

## Supporting Information

### Inner filter effect between upconversion nanoparticles and Fe(II)-1,10-Phenanthroline complex for the detection of Sn(II) and Ascorbic acid (AA)

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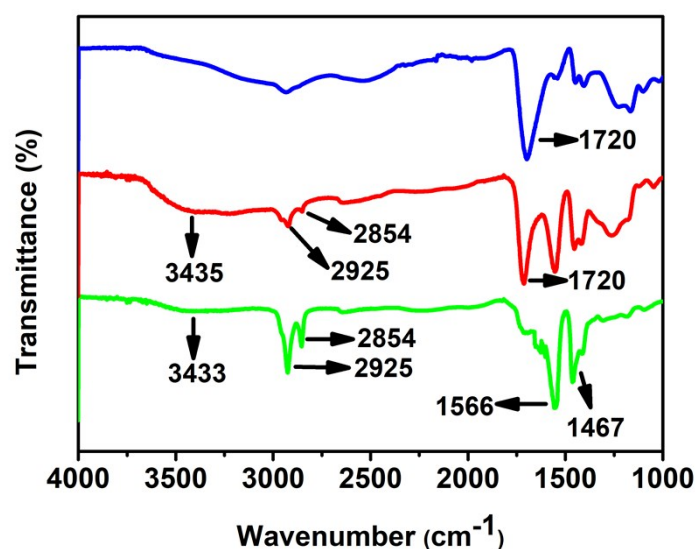
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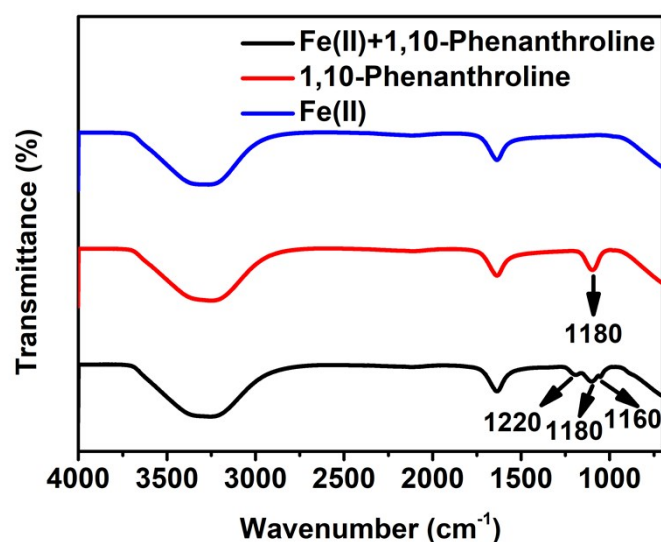
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**Fig. S1** FT-IR spectra of pure PAA (blue line), oleic acid-coated (red line) and PAA-coated (green line) NaYF<sub>4</sub>:Yb/Er@NaYF<sub>4</sub> core-shell nanoparticles

After the coating of PAA on UCNPs, the absorption bands at 2925 and 2854 cm<sup>-1</sup> were weakened due to the stretching vibration of C-H bond, and the absorption peaks at 3430 cm<sup>-1</sup> were significantly enhanced due to the stretching vibration of O-H bond. Meanwhile, new absorption bands were generated at 1720 cm<sup>-1</sup> due to the stretching vibration of C = O bond, which further proved that PAA was coated on the surface of UCNPs.



**Fig. S2** FT-IR spectra of pure 1,10-Phenanthroline (red line), Fe(II) (blue line) and Fe(II) - 1,10-Phenanthroline (black line).

1,10-phenanthroline has the absorption band at 1180 cm<sup>-1</sup> due to the stretching vibration of C-N bond. After adding Fe(II), Fe(II) reacts with 1,10-phenanthroline to form Fe(II) - 1,10-phenanthroline complex. These affects the absorption band at 1180 cm<sup>-1</sup> of 1,10-phenanthroline, new absorption bands were generated at 1160 and 1220 cm<sup>-1</sup>, which proved that the complex is formed.

