Electronic Supplementary Information (ESI)

Flexible and enhanced mutilcolor-emitting films co-assembled by lanthanide complexes and a polymerizable surfactant in aqueous solution

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1. Characterization methods

UV-vis spectroscopy

The UV-vis spectroscopy measurements were carried out using a quartz plate on an HP-8453 spectrometer. The clean quartz plate was utilized as a blank in the experiments.

Zeta potential measurement

The zeta potential of solution samples was determined on a Zetasizer Nano-ZS instrument (ZEN3600, Malvern Instruments, Worcestershire, UK) at 25 ± 0.1 °C. Each value was averaged from three parallel measurements.

2. Synthesis of [choline]$_3$[Ln(DPA)$_3$]

First, 3 mmol 2,6-pyridinedicarboxylic acid was deprotonated through dissolving in 1.7 mL water together with 2.1 mL choline hydroxide solution (46 wt% in water). The pH was adjusted to neutral with hydrochloric acid and the obtained solution was heated to 70 °C, followed by dropwise addition of $EuCl_3·6H_2O$ or $TbCl_3·6H_2O$ aqueous solution (1 mmol). The final solution was left to stir for 2 h and then water was removed using a rotary evaporator. The white color products were washed 3 times with sufficient methanol to remove residues of choline chloride and dried in vacuo at 50 °C for 48 h. The compositions for complexes were verified using elementary analysis with the results as follows (%): Eu-DPA, found (calcd): C 44.62 (44.22), H 5.58 (5.46), N 8.48 (8.59); Tb-DPA, found (calcd): C 42.1 (42.36), H 5.23 (5.63), N 8.63 (8.23).

3. Polarized light microscopic images for LLCs with Eu-DPA doped or not

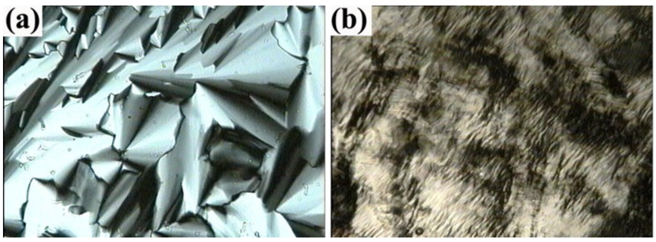

Fig. S1 Polarized light microscopic images for LLCs at C_{12}VIMBr concentrations of 60% (a) and 80% (b).

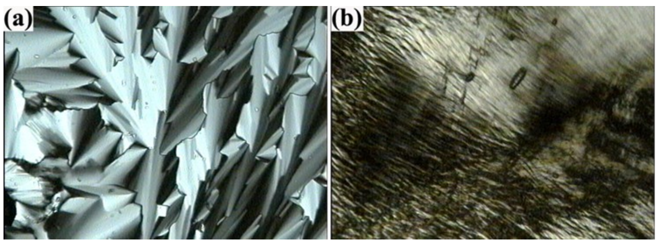

Fig. S2 Polarized light microscopic images for LLCs with doped Eu-DPA (5 × 10^{-3} M) at C_{12}VIMBr concentrations of 60% (a) and 80% (b).

4. Calculation of the lattice parameters (*D*) for lyotropic liquid crystals

The lattice parameters of LLC phases, *D*, denoting the repeated layer spacing for the lamellar structure, or the distance between two adjacent cylinder centers for the hexagonal phase, can be obtained from the first Bragg scattering position (q_1) in SAXS curves according to eq. (1).[1]

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

Table S1. The lattice parameters (*D*) for Eu-DPA-doped (Y) or undoped (N) hexagonal (H_1) and lamellar (Lα) LLCs at 25 °C.

Phase Structure	H_1		Lα	
C_{12}VIMBr (wt%) [a]	60		80	
Eu-DPA-doping (Y/N)	N	Y	N	Y
D (nm)	4.24	4.32	3.27	3.31

[a] (wt%) is the corresponding weight percentage concentration.

