

Supplementary information

Table S1: Nominal lanthanide proportions and absolute quantities for coprecipitation synthesis (shown in mmol and mg)

Nominal Composition	LuCl ₃ ·6H ₂ O (MW 389.42)	GdCl ₃ ·6H ₂ O (MW 371.70)	CeCl ₃ ·7H ₂ O (MW 372.58)	TbCl ₃ ·6H ₂ O (MW 373.38)	EuCl ₃ ·6H ₂ O (MW 366.41)
β-Na(Lu _{0.9} Ce _{0.1})F ₄	0.9 (350.48)		0.1 (37.26)		
β-Na(Lu _{0.6} Gd _{0.4})F ₄	0.6 (233.65)	0.4 (148.68)			
β-Na(Lu _{0.6} Gd _{0.3} Ce _{0.1})F ₄	0.6 (233.65)	0.3 (111.51)	0.1 (37.26)		
β-Na(Lu _{0.2} Gd _{0.4} Ce _{0.4})F ₄	0.2 (77.88)	0.4 (148.68)	0.4 (149.03)		
β-Na(Lu _{0.65} Gd _{0.2} Tb _{0.15})F ₄	0.65 (253.12)	0.2 (74.34)		0.15 (56.00)	
β-Na(Lu _{0.55} Gd _{0.3} Eu _{0.15})F ₄	0.55 (214.18)	0.3 (111.51)			0.15 (54.96)
β-Na(Lu _{0.7} Gd _{0.15} Eu _{0.15})F ₄	0.7 (272.60)	0.15 (55.76)			0.15 (54.96)

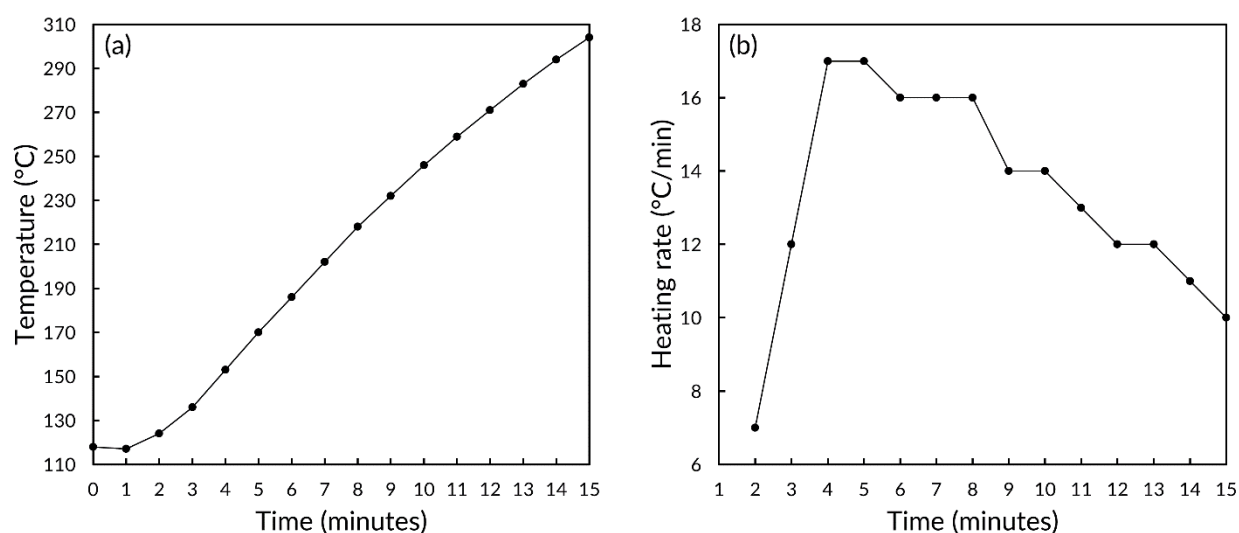


Figure S1: Ramp rate leading into final high-temperature step of nanoparticle synthesis. (a) Temperature during heating to 300 °C. (b) Heating rate in °C/min.

