

Supplementary Information

Luminescent Hybrids Based on Lanthanide Complexes Applied in Information Cryptography

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Table S1. Synthesized materials and synthesis conditions

Condition	Laponite [®] / g	C / mmol	Eu ³⁺ / mmol
1	0.26	2.4	-
2	0.26	2.4	0.3
3	0.52	2.4	-
4	0.52	2.4	0.3
L [®] -CD	0.52	4.85	-
L [®] -(CD)Eu(H ₂ O) _n	0.52	4.85	0.3
5	0.52	4.85	0.6

CD: chelidamic acid.

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The emission and excitation spectra of the synthesized hybrids were obtained and, when compared, it was concluded that $L^{\text{®}}\text{-(CD)Eu(H}_2\text{O)}_n$ and 5 conditions presents a more defined spectral profiles and greater intensity than the other conditions with other Eu^{3+} concentrations. It was noted that both show the same spectral profiles, with no gains in luminescent properties when adding more europium, which justifies the choice of condition $L^{\text{®}}\text{-(CD)Eu(H}_2\text{O)}_n$ as the best for developing the investigation (Figure S1).

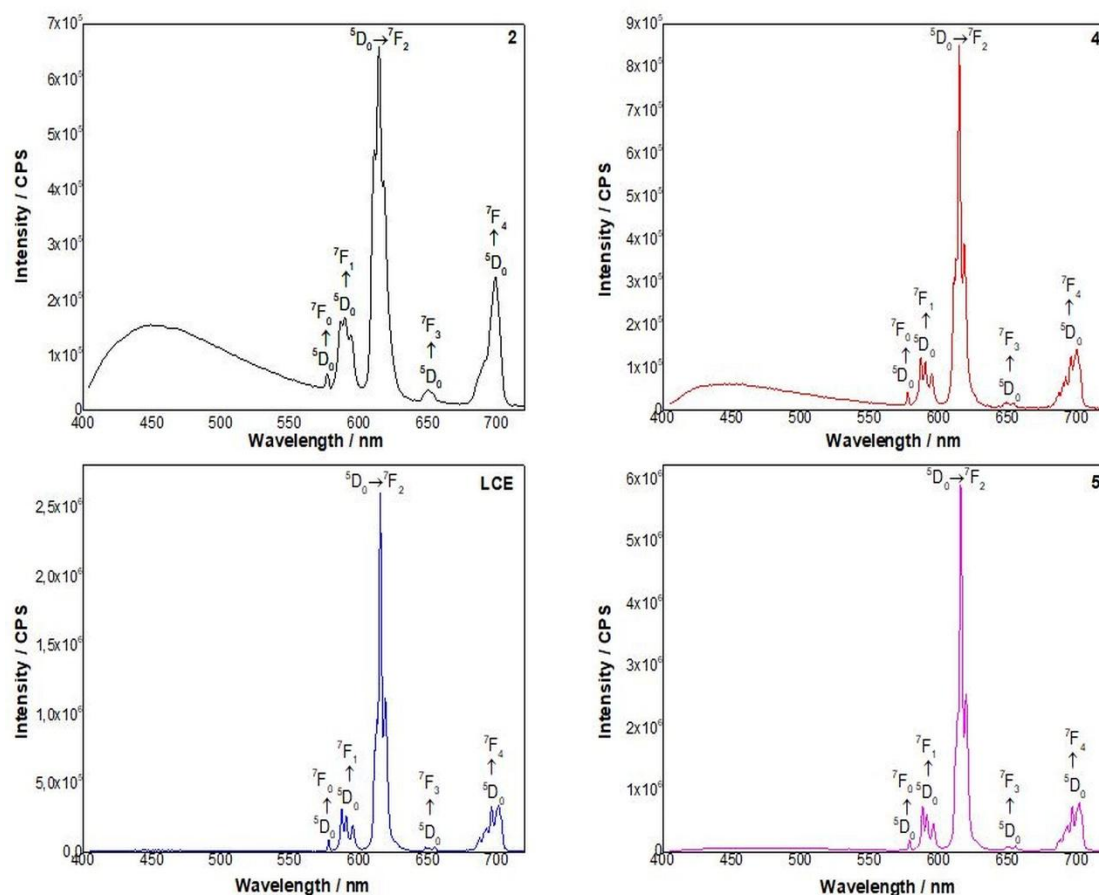


Figure S1. Emission spectra ($\lambda_{\text{ex}} = 395 \text{ nm}$) of the 2,4, $L^{\text{®}}\text{-(CD)Eu(H}_2\text{O)}_n$ and 5 hybrids.

