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Electronic Supplementary Information

Facile Synthesis of $NaYF_4$:Yb, Ln/$NaYF_4$:Yb Core/Shell Upconversion Nanoparticles via Successive Ion Layer Adsorption and Reaction Technique in One-Pot

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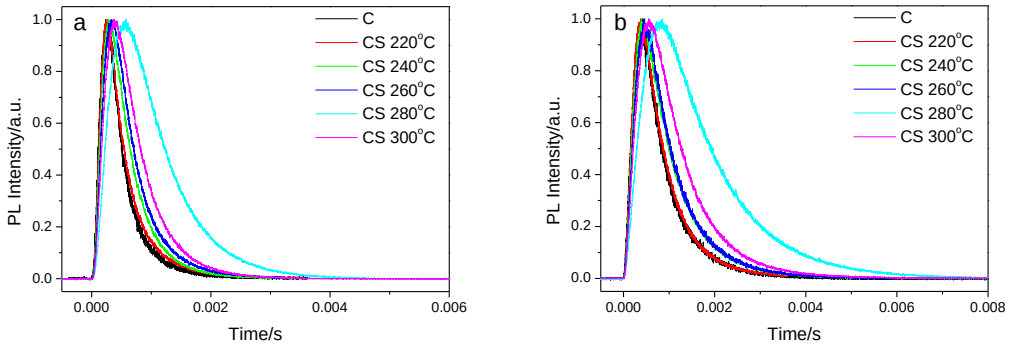

Fig. S1 Room-temperature 477 nm (a) and 801 nm (b) UC luminescent decay spectra of $NaYF_4$:Yb, Tm core NPs and the $NaYF_4$:Yb, Tm/$NaYF_4$:Yb CS NPs prepared at different shell growth temperature. λ_{ex}=980 nm.

Table S1 Upconversion luminescent lifetime of the samples shown in Fig. S1.

	C	CS-220 °C	CS-240 °C	CS-260 °C	CS-280 °C	CS-300 °C
477 nm	330 μs	365 μs	436 μs	453 μs	785 μs	543 μs
801 nm	599 μs	628 μs	738 μs	756 μs	1328 μs	848 μs

Comparing with the luminescent lifetime of core UCNPs, the lifetimes of the CS UCNPs were increased obviously. We know that: $\tau^{-1} = k_r + k_{nr}$, where τ is the observed luminescent lifetime; k_r and k_{nr} are the excited state radiative and non-radiative decay rates respectively. The epitaxial growth of shell would increase the distance between the luminescence centers and surface defects of the UCNPs, separating the core from vibrational solvents or surface-bound ligands and thus leading to the decrease of the non-radiative decay rate. If k_r was kept constant, τ would be increased correspondingly. Since the CS UCNPs grown at 280 °C showed the maximum luminescent lifetime, the non-radiative decay rate was obviously the minimum value, which indicated the optimal shell passivated effect could be achieved at this shell growth temperature.

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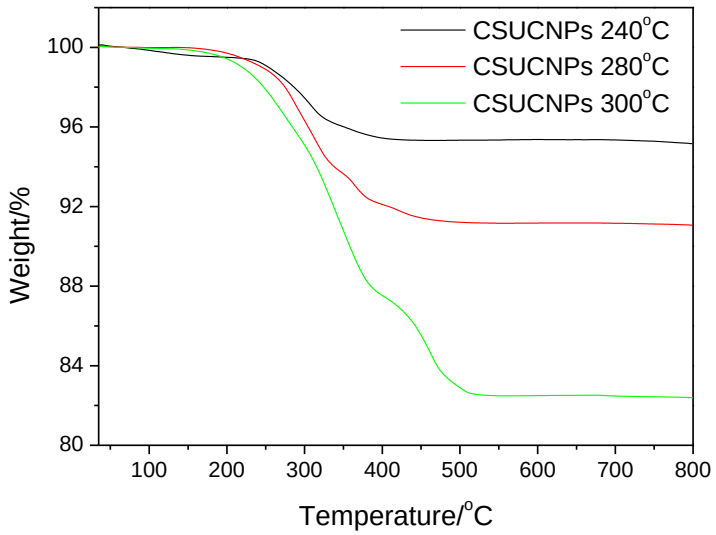

Fig. S2 TGA curves of $NaYF_4$:Yb, Tm/$NaYF_4$:Yb CS NPs prepared at 240 °C (black line), 280 °C (red line), and 300 °C (green line). The measurements were performed under the protection of N_2 flowing. It is observed obviously that the surface ligand adsorbed onto the UCNPs is thermal energy dependent.

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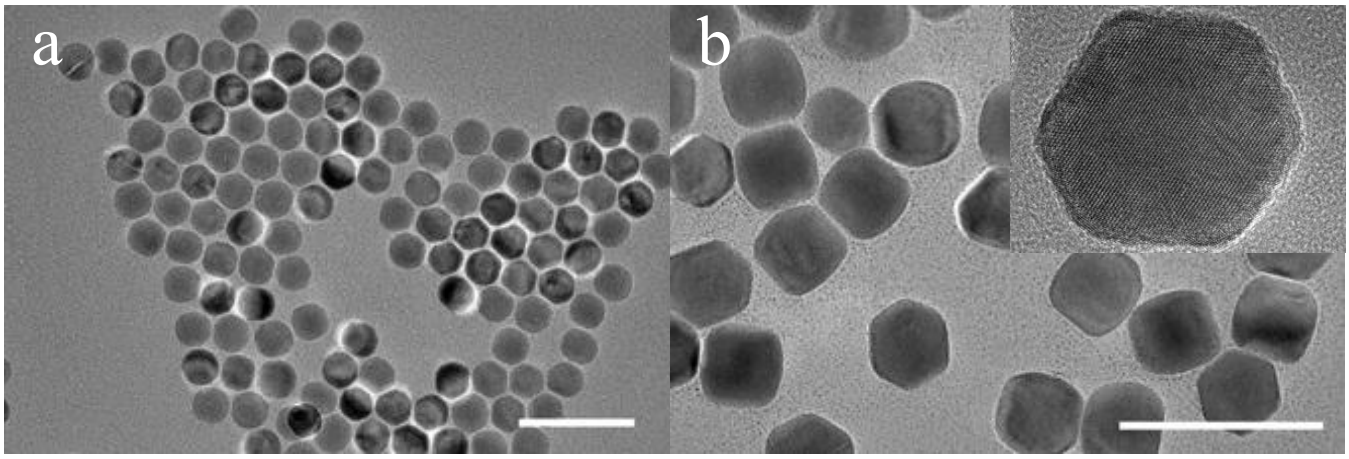

Fig. S3 Transmission electron microscopy (TEM) images of $NaYF_4$ core (a) and 14 ML CS (b) UCNPs prepared in one-pot. Inset is the HRTEM image of the 14 ML CS UCNPs. The scale bar is 100 nm. The TEM measurement was performed on a Tecnai G2 F20 S-TWIN D573 electron microscope operated at 300 kV. From the TEM results, both the $NaYF_4$ core and the 14 ML CS UCNPs are hexagonal prism structure. No interface structure could be observed from the TEM and HRTEM results. These results indicated that the $NaYF_4$ core was homogeneously passivated by the shell through our SILAR technique.