Supporting Information

Title: Emission Stability and Reversibility of Upconversion Nanocrystals

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Table S1 Table of expected and measured shell thickness. (The expected shell thickness was calculated based on the size of core nanocrystal, the amount of core and the amount of shell precursors; the measured shell thickness was calculated by comparing the size difference between the core and core-shell nanocrystals.)

Sample	Core – shell with 1.7 nm shell	Core – shell with 2.5 nm shell	Core – shell with 4.5 nm shell	Core – shell with 8.0 nm shell
Amount of $NaYF_4$:Yb,Er core (mmol)	0.2	0.2	0.2	0.2
Amount of α-$NaYF_4$ seeds as shell precursor (mmol)	0.1	0.2	0.4	0.8
Average size of $NaYF_4$:Yb,Er cores (nm)	24.1	24.1	24.1	24.1
Expected average size of the core-shell $NaYF_4$:Yb,Er@ $NaYF_4$ (nm)	27.4	30.5	34.9	41.2
Measured average size of the core-shell $NaYF_4$:Yb,Er@$NaYF_4$ (nm)	27.1	28.9	33.2	40.1
Expected average thickness of the shell (nm)	1.65	3.15	5.35	8.10
Measured average thickness of the shell (nm)	1.5	2.5	4.5	8.0