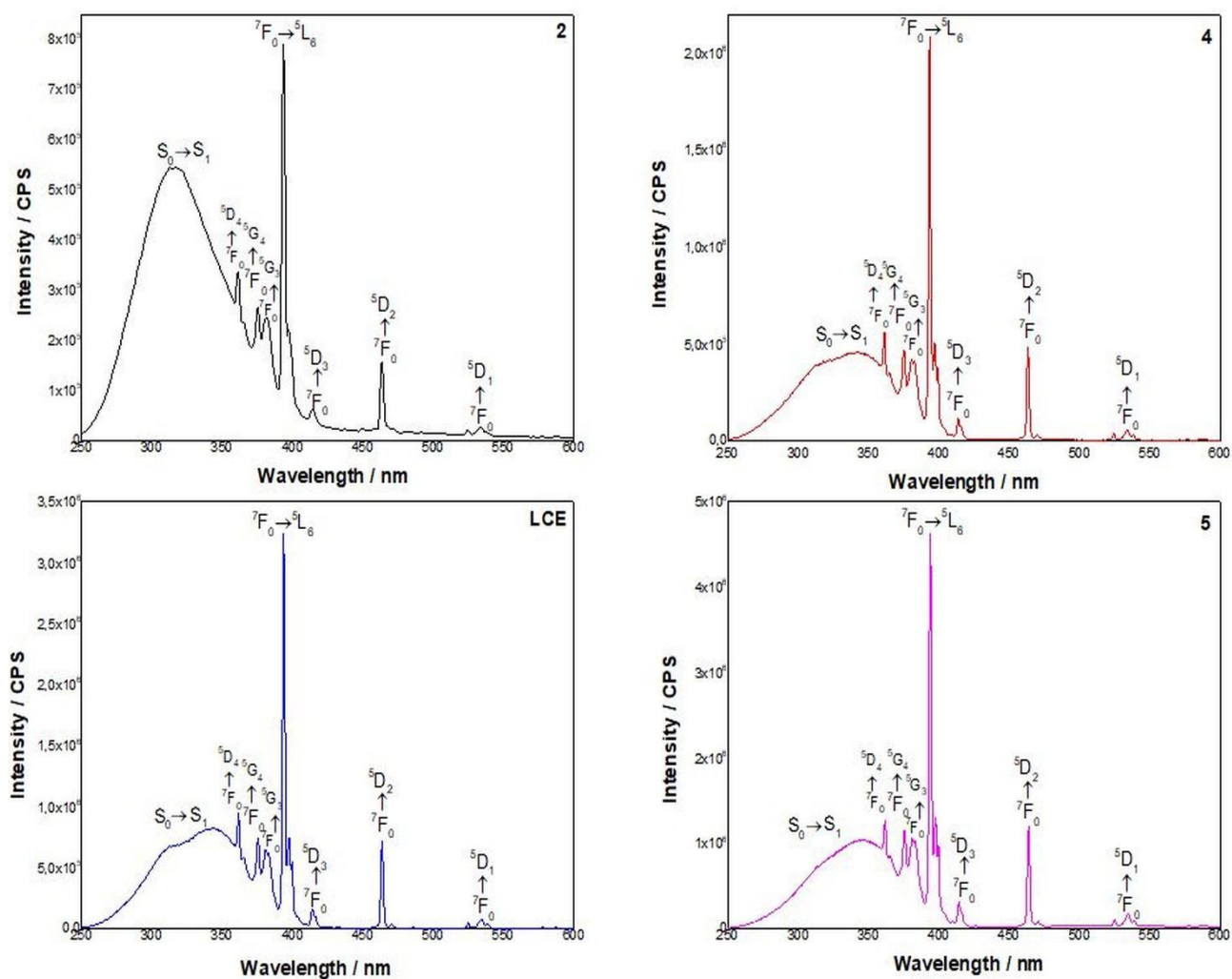


Figure S2. Excitation spectra ($\lambda_{Em} = 614$ nm) of the 2, 4, L° -(CD)Eu(H_2O) $_n$ and 5 hybrids.

Table S2. Synthesized materials and synthesis conditions

λ_{Ex} / nm	395
τ / ms	0.29
L° -(CD)Eu(H_2O) $_n$	

τ : luminescence lifetime; CD: chelidamic acid. L° : laponite[®].

