Electronic Supplementary Information (ESI)

Highly luminescent and stable lyotropic liquid crystals based on europium β–diketonate complex bridged by ethylammonium cation

Sijing Yi,[a] Meihuan Yao,[b] Jiao Wang,[a] Xiao Chen*,[a]

[a] Key Laboratory of Colloid and Interface Chemistry, Shandong University, Ministry of Education, Jinan, 250100, China

[b] School of Chemistry and Chemical Engineering, Henan Normal University, Xinxiang, 453007, China

***Corresponding author: Xiao Chen**

Address: Key Laboratory of Colloid and Interface Chemistry, Shandong University, Ministry of Education, Jinan, 250100, China

E-mail: xchen@sdu.edu.cn.

Tel.: +86-531-88365420.

Fax: +86-531-88564464.

1. X-ray Crystallography

The cell parameters were retrieved and refined using the softwares of SMART and SAINT on all observed reflections.[1] The data reduction was performed with SAINT and corrected for Lorentz and polarization effects. The absorption corrections were applied with the program SADABS.[1] In all cases, the highest possible space group was chosen. All structures were solved by direct methods and refined on F^2 by full-matrix least-squares procedures with SHELXL-97.[2] The hydrogen atoms were placed in calculated positions and included as riding atoms with isotropic displacement parameters 1.2-1.5 times U_{eq} of the attached carbon atoms. Pertinent crystallographic data and refinement parameters for EA-Eu and Bmim-Eu complexes were respectively collected in Table S1, with the ball-and-stick representation of the molecular structure for Bmim-Eu complex shown in Figure S1.

Table S1 Crystal and Structure Refinement Data for EA-Eu and Bmim-Eu complexes.

Parameter	EA-Eu	Bmim-Eu
Empirical formula	$C_{34}H_{24}EuF_{12}NO_8S_4$	$C_{40}H_{31}EuF_{12}N_2O_8S_4$
Formula weight	1082.74	1175.87
Temperature/K	298.15	298.15
Crystal system	triclinic	monoclinic
Space group	P-1	$P2_1/c$
a/Å	10.0179(8)	10.652(3)
b/Å	12.2989(11)	20.230(6)
c/Å	17.6698(16)	23.314(5)
α/°	100.592(5)	90
β/°	95.431(5)	106.314(10)
γ/°	102.457(5)	90
Volume/Å^3	2069.05(32)	4822(2)
Z	2	4
ρ_{calc}/g cm^{-3}	1.738	1.620

μ/mm^{-1}	1.820	1.570
F(000)	1068.0	2336.0
Crystal size/mm^3	0.07 × 0.06 × 0.06	0.1 × 0.08 × 0.02
2θ range for data collection/ °	5.102 to 49.992	4.998 to 50
Index ranges	$-11 \le h \le 11, -14 \le k \le 14, -21 \le l \le 21$	$-12 \le h \le 12, -24 \le k \le 23, -27 \le l \le 25$
Reflections collected	20685	19863
Independent reflections	7261 [R_{int} = 0.0293, R_{sigma} = 0.0334]	8483 [R_{int} = 0.0840, R_{sigma} = 0.1344]
Data/restraints/parameters	7261/78/570	8483/127/633
Goodness-of-fit on F^2	1.095	0.983
Final R indexes [I>=2σ (I)]	R_1 = 0.0423, wR_2 = 0.1135	R_1 = 0.0867, wR_2 = 0.2170
Final R indexes [all data]	R_1 = 0.0491, wR_2 = 0.1200	R_1 = 0.1681, wR_2 = 0.2644
Largest diff. peak/hole / e $Å^{-3}$	2.07/-1.38	2.51/-1.31

