

**Tuning the phase, morphology and size of monodisperse ScF_3 and
 NaScF_4 crystals through lanthanide doping**

Supporting Information

Jingjing Cao^a, Li Yuan^a, Shanshan Hu^{*a}, Jianfeng Tang^a, Xianju Zhou^b and Jun Yang^{*a}

a. School of Chemistry and Chemical Engineering, No. 2 Tiansheng Road, BeiBei District, Chongqing, 400715, China. E-mail: hushan3@swu.edu.cn and jyang@swu.edu.cn.

b. School of Mathematics and Physics, Chongqing University of Posts and Telecommunications, Chongqing, 400065, China

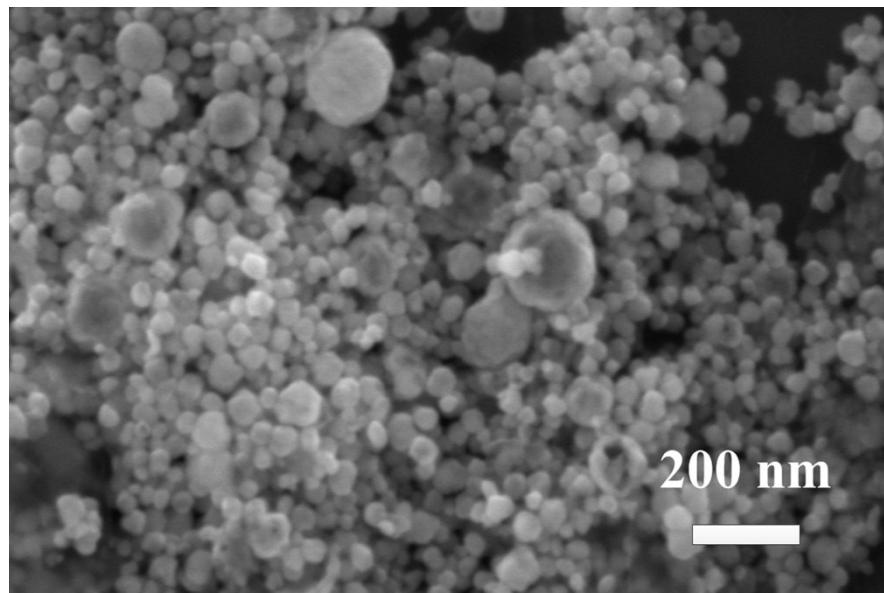


Fig. S1 SEM image of $\text{Na}_7\text{Lu}_{13}\text{F}_{46}$ prepared by doping 70 mol % Lu^{3+} under the condition of $\text{Na}/\text{F}/(\text{Sc}+\text{Ln})=5:3:1$.