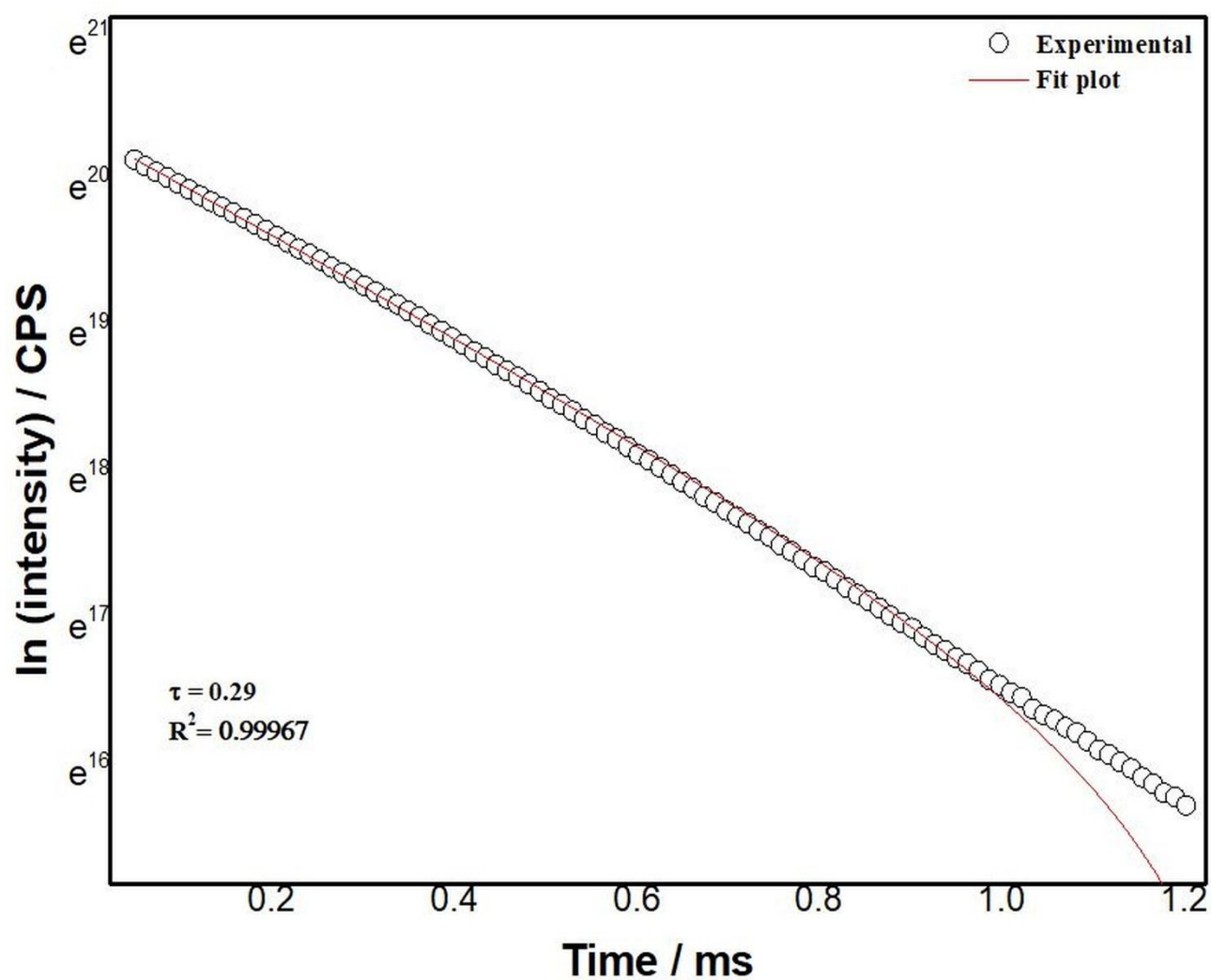


Figure S3. Luminescence decay curve of $L^{®}-(CD)Eu(H_2O)_n$ after excitation at 395 nm and monitoring at 614 nm of LCE.

