Supporting information for

Rare-Earth-Doped Yttrium Oxide Nanoplatelets and Nanotubes: Controllable Fabrication, Topotactic Transformation and Upconversion Luminescence

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MATERIALS AND METHODS

Materials. The starting rare-earth metal sources for synthesis were $Y(NO_3)_3 \cdot 6H_2O$ $Yb(NO_3)_3 \cdot 5H_2O$ and $Er(NO_3)_3 \cdot 5H_2O$ which were analytical grade from the Aladdin Industrial Corporation (Shanghai, China). SDS was purchased from Wako Pure Chemical Industrial Ltd. (Japan). TEA was obtained from Sinopharm Chemical Reagent (Shanghai, China). Deionized water was used throughout.

Synthesis. All the reagents were of analytical grade and used without further purification. Nanoplatelets precursors were synthesized via a facile hydrothermal method using trimethylamine (TEA) as a hydrolysis reagent. In a typical procedure, 0.1 mmol rare earth nitrate ($RE(NO_3)_3 \cdot nH_2O$), with various Y/Yb/Er ratio of 98:1:1, 94:5:1, 89:10:1, 84:15:1, respectively, were put into a Teflon-lined autoclave of 50 mL capacity and dissolved in 30 mL deionized water under stirring at room temperature. 3 ml TEA were mixed in the above solution. After 30 min of stirring, the autoclave was tightly sealed and placed in an electric oven preheated at 180 °C for 24 h. The autoclave was allowed to cool naturally to room temperature. On the other hand, as with the previous synthesis method, nanotubes precursors can also be synthesized by adding 0.413 g SDS as a structure directing agent. The autoclave was allowed to cool naturally. The precipitate was centrifuged at 4500 rpm and washed with deionized water and ethanol for several times, and was finally dried in air at 60 °C for 6 h. The doped precursors were calcined in air to prepare Y_2O_3:Yb/Er nanoplatelets and nanotubes at 650 °C for 2 h.

Characterization. The crystal phase of the products was examined by X-ray diffractometer (XRD, D/max2550 VB+) with Cu Kα radiation ($\lambda = 1.5418$ Å). The sizes and morphologies of products were characterized by FEI Helios Nanolab 600i scanning electron microscope (SEM). Transmission electron microscope (TEM) images, High-resolution TEM (HRTEM), elemental mapping, and the selected area electron diffraction (SAED) were recorded on a Titan G2 60-300 transmission electron microscope. TG analysis measurement was carried out on a TA-STDQ650 (TA Instruments Inc., New Castle, USA) instrument in the temperature range of 30-900°C in air. The UC spectra were recorded using a monochromator (Zolix Instruments, Omni-λ320i) coupled with a photomultiplier (PMTH-S1-CR131), which is equipped with a 150W xenon lamp as the excitation source. Inductively coupled plasma-optical emission spectroscopy (ICP-OES) analyses were performed on SPECTRO BLUE SOP. FTIR spectroscopy was taken on a Nicolet Nexus 670 instrument.

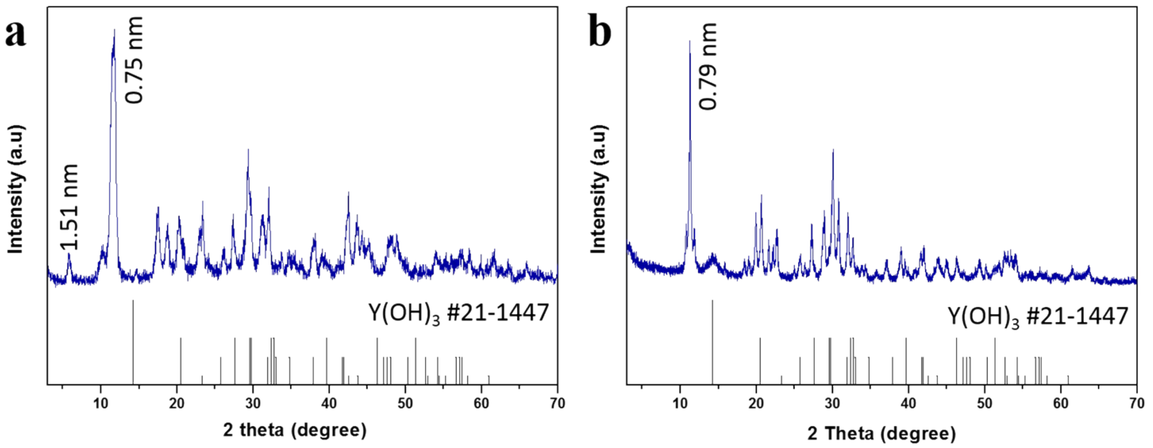

Figure S1. XRD patterns of the precursors with two morphology (a) the nanoplatelets precursor with $Y_{0.98}/Yb_{0.01}/Er_{0.01}$ ratio using 3 ml TEA at 180 °C for 24 h; (b) the nanotubes precursor with $Y_{0.98}/Yb_{0.01}/Er_{0.01}$ ratio using 3 ml TEA and 0.413 g SDS at 180 °C for 24 h.

