

Tuning the phase, morphology and size of monodisperse ScF₃ and NaScF₄ crystals through lanthanide doping

Supporting Information

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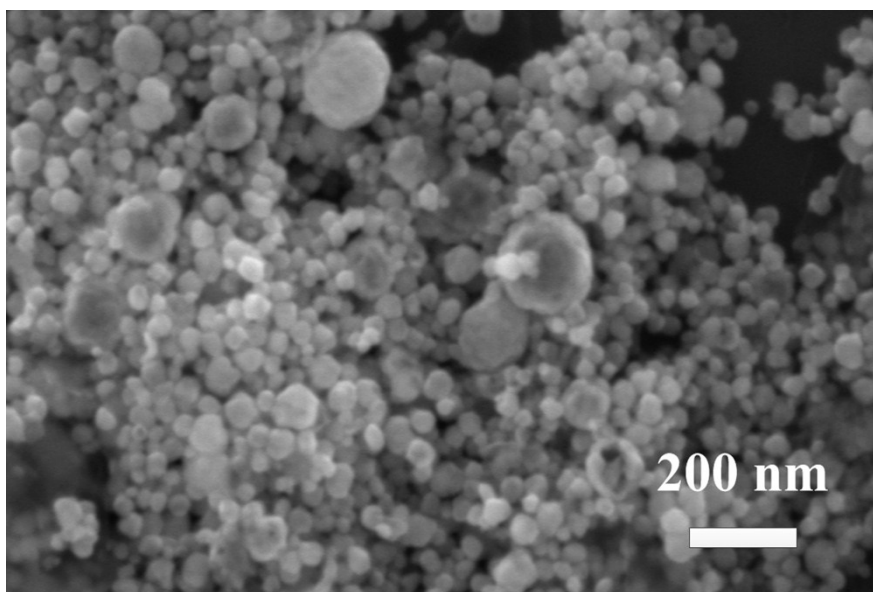


Fig. S1 SEM image of $\text{Na}_7\text{Lu}_{13}\text{F}_{46}$ prepared by doping 70 mol % Lu^{3+} under the condition of $\text{Na}/\text{F}/(\text{Sc}+\text{Ln})=5:3:1$.

