Supplementary Materials

Absolute Quantum Yield Measurements of Colloidal $NaYF_4$ Upconverting Nanoparticles

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Synthetic Procedures

All chemicals utilized in the synthesis of the upconverting nanoparticles and bulk sample were purchased from Aldrich and used as received.

Synthesis of Bulk $NaYF_4$ material

The lanthanide trifluoracetate precursors were prepared from the corresponding lanthanide and yttrium oxides and trifluoroacetic acid (99%). In the case of the $NaYF_4$: Er^{3+}2 mol%, Yb^{3+}20 mol% codoped sample, 9.6 mg (0.025 mmol) of Er_2O_3, 98.5 mg (0.25 mmol) of Yb_2O_3, and 220.2 mg (0.975 mmol) of Y_2O_3were dissolved in 10 mL of 50% aqueous trifluoroacetic acid at 80 ^oC. The residual water and acid were then slowly evaporated at 80 ^oC. Subsequently, 0.3400 g (2.5 mmol) of sodium trifluoroacetate (98%) was added to the lanthanide trifluoroacetates and the powders were ground with a mortar and pestle. The resulting powder was heated to 110 ^oCin an oven and maintained at this temperature overnight to remove any residual moisture. The powder was then placed in a crucible and heated to a temperature of 400 i^oC at a rate of 10 ^oC/min under air in a tube furnace and kept at this temperature for 4 hr. The furnace was then left to cool to RT. The resulting solid was then ground with a mortar and pestle to obtain a fine powder.

Synthesis of 10 nm $NaYF_4$ nanoparticles

The 10 nm $NaYF_4$: Er^{3+}2 mol%, Yb^{3+}20 mol% nanoparticle sample was synthesized using the synthetic procedure outlined in the following publication:

G. S. Yi and G. M. Chow, *Advanced Functional Materials*, 2006, **16**, 2324.

No changes were made to the reported procedure.

Synthesis of 30 nm and 100 nm $NaYF_4$ nanoparticles

The30 nm and 100 nm $NaYF_4$: Er^{3+}2 mol%, Yb^{3+}20 mol% nanoparticle samples was synthesized using the synthetic procedures outlined in the following publications:

H.-S. Qian and Y. Zhang, *Langmuir*, 2008, **24**, 12123.

Z. Li and Y. Zhang, *Nanotechnology*, 2008, **19**, 345606/1.

No changes were made to the reported procedures.

Synthesis of 30 nm $NaYF_4$ core/shell nanoparticles

The 30 nm $NaYF_4$: Er^{3+}2 mol%, Yb^{3+}20 mol% / $NaYF_4$ core/shell nanoparticle sample was synthesized using the synthetic procedure outlined in the following publication:

H.-S. Qian and Y. Zhang, *Langmuir*, 2008, **24**, 12123.

No changes were made to the reported procedures.

Powder X-ray Diffraction

Powder X-ray diffraction (XRD) data were acquired with a Rigaku Miniflex Diffractometer. Concentrated colloidals of the $NaYF_4$ nanoparticle samples in hexanes were drop-cast onto a zero-background holder and allowed to dry. Step-scan X-ray powder diffraction data were collected using a Rigaku Miniflex Diffractometer. A Cr radiation source was used at 30 kV and 15 mA with a Kβ filter, a 4.2º scattering slit, and a 0.3 mm receiving slit. XRD data was collected in the 20-140º (2θ) range with a scanning step size of 0.02° (2θ)and a counting time of 3 s per step.

Transmission Electron Microscopy

TEM was performed on the $NaYF_4$: Er^{3+}2%, Yb^{3+}20% nanoparticle samples using a Hitachi H-7000 microscope operating at 75 kV equipped with a charge-coupled device (CCD)-camera. A small amount of the sample (~1 mg) was dispersed in 1 g of hexane to give an approximate 0.1 wt% solution. One drop of the resulting nanoparticle dispersion was dropcasted on a formvar/carbon film supported on a 300 mesh copper grid (3 mm in diameter)and allowed to dry in air at room temperature.

