Supporting Information

A general strategy for the synthesis of rare earth fluoride nano (micro)crystals

Songtao Liu,[a] Gejihu De, [abc*] Xian Wang, [a] Yueshan Xu, [a] Yuanyuan Liu, [a] Jianxun Wang, [a] Chunyan Cheng. [a]

[a] College of Chemistry and Environment Science, Inner Mongolia Normal University, Hohhot 010022, People's Republic of China
[b] Physics and Chemistry of Functional Materials, Inner Mongolia Normal University, Hohhot 010022, People's Republic of China
[c] State Key Laboratory on Integrated Optoelectronics, Jilin University, Jilin 130012, People's Republic of China

E-mail: degjh@imnu.edu.cn

STable 1 Crystal structure, Excited level, Monitoring wavelength and Lifetime of as-obtained KYF_4:20%Yb^{3+}/2%Er^{3+} nanocrystals.

Samples	Structure	Excited level	Wavelength (nm)	Lifetime (μs)
KY_3F_{10}	Tetragonal	$^4S_{3/2}$	544	39.31
KYF_4	Hexagonal	$^4S_{3/2}$	544	733.01
K_2YF_5	Orthorhombic	$^4S_{3/2}$	544	996.67
KY_3F_{10}	Tetragonal	$^4F_{9/2}$	655	58.88
KYF_4	Hexagonal	$^4F_{9/2}$	655	1045.69
K_2YF_5	Orthorhombic	$^4F_{9/2}$	655	1055.88

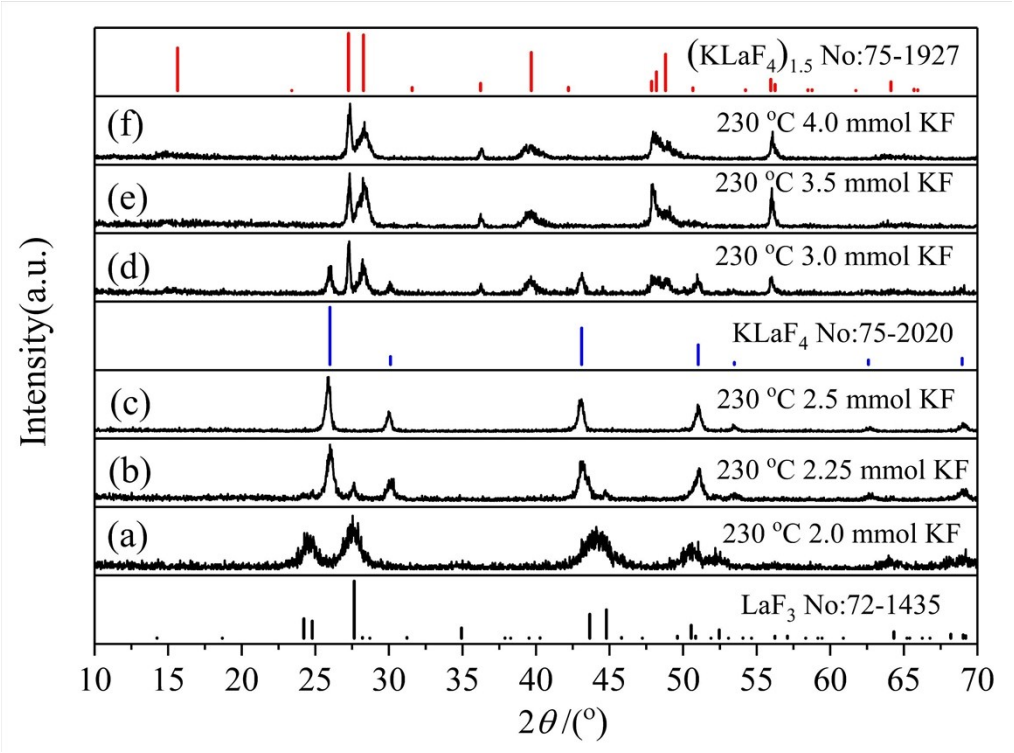

Figure S1: XRD data of the products obtained at different molar ratios KF-to-RE: (a) 2:1; (b) 2.25:1; (c) 2.5:1; (d) 3:1; (e) 3.5:1; (f) 4:1. Other synthesis conditions: 45 mL OA/15 mL HA, $V_{H2O}/V_{CF3COOH}$=9/2, 230 °C for 48 h. Vertical black, red and blue lines depict the XRD references for hexagonal LaF_3 (JCPDS No: 72-1435), cubic $KLaF_4$ (JCPDS No: 75-2020), and hexagonal $(KLaF_4)_{1.5}$ (JCPDS No: 75-1927), respectively.