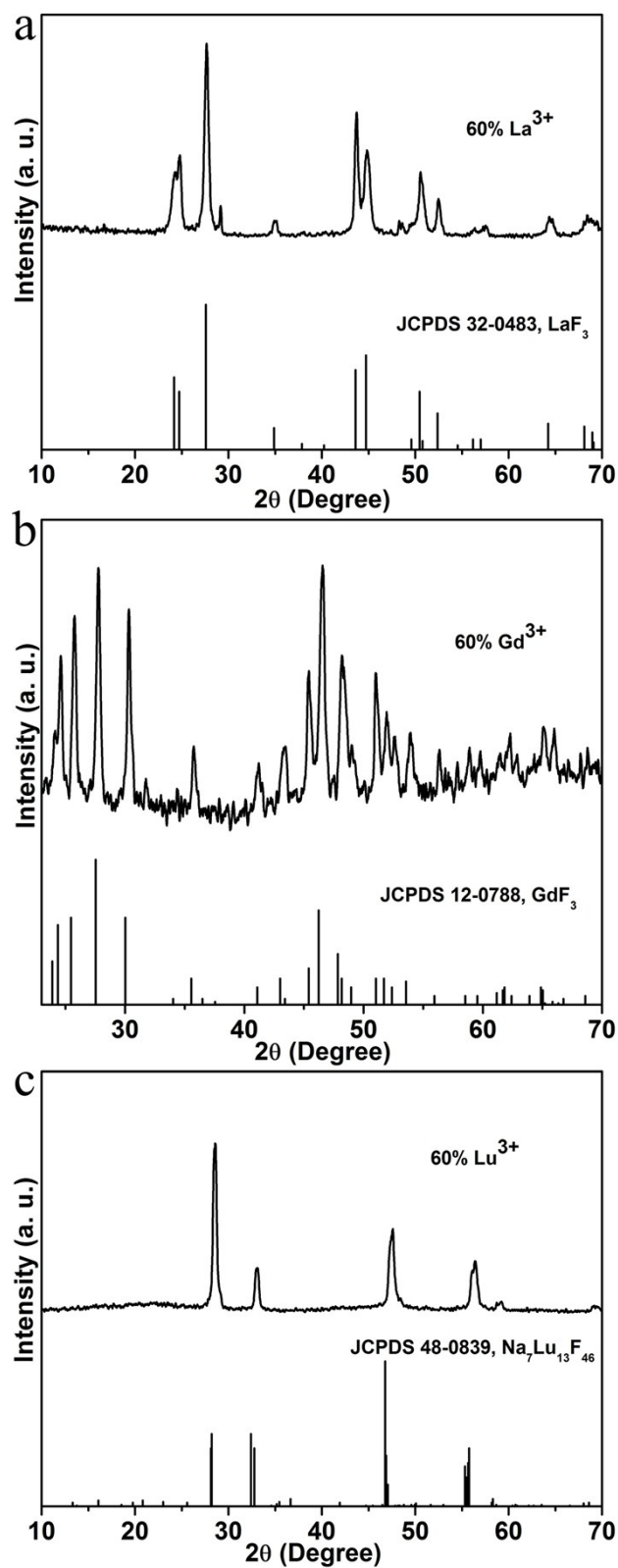


Fig. S2 XRD patterns of the products prepared in the presence of 60 mol% La^{3+} (a), Gd^{3+} (b), Lu^{3+} (c) under the condition of $\text{Na}/\text{F}/(\text{Sc}+\text{Ln})=5:4:1$

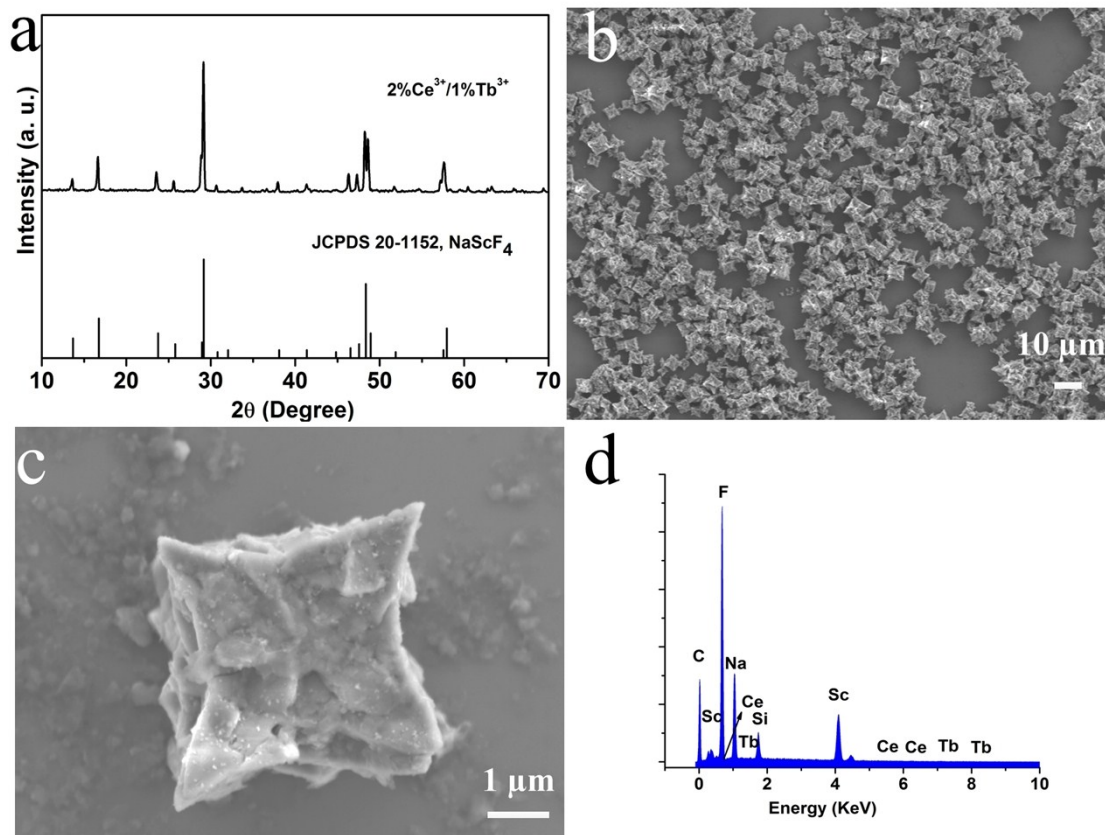


Fig. S3 (a) XRD pattern, (b, c) SEM images and (d) EDS pattern of the prepared product doped with 2% Ce³⁺/1% Tb³⁺ under the condition of Na/F/(Sc+Ln)=5:4:1.

