTS sensor film under repeated variation between pH 4 and pH 7.

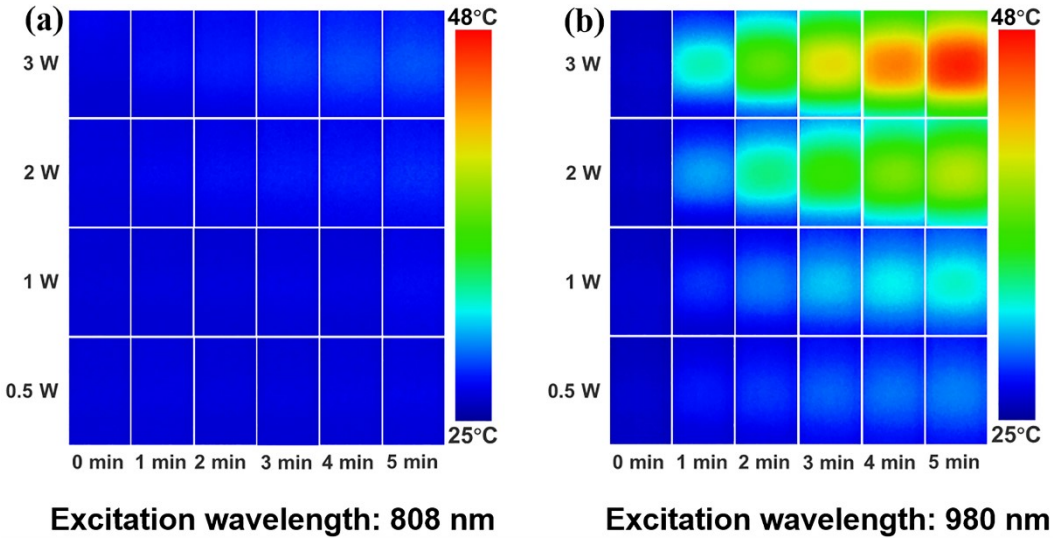

Figure S13. The infrared thermal images of 2 ml serum under irradiation of (a) 808 nm and (b) 980 nm laser with varying power.

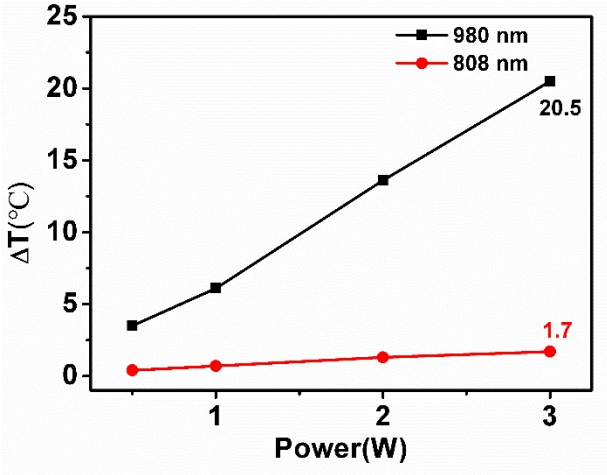

Figure S14. Temperature rises of 2 ml serum under 808 nm and 980 nm excitation at varying power for 5 min irradiation.

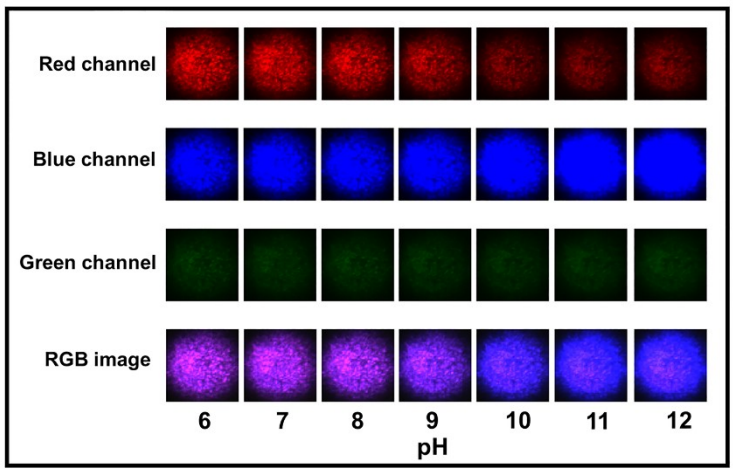

Figure S15. Bottom row shows the RGB images of CTS sensor film based on BTB as pH indicator in buffer solutions with different pH values from 6 to 12 under 808 nm excitation at 3 W power. Top three rows severally show the red, blue and green split signals from red-green-blue channels.

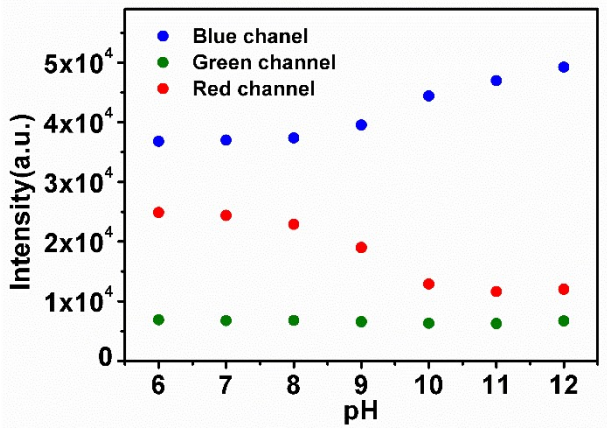

Figure S16. pH-dependent signal intensity curves of red-green-blue channels split from RGB pictures of CTS sensor film based on BTB as pH indicator.