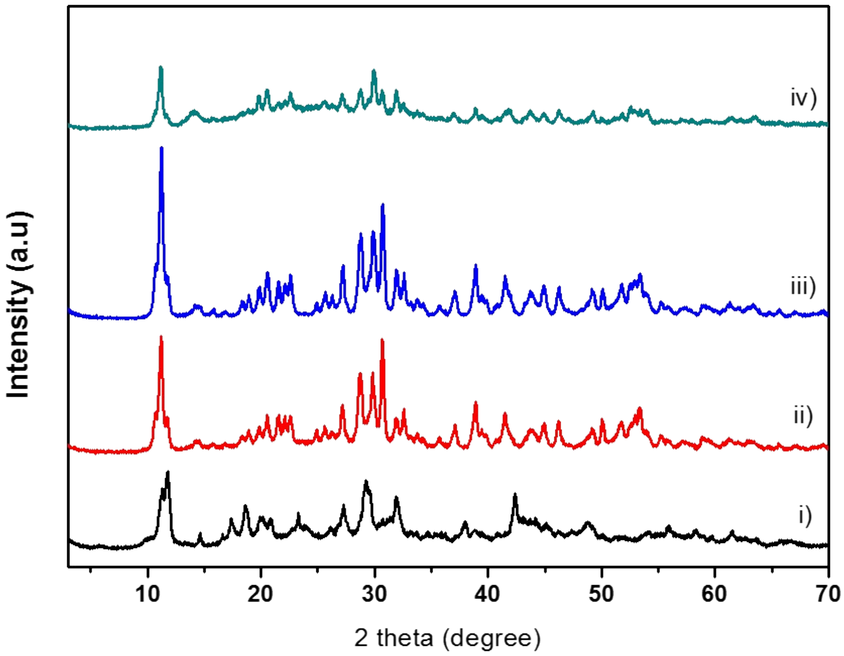

Figure S2. XRD patterns of the without Yb ions and Er ions doping product at 180 °C for 24 h using 3 ml TEA and various amounts of SDS: (i) 0.05 g SDS; (ii) 0.1 g SDS; (iii) 0.2 g SDS; (iv) 0.413 g SDS.

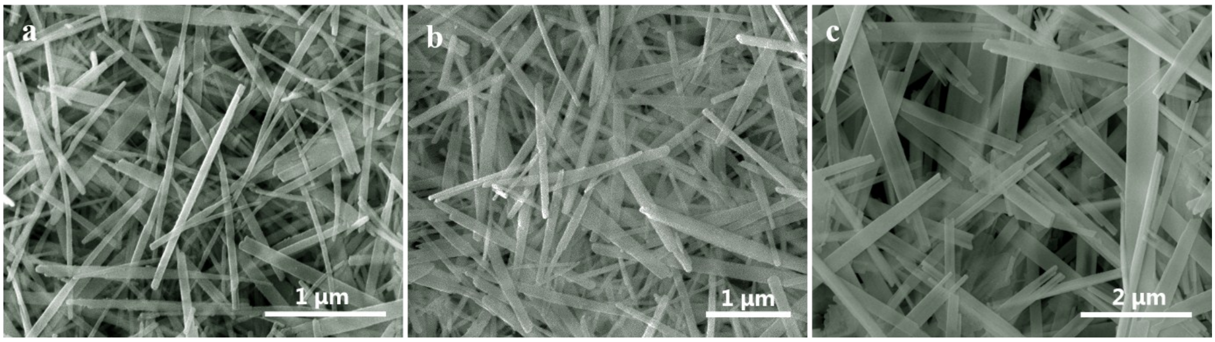

Figure S3. SEM image of nanotubes precursors obtained using 3 ml TEA and 0.413 g SDS at 180 °C for 24h with various Y/Yb/Er ratio: (a) $Y_{0.98}/Yb_{0.01}/Er_{0.01}$; (b) $Y_{0.94}/Yb_{0.05}/Er_{0.01}$; (c) $Y_{0.84}/Yb_{0.15}/Er_{0.01}$.

