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Supplementary Information

Tunable photoluminescence from layered rare-earth
hydroxide/polymer nanocomposite hydrogels by a cascaded energy
transfer effect

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Table S1 Compositions of $\text{LGd}_{0.5}\text{Tb}_{0.5-x}\text{Eu}_x\text{H}$ ($x = 0-0.5$) with different Eu^{3+} molar fraction and the corresponding power X-ray diffraction (PXRD) patterns data.

samples initial x^a	samples final x	chemical composition	PXRD data		
			$2\theta_{(002)}$ (°)	$d_{(002)}$ (Å)	$d_{(220)}$ (nm)
a ($x = 0$)	0	$\text{Gd}_{0.4157}\text{Tb}_{0.5843}(\text{OH})_{2.5}(\text{NO}_3)_{0.5} \cdot 0.8\text{H}_2\text{O}$	10.66	8.29	0.316
b ($x = 0.01$)	0.0115	$\text{Gd}_{0.4502}\text{Tb}_{0.5383}\text{Eu}_{0.0115}(\text{OH})_{2.5}(\text{NO}_3)_{0.5} \cdot 0.8\text{H}_2\text{O}$	10.62	8.32	0.315
c ($x = 0.05$)	0.0495	$\text{Gd}_{0.5843}\text{Tb}_{0.503}\text{Eu}_{0.0495}(\text{OH})_{2.5}(\text{NO}_3)_{0.5} \cdot 0.8\text{H}_2\text{O}$	10.60	8.34	0.316
d ($x = 0.1$)	0.1047	$\text{Gd}_{0.4655}\text{Tb}_{0.4298}\text{Eu}_{0.1047}(\text{OH})_{2.5}(\text{NO}_3)_{0.5} \cdot 0.8\text{H}_2\text{O}$	10.56	8.37	0.316
e ($x = 0.15$)	0.1493	$\text{Gd}_{0.4643}\text{Tb}_{0.3864}\text{Eu}_{0.1493}(\text{OH})_{2.5}(\text{NO}_3)_{0.5} \cdot 0.8\text{H}_2\text{O}$	10.62	8.32	0.316
f ($x = 0.2$)	0.1948	$\text{Gd}_{0.4629}\text{Tb}_{0.3422}\text{Eu}_{0.1948}(\text{OH})_{2.5}(\text{NO}_3)_{0.5} \cdot 0.8\text{H}_2\text{O}$	10.52	8.40	0.317
g ($x = 0.225$)	0.2227	$\text{Gd}_{0.4609}\text{Tb}_{0.3164}\text{Eu}_{0.2227}(\text{OH})_{2.5}(\text{NO}_3)_{0.5} \cdot 0.8\text{H}_2\text{O}$	10.64	8.31	0.316
h ($x = 0.25$)	0.2431	$\text{Gd}_{0.4671}\text{Tb}_{0.2898}\text{Eu}_{0.2431}(\text{OH})_{2.5}(\text{NO}_3)_{0.5} \cdot 0.8\text{H}_2\text{O}$	10.68	8.28	0.316
i ($x = 0.275$)	0.2725	$\text{Gd}_{0.4731}\text{Tb}_{0.2544}\text{Eu}_{0.2725}(\text{OH})_{2.5}(\text{NO}_3)_{0.5} \cdot 0.8\text{H}_2\text{O}$	10.60	8.34	0.316
j ($x = 0.3$)	0.29	$\text{Gd}_{0.4728}\text{Tb}_{0.2372}\text{Eu}_{0.29}(\text{OH})_{2.5}(\text{NO}_3)_{0.5} \cdot 0.8\text{H}_2\text{O}$	10.62	8.32	0.317
k ($x = 0.4$)	0.3977	$\text{Gd}_{0.4776}\text{Tb}_{0.1247}\text{Eu}_{0.3977}(\text{OH})_{2.5}(\text{NO}_3)_{0.5} \cdot 0.8\text{H}_2\text{O}$	10.64	8.31	0.317
l ($x = 0.5$)	0.5843	$\text{Gd}_{0.4157}\text{Eu}_{0.5843}(\text{OH})_{2.5}(\text{NO}_3)_{0.5} \cdot 0.8\text{H}_2\text{O}$	10.66	8.29	0.318

^{a)} x stands for the molar fraction of Eu^{3+} in the total rare-earth ions (Gd^{3+} , Eu^{3+} and Tb^{3+}).