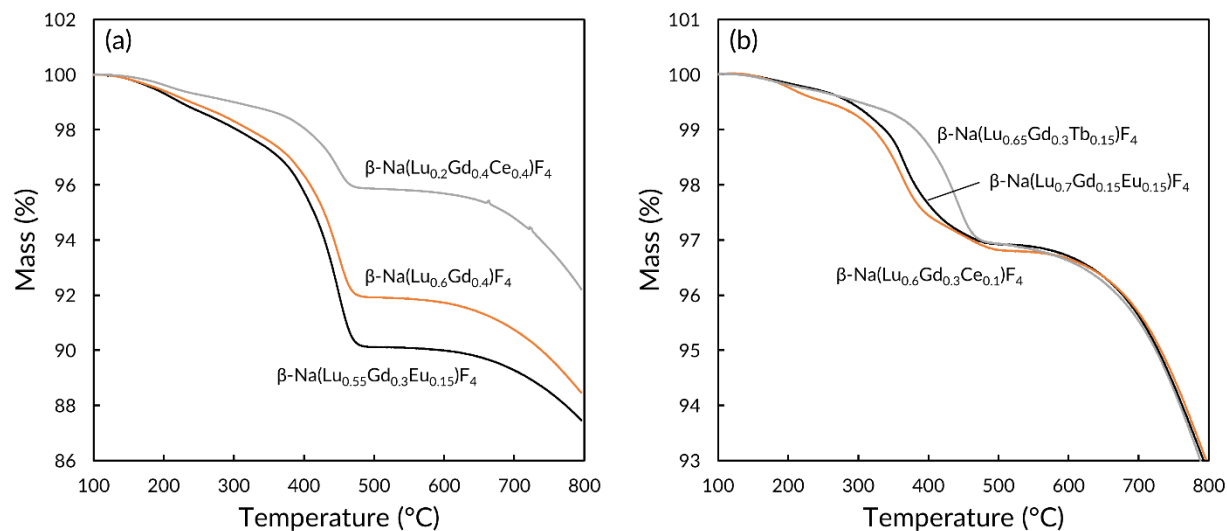


Figure S2: Thermogravimetric analysis (TGA) curves for the nanoparticles used for colloidal measurements. Data is divided into two figures for legibility. To determine the mass of the oleate ligands, the mass loss (%) was determined between 100 & ~500 °C. (a) Samples consisting of 4-10% oleate. (b) Samples consisting of ~3% oleate.

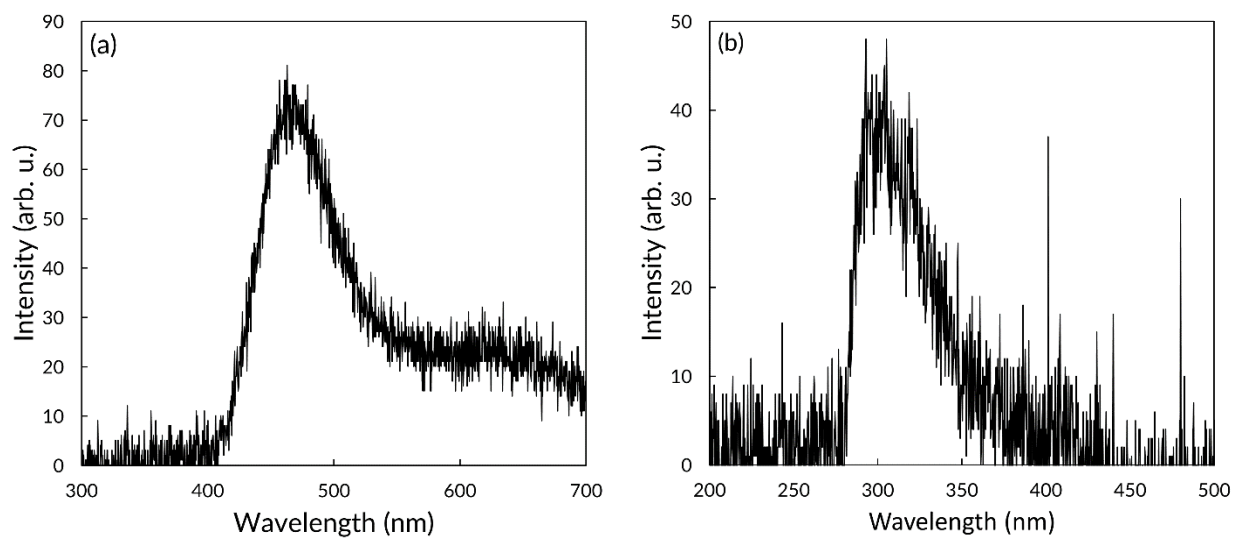


Figure S3: Background signals during x-ray irradiation. (a) Stem effect in the bare optical fiber. (b) Radioluminescence of pure toluene.

