

Supporting Information

Core-Shell Approach to Impurity Incorporation and Controlled Growth of a NaGdF₄ Nanostructure

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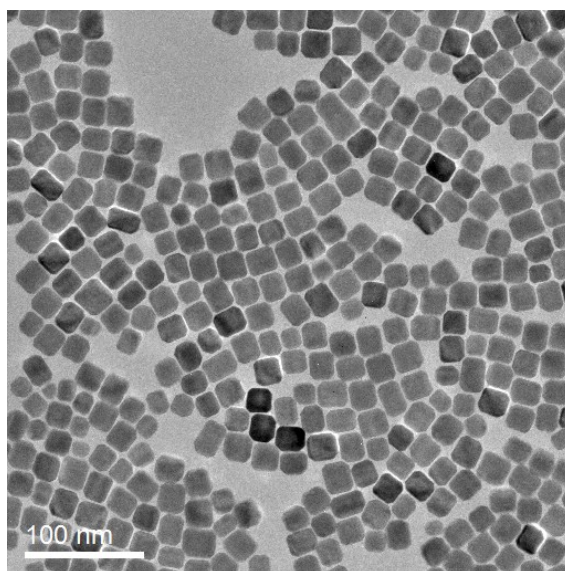


Figure. S1 SEM image of NaGdF₄ nanoparticles without doping

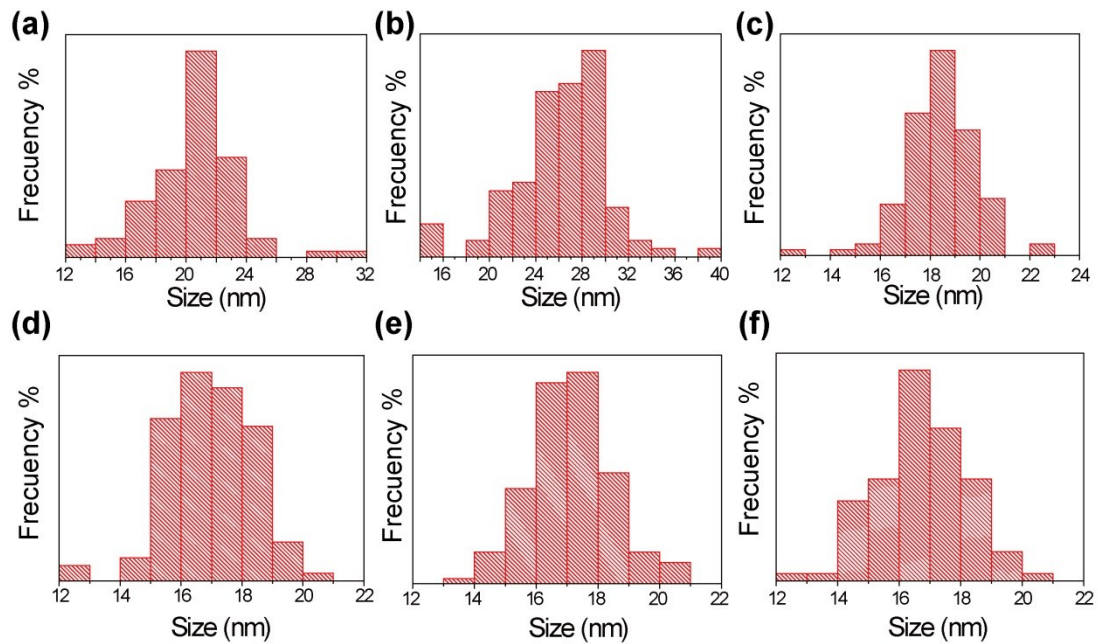


Figure S2 The particle size distribution of NaGdF₄:Cr core with different concentration of Cr(CF₃COO)₃: (a)50 %; (b)40 %; (c)30 %; (d)10 %; (e)5 %; (f)3 %.