Table S2 Energy Transfer Efficiency (E) between the Tb^{3+} and Eu^{3+} in the $\text{LGd}_{0.5}\text{Tb}_{0.5-x}\text{Eu}_x\text{H-NO}_3/\text{PAM}$ NC hydrogels ($x = 0.01\text{--}0.2$).

	Sample b	Sample c	Sample d	Sample e	Sample f
	($x = 0.01$)	($x = 0.05$)	($x = 0.1$)	($x = 0.15$)	($x = 0.2$)
E (%)	7.7	24.5	34.8	37.9	40.3

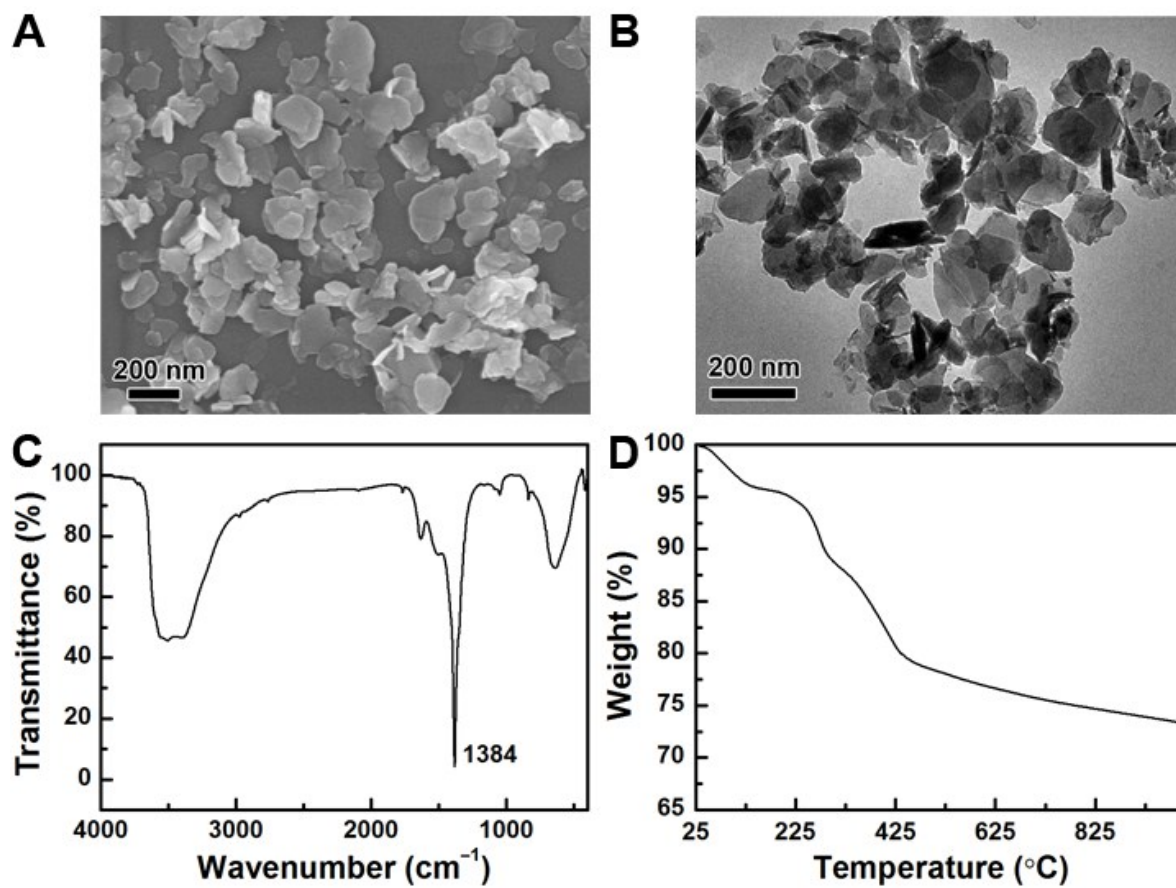


Fig. S1 (A) SEM image, (B) TEM image, (C) FTIR spectrum and (D) TGA curve of $\text{LG}_{0.5}\text{Tb}_{0.3}\text{Eu}_{0.2}\text{H-NO}_3$.

