SUPPORTING INFORMATION

Insights into Li+-induced morphology evolution and upconversion luminescence enhancement of KSc$_2$F$_7$:Yb/Er nanocrystals

Yangbo Wang,[a] Tian Wei,[a] Xingwen Cheng,[a] Yue Pan,[b] Hui Ma,[a] Juan Xie,[c] Haiquan Su,[b] Xiaoji Xie,*[a] Ling Huang*[a] and Wei Huang*[ac]

[a]Key Laboratory of Flexible Electronics (KLOFE) & Institute of Advanced Materials (IAM), Jiangsu National Synergetic Innovation Center for Advanced Materials (SICAM), Nanjing Tech University (NanjingTech), 30 South Puzhu Road, Nanjing 211816, P. R. China. E-mail: iamxjxie@njtech.edu.cn, iamlhuang@njtech.edu.cn, iamwhuang@njtech.edu.cn

[b]School of Chemistry and Chemical Engineering, Inner Mongolia University, 235 West Daxue Road, Hohhot 010021, P. R. China

[c]Key Laboratory for Organic Electronics and Information Displays & Institute of Advanced Materials (IAM), Jiangsu National Synergetic Innovation Center for Advanced Materials (SICAM), Nanjing University of Posts & Telecommunications, 9 Wenyuan Road, Nanjing 210023, P. R. China.
