

# **NaF-Mediated Controlled-Synthesis of Multicolor Na<sub>x</sub>ScF<sub>3+x</sub>:Yb/Er Upconversion Nanocrystals**

Wen-Bo Pei,<sup>a</sup> Bo Chen,<sup>a</sup> Lili Wang,<sup>a</sup> Jiansheng Wu,<sup>c</sup> Xue Teng,<sup>a</sup> Raymond Lau,<sup>\*a</sup>  
Ling Huang,<sup>\*b</sup> Wei Huang<sup>b</sup>

<sup>a</sup> School of Chemical and Biomedical Engineering, Nanyang Technological University, 62 Nanyang Drive, Singapore 637459

<sup>b</sup> Key Laboratory of Flexible Electronics (KLOFE) & Institute of Advanced Materials (IAM), Jiangsu National Synergistic Innovation Center for Advanced Materials (SICAM), Nanjing Tech University (NanjingTech), 30 South Puzhu Road, Nanjing, P.R. China, 211816

<sup>c</sup> School of Materials Science and Engineering, Nanyang Technological University, 50 Nanyang Ave, Singapore 639672

Tel.: +65 63168830

Fax: +65 67947553

Email: wmlau@ntu.edu.sg, iamlhuang@njtech.edu.cn

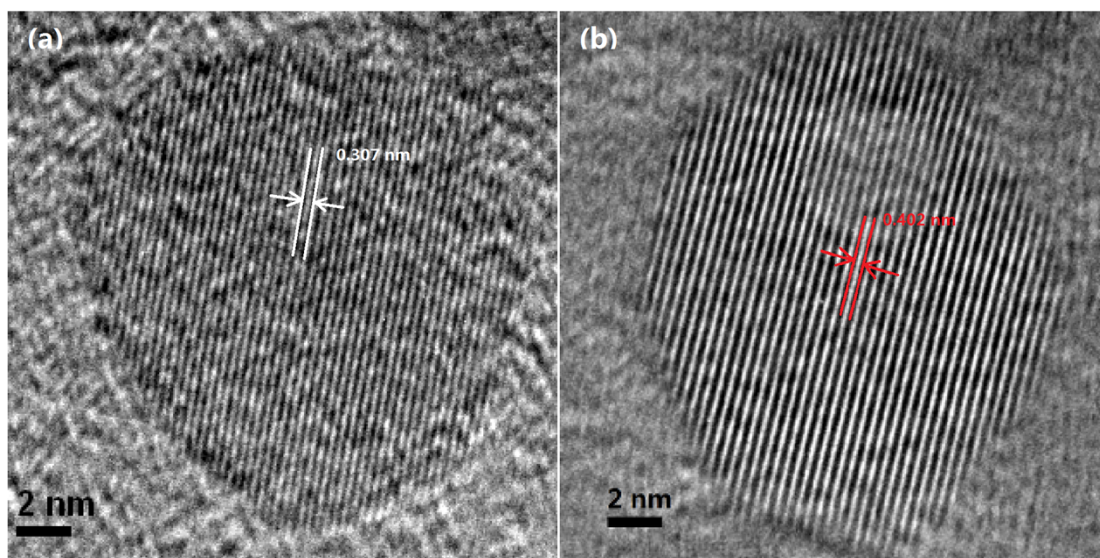


Figure S1 High resolution TEM images of the resulting NaScF<sub>4</sub>:Yb/Er (a) and Na<sub>3</sub>ScF<sub>6</sub>:Yb/Er (b) nanocrystals, showing lattice fringes with an observed d-spacing of 0.307 nm and 0.402 nm, respectively.