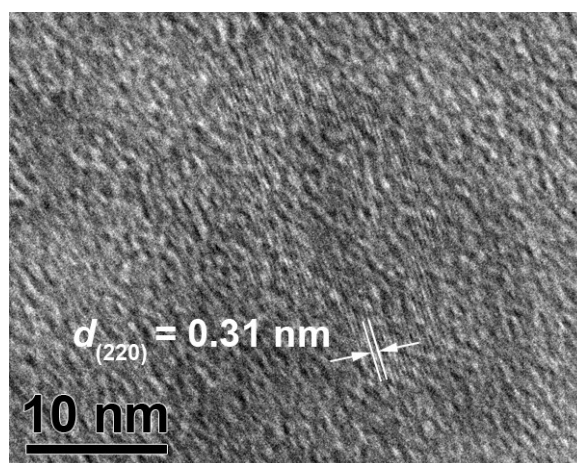


Fig. S2 HRTEM image of the $\text{LG}_{0.5}\text{Tb}_{0.3}\text{Eu}_{0.2}\text{H-NO}_3/\text{PAM NC}$ hydrogel.

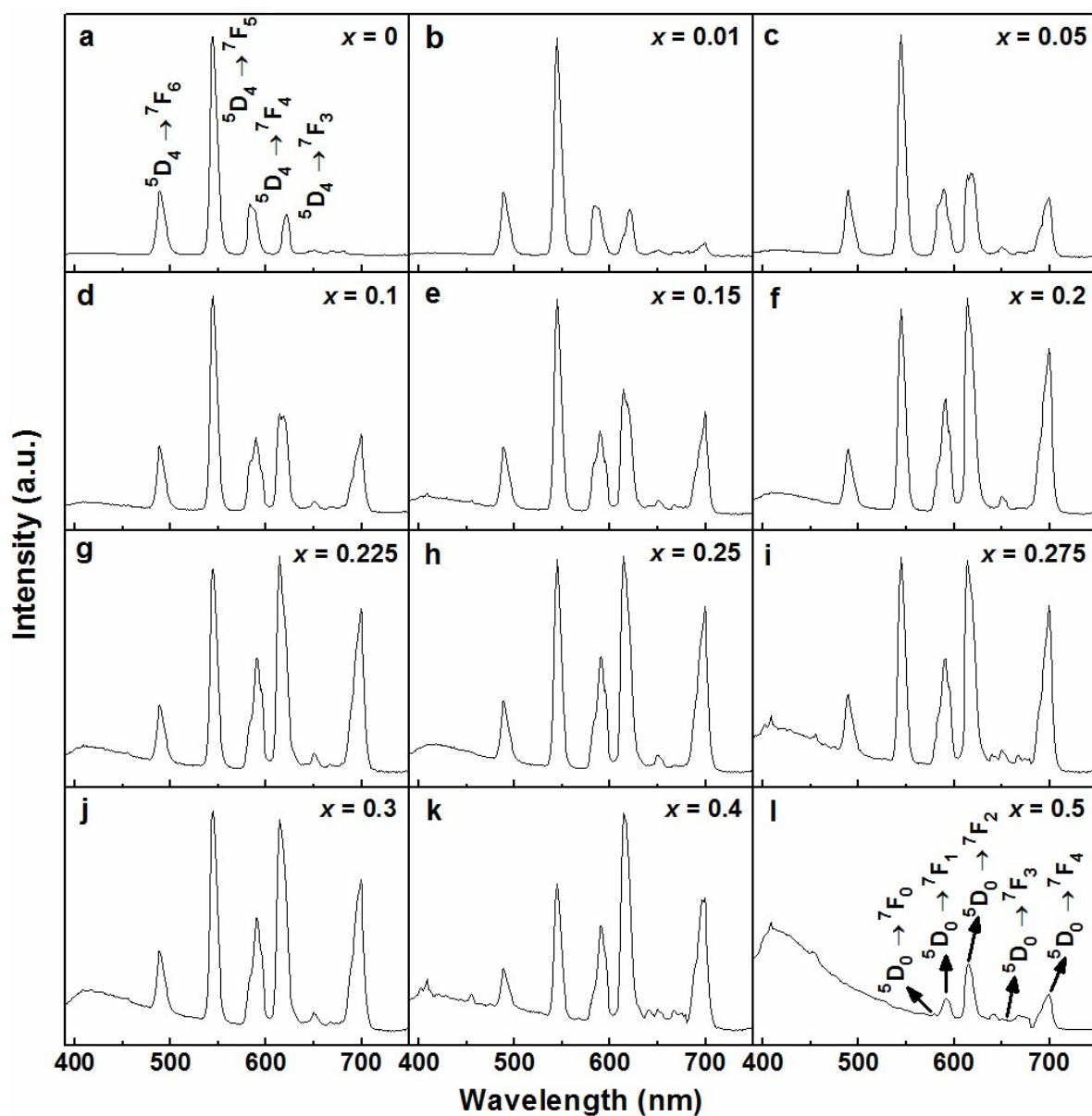


Fig. S3 PL emission spectra of the $\text{LGd}_{0.5}\text{Tb}_{0.5-x}\text{Eu}_x\text{H-NO}_3/\text{PAM}$ NC hydrogels ($x = 0\text{--}0.5$) at room temperature with UV excitation at 365 nm.