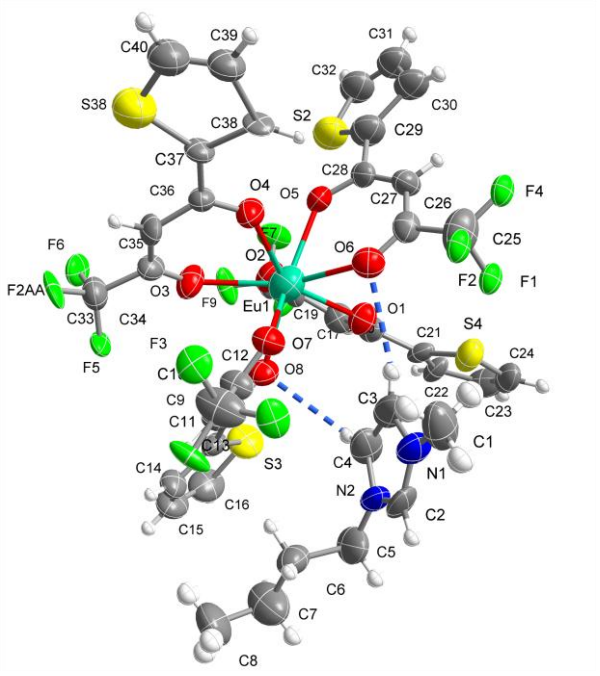

Fig. S1 Ortep view of the coordination structure for Bmim-Eu complex.

2. Luminescence Decay Curves for Pure EA-Eu Complex and Its Liquid Phase

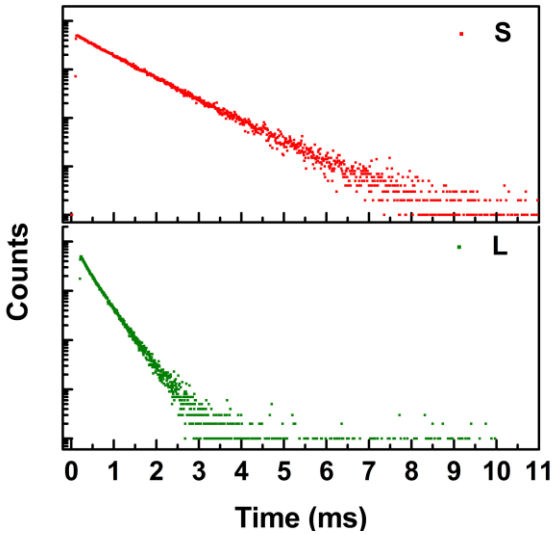

Fig. S2 Luminescence decay curves of pure EA-Eu complex (S) and its liquid phase by dissolving in EAN (L) observed at 612 nm at room temperature. The excitation wavelengths were 395 and 327 nm, respectively. All curves could be well-fitted by a mono-exponential function.

3. 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 could be estimated.[3] The radiative contribution (k_r) could be obtained from the relative intensities of the $^5D_0 \rightarrow {}^7F_{0\text{-}6}$ transitions of Eu^{3+}. The $^5D_0 \rightarrow {}^7F_5$ and $^5D_0 \rightarrow {}^7F_6$ transitions could be ignored in the depopulation of the $^5D_0$ excited state since these transitions presented very weak intensities in our emission spectra, which contributed less than 5% to the total luminescence output. The $^5D_0 \rightarrow {}^7F_1$ transition could be taken as a reference for its dipolar magnetic nature, so k_r could be given as

$$k_r = \sum_{J=0}^{4} k_{0\rightarrow J} = k_{01} \sum_{J=0}^{4} \left(\frac{S_{0J}}{S_{01}} \right) \left(\frac{v_{01}}{v_{0J}} \right) \quad (1)$$

where S_{01} and S_{0J} were the integrated intensity (areas under the curves) of the $^5D_0 \rightarrow {}^7F_1$ and $^5D_0 \rightarrow {}^7F_J$ transitions, with v_{01} and v_{0J} being their energy barycentres, respectively. k_{01} was the Einstein coefficient of spontaneous emission between the $^5D_0$ and $^7F_1$ energy levels and could be determined to be about 50 s^{-1} in air.[4] From the experimental $^5D_0$ decay rate, the non-radiative contribution could