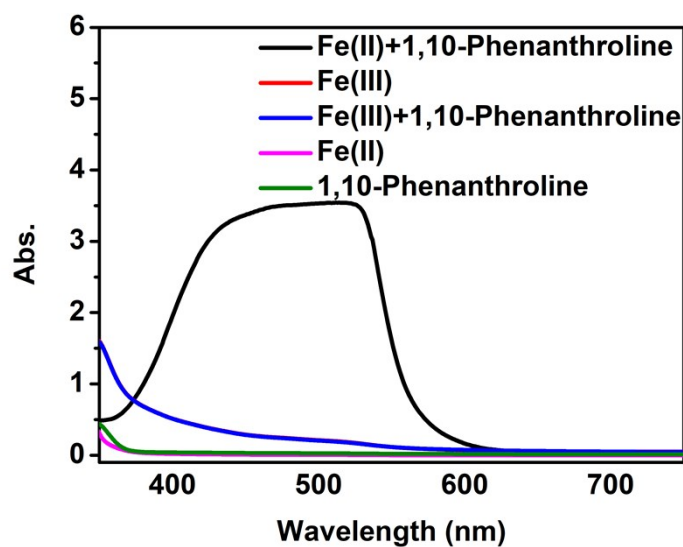


Fig. S3 Absorption spectrum of Fe(II) (0.4 mmol/L)+1,10-Phenanthroline (2.0 mmol/L) (black line), Fe(III) (0.4 mmol/L) (red line), Fe(III) (0.4 mmol/L)+1,10-Phenanthroline (2.0 mmol/L) (blue line), Fe(II) (purple line) and 1,10-Phenanthroline (2.0 mmol/L) (green line).

The absorption spectrum of Fe(III), Fe(III) + 1,10-phenanthroline, Fe(II) and 1,10-phenanthroline do not have the absorption band at 350 nm ~ 600 nm. But the absorption spectrum of Fe(II) + 1,10-phenanthroline have the absorption band at 350 nm ~ 600 nm, which further proved that the complex is formed.

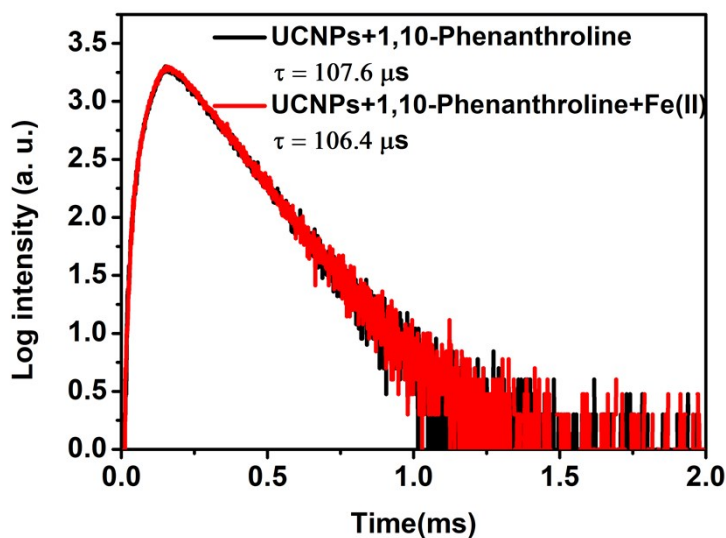
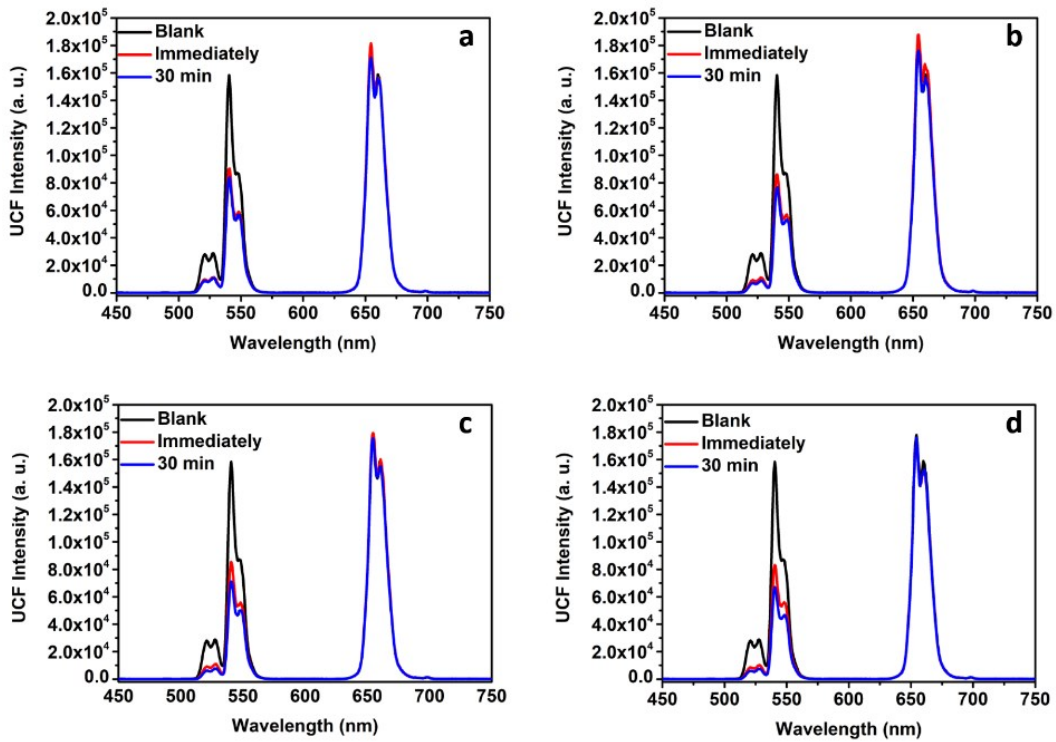
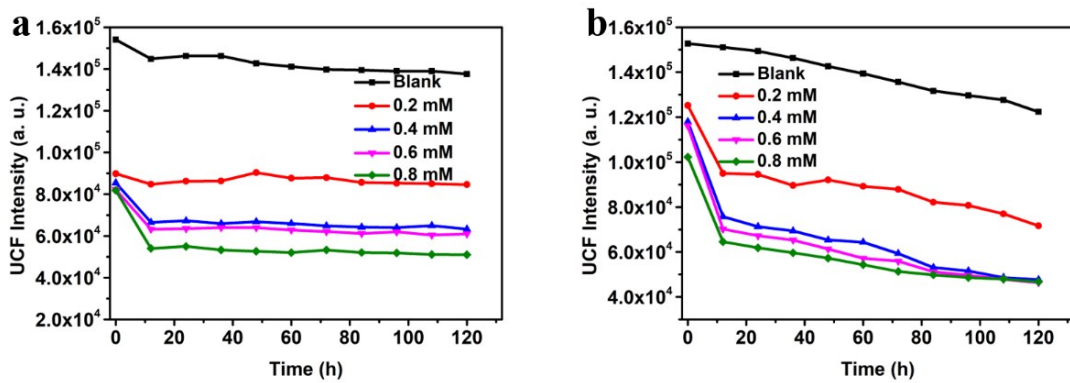