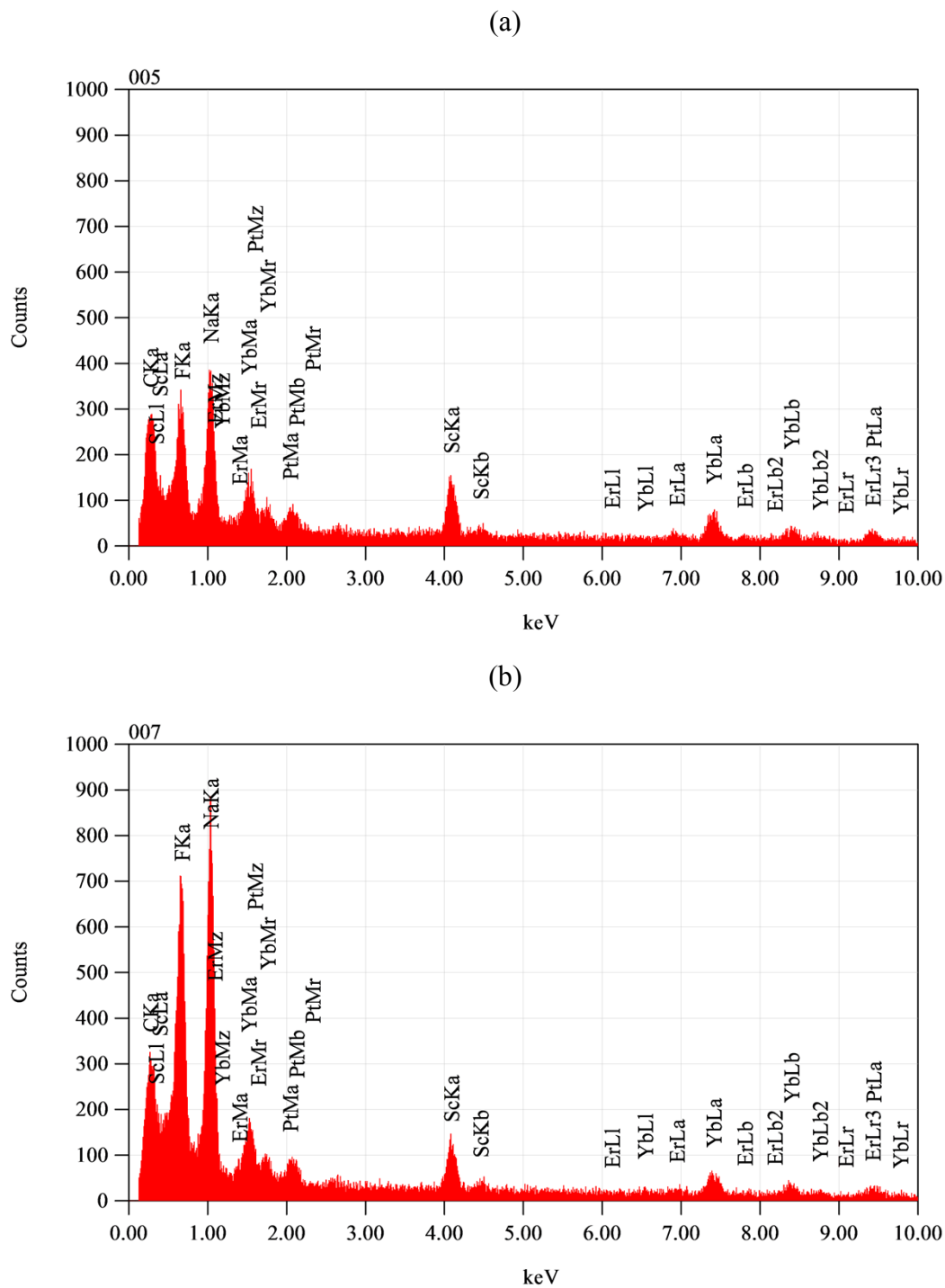


Figure S2 EDS data of the resulting NaScF<sub>4</sub>:Yb/Er (a) and Na<sub>3</sub>ScF<sub>6</sub>:Yb/Er (b) nanocrystals showing the presence of the doped Yb, Er elements.

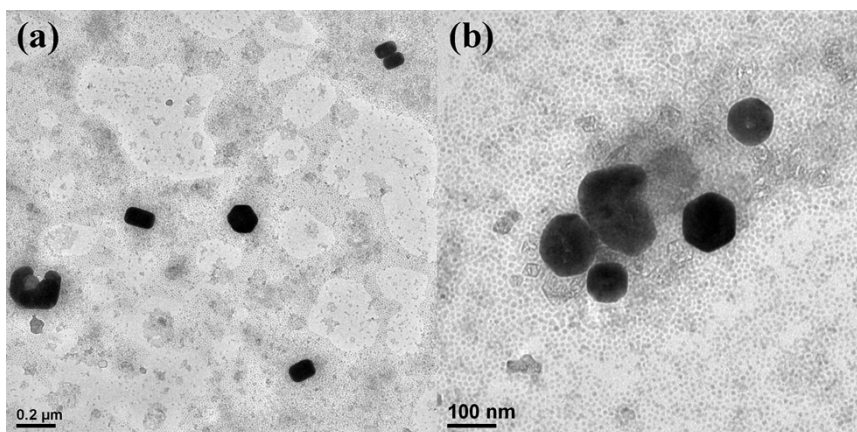


Figure S3 TEM images for the nanocrystals synthesized at NaF:Ln<sup>3+</sup> mole ratio of 14 (a) and 20 (b).