be calculated by assuming that

$$\frac{1}{\tau_{obs}} = k_r + k_{nr} \tag{2}$$

where τ_{obs} was the observed luminescence lifetime of the $^5D_0$ excited state. Assuming that only nonradiative and radiative processes were involved in the depopulation of the $^5D_0$ state, the quantum efficiency (Q) could be determined using the formula: [4]

$$Q = \frac{k_r}{k_r + k_{nr}} \tag{3}$$

4. SAXS Profiles

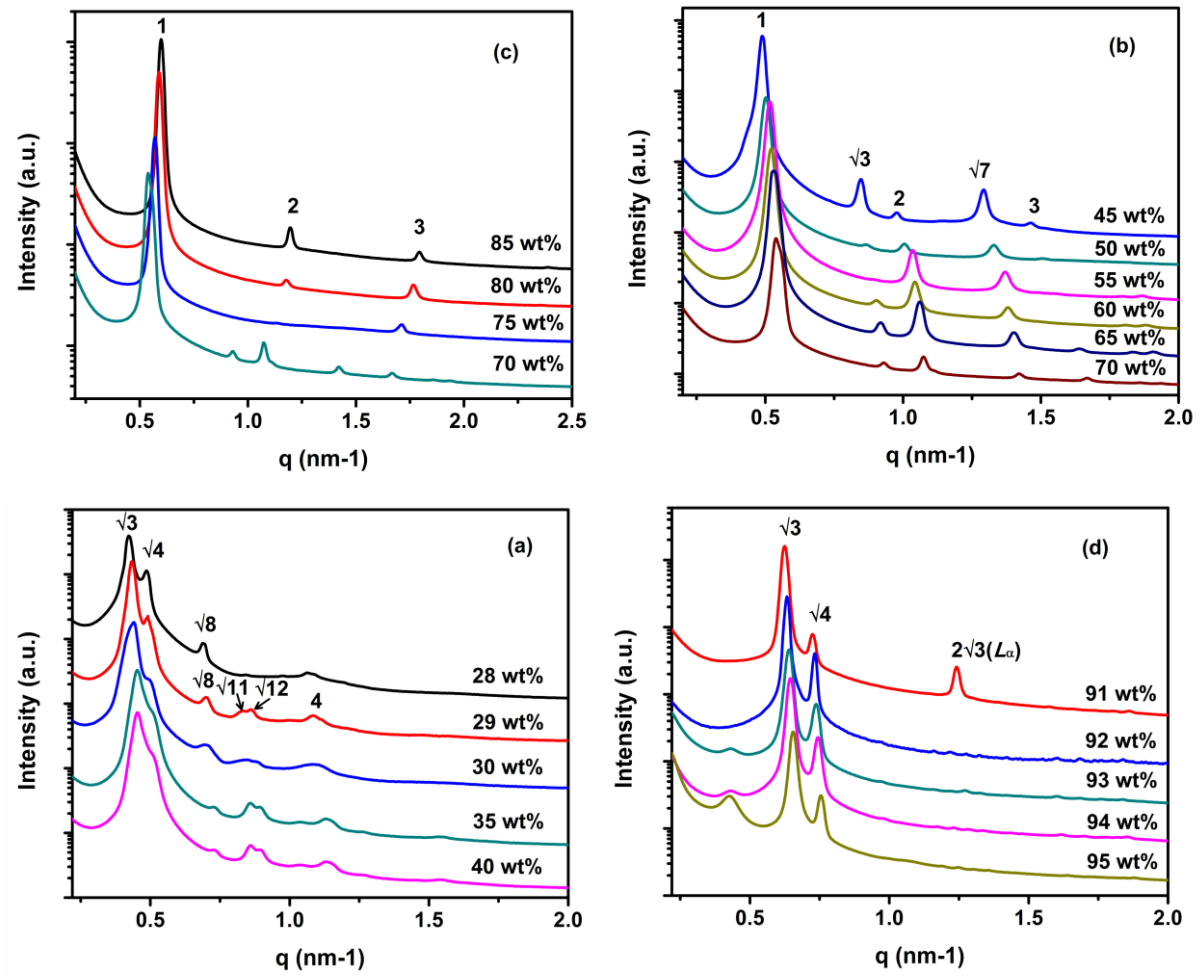

Fig. S3 SAXS profiles for LLC matrices at different P123 concentrations: a. I_1, b. H_1, c. $L\alpha$, d. V_2.