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.

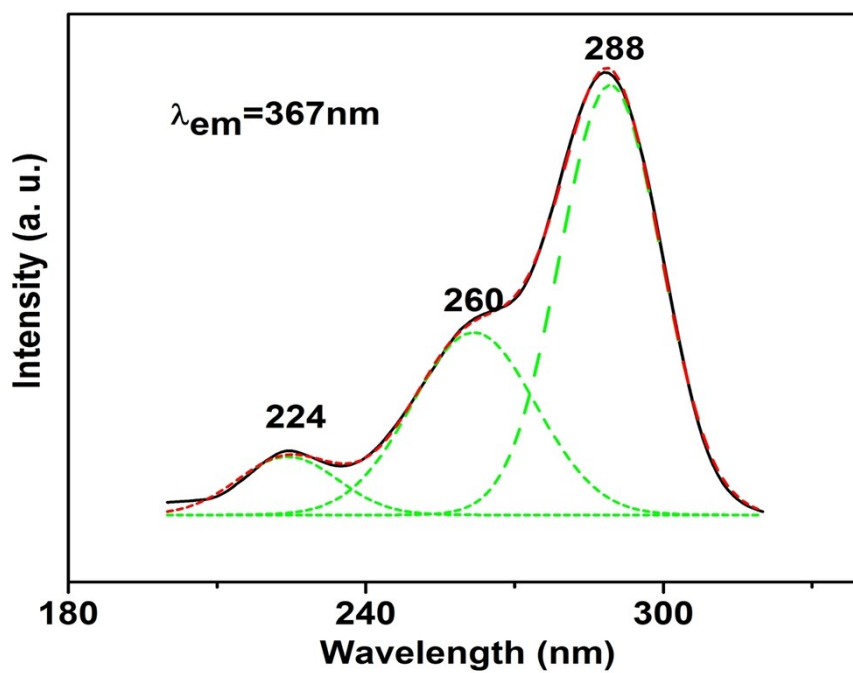


Fig. S4 The Gaussian fitting bands of excitation spectrum for NaScF₄:1% Ce³⁺ sample.