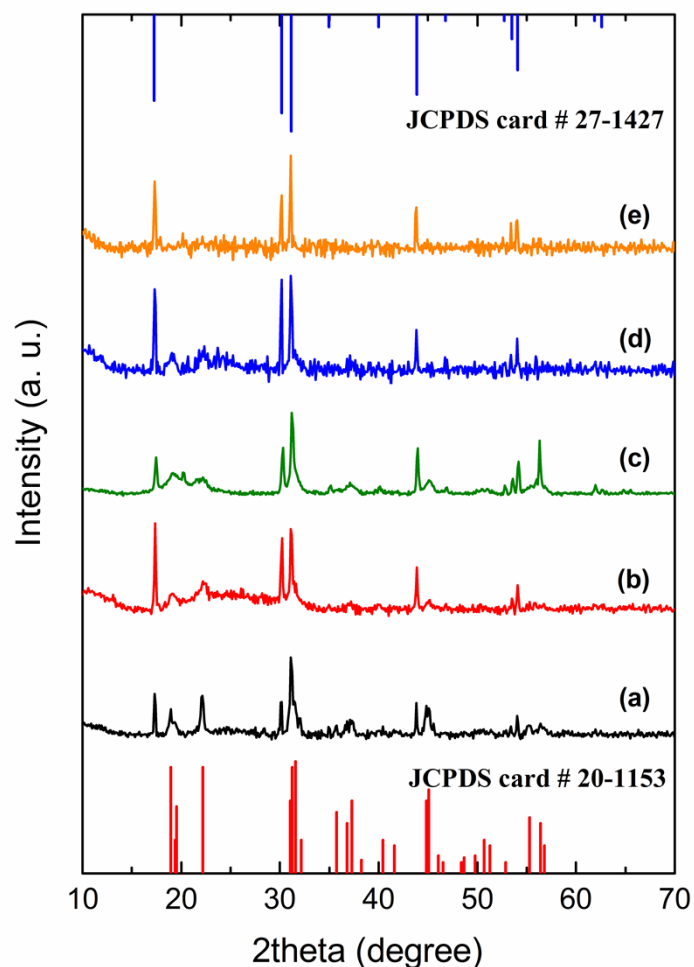


Figure S4 XRD patterns for the nanocrystals synthesized at NaF:Ln<sup>3+</sup> mole ratio of 6 (a), 8 (b), 10 (c), 14 (d) and 20 (e), proving the mixture of both monoclinic Na<sub>3</sub>ScF<sub>6</sub> phase and hexagonal NaYbF<sub>4</sub> crystal phase (blue and red lines at the top and bottom are the standard XRD patterns of hexagonal phase NaYbF<sub>4</sub> crystals (JCPDS card No. 27-1427) and monoclinic phase Na<sub>3</sub>ScF<sub>6</sub> crystals (JCPDS card No. 20-1153)).