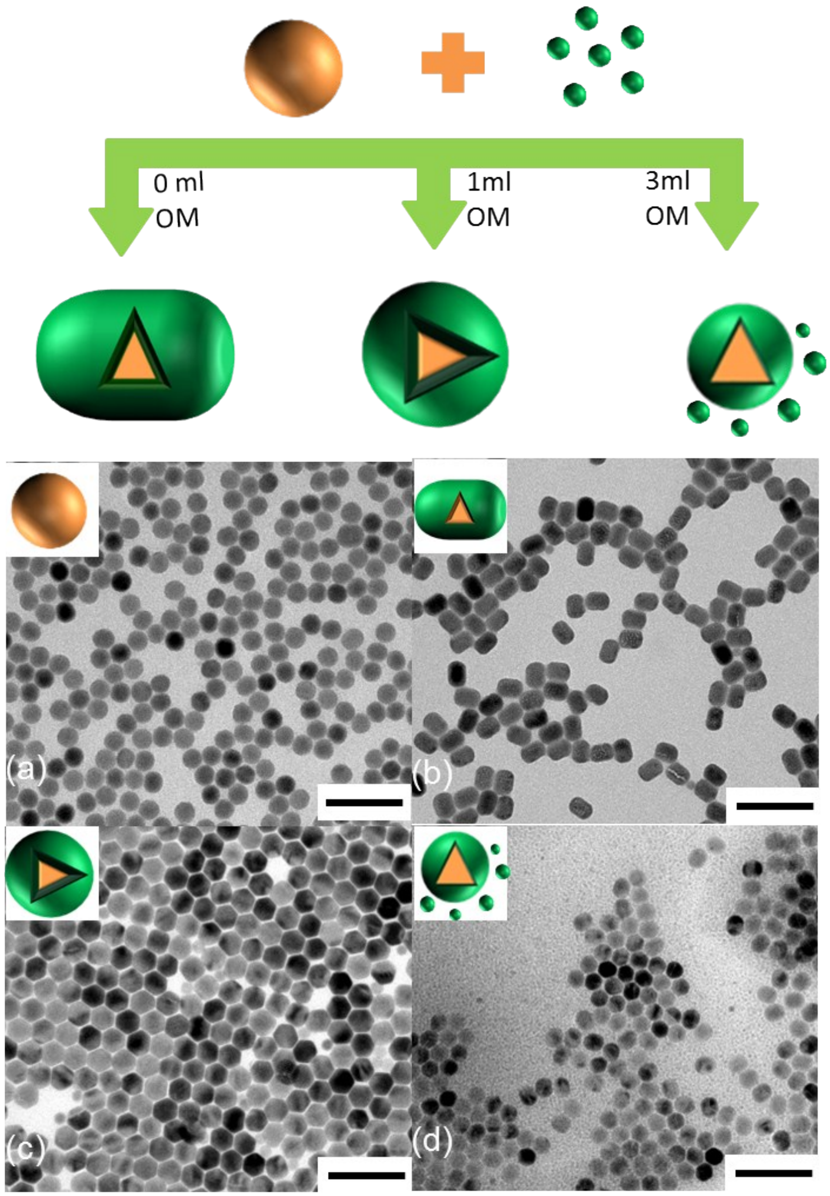

Figure S1 Schematics of controlled growth of homogeneous shells by adjusting the amount of oleylamine (OM). TEM images of core (a) and core-shell UCNPs synthesized with 0 ml, 1ml and 3ml OM, at the same reaction temperature, reaction time, and the same amounts of 5 mL OA and 8 mL ODE.

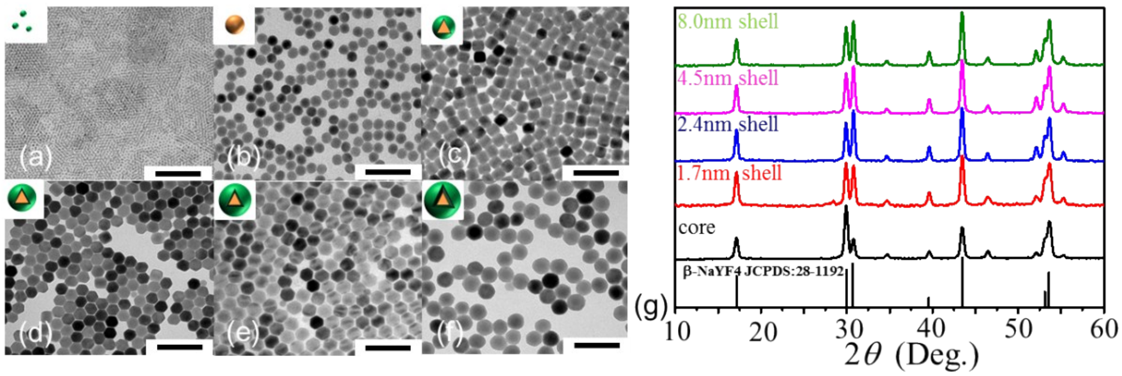

Figure S2 Materials characterization. TEM images of a-$NaYF_4$ shell precursor (a), $NaYF_4$: Er,Yb core (b), and $NaYF_4$: Er,Yb@$NaYF_4$ core-shell UCNPs with different shell thickness, 1.5 nm (c), 2 nm (d), 2.5 (e) and 4.0 nm (f); XRD spectra of core and core-shell UCNPs (g) (Scale bar: 50 nm)