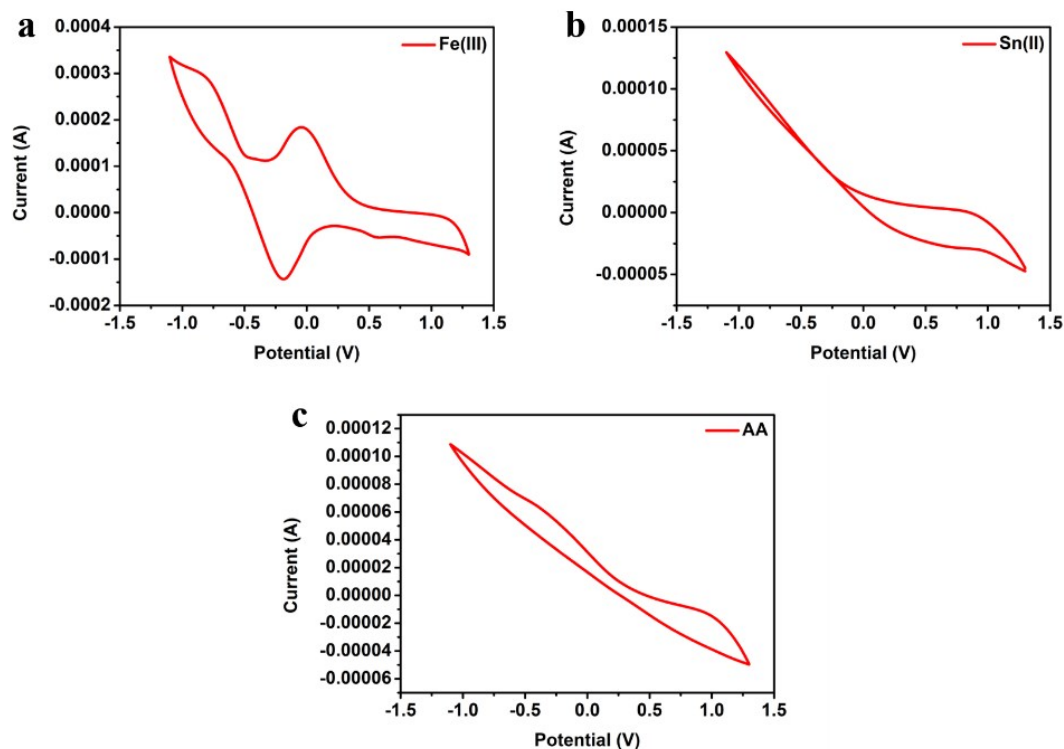
Fig. S4 Decay curves of UCNPs @PAA/1,10-Phenanthroline/Fe(III) with and without Sn(II) and AA under excitation of 980 nm lasers.



