Microwave-assisted Synthesis, Down- and Up-Conversion Luminescence Properties of $BaYF_5$:Ln (Ln = Ce/Tb, Yb/Er) Nanocrystals

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Experimental procedures

All the chemicals were of analytical grade and used as received without further purification. $Y(NO_3)_3$, $Er(NO_3)_3$, $Yb(NO_3)_3$, $Ce(NO_3)_3$, $Tb(NO_3)_3$ aqueous solution were obtained by dissolving $Y(NO_3)_3 \cdot 6H_2O$(99.9%), $Er(NO_3)_3 \cdot 6H_2O$ (99.9%), $Yb(NO_3)_3 \cdot 6H_2O$ (99.9%), $Ce(NO_3)_3 \cdot 6H_2O$ (99.9%), $Tb(NO_3)_3 \cdot 6H_2O$ (99.9%) in deionized water, respectively.

All the synthesis processes were performed on a programmed microwave synthesis reactor (START SYNTH, Milestone), which is equipped with inner symmetrical quartz tubes. The tubes were located on a rotated plate, which make all the reaction in the same condition. The temperature was monitored by an inner IR detector. All the reaction parameters were programmed with optimized increased time, target temperature, standing time and temperature. For a typical experiment, 0.2 mmol stoichiometric reagents of $Ba(CH_3COO)_2$, $Y(NO_3)_3$, $Tb(NO_3)_3$, $Ce(NO_3)_3$ were dissolved in 15 mL aqueous solution containing 1 mmol NH_4F under vigorous stirring until the solution becomes homogeneous and the system was additional stirred for 30 min. The resultant solution was transferred to the quartz tubes and located in the reactor, and then set parameters are as follows: microwave irradiation power 200 W, increasing time 5 min, target temperature 90 ^oC,

standing time 10 min, standing temperature 90 ^{o}C. Finally, the quartz tubes were cooled to room temperature naturally. The precipitates were separated by centrifugation, followed by washed with deionized water for 3 times. The final product was dried at 80 ^{o}C in air for about 12 h. The the Yb^{3+}/Er^{3+}-doped $BaYF_5$ nanocrystals were prepared by the same procedure, except for adding corresponding relevant Ln^{3+} (Ln^{3+} = Yb^{3+} and Er^{3+}) into the solution at the initial stage. To improve the crystallinity of the nanocrystalline powder, the Yb^{3+}/Er^{3+}-doped $BaYF_5$ resultant product was annealed at 400 ^{o}C for 4h.

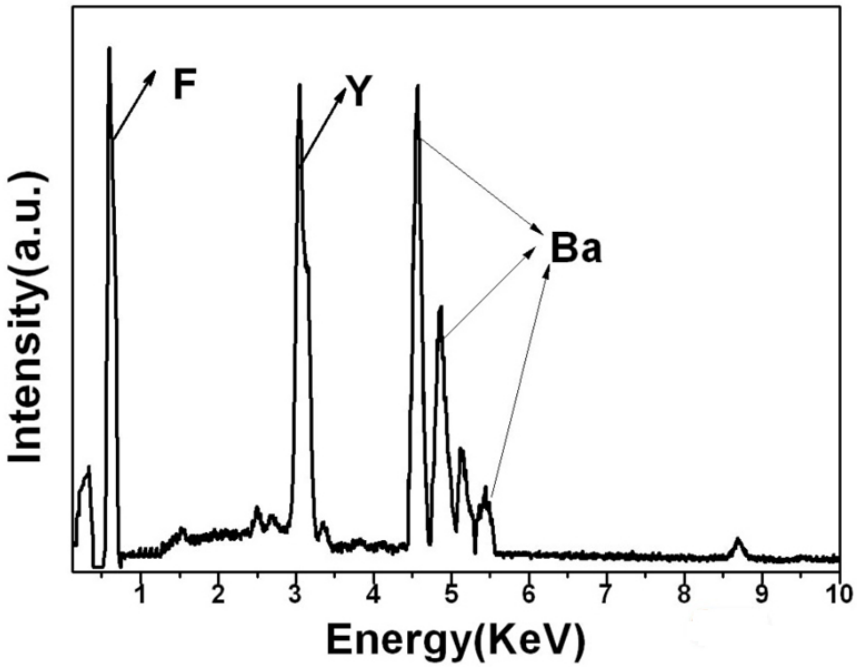

Fig.S1 EDX spectrum of the as-synthesized $BaYF_5$ nanocrystals.

