

Electronic Supplementary Information (ESI)

Enhanced energy transfer efficiency and stability of europium β -diketonate complex in ionic liquid-based lyotropic liquid crystals

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1. Calculation of the lattice parameters for liquid crystalline phases

The lattice parameters of LLC phases, a , correspond respectively to the lamellae periodicity for the lamellar structure, and the distance between the centers of two adjacent cylinders for the hexagonal structure. They can be calculated from the first Bragg scattering position (q_1) in SAXS profiles according to the following equations:¹

$$\text{Lamellar phase: } a = 2\pi/q_1, \quad \text{Hexagonal phase: } a = 4\pi/\sqrt{3}q_1 \quad (1)$$

2. Calculation of the quantum efficiency (Q), radiative (k_r) and nonradiative (k_{nr}) rate constants

On the basis of the data from emission spectra and 5D_0 lifetimes, the 5D_0 quantum efficiency (Q), radiative (k_r) and nonradiative (k_{nr}) rate constants can be estimated.² The radiative contribution (k_r) can be obtained from the relative intensities of the ${}^5D_0 \rightarrow {}^7F_{0-6}$ transitions of Eu^{3+} . The ${}^5D_0 \rightarrow {}^7F_5$ and ${}^5D_0 \rightarrow {}^7F_6$ transitions can be ignored in the depopulation of the 5D_0 excited state since these transitions present a very weak intensity in our emission spectra, which contribute less than 5% to the total luminescence output. The ${}^5D_0 \rightarrow {}^7F_1$ transition can be taken as a reference for its dipolar magnetic nature, so k_r can be given as

$$k_r = \sum_{J=0}^4 k_{0 \rightarrow J} = k_{01} \sum_{J=0}^4 \left(\frac{S_{0J}}{S_{01}} \right) \left(\frac{\nu_{01}}{\nu_{0J}} \right) \quad (2)$$

where S_{01} and S_{0J} are the integrated intensity (areas under the curves) of the ${}^5D_0 \rightarrow {}^7F_1$ and ${}^5D_0 \rightarrow {}^7F_J$ transitions, with ν_{01} and ν_{0J} being their energy barycentres, respectively. k_{01} is the Einstein coefficient of spontaneous emission between the 5D_0 and 7F_1 energy levels and can be determined to be about 50 s^{-1} in air.³ From the experimental 5D_0 decay rate, the non-radiative contribution can be calculated by assuming that

$$\frac{1}{\tau_{obs}} = k_r + k_{nr} \quad (3)$$

where τ_{obs} is the observed luminescence lifetime of the 5D_0 excited state. Assuming that only nonradiative and radiative processes are involved in the depopulation of the 5D_0 state, the quantum efficiency (Q) can be determined using the formula: ²

$$Q = \frac{k_r}{k_r + k_{nr}} \quad (4)$$

Based on the emission spectra, the Judd-Ofelt intensity parameters Ω_2 for Eu[III] at different states can be determined from the expression ⁴

$$\left[\Omega_2 = \frac{3hc^3 k_{0-J}}{4e^2 \omega^3 \chi \langle {}^5D_0 \| U^{(2)} \| {}^7D_J \rangle^2} \right] \quad (5)$$

where $\chi = n_0(n_0^2 + 2)^2/9$ is the Lorentz local field correction. n_0 is the refractive index and those measured for [Bmim]PF₆, *H_l* and *La* LLCs were 1.4019, 1.4372 and 1.4481, respectively.

$\langle {}^5D_0 \| U^{(2)} \| {}^7D_J \rangle^2$ is the squared reduced matrix element whose value is 0.0032 for $J = 2$.

3. Luminescence Decay Curves

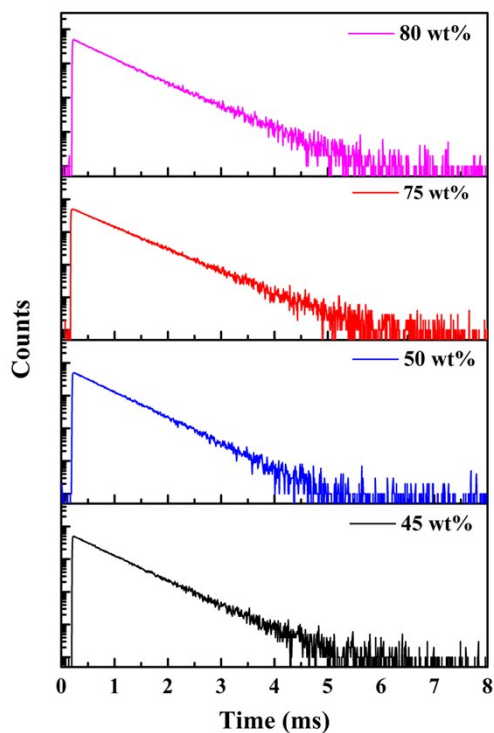


Fig. S1 Luminescence decay curves of Eu[III]-doped LLCs materials at different P123 concentrations under excitation at 340 nm and observed at 613 nm at room temperature. All curves can be well-fitted by a mono-exponential function.

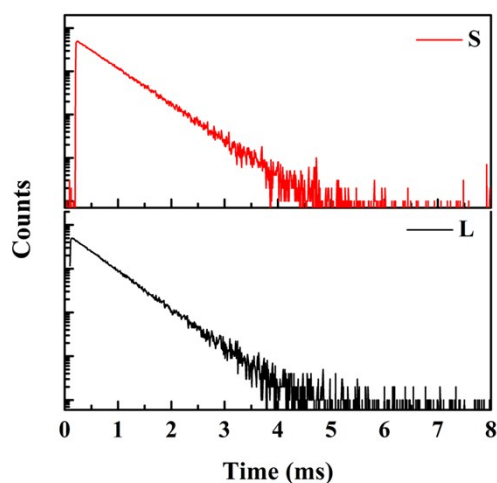


Fig. S2 Luminescence decay curves of pure europium complexes (S) and Eu(III)-dissolved in [Bmim]PF₆ under excitation at 340 nm, and observed at 613 nm at room temperature. All curves can be well-fitted by a mono-exponential function.

4. FTIR Spectrum of pure europium complexes.

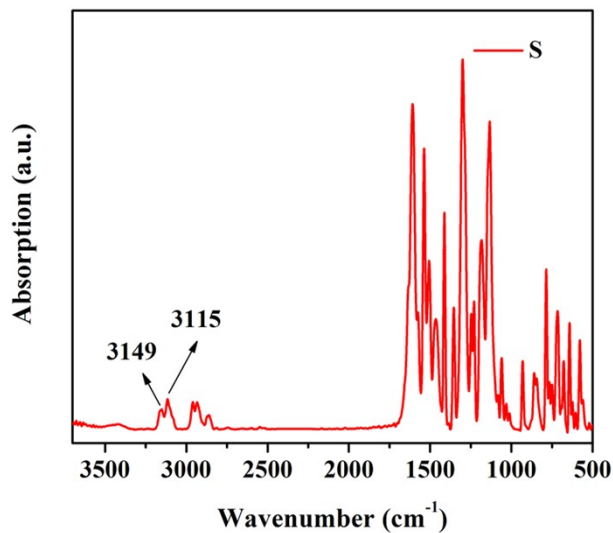


Fig. S3 FTIR spectrum for pure [Bmim][Eu(TTA)₄] solid powder.

References

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