5. Experiments to confirm the existence of electrostatic interaction and hydrogen bonding

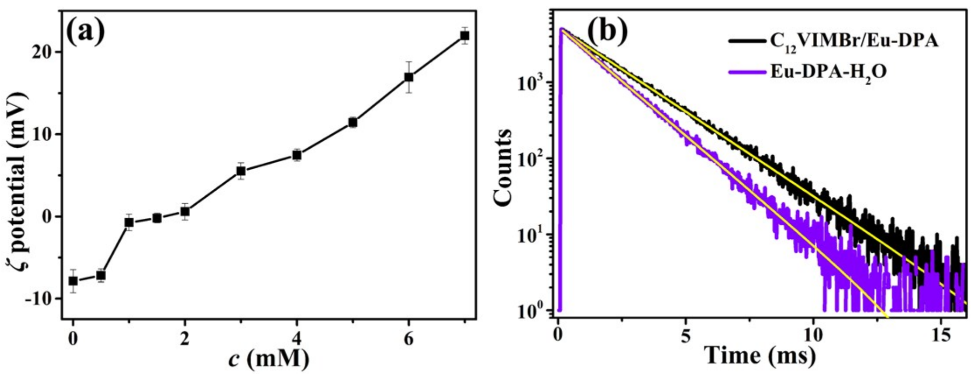

Fig. S3 Zeta potential of 0.5 mM Eu-DPA complex aqueous solution with increasing C_{12}VIMBr concentration *c* (a) and luminescence decay curves detected at 616 nm for pure complex solution (purple) and mixed solution with 6 mM C_{12}VIMBr (black), fitted according to a single-exponential function (b).

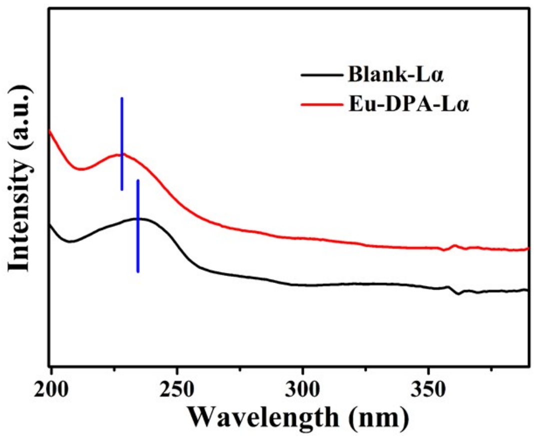

Fig. S4 UV-vis spectra of C_{12}VIMBr in lamellar LLC with or without Eu-DPA complex doped.

6. Calculation of the interaction strength parameter (*A*) between molecules in LLCs based on the Bohlin cooperative flow theory

The quantitatively relationship between the microstructure of a flowing substance and its rheological properties could be determined by Bohlin cooperative flow theory,[2] which provides the link between the dynamic moduli and angular frequency (ω) concerning the interaction of molecules in LLCs by the eq. (2),

$$|G^*| = \sqrt{G'^2 + G''^2} = A\omega^{\frac{1}{z}} \tag{2}$$

where $|G^*|$ is the complex modulus, A is defined as the interaction strength between molecules in LLCs, and z is a parameter considered as the "coordination number" of the interactive flow units.

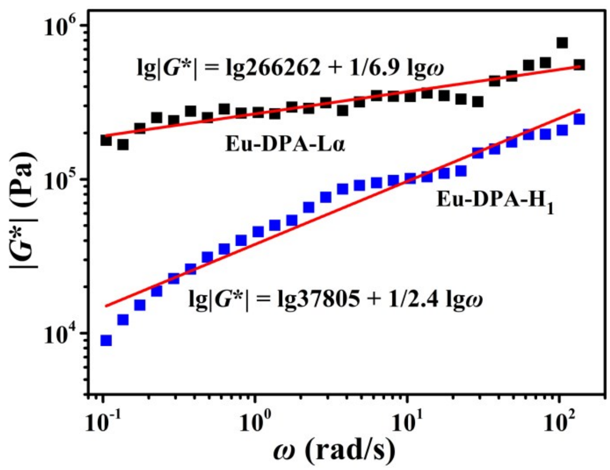

Fig. S5 Complex modulus $|G^*|$ as a function of angular frequency (ω) for Eu-DPA doped LLCs based on the eq. (2) and corresponding fitting curves (red) of the experimental data.