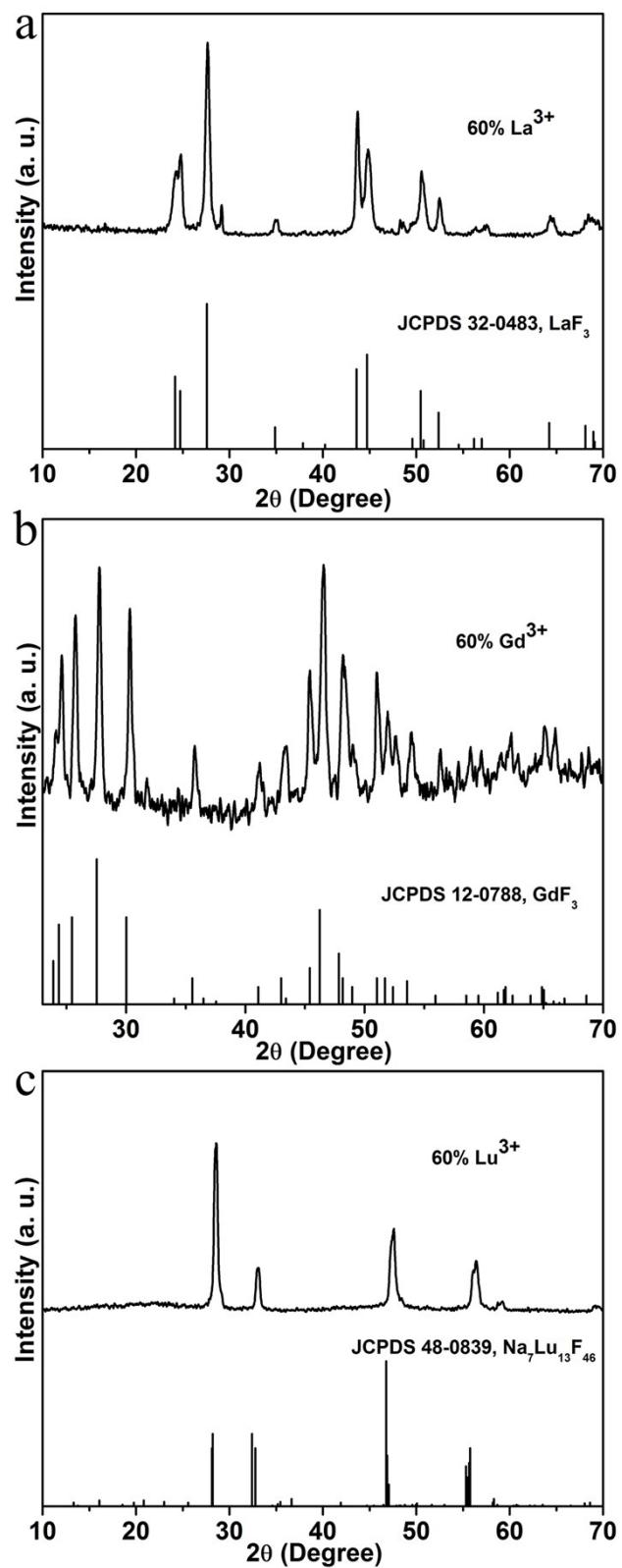


Fig. S2 XRD patterns of the products prepared in the presence of 60 mol% La^{3+} (a), Gd^{3+} (b), Lu^{3+} (c) under the condition of $\text{Na}/\text{F}/(\text{Sc}+\text{Ln})=5:4:1$

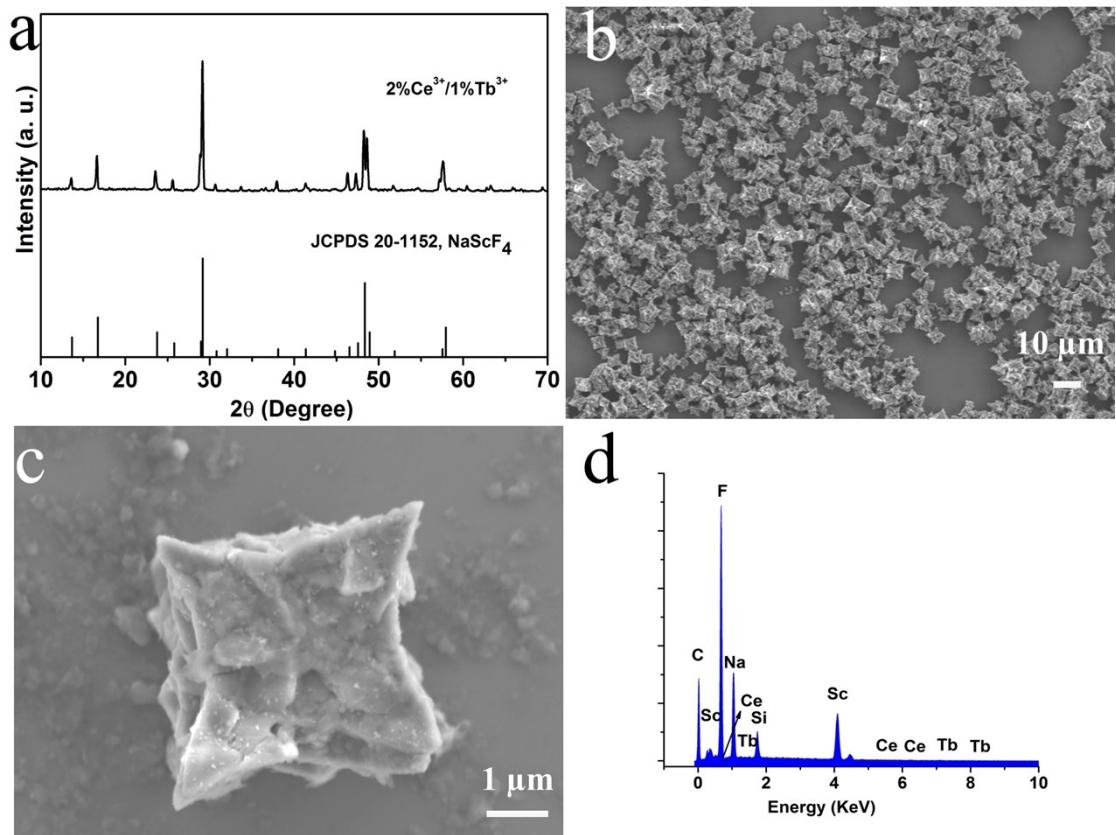


Fig. S3 (a) XRD pattern, (b, c) SEM images and (d) EDS pattern of the prepared product doped with 2% Ce³⁺/1% Tb³⁺ under the condition of Na/F/(Sc+Ln)=5:4:1.