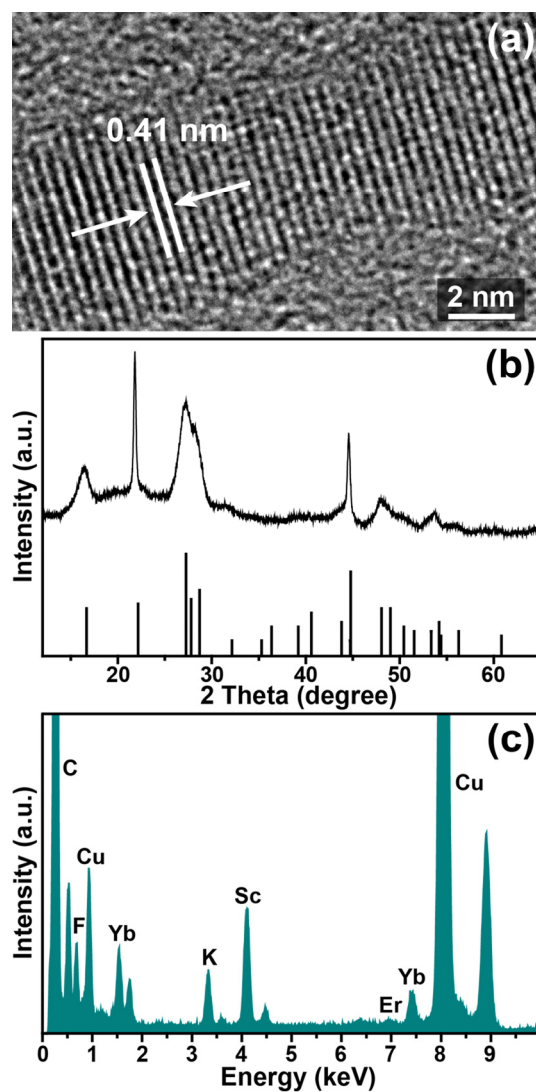
Fig. S1 (a) HRTEM image and (b) XRD of the as-synthesized KSc_2F_7:Yb/Er nanocrystals. The diffraction pattern at the bottom is the literature reference of orthorhombic KSc_2F_7 crystal (JCPDS: 39-0784). (c) The energy-dispersive X-ray spectrum of the as-synthesized KSc_2F_7:Yb/Er nanocrystals, proving the presence of K, Sc, F, Yb and Er.
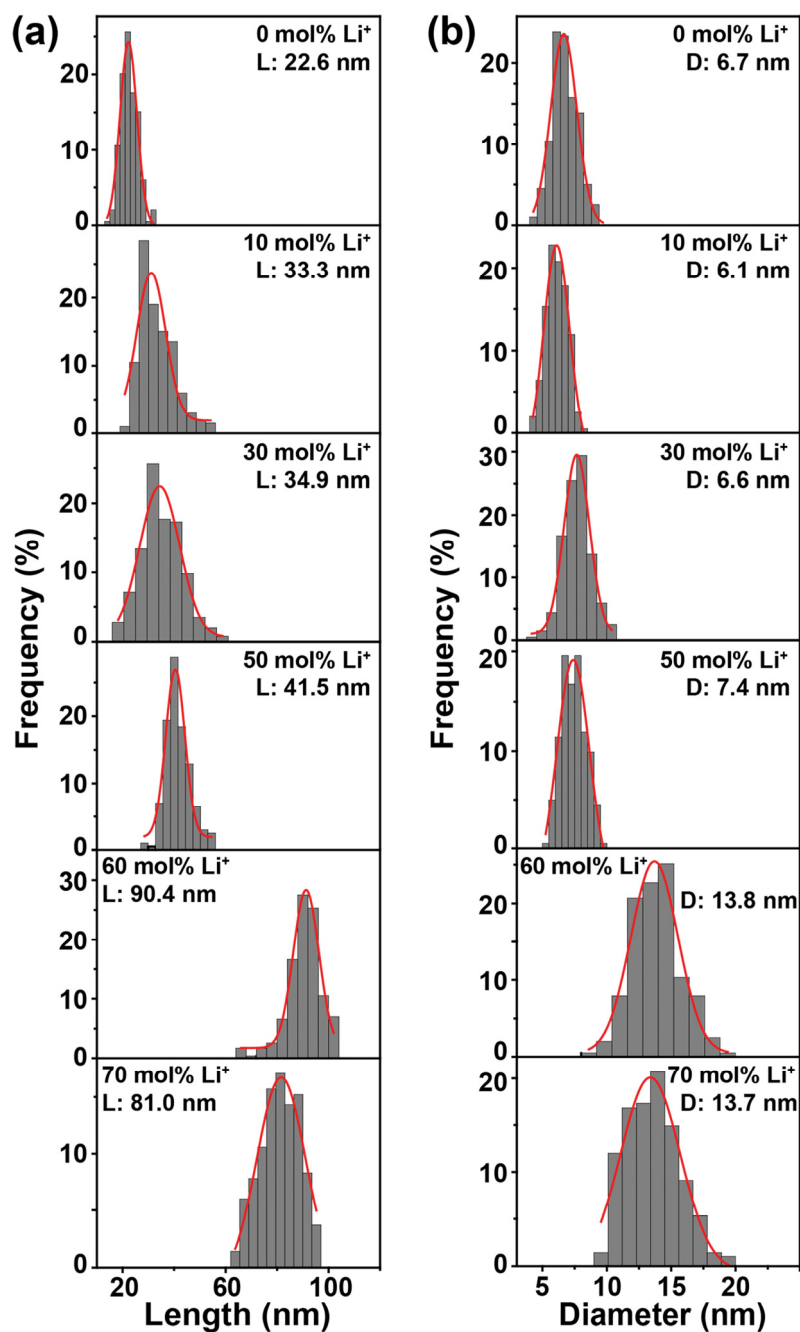
Fig. S2 The (a) length and (b) diameter distributions of KSc_2F_7:Yb/Er nanocrystals doped with varied amounts of Li^+ (0-70 mol%). L and D represent length and diameter, respectively.
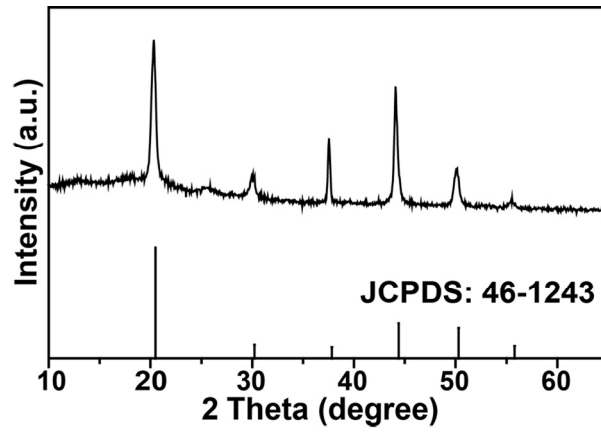
Fig. S3 (a) XRD pattern of KSc_2F_7:Yb/Er nanocrystals doped with 80 mol% Li^+. The diffraction pattern at the bottom is the literature reference of cubic ScF_3 crystal (JCPDS: 46-1243).
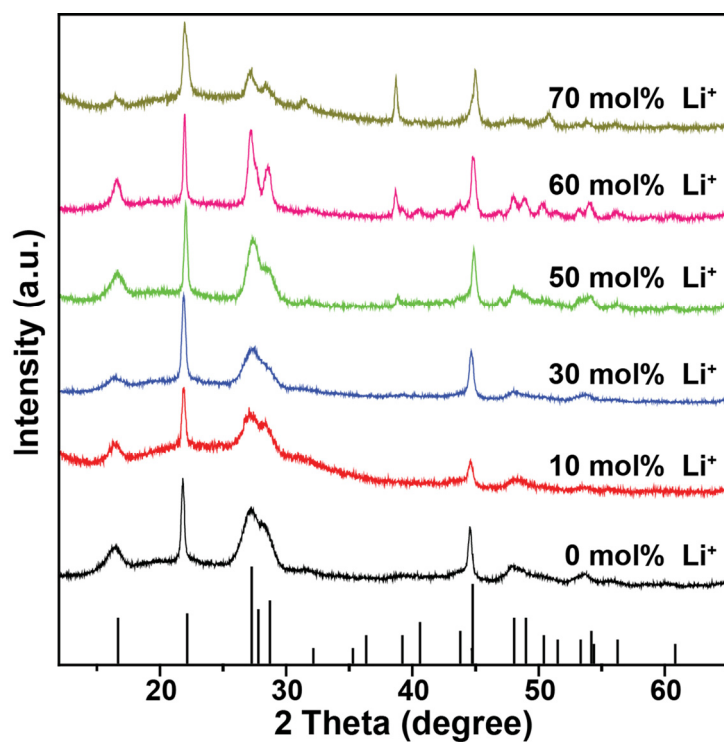