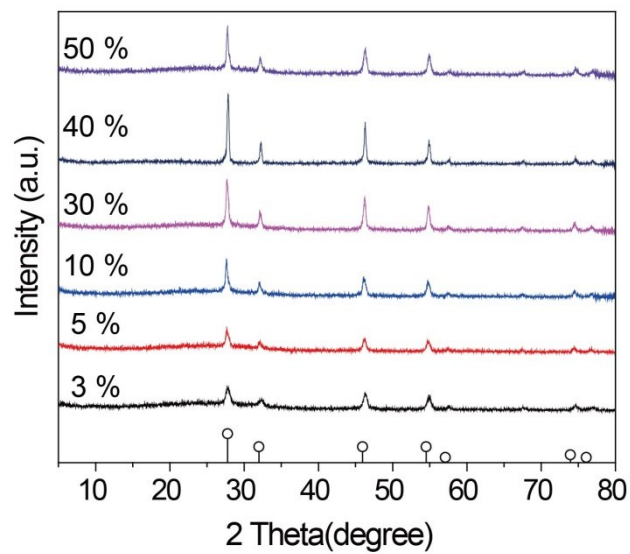


Figure S3 XRD patterns of NaGdF₄:Cr@NaGdF₄:Yb/Tm core-shell nanoparticles with different concentration of Cr(CF₃COO)₃ precursor in core preparation

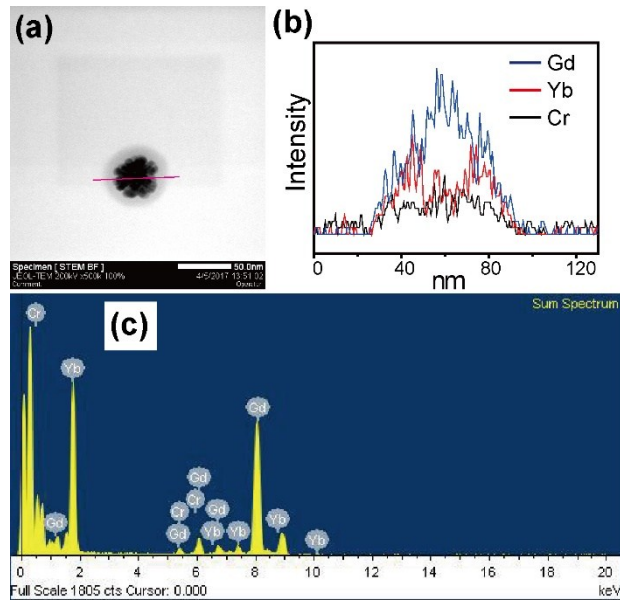


Figure S4 The electron energy-loss spectroscopy (EELS) 2D elemental maps and line profiles (a,b) and EDS (c) of Gd^{3+} , Yb^{3+} and Cr^{3+} in $NaGdF_4:Cr(50\%)@NaGdF_4:Yb/Tm$ core-shell nanoparticles (the reaction time is 0.5 h).

