

## Supporting Information

### Controlled synthesis and tunable upconversion luminescence of NaYF<sub>4</sub>:Yb<sup>3+</sup>/Er<sup>3+</sup> nanocrystals by Pb<sup>2+</sup> tridoping

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#### 1. Experimental details

**Chemicals.** Analytical grade Ln(NO<sub>3</sub>)<sub>3</sub>·6H<sub>2</sub>O (Ln = Y, Yb, and Er), Pb(NO<sub>3</sub>)<sub>2</sub>, NaF, ethanol, and oleic acid, were obtained from Beijing Chemical Reagents, China. All of the reagents and solvents were used as received without further purification. Deionized water was used throughout.

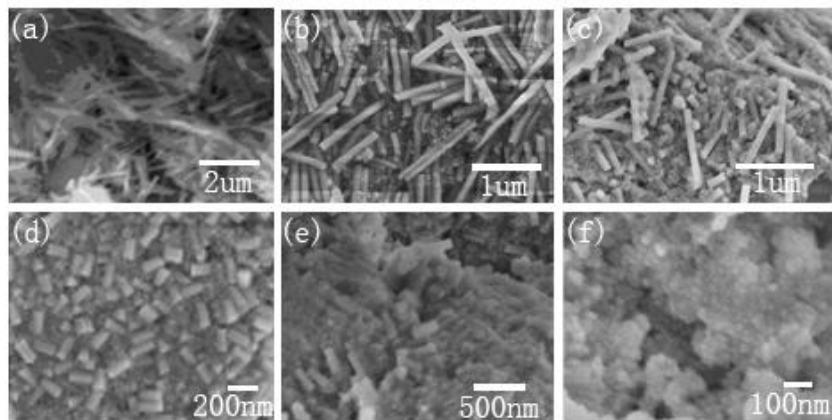
**Synthesis of NaYF<sub>4</sub>:Yb<sup>3+</sup>/Er<sup>3+</sup>/Pb<sup>2+</sup> Nanocrystals.** In a typical synthesis, 7 mL of NaF aqueous solution (1 mol/L), 1 mL of Ln(NO<sub>3</sub>)<sub>3</sub> aqueous solution (0.5 mol/L), and Pb(NO<sub>3</sub>)<sub>2</sub> aqueous solution (0.5 M) were added to a mixture of NaOH (1.2 g), ethanol (8 mL), deionized water (4 mL), and oleic acid (20 mL), and the solution was thoroughly stirred. Subsequently, the milky colloidal solution was transferred to a 50 mL Teflon-lined autoclave, and heated at 180 °C for 24 h. The systems were then allowed to cool to room temperature. The final products were collected by means of centrifugation, washed with ethanol, and finally dried in vacuum at 80 °C for 4 h.

**Powder X-ray Diffraction (XRD).** The crystal structure was analyzed by a Rigaku (Japan) D/MAX-rA X-ray diffractionmeter equipped with graphite monochromatized Cu K $\alpha$  radiation ( $\gamma=1.541874$  Å), keeping the operating voltage and current at 40 kV and 40 mA, respectively.

**Transmission Electron Microscopy (TEM) and scanning electron microscopy (SEM).** The size and morphology of the final products were determined by using JSM-6301F scanning electron microscope (SEM) and JEOL JEM-2010F transmission electron microscope operated at 200 kV.

**Fluorescence Spectroscopy.** The up-conversion luminescence spectra were recorded using a Hitachi F-4500 fluorescence spectrophotometer with an adjustable laser (980 nm, Beijing Hi-Tech Optoelectronic Co., China) as the excitation source with a fiber-optic accessory.

**Figure S1.** SEM images of  $\text{NaYF}_4:\text{Yb}^{3+}/\text{Er}^{3+}/\text{Pb}^{2+}$  nanocrystals prepared at 180 °C for 24 h with different  $\text{Pb}(\text{NO}_3)_2$  aqueous solution as raw materials: (a) 0 mL, (b) 0.5 mL, (c) 1 mL, (d) 3 mL, (e) 5 mL, and (f) 7 mL.



**Figure S2.** UC mechanism of  $\text{Yb}^{3+}$ -sensitized  $\text{Er}^{3+}$  emissions in  $\text{NaYF}_4:\text{Yb}^{3+}/\text{Er}^{3+}/\text{Pb}^{2+}$  nanocrystals.