Table S1. Raw data used for calculation of upconversion quantum yields for $NaYF_4$: Er^{3+} 2 mol%, Yb^{3+} 20 mol% samples. The muber of *hv* Absorbed must be multiplied by 10000 to take into the account attenuation factor of the neutral density filter.

Samples	Power Density (W/cm^2)	Number of *hv* Emitted	Number of *hv* Absorbed
ErYb1	20	40989	132
ErYb2	150	26118	1154
ErYb3	150	16101	1321
ErYb4	150	428	1257
ErYb5	150	27916	1380

Figure S1. Photos of the experimental set-up showing the position of the diode laser and integrating sphere in the fluorimeter.

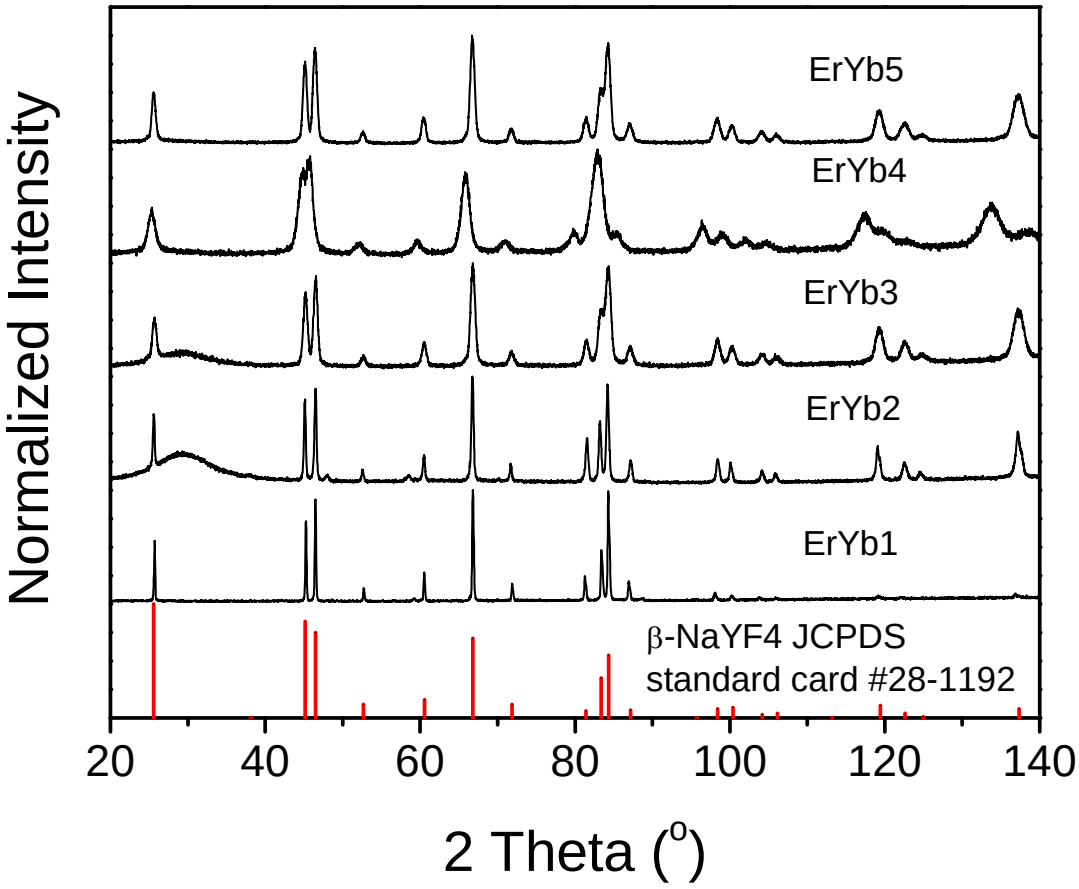

Figure S2. Experimental X-ray diffraction (XRD) patterns for $NaYF_4$: Er^{3+} 2%, Yb^{3+} 20% nanoparticleand bulk samples. Broad peak located at 30° is attributed to organic oleate layer.