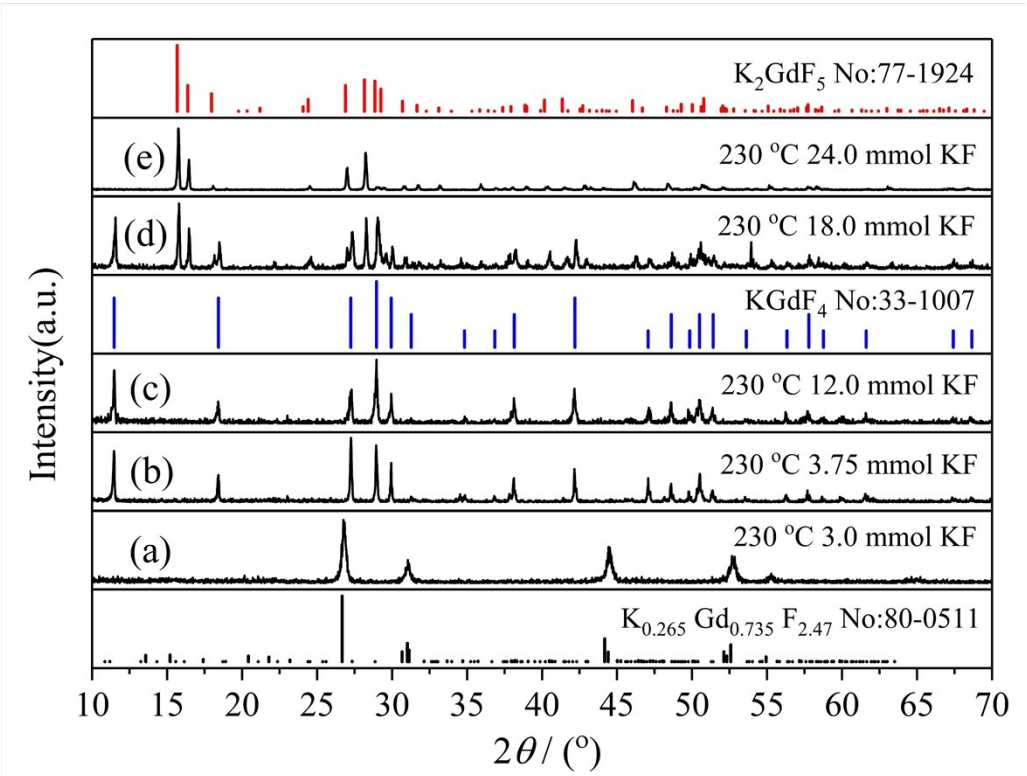

Figure S2: XRD patterns of the $KGdF_4$ nanocrystals synthesized at different molar ratios KF-to-RE: (a) 3:1; (b) 3.75:1; (c) 12:1; (d) 18:1; (e) 24:1;. Other synthesis conditions: 45 mL OA/15 mL HA, $V_{H2O}/V_{CF3COOH}$=9/2, 230 °C for 48 h. The standard data of orthorhombic of K_2GdF_5 (JCPDS No: 77-1924), $KGdF_4$ (JCPDS No: 33-1007) and $K_{0.265}Gd_{0.735}F_{2.47}$ (JCPDS No: 80-0511) are also shown.