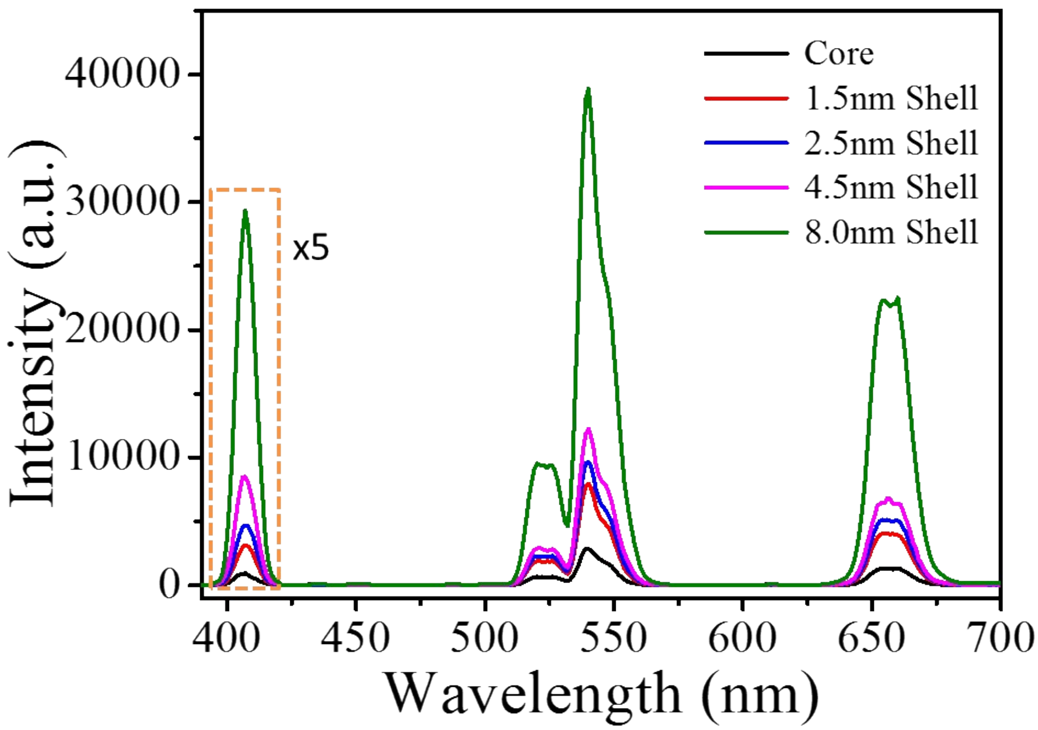

Figure S3 Luminescence spectra to quantify the enhancement by different thickness of shells. Luminescence spectrum of core-only and core-shell UCNPs under 200 mW 980 nm laser. The violet emission band was amplified by 5 times for a better revisualization.