7. Scanning electron micrographs and corresponding elemental mapping images of film cross sections doped with Eu-DPA

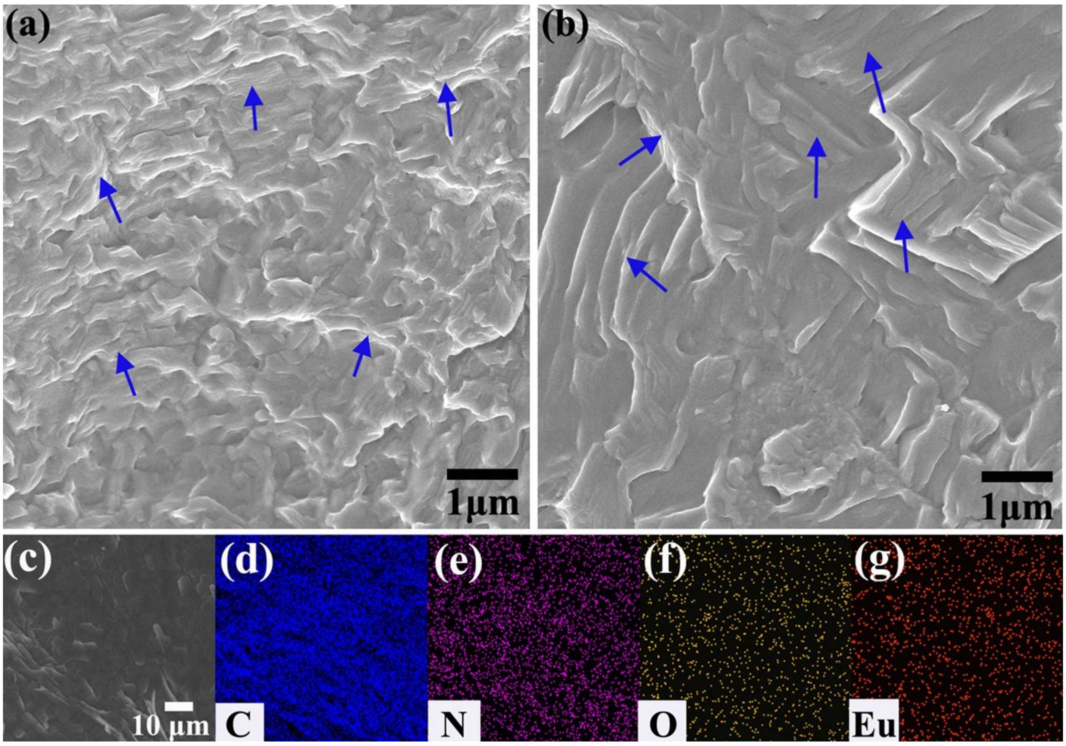

Fig. S6 Scanning electron micrographs of the cross sections for Eu-DPA-Film (a), (b)&(c) and corresponding elemental mapping images of C (d), N (e), O (f) and Eu (g), respectively for the selected cross section of (c).

8. SAXS profiles and excitation spectra for the multicolor emitting films

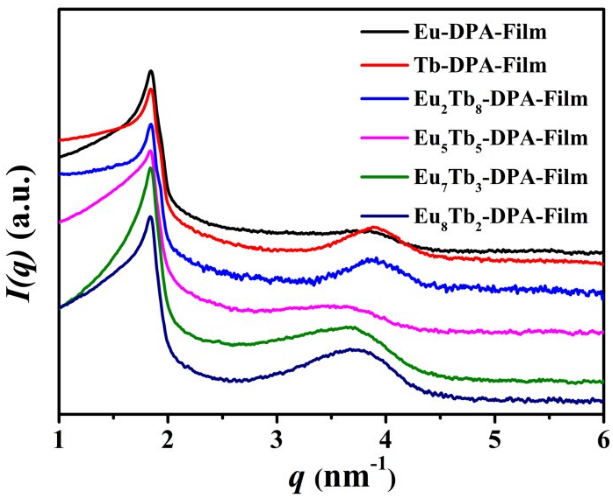

Fig. S7 SAXS patterns for multicolor emitting films.