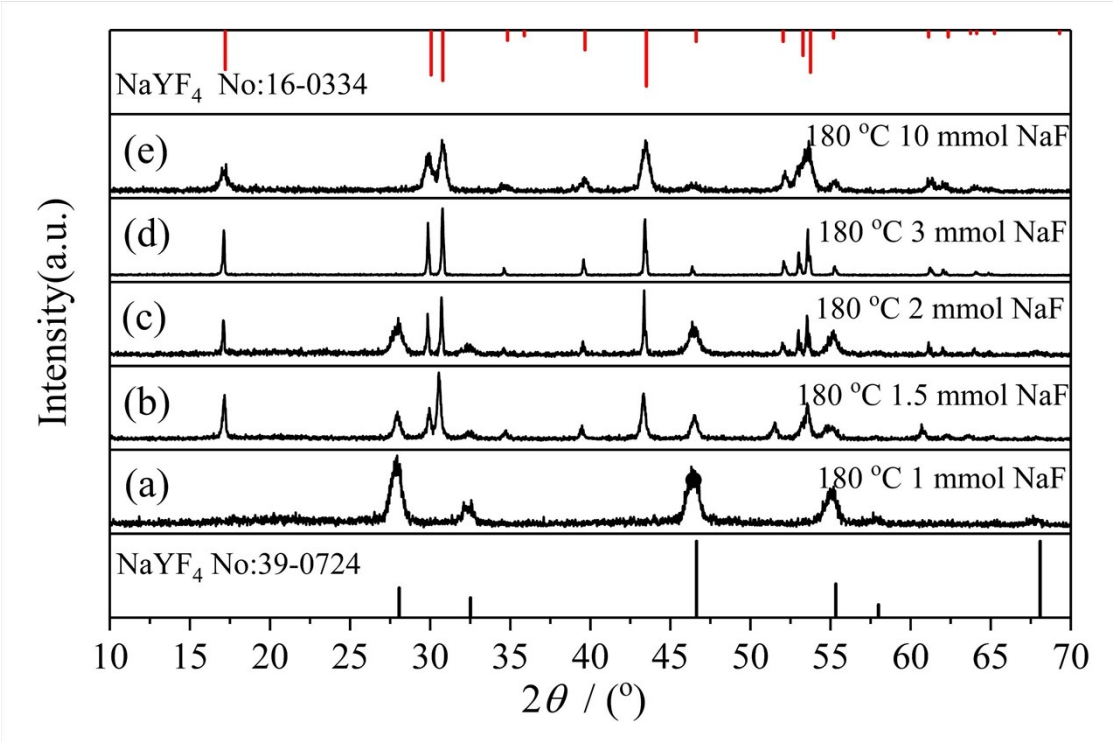

Figure S3: XRD data of the products obtained at different molar ratios NaF-to-RE: (a) 1:1; (b) 1.5:1; (c) 2:1; (d) 3:1. Other synthesis conditions: 45 mL OA/15 mL HA, $V_{H2O}/V_{CF3COOH}$=9/2, 180 °C for 48 h. Vertical black, red and black lines depict the XRD references for hexagonal $NaYF_4$ (JCPDS No: 16-0334), cubic $NaYF_4$ (JCPDS No: 39-0725), respectively.

