

## Supporting Information

# Electrically Tunable Polarized Luminescence from Guest-Host Composites via Interaction Between Rare Earth Complexes and Liquid Crystals

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It can be seen that the brightness under a polarizing microscope of all samples changes when voltage is applied (Fig. S1a, c, e, f, h, and j) and removed (Fig. S1b, d, g and i). This change in brightness indicates that the molecular orientation in the LC cells changes with the application and removal of voltage. After multiple consecutive measurements, it was found that this change is repeatable (Fig. S1c, d, e, h, i, j). This indicates that the regulation of molecular orientation by voltage is reversible. Moreover, the same results were obtained for E7 and Eu(tta)<sub>3</sub>phen/E7, indicating that even the presence of Eu complexes does not have an adverse effect on the electrically controlled molecular orientation.

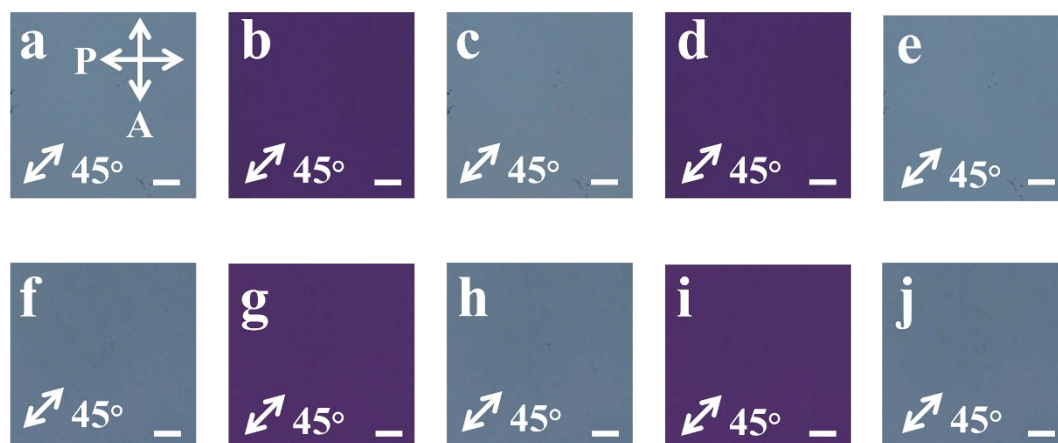


Fig. S1. POM images of E7 (a-e) and the Eu(tta)<sub>3</sub>phen/E7 composites with the concentration of 0.345 wt% (f-j) in LC cells, respectively. 20×, crossed polarizers. A, analyzer; P, polarizer. The square wave voltage (2.5 V<sub>rms</sub>) was applied across the LC cells (a, c, e, f, h, j) or not (b, d, g, i). The angle between the direction of aligning layer and the polarization was 45°. The scale bar is 20 μm.

As displayed in Fig. S2, the polarization-dependent properties of absorption demonstrate the directional arrangement of the  $\text{Eu}(\text{tta})_3\text{phen}$  complexes molecules in the  $\text{Eu}(\text{tta})_3\text{phen}/\text{E7}$  composites, which is consistent with the conclusions obtained through polarized emission spectra in the following text.<sup>[11]</sup> At the same time, the changes in polarization absorption spectra when voltage is applied demonstrate the reorientation of  $\text{Eu}(\text{tta})_3\text{phen}$  molecules under voltage regulation. This result is helpful for the analysis of electrically controllable polarized luminescence.

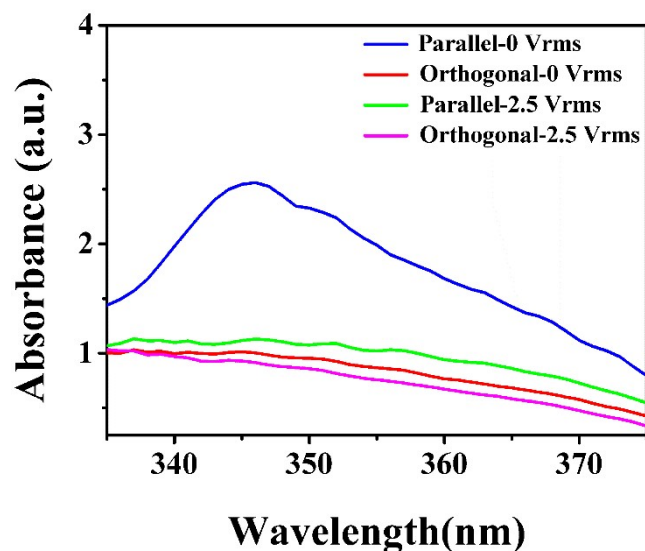


Fig. S2. Polarized absorption spectra of  $\text{Eu}(\text{tta})_3\text{phen}$  complexes in the  $\text{Eu}(\text{tta})_3\text{phen}/\text{E7}$  composites without or with voltage, measured using the polarized absorption of E7 as the baseline.

