Electronic Supplementary Information

Enhanced 808 nm driven Ce^{3+} doped red-emitting upcoversion nanocrystals by intercalated nanostructure

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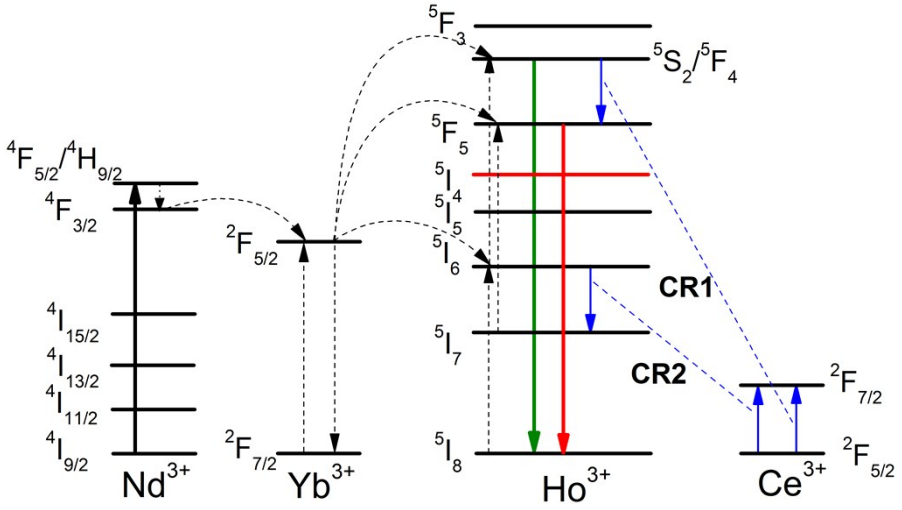

Fig. S1. Energy level diagrams of Nd^{3+}, Yb^{3+}, Ho^{3+} and Ce^{3+} ions, as well as proposed energy transfer mechanisms of Yb^{3+} sensitized 980 nm driven red-emitting UCNCs and Nd^{3+} sensitized 808 nm driven red-emitting UCNCs. Green and red emissions at ~540 nm and ~650 nm correspond to the transition $^5S_2/^5F_4 \rightarrow {}^5I_8$, and $^5F_5 \rightarrow {}^5I_8$ of Ho^{3+} ions, respectively. The enhancd red UCL and red-to-green ratio of the UCNCs by Ce^{3+} doping are mainly attributed to the cross-relaxation processes between Ho^{3+} and Ce^{3+} (CR1:Ho^{3+}:$^5S_2/^5F_4$+Ce^{3+}:$^2F_{5/2} \rightarrow Ho^{3+}$:$^5F_5$+ Ce^{3+}:$^2F_{7/2}$; CR2:Ho^{3+}:$^5I_6$+Ce^{3+}:$^2F_{5/2} \rightarrow Ho^{3+}$:$^5I_7$+$Ce^{3+}$:$^2F_{7/2}$).[1-3]

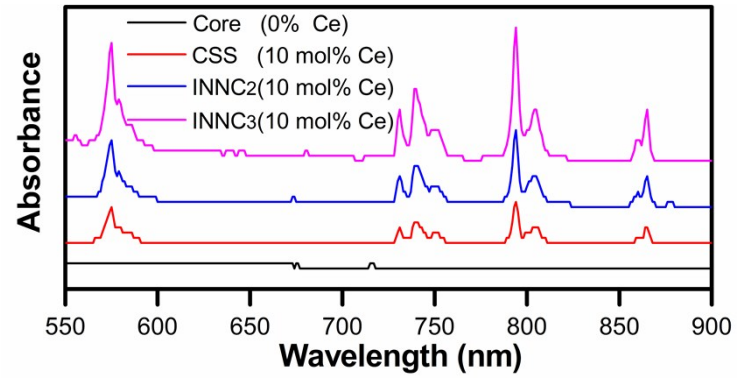

Fig. S2. Visible-near-infrared absorption spectra of $NaYF_4$:Yb/Ho (8/1 mol%) NCs, 10 mol% Ce^{3+} doped CSS structured UCNCs, 10 mol% Ce^{3+} doped $INNC_2$ and 10 mol% Ce^{3+} doped $INNC_3$ in cyclohexane (8 mM). The energy absorption capacity of the Nd^{3+} sensitized UCNCs was reflected by the variation in characteristic absorption bands of Nd^{3+} in the visible-near-infrared absorption spectra. The characteristic absorption bands of Nd^{3+} appeared in Nd^{3+} sensitized UCNCs. The $INNC_3$ showed enhanced energy absorption capacity compared with both the CSS structured UCNCs and the $INNC_2$.

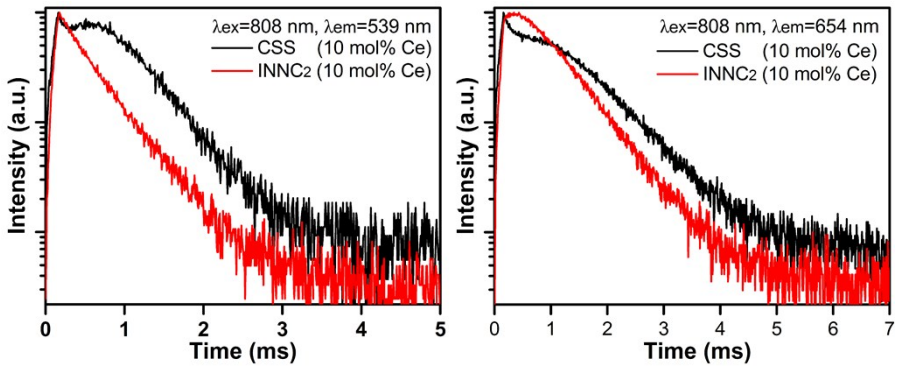

Fig. S3. Upconversion decay curves of the as-prepared 10 mol% Ce^{3+} doped CSS structured UCNCs and 10 mol% Ce^{3+} doped $INNC_2$.

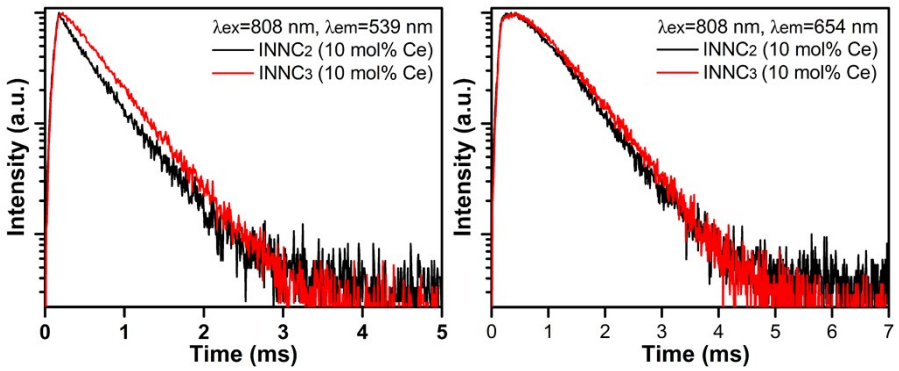

Fig. S4. Upconversion decay curves the as-prepared $INNC_2$ and $INNC_3$.

References

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3. D. Q. Chen, L. Liu, P. Huang, M. Y. Ding, J. S. Zhong and Z. G. Ji, *J. Phys. Chem. Lett.*, 2015, **6**, 2833.