Supporting Information

Designing lanthanide-doped nanocrystals with both up- and down-conversion luminescence for anti-counterfeiting

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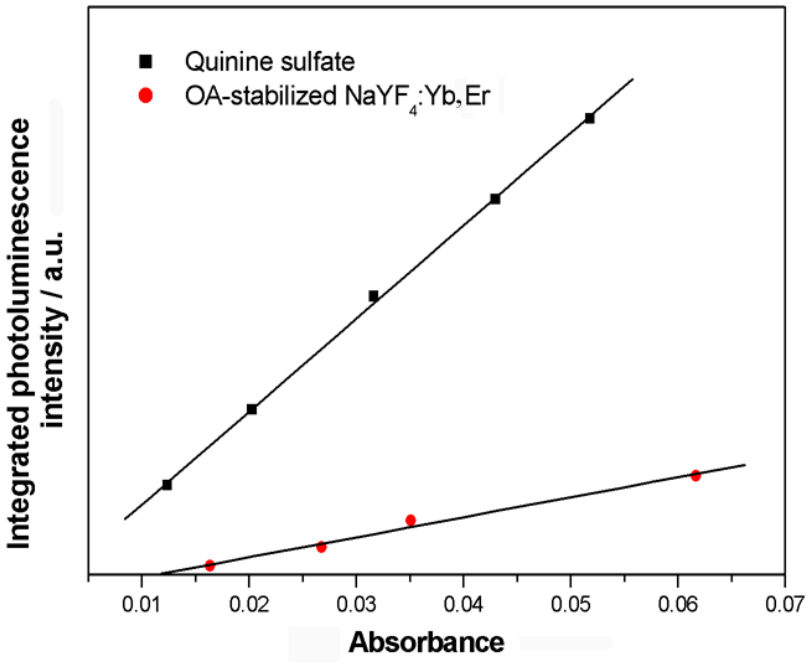

Fig. S1 Integrated fluorescence intensity versus absorbance of oleic acid-stabilized $NaYF_4$:Yb,Er nanocrystals and quinine sulfate.