Fig. S3(a) shows the XRD pattern of the prepared products doped with 2% Ce³⁺/1% Tb³⁺, which matches well with pure Monoclinic ScF₃ phase. Fig. S3(b), 3(c) present the morphology of the product is four-angle star.

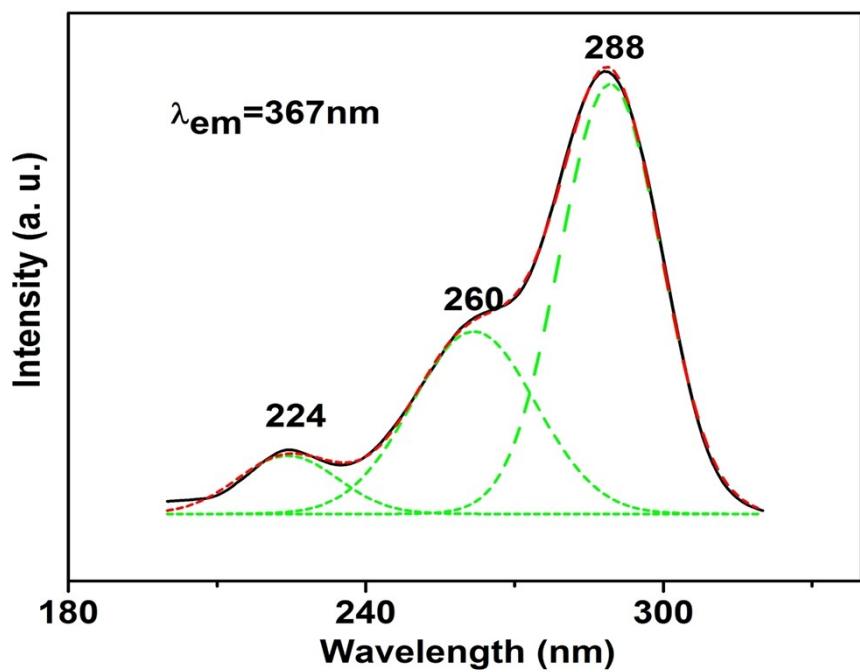


Fig. S4 The Gaussian fitting bands of excitation spectrum for $\text{NaScF}_4:1\% \text{Ce}^{3+}$ sample.