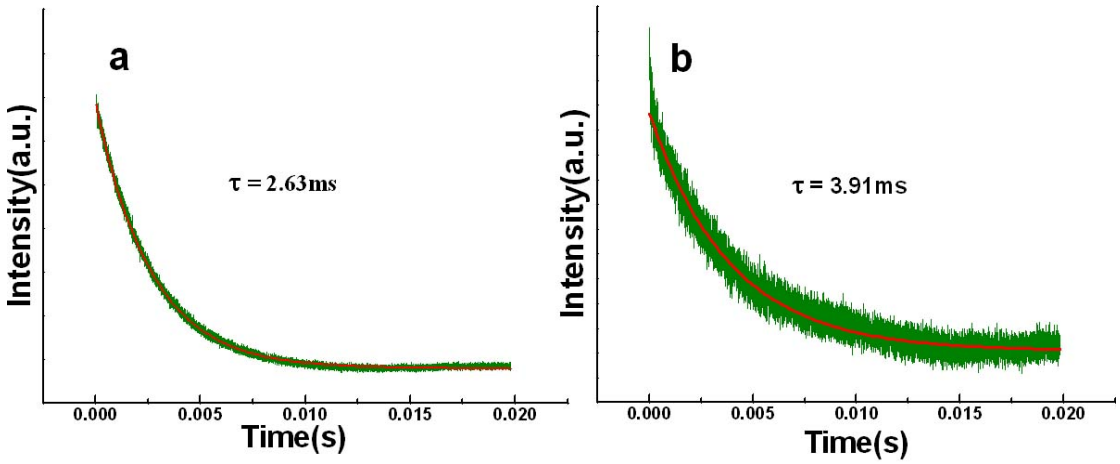

Fig.**S2** The luminescent decay curves: (a) $BaY_{0.93}Ce_{0.02}Tb_{0.05}F_5$ NCs, (b) $BaY_{0.88}Ce_{0.07}Tb_{0.05}F_5$ NCs.

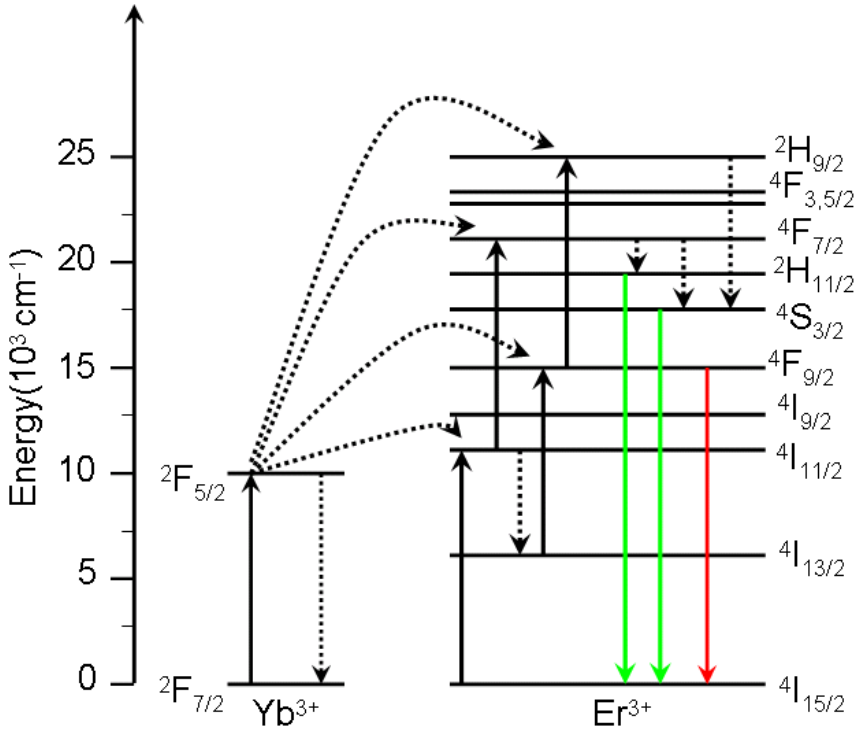

Fig.S3 Energy level diagram of the Yb^{3+}, Er^{3+} ions and the proposed UC mechanism.