Fig. S3a intuitively shows that the two-lobe polarization gradually decreases with the increase of voltage value, reflecting the effect of different values of applied voltage on the polarized luminescence property of  $\text{Eu}(\text{tta})_3\text{phen}/\text{E7}$  composites. Fig. S3b shows the corresponding DOP values for the transitions of  $\text{Eu}^{3+}$  ions at  ${}^5\text{D}_0 \rightarrow {}^7\text{F}_2$  under different voltages.

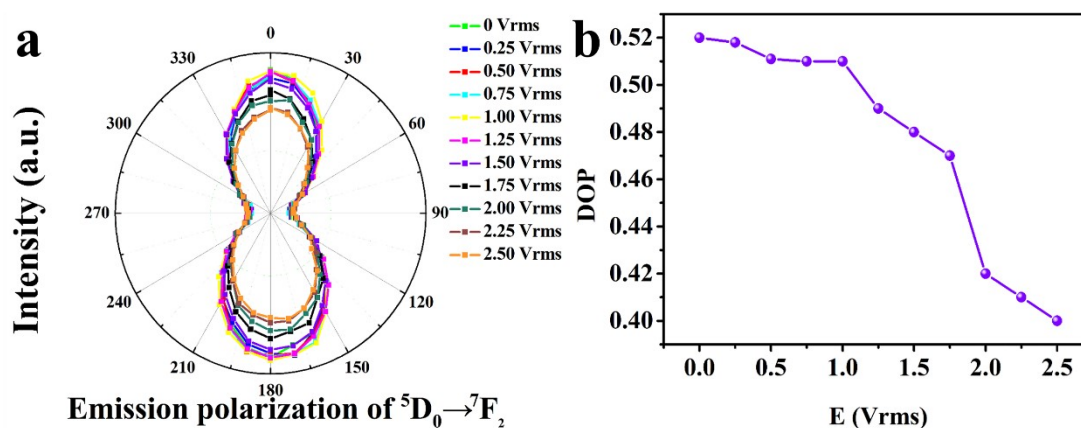


Fig. S3. Polarization diagram of  $\text{Eu}(\text{tta})_3\text{phen}/\text{E7}$  composites under different values of applied voltage (a).  $\lambda_{\text{ex}}=337$  nm. The value of DOP for the transitions of  $\text{Eu}^{3+}$  ions at  ${}^5\text{D}_0 \rightarrow {}^7\text{F}_2$  under different values of applied voltage (b).

As shown in Fig. S4, the voltage and polarization have little effect on the luminescence lifetime. This is because the luminescence lifetime is the time after which the population of an excited state has decayed to  $1/e$  or 36.8% of the initial population.<sup>[28]</sup>

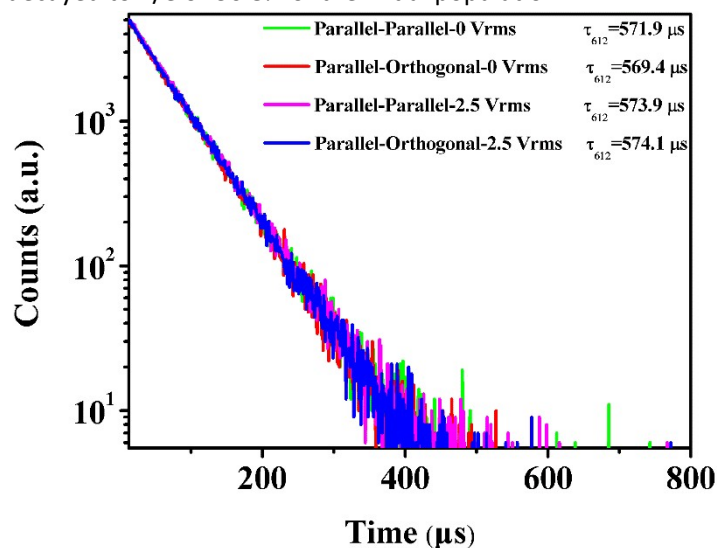


Fig. S4. Polarized decay curves for the luminescence of the  $\text{Eu}(\text{tta})_3\text{phen}/\text{E7}$  composites (monitored at 612 nm), obey the single-exponential function.

As shown in Fig. S5, when the emission wavelength of pure E7 is used as the monitoring wavelength, the optimal excitation wavelength obtained is 337 nm, which corresponds to the characteristic excitation wavelength of E7.<sup>[21]</sup> Therefore, the absorption of the energy of incident light (337 nm) by E7 in  $\text{Eu}(\text{tta})_3\text{phen}/\text{E7}$  composites has been confirmed.

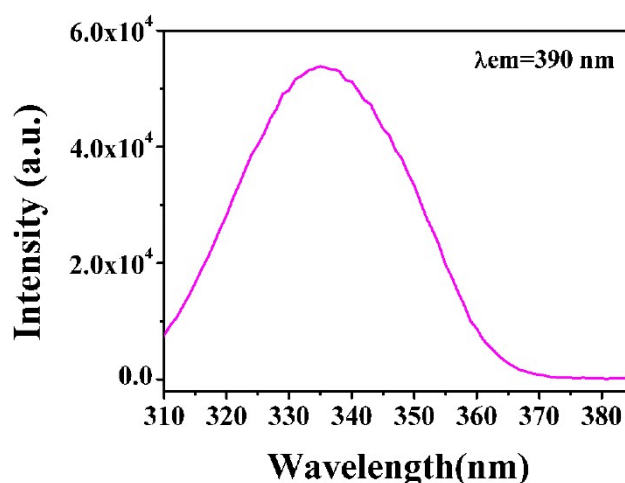


Fig. S5. Excitation spectra ( $\lambda_{\text{em}}=390$  nm) of the  $\text{Eu}(\text{tta})_3\text{phen}/\text{E7}$  composites.