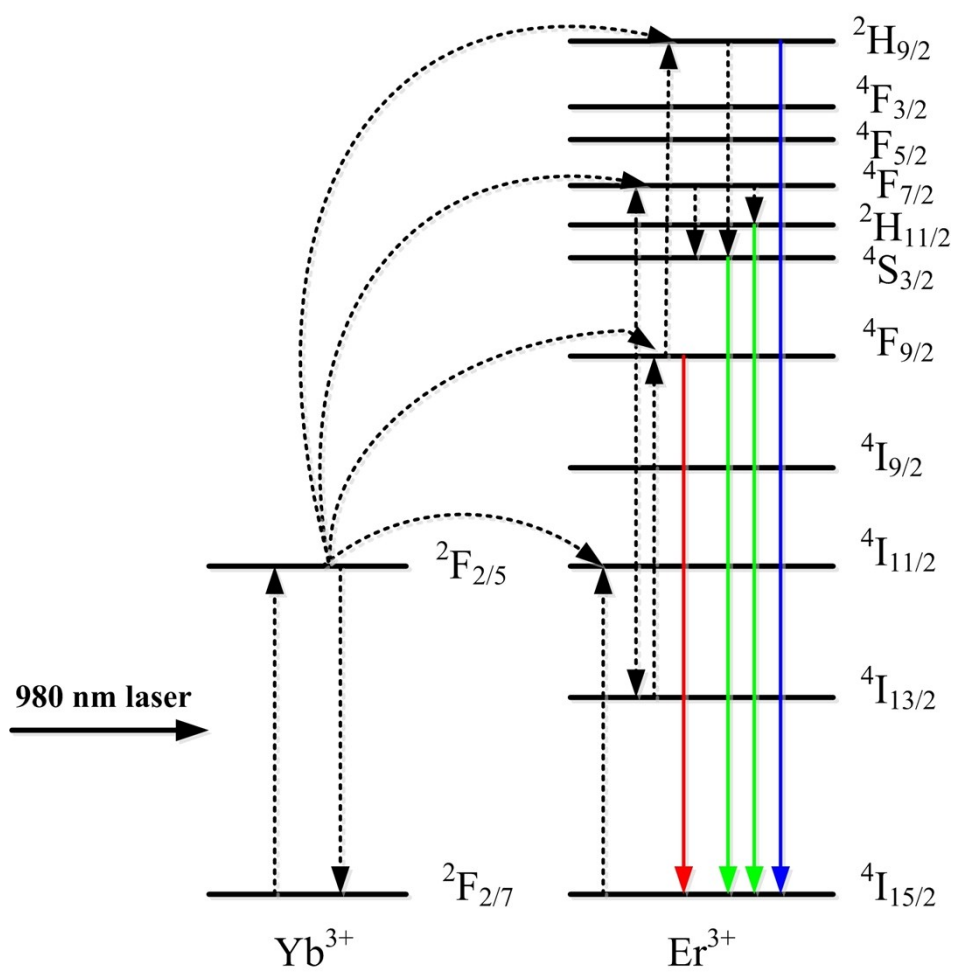


Fig. S5 UC energy transfer mechanisms of ScF_3 :30% Yb^{3+} /1% Er^{3+} excited with a 980 nm laser under the condition of $\text{Na}/\text{F}/(\text{Sc}+\text{Ln})=5:4:1$.

Table S1 Phases, morphologies and sizes of the products with different kinds of and different levels of Ln³⁺ doping (Ln=Ce, Eu and Lu) under the condition of Na/F/(Sc+Ln)=5:3:1.

Ln ³⁺ concentration	Phase	Morphology	Size
Ce ³⁺ : 0.01 %~1 %	ScF ₃	Cube	S=3μm
Ce ³⁺ : 5 %~70 %	ScF ₃ and CeF ₃		
Eu ³⁺ : 0.01 %~1 %	ScF ₃	Cube	S=2μm
Eu ³⁺ : 5 %~40 %	ScF ₃ and EuF ₃		
Lu ³⁺ : 0.01 %~20 %	ScF ₃	Cuboid	L=900nm W=60nm
Lu ³⁺ : 30 %~50 %	ScF ₃ and Na ₇ Lu ₁₃ F ₄₆		
Lu ³⁺ : 70 %	Na ₇ Lu ₁₃ F ₄₆	Sphere	D=60nm

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 Na/F/(Sc+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	<i>L</i> =2.5μm
Medium	Gd ³⁺ or Tb ³⁺	Monoclinic ScF ₃	Cube	<i>D</i> =50nm
Heavy	Er ³⁺ or Lu ³⁺	Hexagonal NaScF ₄	Micro-rod	<i>L</i> =2.5μm <i>D</i> =500nm

Table S3 The summary of the changes of phases, morphologies and sizes of the products with different Lu³⁺ doping concentrations under the condition of Na/F/(Sc+Ln)=5:4:1.

Sample	Lu ³⁺	Crystal phase	Shape	Size
A	0 %	Hexagonal NaScF ₄	Nano-rod	<i>l</i> =650nm <i>W</i> =300nm
B	1 %	Hexagonal NaScF ₄	Micro-rod	<i>l</i> =2.5μm <i>W</i> =500nm
C	8%	Hexagonal NaScF ₄	Shuttle	<i>l</i> =1.5μm
D	15 %	Monoclinic ScF ₃ and hexagonal NaScF ₄	Shuttle and wafer	<i>l</i> =2.5μm <i>d</i> =260nm
E	30 %	Monoclinic ScF ₃ and orthorhombic Na ₇ Lu ₁₃ F ₄₆	Wafer and zonal body	<i>d</i> =260nm <i>l</i> =2.5μm
F	60 %	Orthorhombic Na ₇ Lu ₁₃ F ₄₆	Sphere	<i>d</i> =60nm