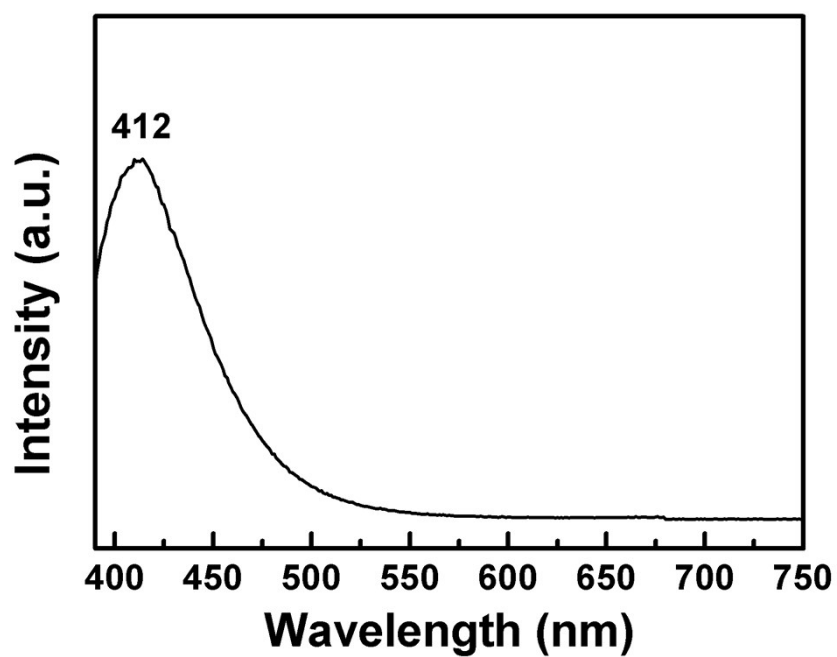


Fig. S4 The emission spectrum of sodium salicylate (SA) aqueous solution under the 365 nm excitation wavelength at room temperature.

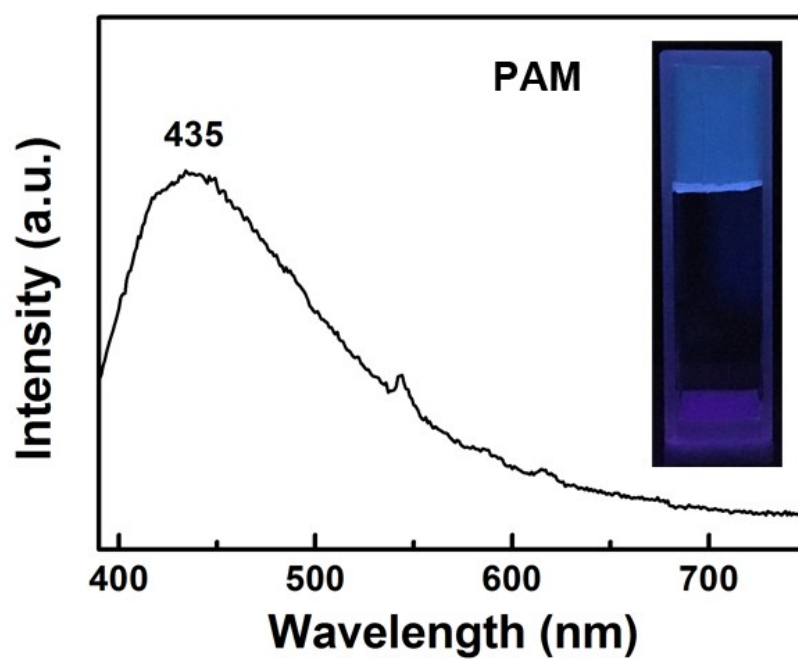


Fig. S5 PL emission spectrum of pure PAM hydrogel at room temperature with UV excitation at 365 nm, the inset is the photograph of pure PAM hydrogel with UV irradiation (365 nm).