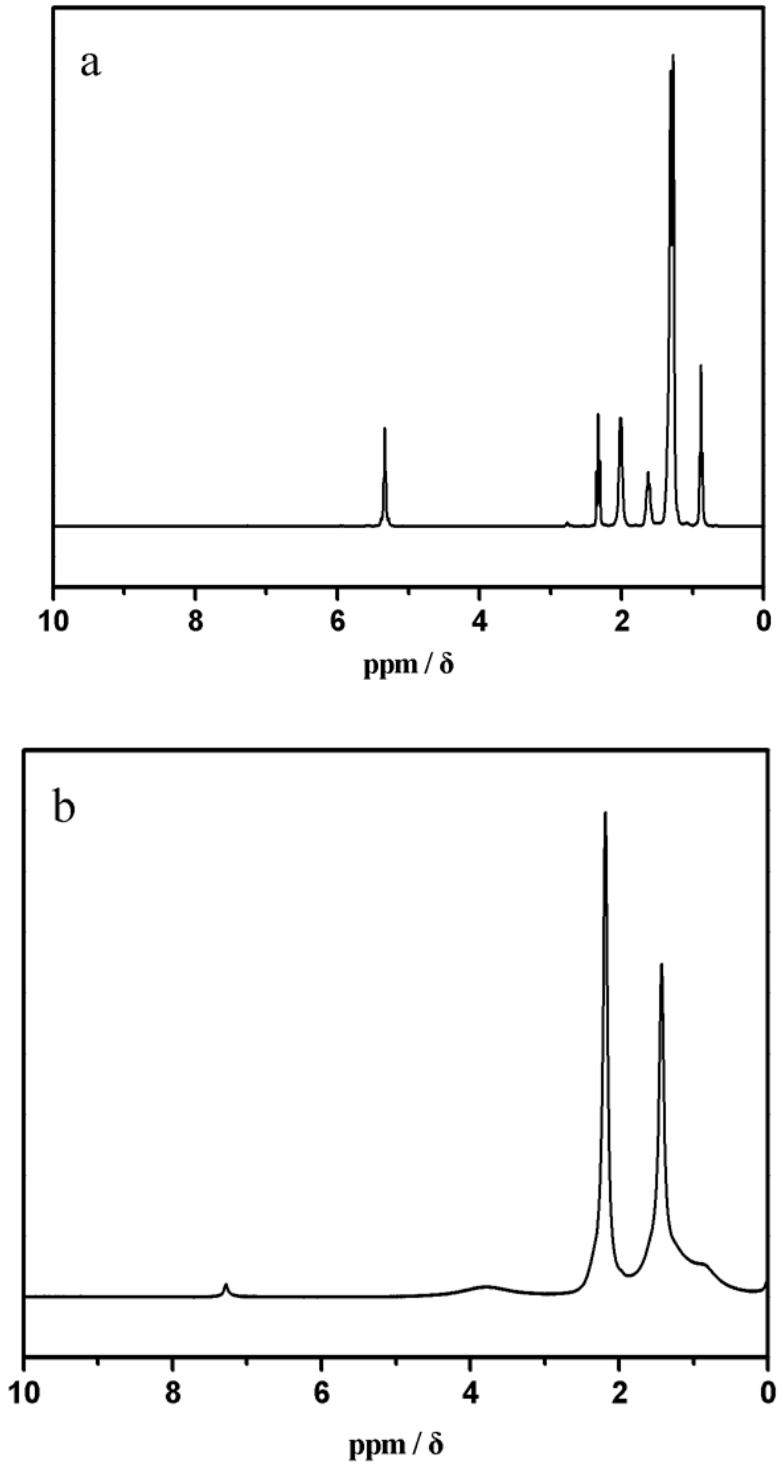

Fig. S2 The 1H NMR spectra of a) free OA dispersed in $CDCl_3$, b) OA-stabilized $NaYF_4$:Yb,Er nanocrystals dispersed in $CDCl_3$. Chemical shifts are reported in parts-per-million (δ): 5.2-5.45 (-CH=CH-), 2-2.4 ($-CH_2-$), 1.2-1.4 ($-(CH_2)_6-$), 0.8-1.00 ($-CH_3$).

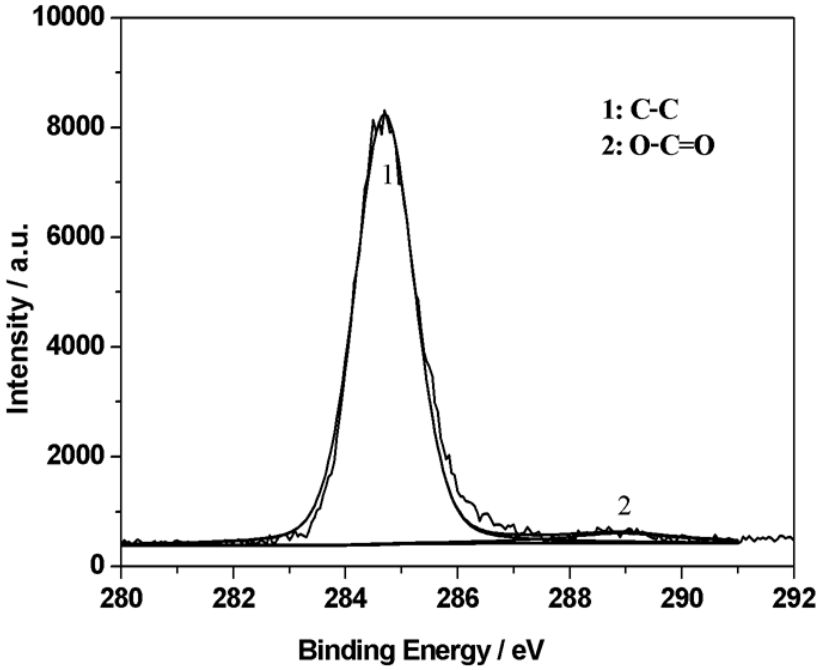

Fig. S3 XPS spectrum of C 1s core-level for the OA-stabilized $NaYF_4$:Yb,Er nanocrystals. C-C (284.6 eV), O–C=O (288.6 eV).[1]