Fig. S4 XRD patterns of KSc$_2$F$_7$:Yb/Er nanocrystals doped with varied amounts of Li$^+$ (0-70 mol%). The diffraction pattern at the bottom is the literature reference of orthorhombic KSc$_2$F$_7$ crystal (JCPDS: 39-0784).
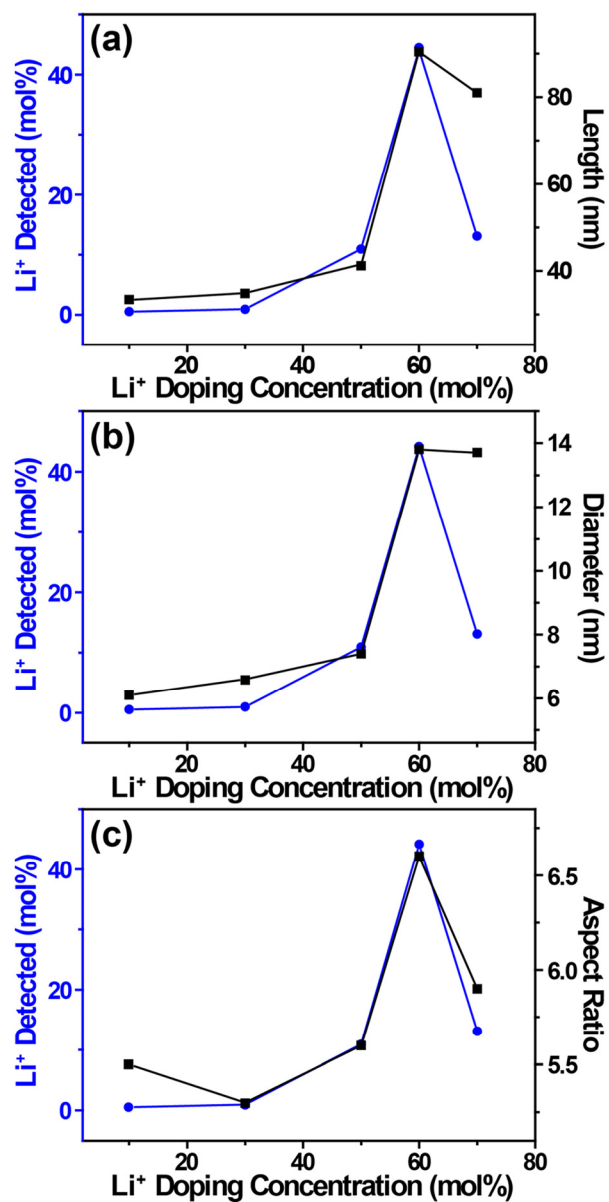
Fig. S5 The amount of Li$^+$ detected in the KSc$_2$F$_7$ nanocrystals and the (a) length, (b) diameter, and (c) aspect ratio of the corresponding nanocrystals as a function of Li$^+$ doping concentration.
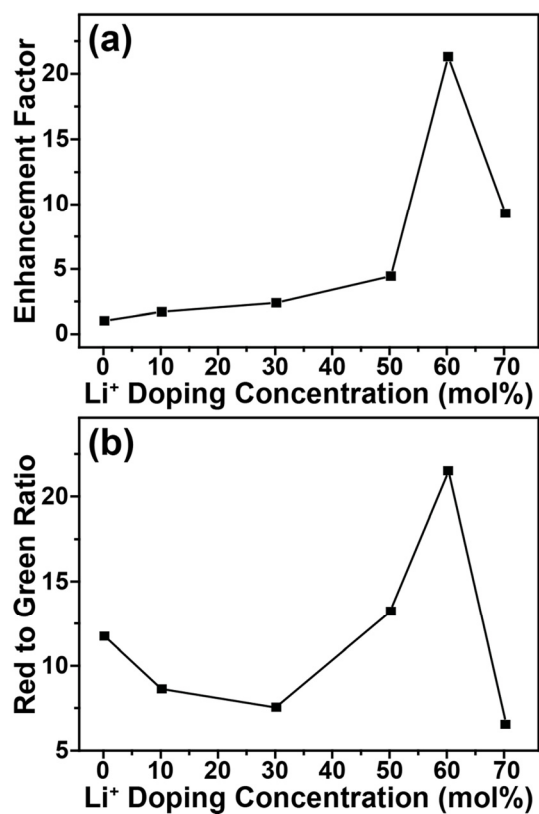
Fig. S6 (a) Relative enhancement of upconversion emission as a function of Li^+ doping concentration. The emission intensity of KSc_2F_7 nanocrystals without Li^+ doping was set as 1. (b) Red to green emission intensity ratio as a function of Li^+ doping concentration.
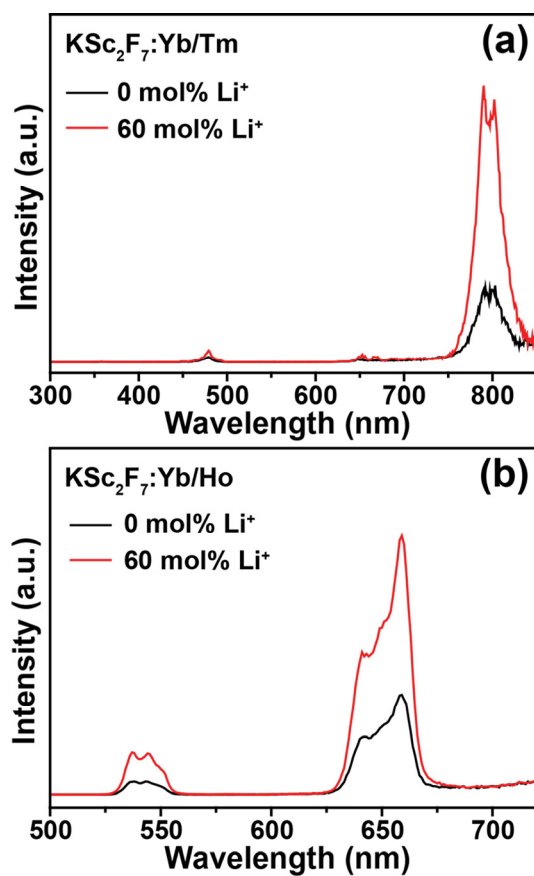
Fig. S7 Photoluminescence spectra of (a) KSc_2F_7:Yb/Tm (20/0.5 mol%) and (b) KSc_2F_7:Yb/Ho (20/2 mol%) nanocrystals without and with 60 mol% Li^+ doping under the excitation of a 980 nm laser.