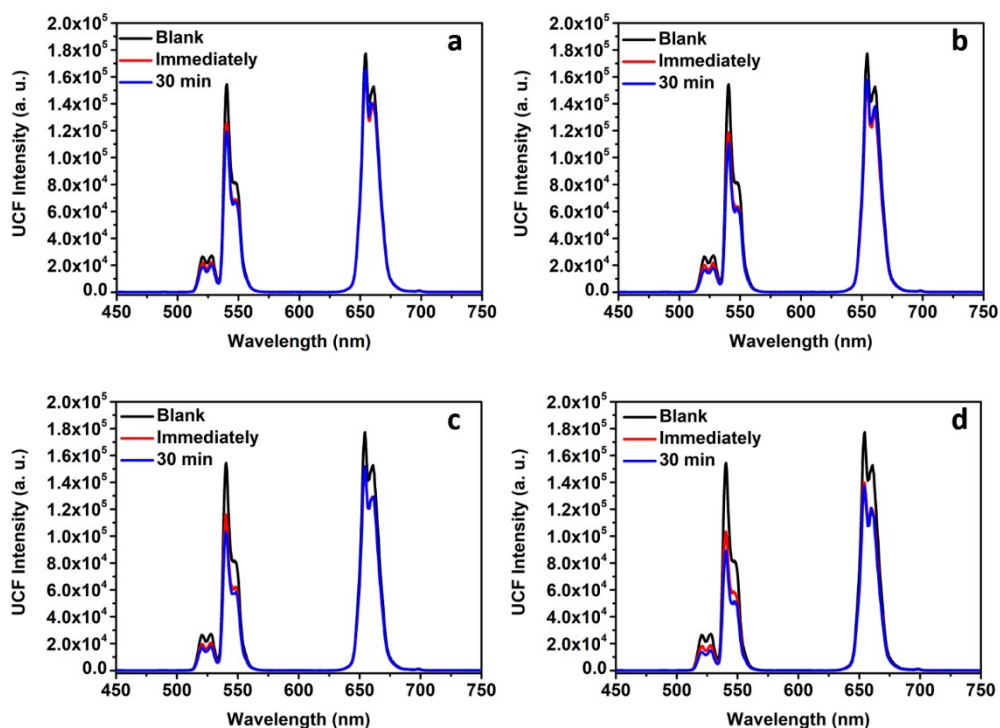
**Fig. S5** The upconversion emission spectrum of UCNPs @PAA/1,10-Phenanthroline/Fe(III) after adding Sn(II) under excitation of 980 nm lasers. a [Sn(II)] = 0.2 mmol/L, b [Sn(II)] = 0.4 mmol/L, c [Sn(II)] = 0.6 mmol/L, d [Sn(II)] = 0.8 mmol/L. [1,10-Phenanthroline] = 2.0 mmol/L, [Fe(III)] = 0.4 mmol/L.



**Fig. S6** Time-dependent fluorescence intensity at 540 nm of UCNPs/1,10-Phenanthroline/Fe(III) system with different concentration of a Sn(II) and b AA.



**Fig. S7** Cyclic voltammograms of a Fe(III), b Sn(II) and c AA. The scan rate is 20 mV/s. [Fe(III)] = 0.4 mmol/L, [Sn(II)] = 0.2 mmol/L, [AA] = 0.2 mmol/L.



**Fig. S8** The upconversion emission spectrum of UCNPs @PAA/1,10-Phenanthroline/Fe(III) after adding AA under excitation of 980 nm lasers. a [AA] = 0.2 mmol/L, b [AA] = 0.4 mmol/L, c [AA] = 0.6 mmol/L, d [AA] = 0.8 mmol/L. [1,10-Phenanthroline] = 2.0 mmol/L, [Fe(III)] = 0.4 mmol/L.