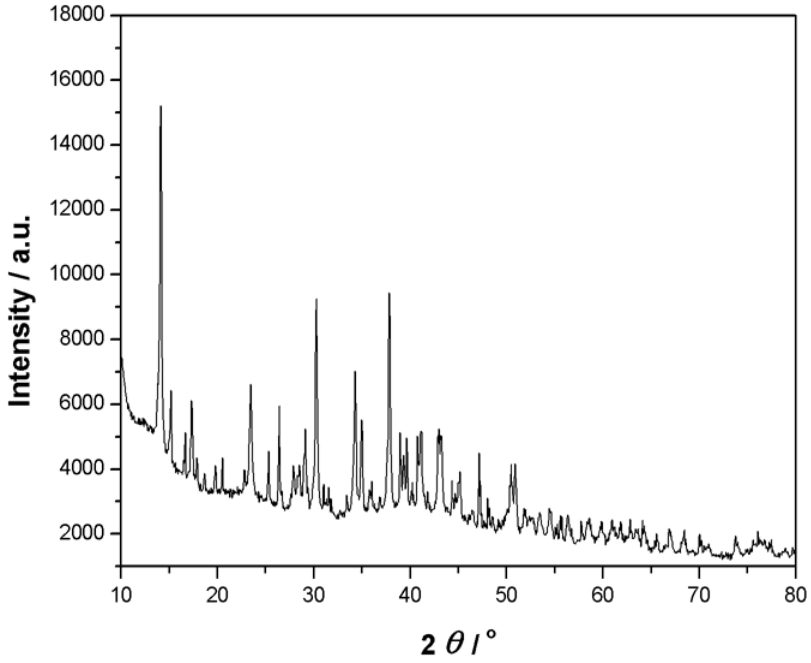

Fig. S4 XRD pattern of the product obtained after evaporating the YCl_3 aqueous solution.

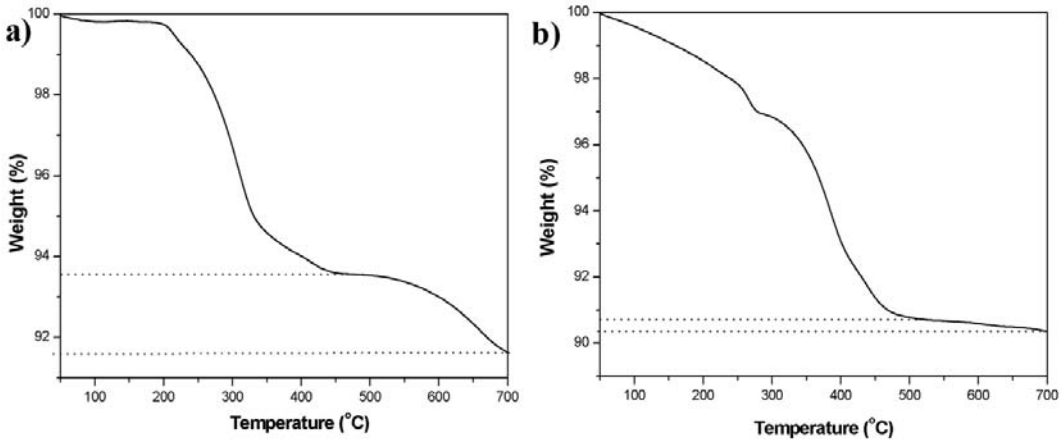

Fig. S5 TGA curves of a) oleic acid-stabilized $NaYF_4$:Yb,Er nanocrystals prepared in our strategy and b) oleic acid-stabilized $NaYF_4$:Yb,Er nanocrystals obtained by the thermal-decomposition trifluoroacetates method.