5. Excitation Spectra

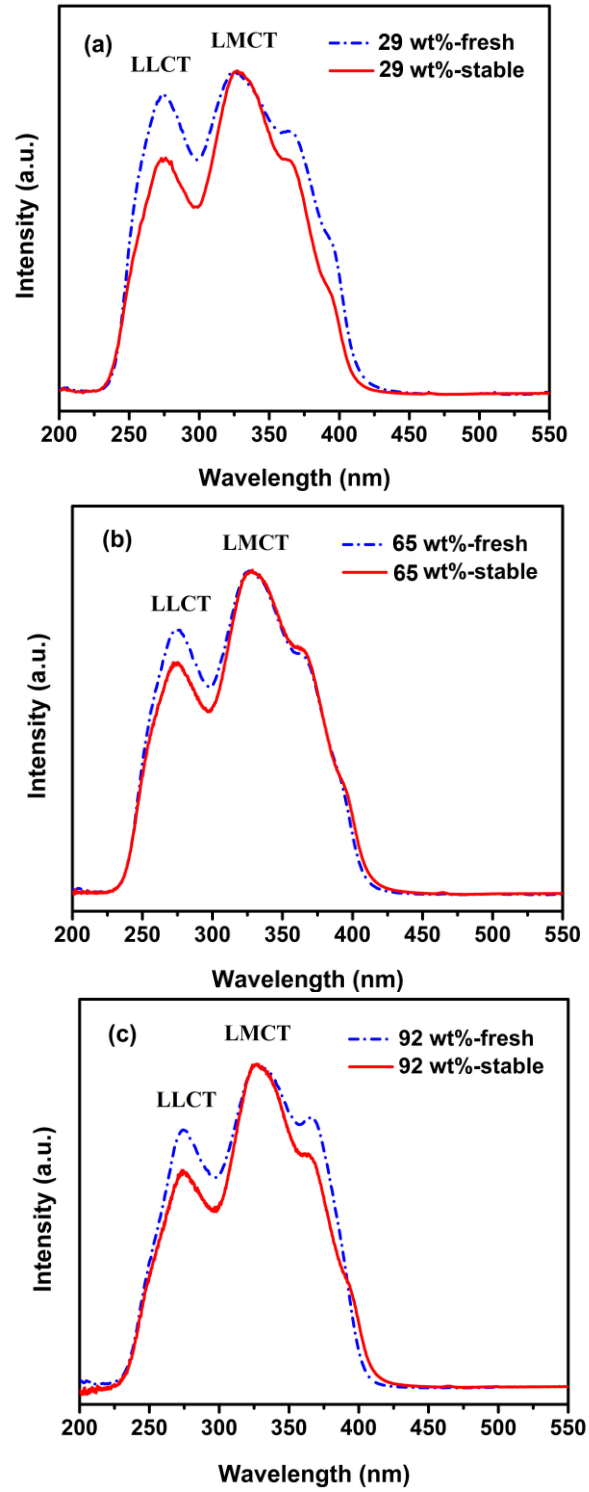

Fig. S4 The excitation spectra of EA-Eu-doped LLC materials in different mesophases:

a. I_1, b. H_1, c. V_2.