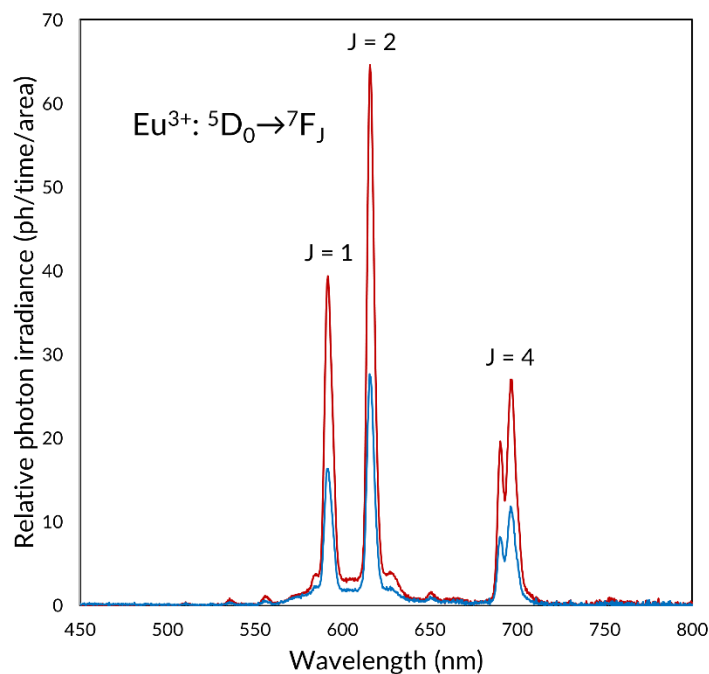


Figure S4: Radioluminescence spectra of colloidal $\beta\text{-Na}(\text{Lu}_{0.7}\text{Gd}_{0.15}\text{Eu}_{0.15})\text{F}_4$ (red, higher intensity) and $\beta\text{-Na}(\text{Lu}_{0.55}\text{Gd}_{0.3}\text{Eu}_{0.15})\text{F}_4$ (blue, lower intensity) at 10 mg/mL in toluene.

Table S2: Monte Carlo-derived and calculated quantities for radioluminescence yield calculations

Nominal Composition	D_{nps}/ϕ ($\times 10^{-13} \text{ Gy}\cdot\text{cm}^2$)	$\left(\frac{\bar{L}}{\rho}\right)_{nps}^{np}$	D_{np}/ϕ ($\times 10^{-12} \text{ Gy}\cdot\text{cm}^2$)	E_{np}/ϕ ($\text{eV}\cdot\text{cm}^2$)	$\left(\frac{\bar{\mu}_{en}}{\rho}\right)_{nps}^{np}$
p-Terphenyl in toluene (TP)	5.019	-	-	2716.19	-
$\beta\text{-Na}(\text{Lu}_{0.6}\text{Gd}_{0.4})\text{F}_4$	8.455	2.217	1.874	117.0	39.437
$\beta\text{-Na}(\text{Lu}_{0.6}\text{Gd}_{0.3}\text{Ce}_{0.1})\text{F}_4$	8.424	2.204	1.857	115.9	39.369
$\beta\text{-Na}(\text{Lu}_{0.2}\text{Gd}_{0.4}\text{Ce}_{0.4})\text{F}_4$	8.096	2.101	1.701	106.2	39.640
$\beta\text{-Na}(\text{Lu}_{0.55}\text{Gd}_{0.3}\text{Eu}_{0.15})\text{F}_4$	8.414	2.203	1.854	115.7	39.600
$\beta\text{-Na}(\text{Lu}_{0.7}\text{Gd}_{0.15}\text{Eu}_{0.15})\text{F}_4$	8.510	2.226	1.894	118.2	39.424
$\beta\text{-Na}(\text{Lu}_{0.65}\text{Gd}_{0.2}\text{Tb}_{0.15})\text{F}_4$	8.483	2.228	1.890	118.0	39.502