

Supporting Information

Morphology evolution, energy transfer and multicolor luminescence of lanthanide-doped Ba₂LaF₇ nanocrystals by one-step hydrothermal synthesis

Yini Mao,^a Li Jiang,^a Rui Ye,^a Shanshan Hu^{*a} and Jun Yang^{*a}

^aSchool of Chemistry and Chemical Engineering, Southwest University, No. 2 Tiansheng Road, Beibei District, Chongqing 400715, China

Fig 8a shows the excitation and emission spectra of Ba₂LaF₇:3%Tm³⁺, only one emission peak at 455 nm in the blue region is obtained, which is derived from the ¹D₂ → ³F₄ transition of Tm³⁺ ions. And the strongest peak at 355 nm of the excitation spectrum is attributed to the ³H₆ → ¹D₂ transition.^{1,2} The excitation and emission spectra of Ba₂LaF₇:1%Er³⁺ is shown in Fig 8b, at a wavelength of 378 nm, the emission peaks at 525 nm and 552 nm are originated from the ²H_{11/2}/⁴S_{3/2} → ⁴I_{15/2} transition of Er³⁺, respectively. And when using 552 nm as a monitoring wavelength, the excitation peaks are mainly located at 363nm (⁴I_{15/2} → ⁴G_{9/2}), 378nm (⁴I_{15/2} → ⁴G_{11/2}) and 406nm (⁴I_{15/2} → ²H_{9/2}).³ As for Ba₂LaF₇:1%Ho³⁺ (Fig 8c), when excited with a wavelength of 451 nm, a single peak at 546 nm in the green region which derived from the ⁵S₂ → ⁵I₈ transition of Ho³⁺ ions is obtained, and the peaks of the excitation spectrum at 360 nm, 384 nm, 416 nm, 451 nm and 484 nm are due to the transitions from the ground state ⁵I₈ to the excited state ³H₆, ⁵G₄, ⁵G₅, ⁶G₆ and ⁵F₃ of Ho³⁺, respectively.¹⁻³ And the Ba₂LaF₇:2%Dy³⁺ sample, there are two main emission peaks including the strongest emission peak at 480 nm (⁴F_{9/2} → ⁶H_{15/2}) in the blue region and a weaker emission peak at 575 nm (⁴F_{9/2} → ⁶H_{13/2}) in the yellow region. At the monitoring wavelength of 480 nm, the excitation spectrum of Dy³⁺ ions consists

of many peaks at 295, 324, 350, 364, 387 nm, which are assigned to ground level ${}^6\text{H}_{15/2}$ to the excited levels ${}^4\text{K}_{13/2}+{}^6\text{H}_{15/2}$, ${}^4\text{K}_{15/2}$, ${}^6\text{M}_{15/2}+{}^6\text{P}_{7/2}$, ${}^4\text{I}_{11/2}$ and ${}^4\text{M}_{21/2}+{}^4\text{I}_{13/2}+{}^4\text{K}_{17/2}+{}^4\text{F}_{7/2}$, respectively.⁴ Fig 8g shows the excitation and emission spectra of $\text{Ba}_2\text{LaF}_7:2\%\text{Sm}^{3+}$, when using 599 nm as a monitoring wavelength, the excitation spectrum of Sm^{3+} mainly consists of three peaks at 360, 372 and 400 nm, which are attributed to the transitions of ${}^6\text{H}_{5/2}\rightarrow{}^4\text{D}_{5/2}$, ${}^6\text{H}_{5/2}\rightarrow{}^6\text{P}_{7/2}$ and ${}^6\text{H}_{5/2}\rightarrow{}^4\text{K}_{11/2}$, respectively. When using 400 nm as the excitation wavelength, the three emission peaks in the visible region near 561, 599, and 645 nm, which are assigned to the intra-4f-shell transitions from the excited level ${}^4\text{G}_{5/2}$ to ground levels ${}^6\text{H}_{5/2}$, ${}^6\text{H}_{7/2}$, ${}^6\text{H}_{9/2}$, respectively.³ The spectrum of $\text{Ba}_2\text{LaF}_7:10\%\text{Ce}^{3+}$ phosphor is shown in Figure 8h, at 351 nm, the doublet (263 nm and 285 nm) of Ce^{3+} ions can be assigned to the transitions of ${}^2\text{F}_{5/2}$ and ${}^2\text{F}_{7/2}$ to 5d level respectively, which appears due to the strong coupling of the 5d electron with host lattice.⁵⁻⁶ Upon excitation at 285 nm, the emission spectrum of $\text{Ba}_2\text{LaF}_7:10\%\text{Ce}^{3+}$ phosphors display a palpable peak at 365 nm, which corresponds to the transitions from 5d to 4f state.⁵⁻⁶

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