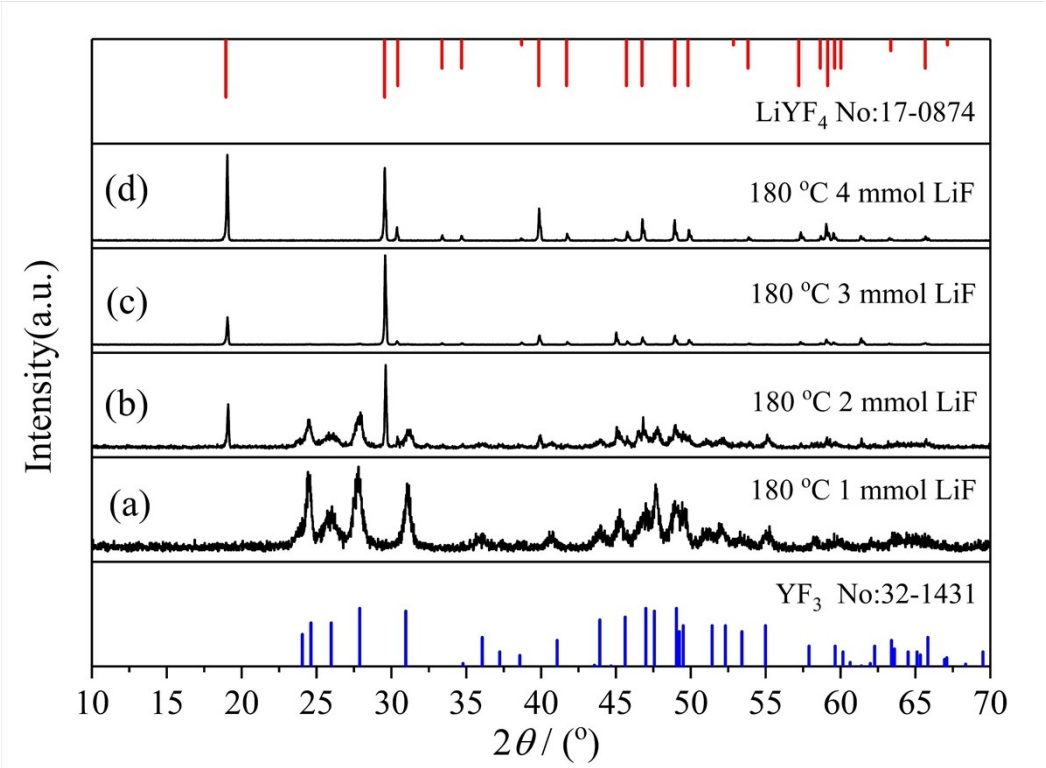

Figure S4: XRD data of the products obtained at different molar ratios LiF-to-RE: (a) 1:1; (b) 2:1; (c) 3:1; (d) 4:1. Other synthesis conditions: 45 mL OA/15 mL HA, $V_{H2O}/V_{CF3COOH}$=9/2, 180 °C for 48 h. Vertical black, red and blue lines depict the XRD references for tetragonal $LiYF_4$ (JCPDS No: 17-0874), orthorhombic YF_3 (JCPDS No: 32-1431), respectively.

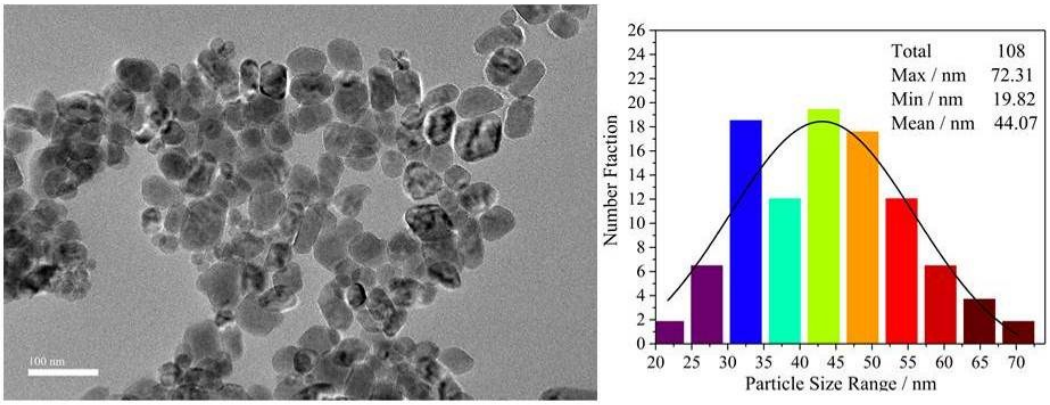

Figure S5: TEM image and particle size distribution of KYF_4 nanocrystals obtained in 45 mL OA/15 mL HA, $V_{H2O}/V_{CF3COOH}$=9/2, 250 °C for 48 h at molar ratio of KF/RE=2:5.75.