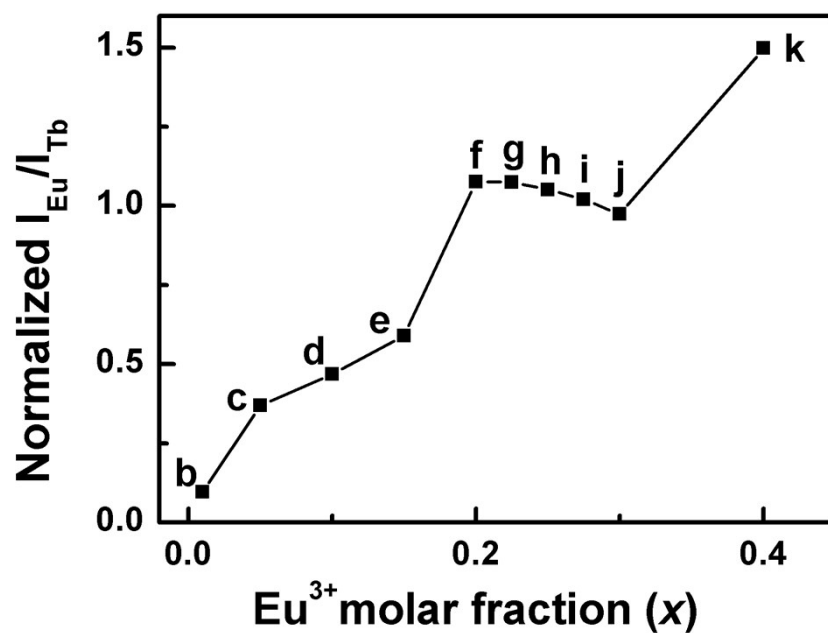


Fig. S6 Dependence of molar fraction with the integrated intensity ratio of Eu^{3+} (614 nm) to Tb^{3+} (544 nm) for the $\text{LGd}_{0.5}\text{Tb}_{0.5-x}\text{Eu}_x\text{H-NO}_3/\text{PAM NC}$ hydrogels ($0 < x < 0.5$).

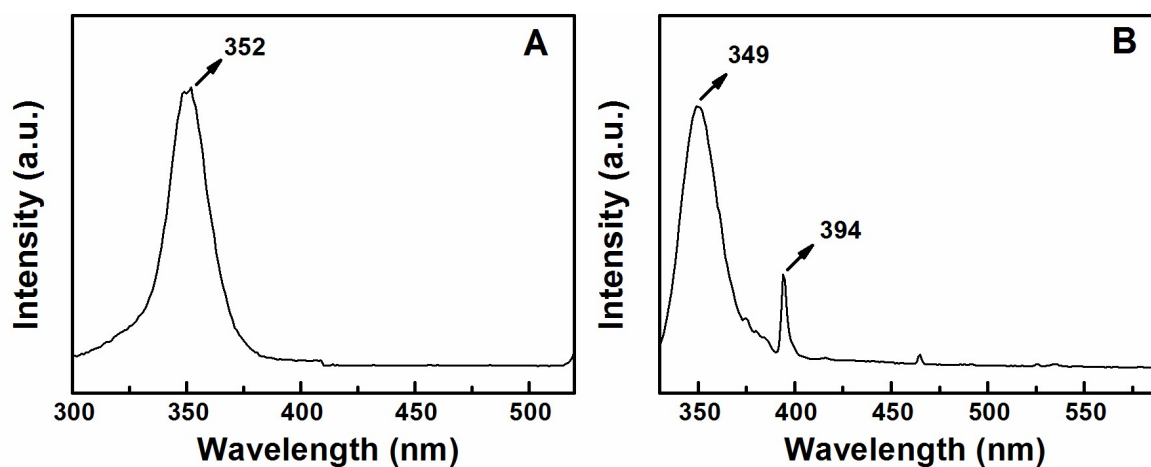


Fig. S7 The photoluminescent excitation spectra at room temperature for the $\text{LGd}_{0.5}\text{Tb}_{0.25}\text{Eu}_{0.25}\text{H-NO}_3/\text{PAM NC}$ hydrogel by monitoring (A) 544 nm and (B) 614 nm emissions, respectively.