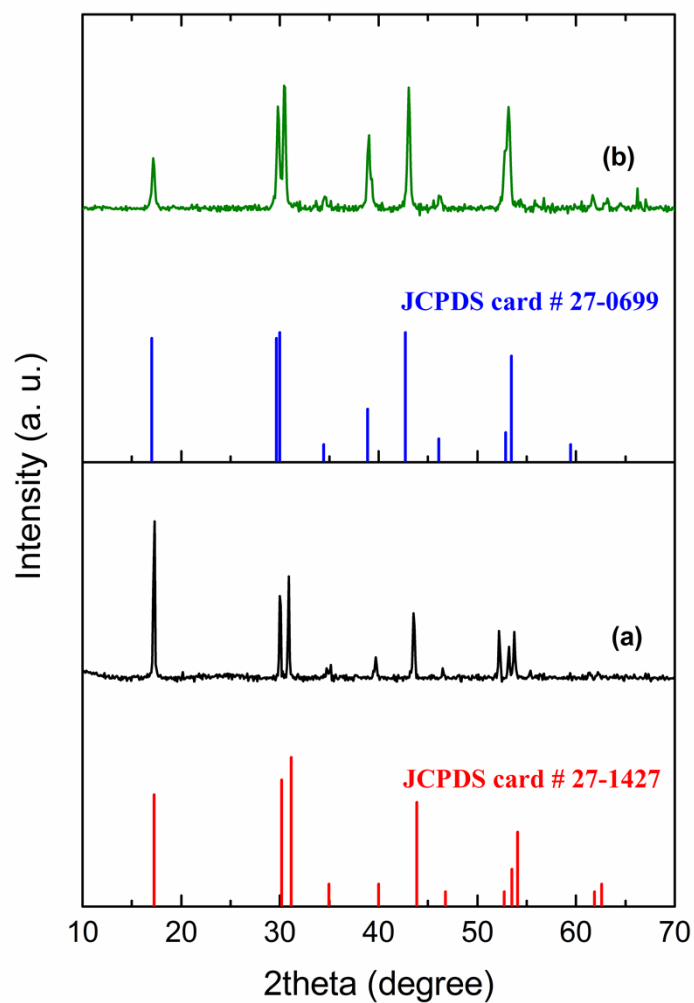


Figure S5 XRD patterns for the NaYF<sub>4</sub>:Yb/Er (a) and NaGdF<sub>4</sub>:Yb/Er (b) nanocrystals synthesized at NaF:Ln<sup>3+</sup> mole ratio of 10 (blue and red lines are the standard XRD patterns of hexagonal phase NaGdF<sub>4</sub> crystals (JCPDS card No. 27-0699) and hexagonal phase NaYF<sub>4</sub> crystals (JCPDS card No. 27-1427)).

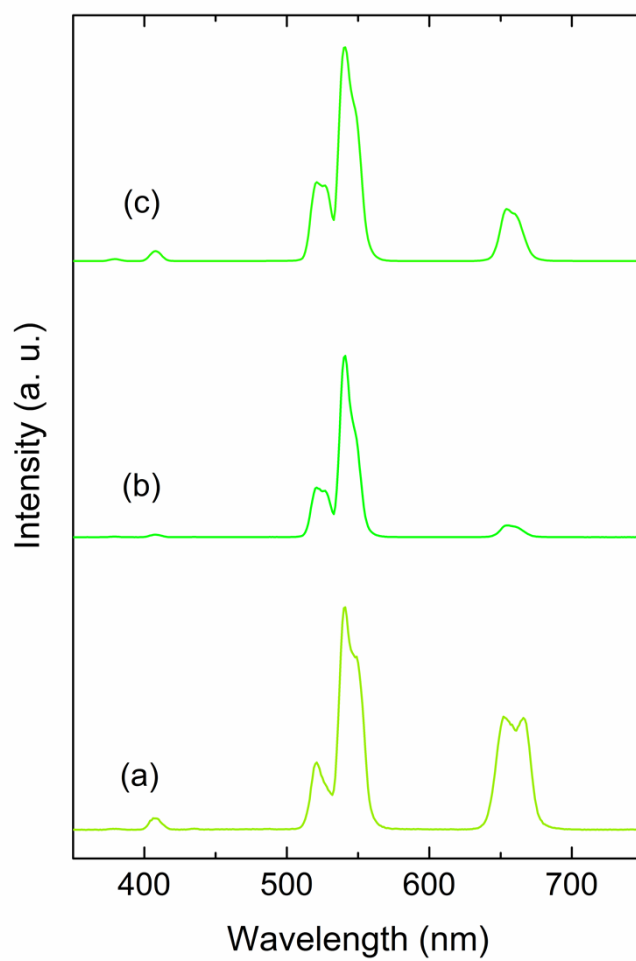


Figure S6 UC fluorescence spectra of the corresponding NaYF<sub>4</sub>:Yb/Er nanocrystals synthesized at NaF:Ln<sup>3+</sup> = 1 (a), 4 (b) and 10 (c), with a R/G ratio of 0.6516, 0.0707 and 0.2151 respectively.

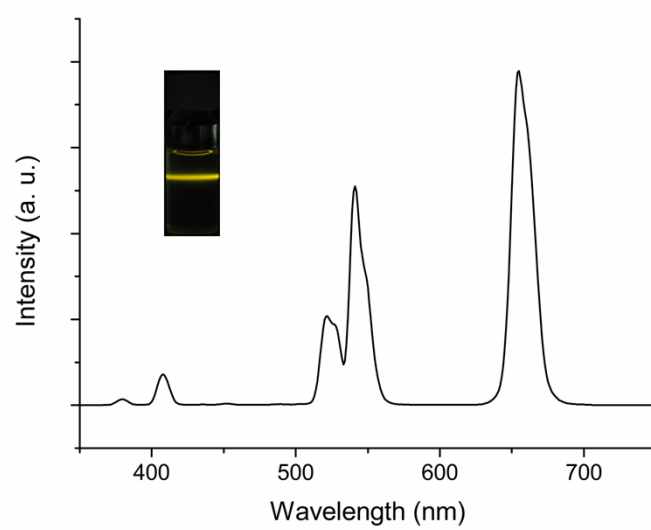


Figure S7 UC fluorescence spectra of the corresponding NaYbF<sub>4</sub>:Er nanocrystals with R/G ratio of 1.4077, the inset photo shows the corresponding PL photograph of nanoparticles dispersed in cyclohexane.