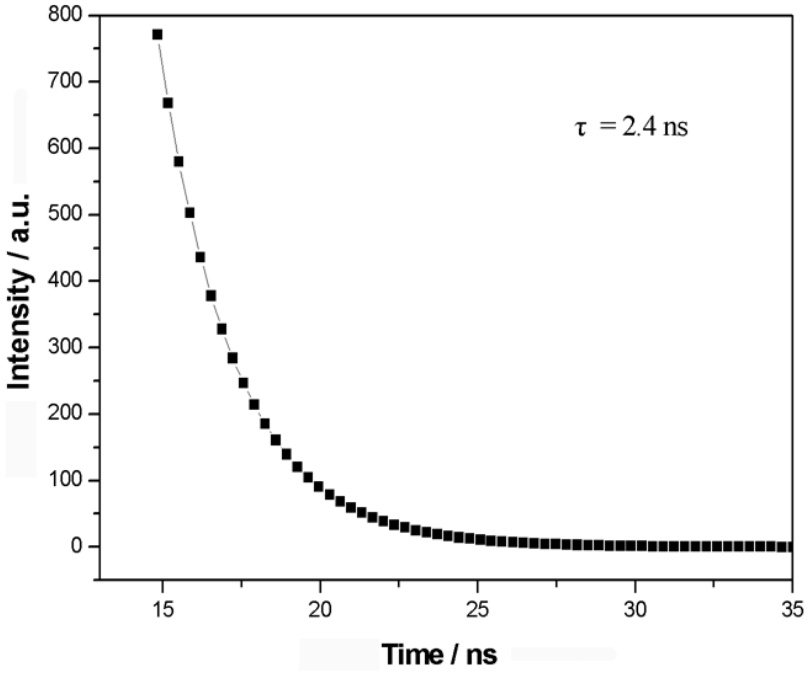

Fig. S6 Fluorescence decay curve of oleic acid-stabilized $NaYF_4$:Yb,Er nanocrystals in cyclohexane.

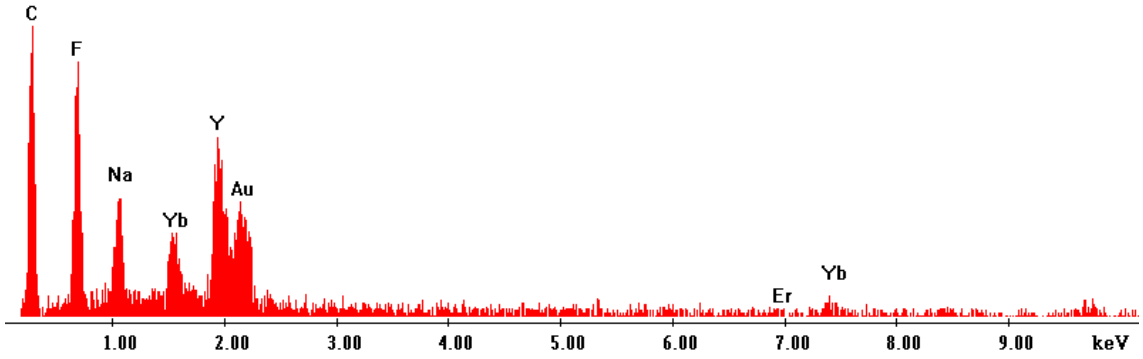

Fig. S7 EDX pattern of the fingerprint impressed on the transparent film.

samples	$NaYF_4$:Yb,Tm	$NaYF_4$:Yb,Er	$NaYbF_4$:Er
stoichiometric molar ratio of Y/Yb/Er/Tm	0.75:0.25:0.003	0.80:0.18:0.02	0.98:0.02
actual molar ratio of Y/Yb/Er/Tm	0.74:0.247:0.003	0.762:0.186:0.02	0.981:0.02

Table S1. Stoichiometric and actual molar ratios of Y/Yb/Er, Y/Yb/Tm and Yb/Er in lanthanide-doped fluoride nanocrystals.

1 L. Y. Cao, Y. L. Liu, B. H. Zhang, L. H. Lu, *Appl. Mater. Interf.* 2010, **2**, 2339.