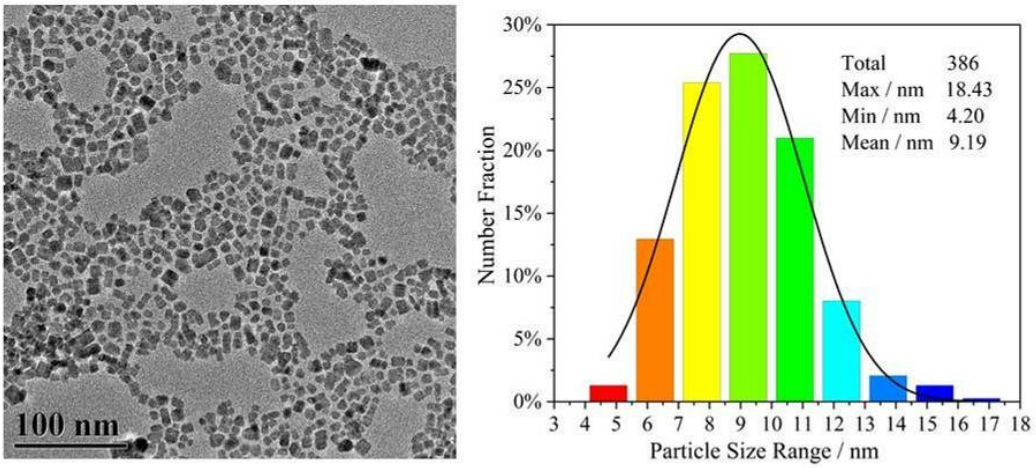

Figure S6: TEM image and particle size distribution of LaF_3 nanocrystals obtained in 45 mL OA/15 mL HA, $V_{H2O}/V_{CF3COOH}$=9/2, 230 °C for 48 h at molar ratio of KF/RE=2:1.

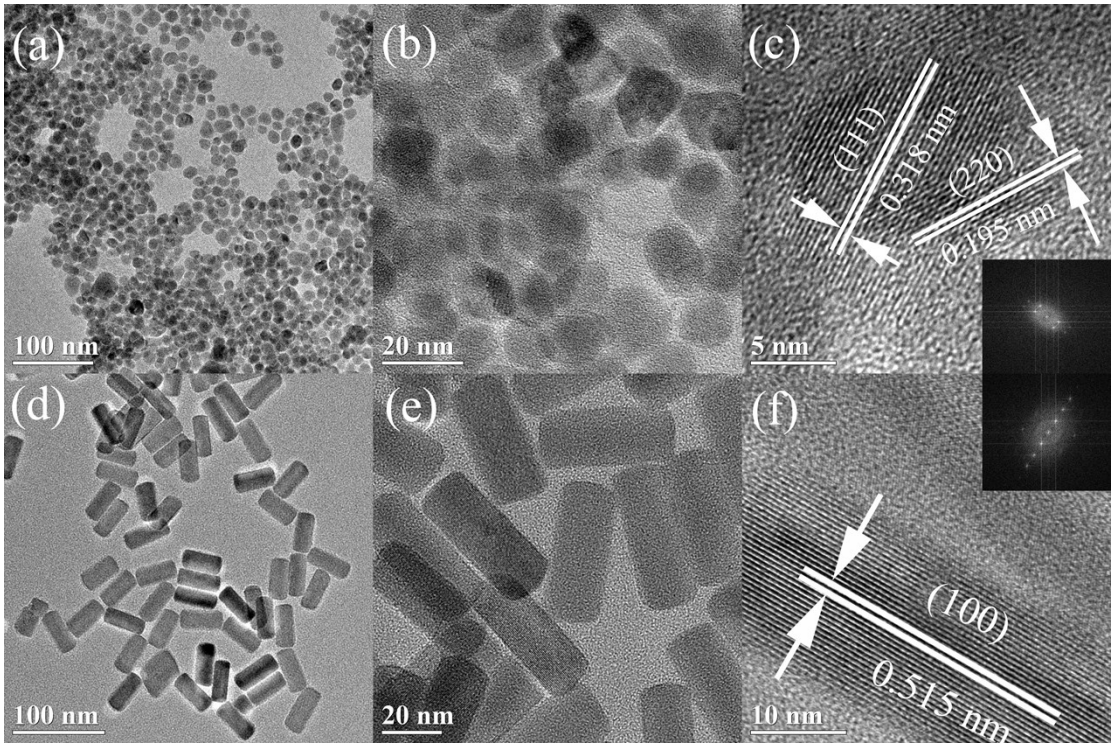

Figure S7: TEM and HRTEM images of $NaYF_4$ (cubic) and $NaYF_4$ (hexagonal) Nanocrystals obtained in 45 mL OA/15 mL HA, $V_{H2O}/V_{CF3COOH}$=9/2, 180 °C for 48 h at different molar ratios NaF-to-RE: (a-c): 1:1; (d-f): 10:1.