6. Luminescence Decay Curves for LLC Materials in Different Mesophases

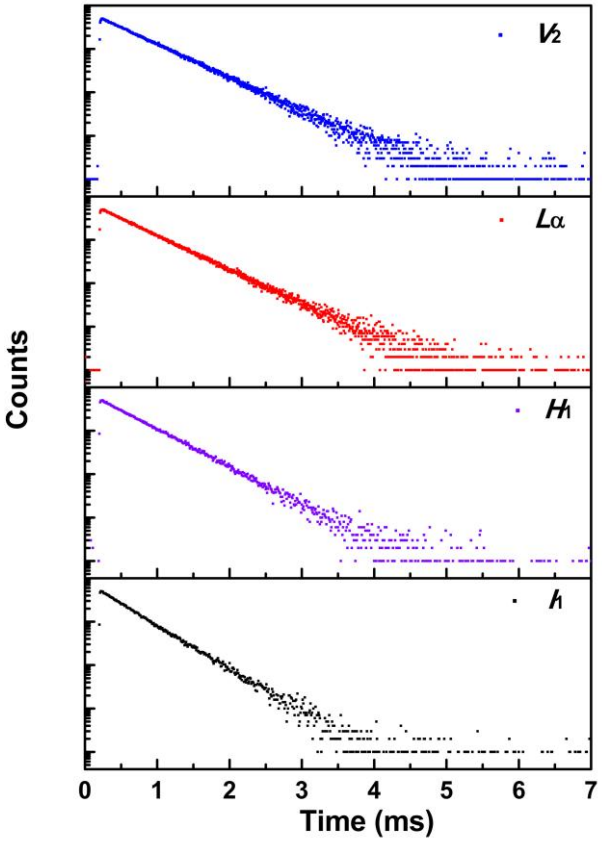

Fig. S5 Luminescence decay curves of luminescent LLC materials at different mesophases under excitation at 326 nm and observed at 612 nm at room temperature. All curves could be well-fitted by a mono-exponential function.

7. Calculation of the lattice parameters for liquid crystalline phases

The lattice parameter of LLC phases, *a*, corresponds respectively to the lamellae periodicity for the lamellar structure, and the distance between the centers of two adjacent cylinders for the hexagonal structure. It can be calculated from the first Bragg scattering position (q_1) in SAXS profiles according to the following equations:[5]

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

For the micelle and reverse bicontinuous cubic structure, the cell lattice parameter can be obtained by the slope of a curve, which is got by plotting the reciprocal spacings ($1/d_{hkl}$) of the various reflections versus $m = (h^2+k^2+l^2)^{1/2}$, where *h*, *k*, *l* are the Miller indices.[6]

8. FTIR Spectrum of EAN and Pure EA-Eu Complex.

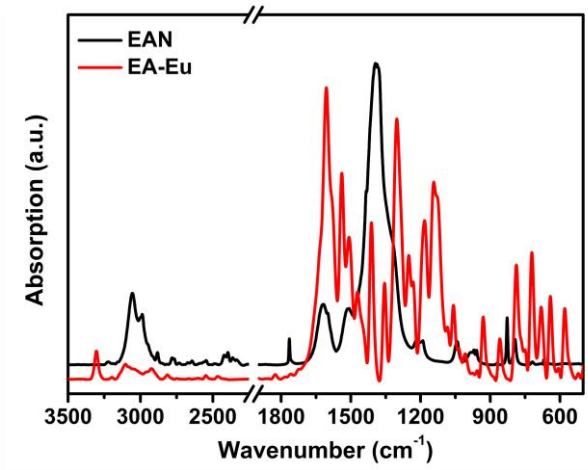

Fig. S6 FT-IR spectra of pure EAN and EA-Eu complex.

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2. G. M. Sheldrick, SHELXS-97, Program for X-ray Crystal Structure Solution, University of Göttingen, Göttingen, Germany, 1997**.**

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4. Y. F. Shao, B. Yan and Q. P. Li, *Eur. J. Inorg. Chem.*, 2013, **3**, 381-387.

5. R. Ivanova, P. Alexandridis and B. Lindman, *Colloids Surf. A*, 2001, **183**, 41-53.

6. R. Ivanova, B. Lindman and P. Alexandridis, *Langmuir*, 2000, **16**, 9058-9069.