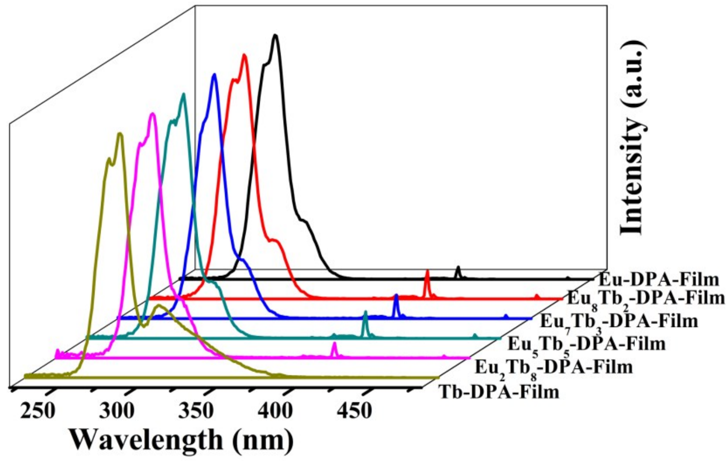

Fig. S8 Excitation spectra for multicolor emitting films.

9. Thermal stability and mechanical properties of the film materials

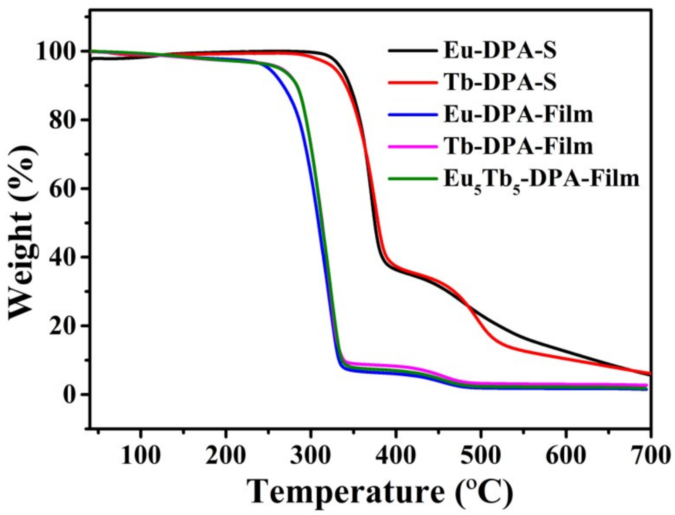

Fig. S9 Thermogravimetric curves of the luminescent films and corresponding complexes.

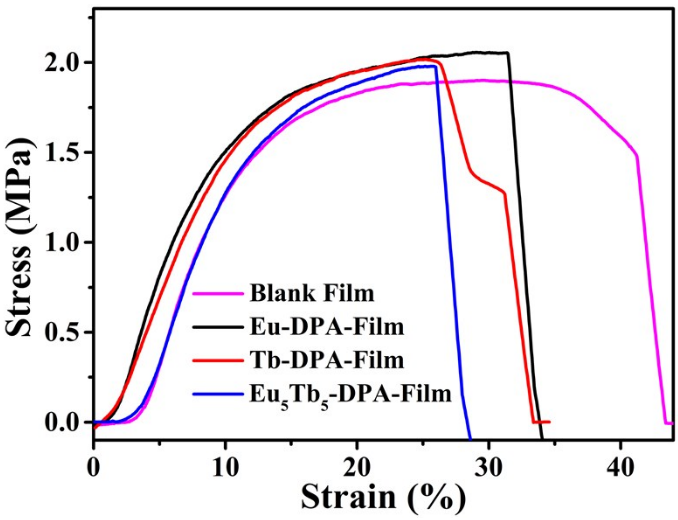

Fig. S10 Stress-strain profiles of the blank film without lanthanide complexes and corresponding luminescent films.

References

1 S. S. Soni, G. Brotons, M. Bellour, T. Narayanan and A. Gibaud, *J. Phys. Chem. B*, 2006, **110**, 15157–15165.

2 L. Bohlin, *J. Colloid Interface Sci.*, 1980, **74**, 423–434.