As shown in Fig. S6a, the emission intensities of the parallel components and orthogonal components for the polarized luminescence of  $\text{Eu}(\text{tta})_3\text{phen}/\text{E7}$  composites can be regulated by voltage. As exhibited in Fig. S6b, based on the optical synergistic effect between  $\text{Eu}(\text{tta})_3\text{phen}$  complexes and E7, the CIE coordinates of the parallel component change from (0.4068, 0.1868) at point A to (0.4365, 0.2037) at point B with the voltage increases, and the emitting color becomes from reddish purple to purplish red. Meanwhile, the CIE coordinates of the orthogonal component change from (0.4607, 0.2142) at point C to (0.4425, 0.2036) at point D as the voltage increases. The ratio of the integral intensity for  $\text{Eu}(\text{tta})_3\text{phen}$  complexes to E7 under the conditions of no voltage and applied 2.5 Vrms voltage can be used to characterize the change in emitting color.

Cyclic measurements of these two components indicate that the regulation of the emitting color for both parallel components (Fig. S6c) and orthogonal components (Fig. S6d) by applying voltage are reversible. This demonstration confirms the potential applications of this electrically tunable polarized luminescence in fields such as anti-counterfeiting and displays.

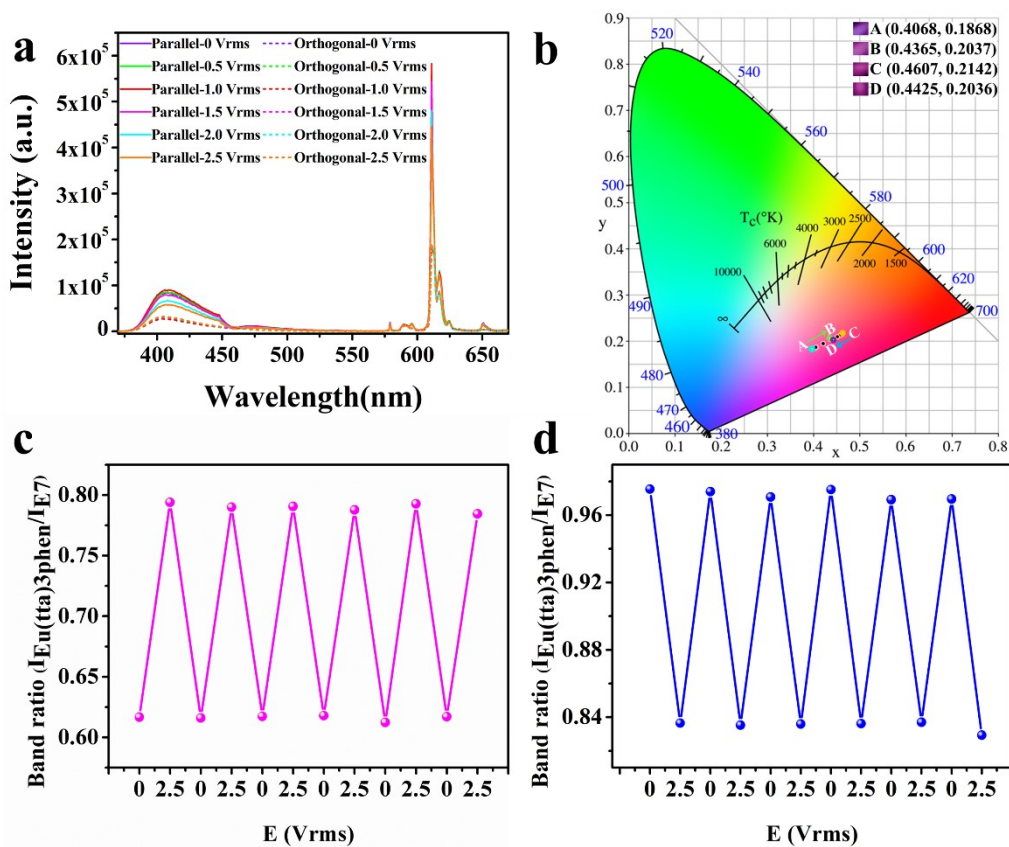


Fig. S6. Polarized emission spectra of parallel components (solid line) and orthogonal components (dashed line) for  $\text{Eu}(\text{tta})_3\text{phen}/\text{E7}$  composites under excitation of 337 nm with a different voltage (a), the CIE coordinates of (a) and the illustrations are the luminescent color of the sample (b), changes in the ratio of the integral intensity of  $\text{Eu}(\text{tta})_3\text{phen}$  to E7 of parallel components (c) and orthogonal components (d) under the condition of open circuit and applying a voltage of 2.5 Vrms.