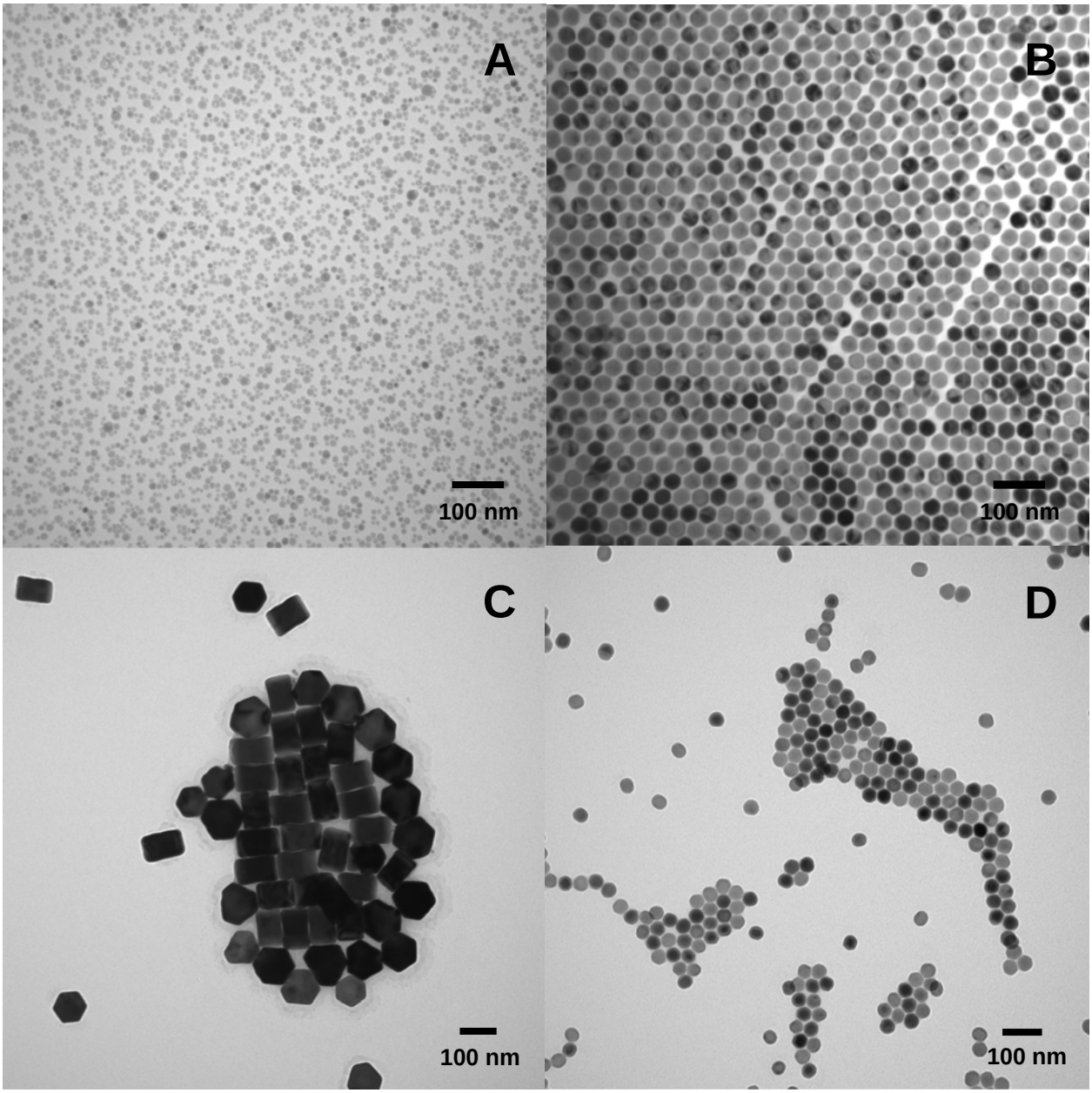

Figure S3. Transmission Electron Microscopy (TEM) images of $NaYF_4$: Er^{3+} 2%, Yb^{3+} 20% nanoparticles with average particle size of A) 10 nm, B) 30 nm, and C) 100 nm, respectively. D) TEM image of $NaYF_4$: Er^{3+} 2%, Yb^{3+} 20% / $NaYF_4$ core/shell nanoparticles.