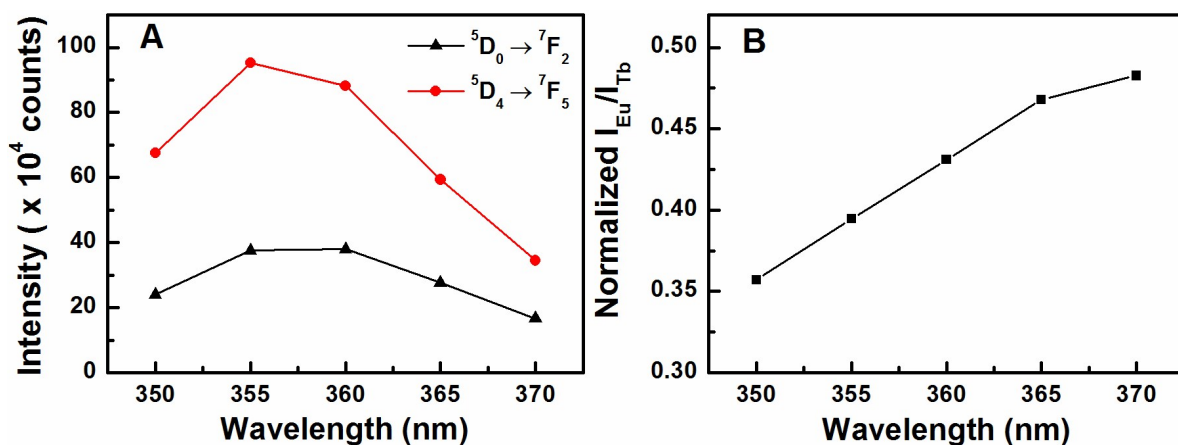


Fig. S8 Dependence of (A) intensity and (B) normalized $I_{\text{Eu}}/I_{\text{Tb}}$ with excitation wavelength for the $^5D_0 \rightarrow ^7F_2$ transition of Eu^{3+} ions and $^5D_4 \rightarrow ^7F_5$ transition of Tb^{3+} ions in the $\text{LG}_{0.5}\text{Tb}_{0.4}\text{Eu}_{0.1}\text{H-NO}_3/\text{PAM NC}$ hydrogel.

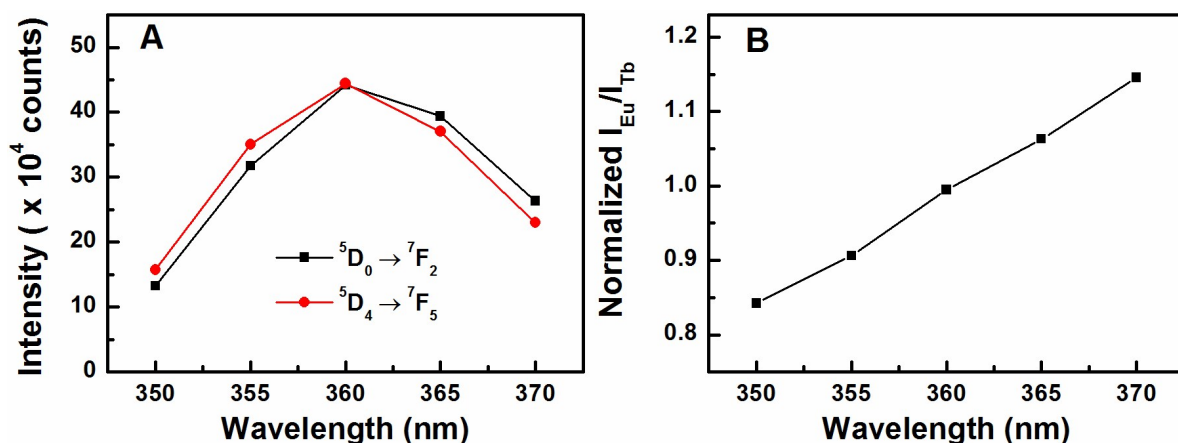


Fig. S9 Dependence of (A) intensity and (B) normalized $I_{\text{Eu}}/I_{\text{Tb}}$ with excitation wavelength for the $^5D_0 \rightarrow ^7F_2$ transition of Eu^{3+} ions and $^5D_4 \rightarrow ^7F_5$ transition of Tb^{3+} ions in the $\text{LG}_{0.5}\text{Tb}_{0.3}\text{Eu}_{0.2}\text{H-NO}_3/\text{PAM NC}$ hydrogel.