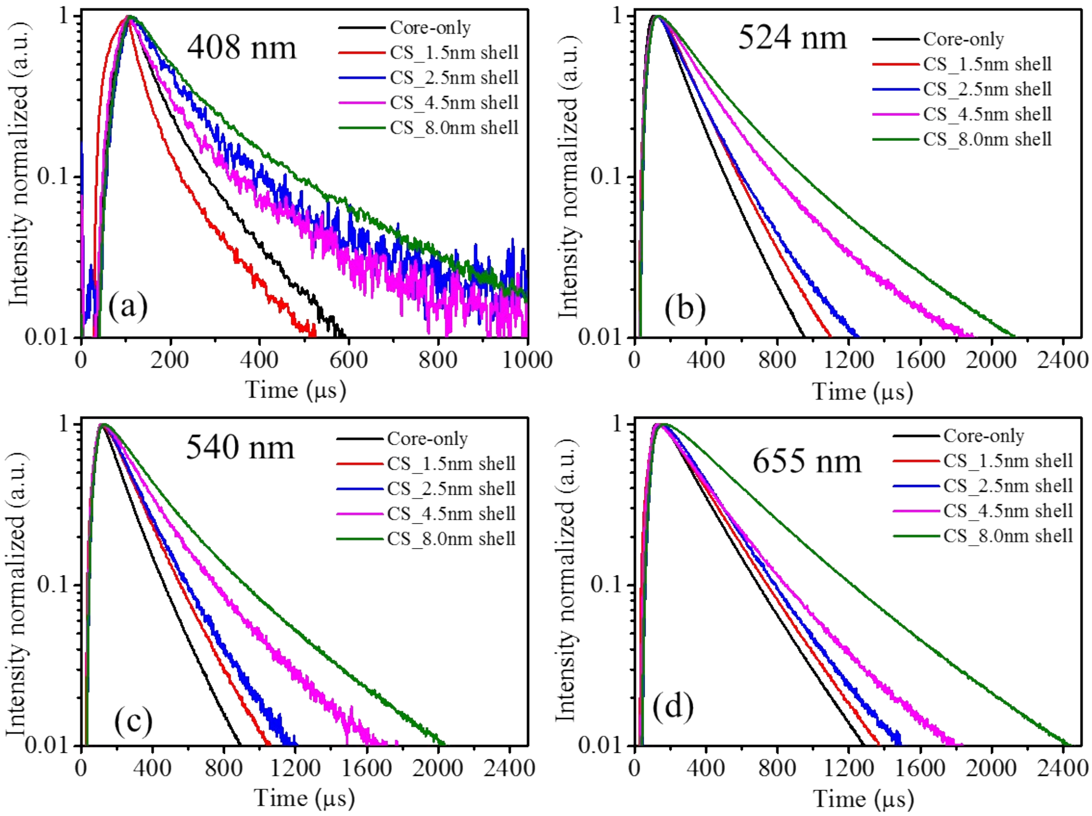

Figure S4 Luminescence decay lifetimes from core and core-shell UCNP samples with different thickness of shells at emissions of 408nm (a), 524 nm (b), 540 nm (c) and 655 nm (d).

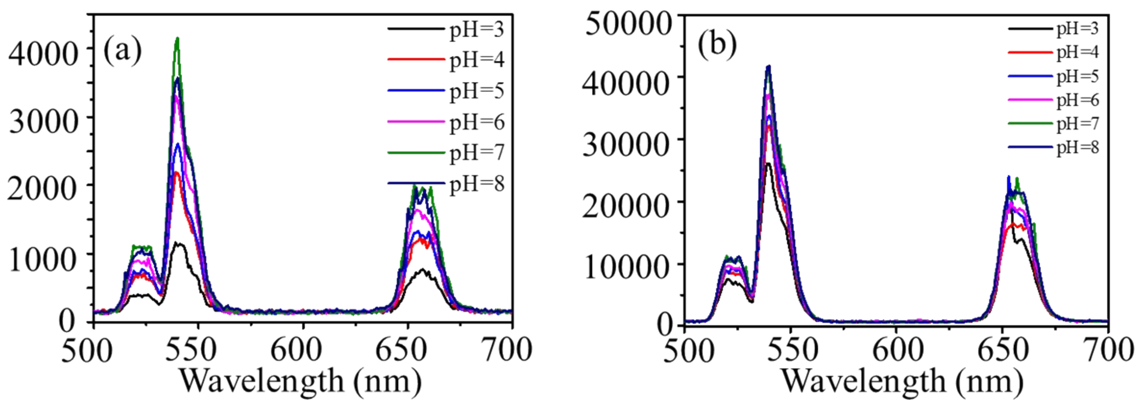

Figure S5 Emission spectra of core-only (a) and core-shell UCNP samples (b) to study the shell impact on the luminescence stability in different pH solution.

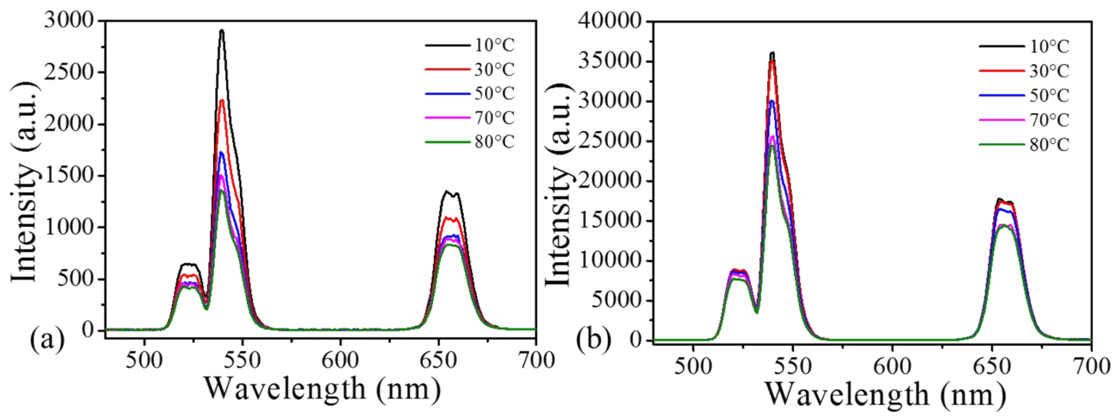

Figure S6 spectra of core-only sample (a) and core-shell samples (b) to study the shell impact on the luminescence stability under varied temperature.