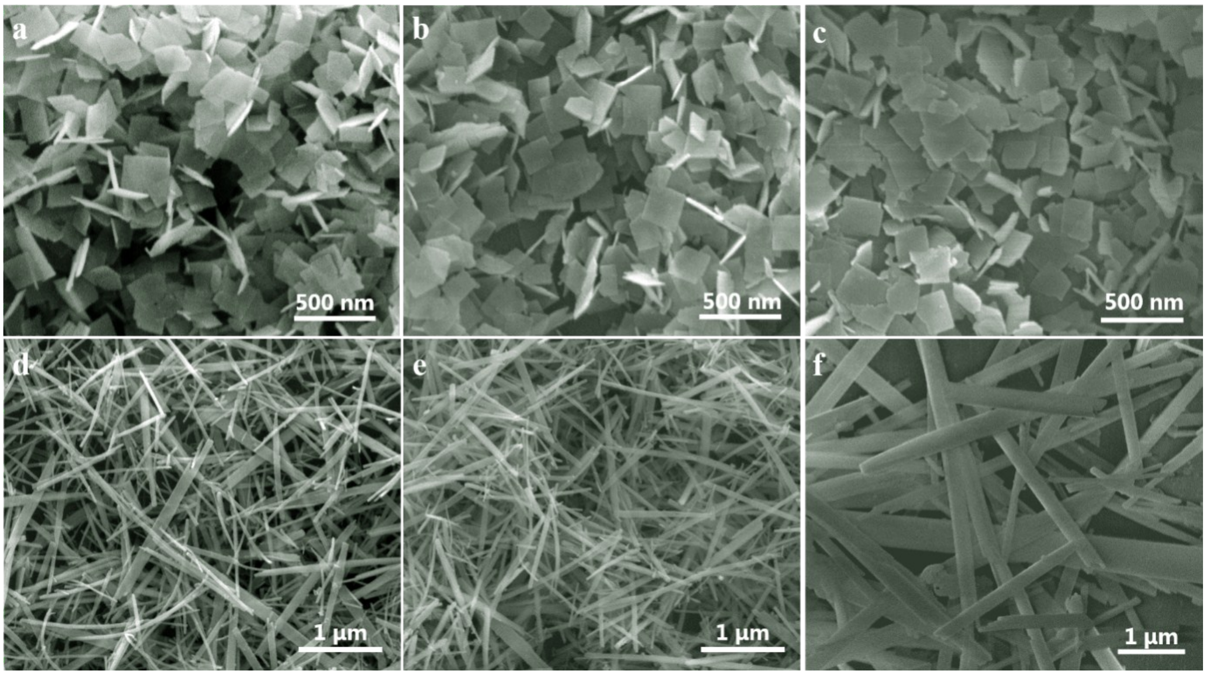

Figure S4. SEM images of tri-metallic oxide nanoplatelets obtained by the calcination of the as- prepared nanotubes precursor in air at 650 °C for 2 h with varied Y/Yb/Er ratio: (a) $Y_{0.98}/Yb_{0.01}/Er_{0.01}$; (b) $Y_{0.94}/Yb_{0.05}/Er_{0.01}$; (c) $Y_{0.84}/Yb_{0.15}/Er_{0.01}$. SEM images of tri-metallic oxide nanotubes btained by the calcination of the as- prepared nanotubes precursor in air at 650 °C for 2 h with varied Y/Yb/Er ratio: (d) $Y_{0.98}/Yb_{0.01}/Er_{0.01}$; (e) $Y_{0.94}/Yb_{0.05}/Er_{0.01}$; (f) $Y_{0.84}/Yb_{0.15}/Er_{0.01}$.

Table S1. ICP analyses of nanoplatelets and nanotubes with Yb:Er ratio of 10:1.

element	nanoplatelets at Yb/Er:10:1 ratio	nanotubes at Yb/Er:10:1 ratio
Y	79.44%	76.96%
Yb	18.87%	16.68%
Er	1.68%	1.57%
S	0.01%	4.79%

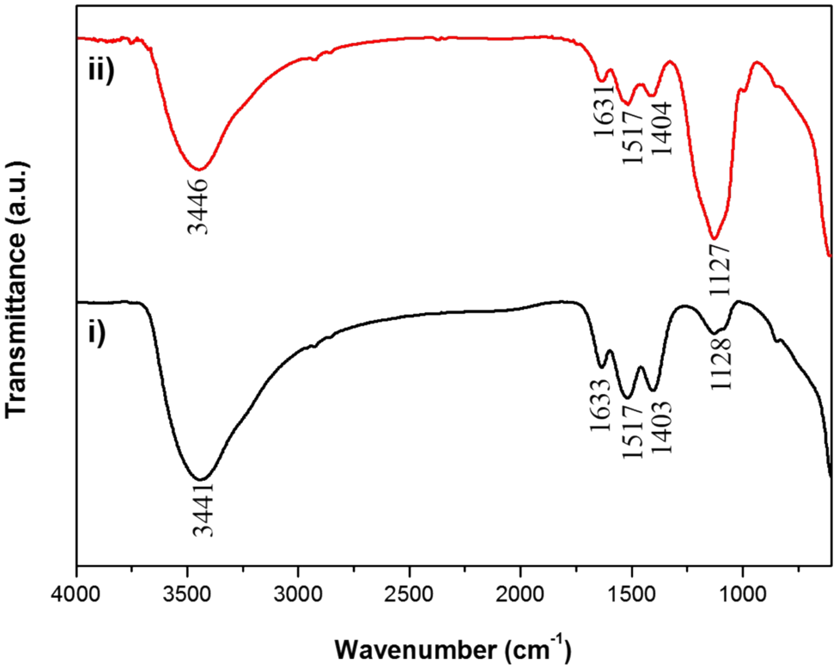

Figure S5. (a) FTIR spectra for i) nanoplatelets, ii) nanotubes with Yb:Er ratio of 10:1 obtained by the calcination of the as-prepared nanoplatelets (nanotubes) precursor in air at 650 °C for 2 h.