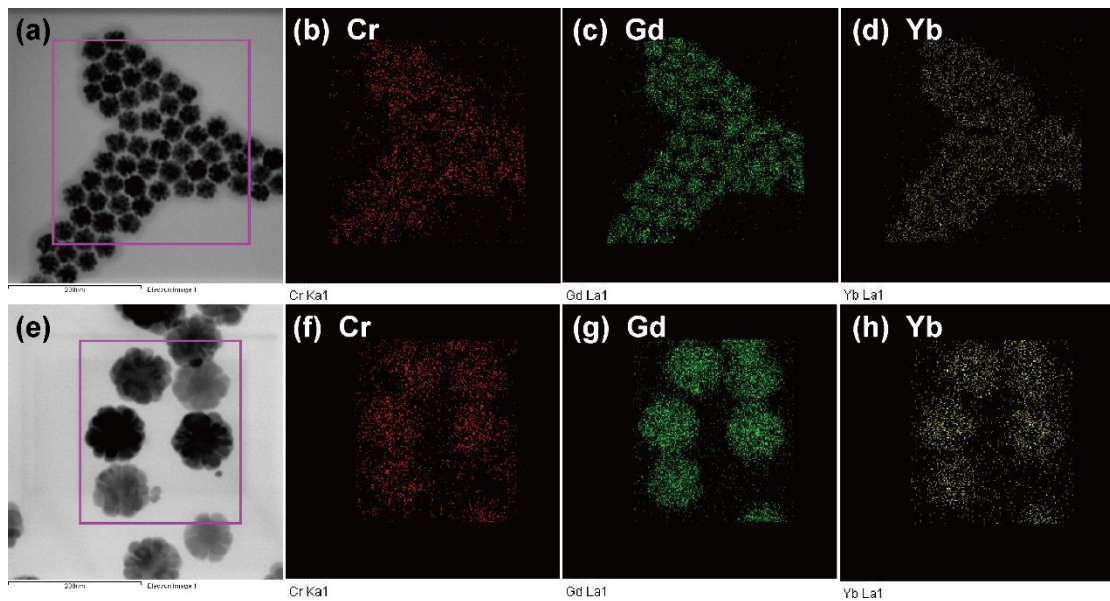


Figure S5 TEM images and element mapping of Cr, Gd and Yb: (a)-(d) $NaGdF_4:Cr@NaGdF_4:Yb,Tm$ UCNPs (0.5 h) and (e)-(h) $NaGdF_4:Cr@NaGdF_4:Yb,Tm$ UCNPs (6 h).

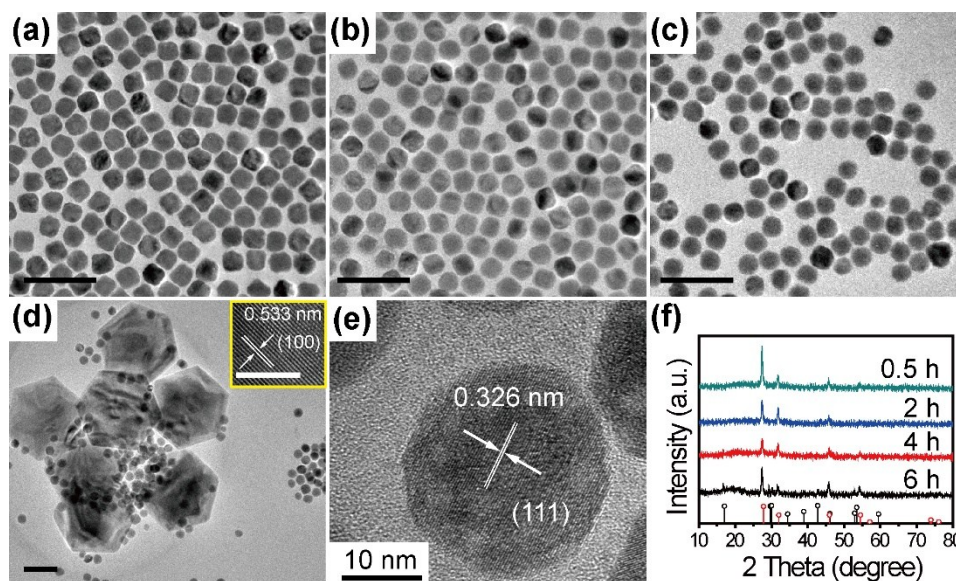


Figure S6 The TEM images of NaGdF₄@NaGdF₄:Yb/Tm UCNPs prepared with different reaction time: (a)0.5 h; (b)2 h; (c)4 h; (d)6 h; (e)6 h. The XRD patterns (f) of NaGdF₄@NaGdF₄:Yb/Tm UCNPs. The scale bar in inset figure of (d) is 10 nm, while the other bars in (a)-(d) are all 100 nm.

Table S1 The concentrations of Cr, Gd and Yb in NaGdF₄:Cr@NaGdF₄:Yb,Tm UCNPs

NaGdF ₄ :Cr@NaGdF ₄ :Yb,Tm 0.5 h			NaGdF ₄ :Cr@NaGdF ₄ :Yb,Tm 6 h		
Element	Weight%	Atomic%	Element	Weight %	Atomic %
Cr K	4.69	13.42	Cr K	4.61	13.11
Gd L	53.19	50.34	Gd L	63.87	60.00
Yb L	42.13	36.24	Yb L	31.51	26.90