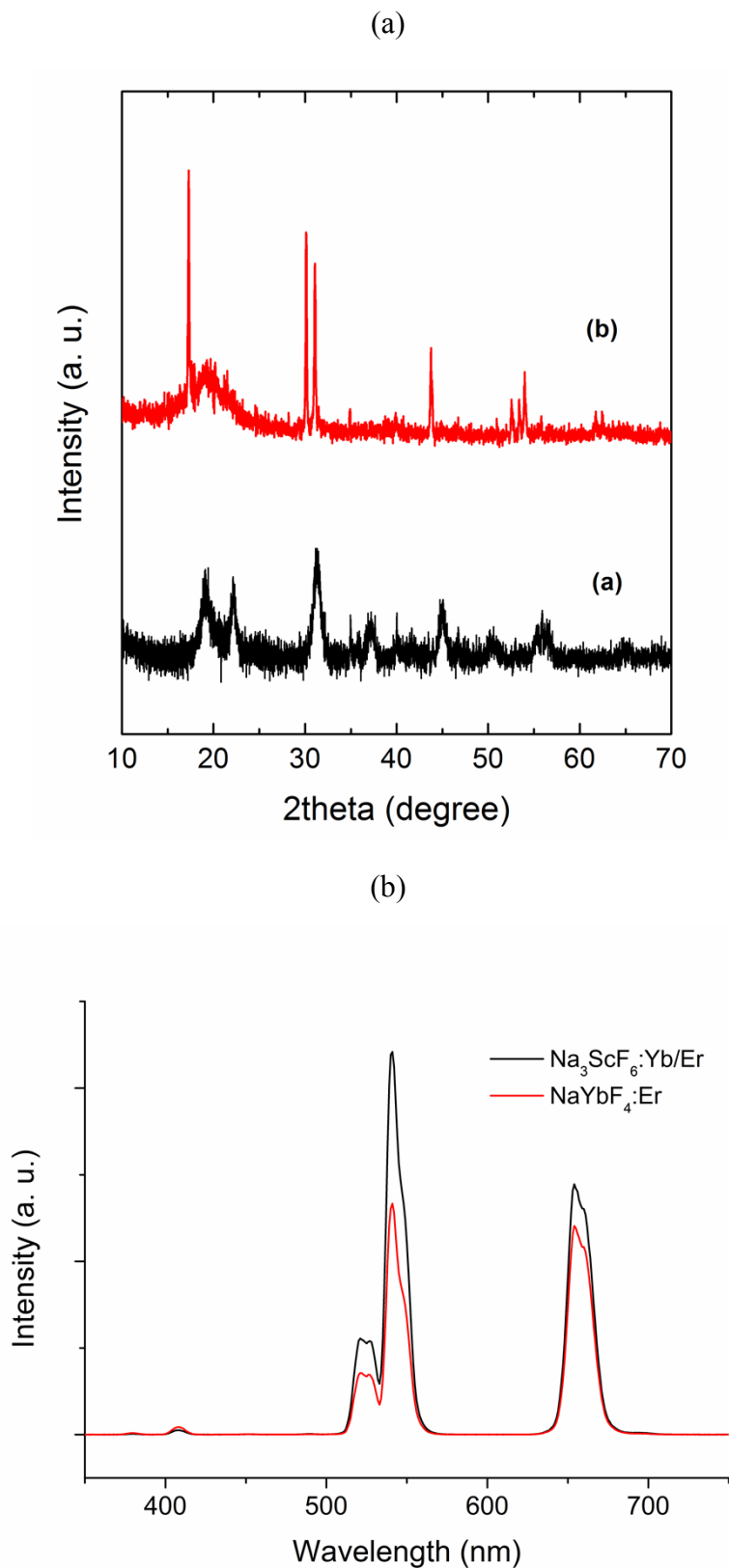


Figure S8 XRD Pattern (top) and UC fluorescence spectra (bottom) of the corresponding  $\text{Na}_3\text{ScF}_6\text{:Yb/Er}$  (black line) and  $\text{NaYbF}_4\text{:Er}$  (red line) nanocrystals from the sample prepared at  $\text{NaF}:\text{Ln}^{3+}$  mole ratio of 10.