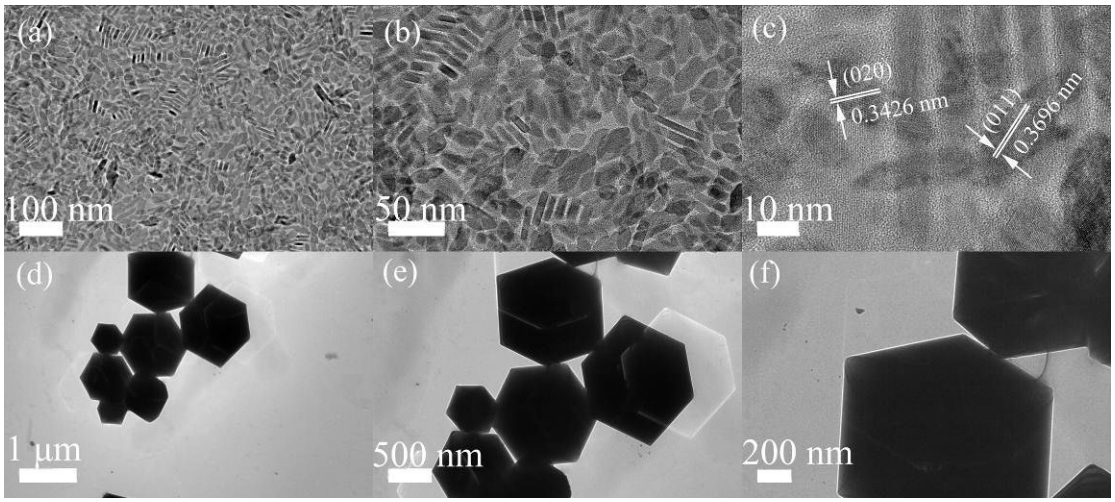

Figure S8: TEM and HRTEM images of YF_3 and $LiYF_4$ nano (micro)crystals obtained in 45 mL OA/15 mL HA, $V_{H2O}/V_{CF3COOH}$=9/2, 180 °C for 48 h at different molar ratios LiF-to-RE: (a-c): 1:1; (d-f): 4:1.

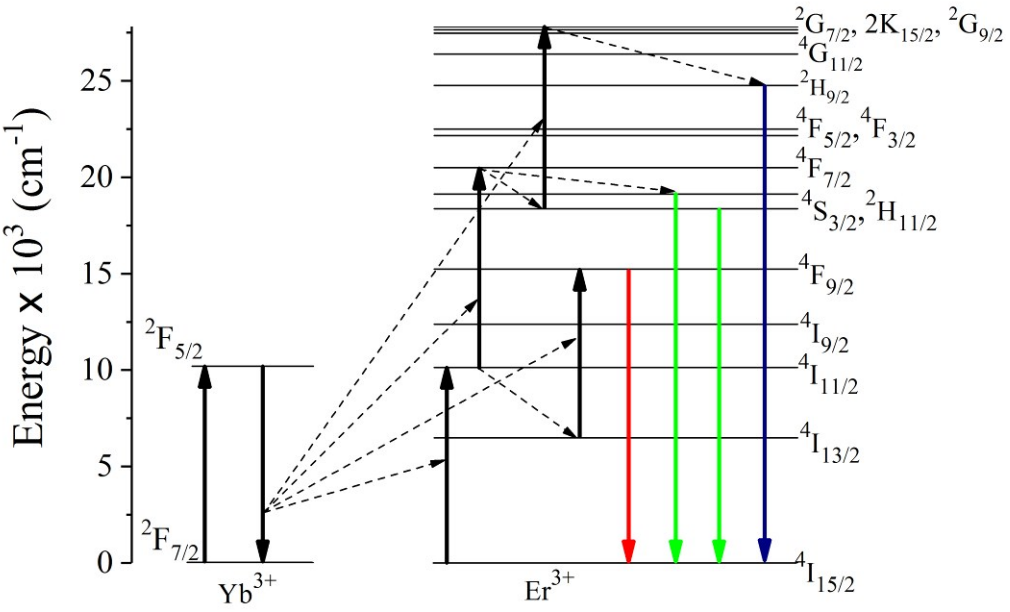

Figure S9: The energy level diagram of Yb^{3+} sensitized Er^{3+} and upconversion mechanisms under near-infrared (980 nm) excitation.