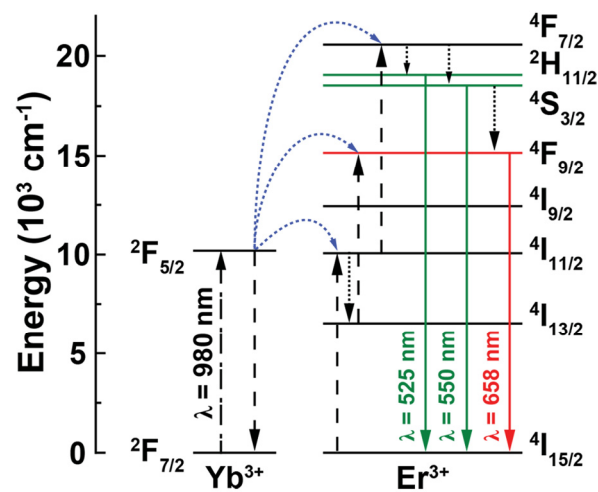**Fig. S8** Proposed upconversion mechanism under 980 nm laser excitation in KSc$_2$F$_7$:Yb/Er nanocrystals. The dash, dotted, dash-dotted and full arrows represent energy transfer, multiphonon relaxation, excitation, and emission process, respectively.

Table S1 Luminescent lifetime of $^4F_{9/2}$ state of Er^{3+} ions in KSc_2F_7:Yb/Er nanocrystals

Li$^+$ doped (mol%)	τ_{eff} (μs)
0	56.7
10	87.0
30	161.6
50	260.8
60	462.5
70	315.1

The effective luminescent lifetime (τ_{eff}) was calculated by:

$$\tau_{eff} = \frac{1}{I_0}\int_0^\infty I(t)dt$$

where I_0 is the maximum intensity, and $I(t)$ is the luminescent intensity as a function of time t.