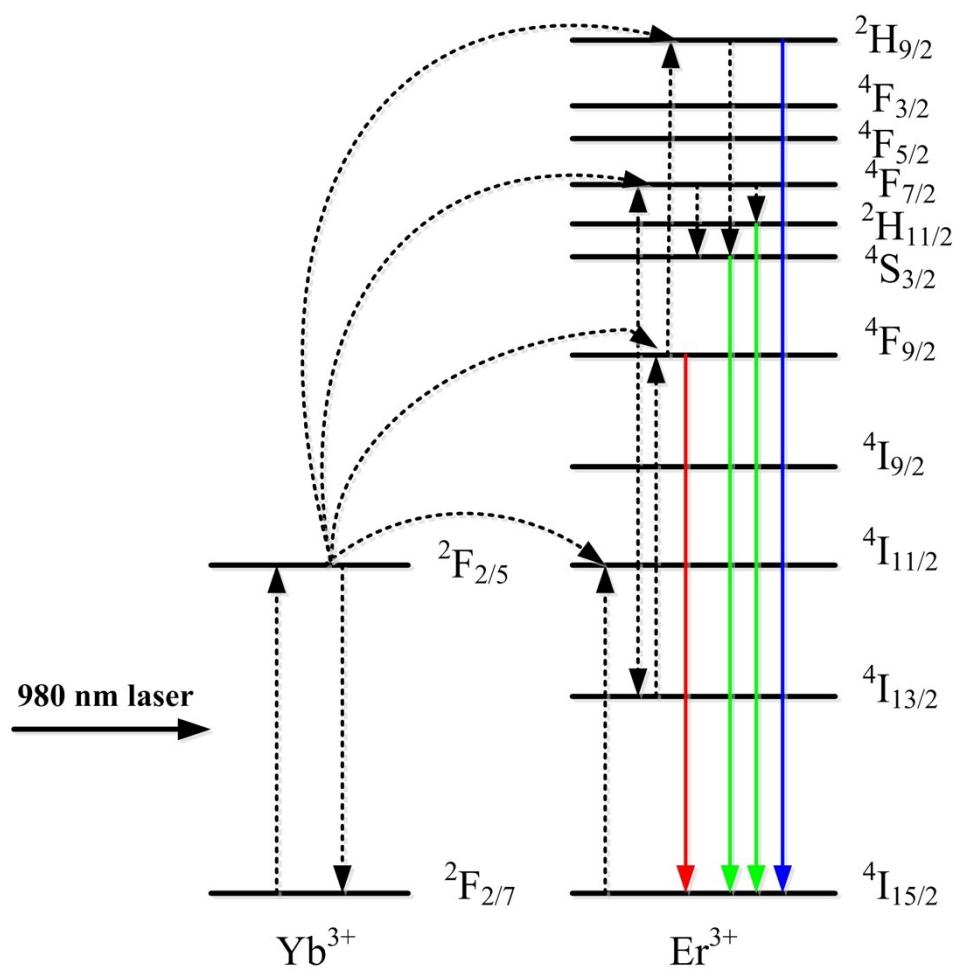


Fig. S5 UC energy transfer mechanisms of $\text{ScF}_3:30\% \text{Yb}^{3+}/1\% \text{Er}^{3+}$ excited with a 980 nm laser under the condition of $\text{Na}/\text{F}/(\text{Sc}+\text{Ln})=5:4:1$.

Table S1 Phases, morphologies and sizes of the products with different kinds of and different levels of Ln^{3+} doping (Ln=Ce, Eu and Lu) under the condition of $\text{Na}/\text{F}/(\text{Sc}+\text{Ln})=5:3:1$.

Ln ³⁺ concentration	Phase	Morphology	Size
Ce ³⁺ : 0.01 %~1 %	ScF_3	Cube	$S=3\mu\text{m}$
Ce ³⁺ : 5 %~70 %	ScF_3 and CeF_3		
Eu ³⁺ : 0.01 %~1 %	ScF_3	Cube	$S=2\mu\text{m}$
Eu ³⁺ : 5 %~40 %	ScF_3 and EuF_3		
Lu ³⁺ : 0.01 %~20 %	ScF_3	Cuboid	$L=900\text{nm}$ $W=60\text{nm}$
Lu ³⁺ : 30 %~50 %	ScF_3 and $\text{Na}_7\text{Lu}_{13}\text{F}_{46}$		
Lu ³⁺ : 70 %	$\text{Na}_7\text{Lu}_{13}\text{F}_{46}$	Sphere	$D=60\text{nm}$

Table S2 Phases, morphologies and sizes of the products doped with three groups of 1% light, medium and heavy rare earth ions under the condition of $\text{Na}/\text{F}/(\text{Sc}+\text{Ln})=5:4:1$.

Rare earth ions	1% Ln^{3+}	Crystal phase	Shape	Size
Light	Ce^{3+} or Pr^{3+}	Hexagonal NaScF_4	Four-angle star	$L=2.5\mu\text{m}$
Medium	Gd^{3+} or Tb^{3+}	Monoclinic ScF_3	Cube	$D=50\text{nm}$
Heavy	Er^{3+} or Lu^{3+}	Hexagonal NaScF_4	Micro-rod	$L=2.5\mu\text{m}$ $D=500\text{nm}$

Table S3 The summary of the changes of phases, morphologies and sizes of the products with different Lu^{3+} doping concentrations under the condition of $\text{Na}/\text{F}/(\text{Sc}+\text{Ln})=5:4:1$.

Sample	Lu^{3+}	Crystal phase	Shape	Size
A	0 %	Hexagonal NaScF_4	Nano-rod	$l=650\text{nm}$ $W=300\text{nm}$
B	1 %	Hexagonal NaScF_4	Micro-rod	$l=2.5\mu\text{m}$ $W=500\text{nm}$
C	8%	Hexagonal NaScF_4	Shuttle	$l=1.5\mu\text{m}$
D	15 %	Monoclinic ScF_3 and hexagonal NaScF_4	Shuttle and wafer	$l=2.5\mu\text{m}$ $d=260\text{nm}$
E	30 %	Monoclinic ScF_3 and orthorhombic $\text{Na}_7\text{Lu}_{13}\text{F}_{46}$	Wafer and zonal body	$d=260\text{nm}$ $l=2.5\mu\text{m}$
F	60 %	Orthorhombic $\text{Na}_7\text{Lu}_{13}\text{F}_{46}$	Sphere	$d=60\text{nm}$