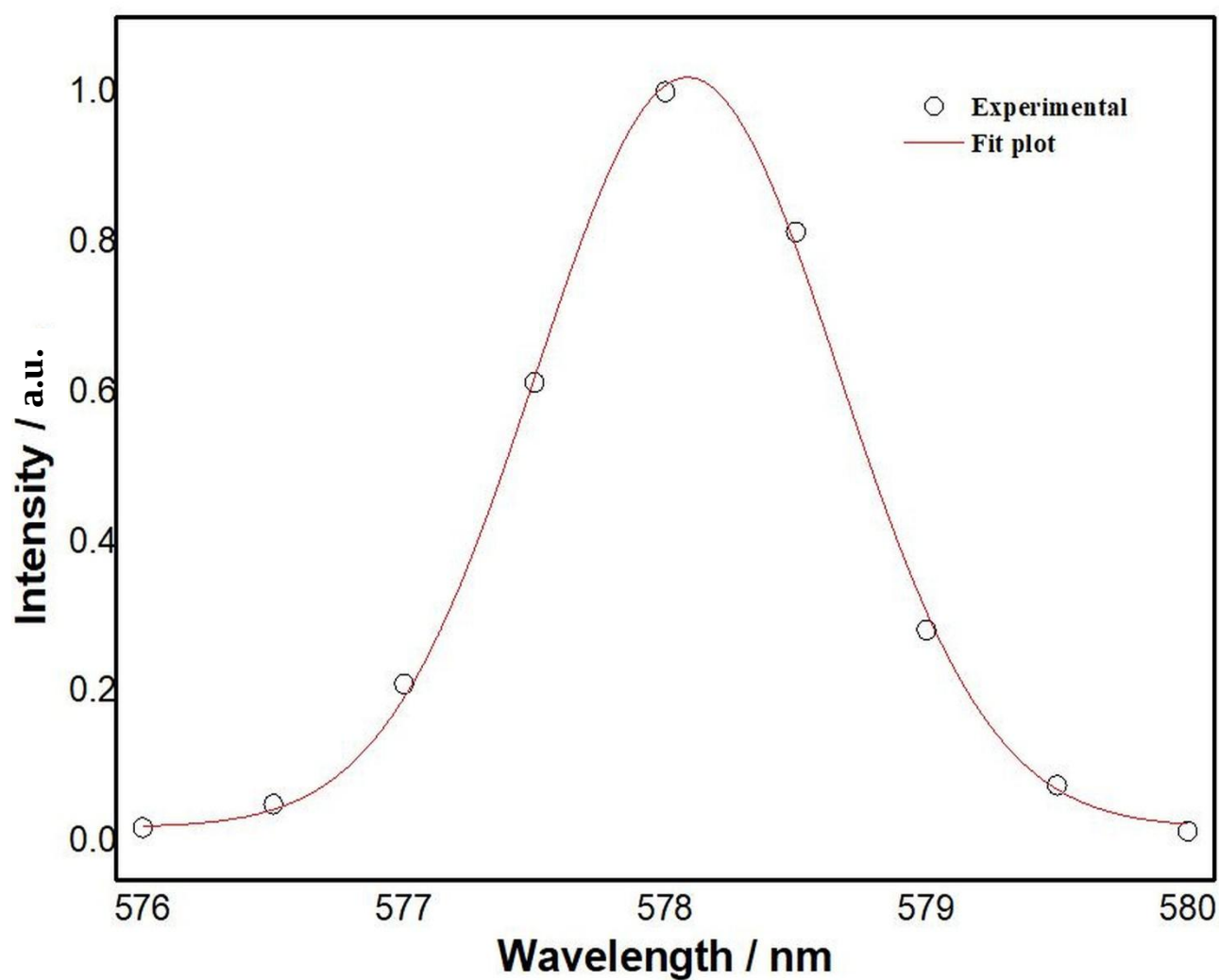


Figure S4. Emission spectra and Gaussian fit of the $^5D_0 \rightarrow ^7F_0$ of $L^{®}-(CD)Eu(H_2O)_n$.

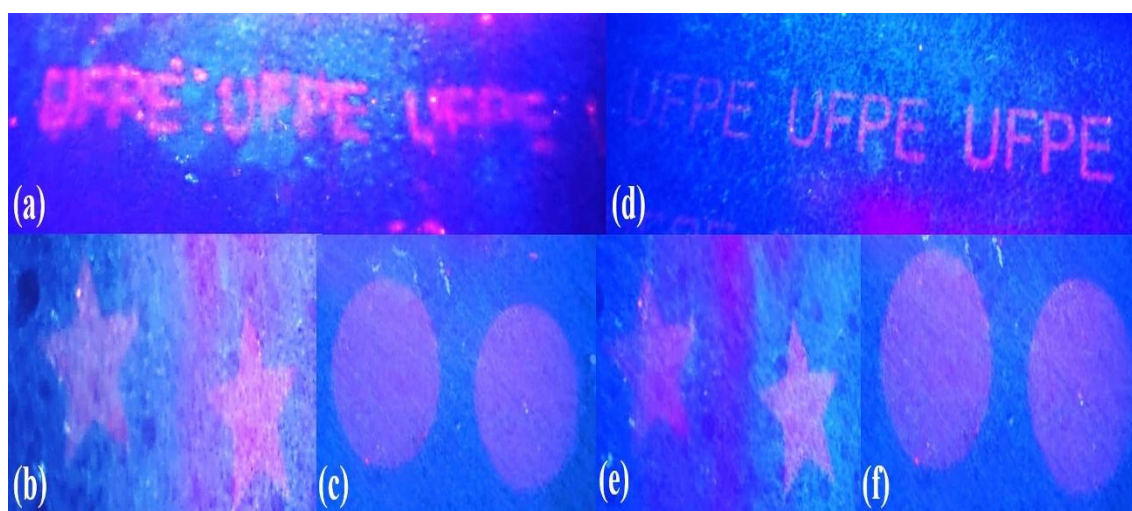


Figure S5. Printing on tracing paper under ultraviolet light (365 nm) after addition of BTFA (a) from the acronym “UFPE”, geometric shapes (b) of stars and (c) circles, printing on PET paper under ultraviolet light (365 nm) after addition of BTFA (d) from the acronym “UFPE”, geometric shapes (e) of stars and (f) circles.

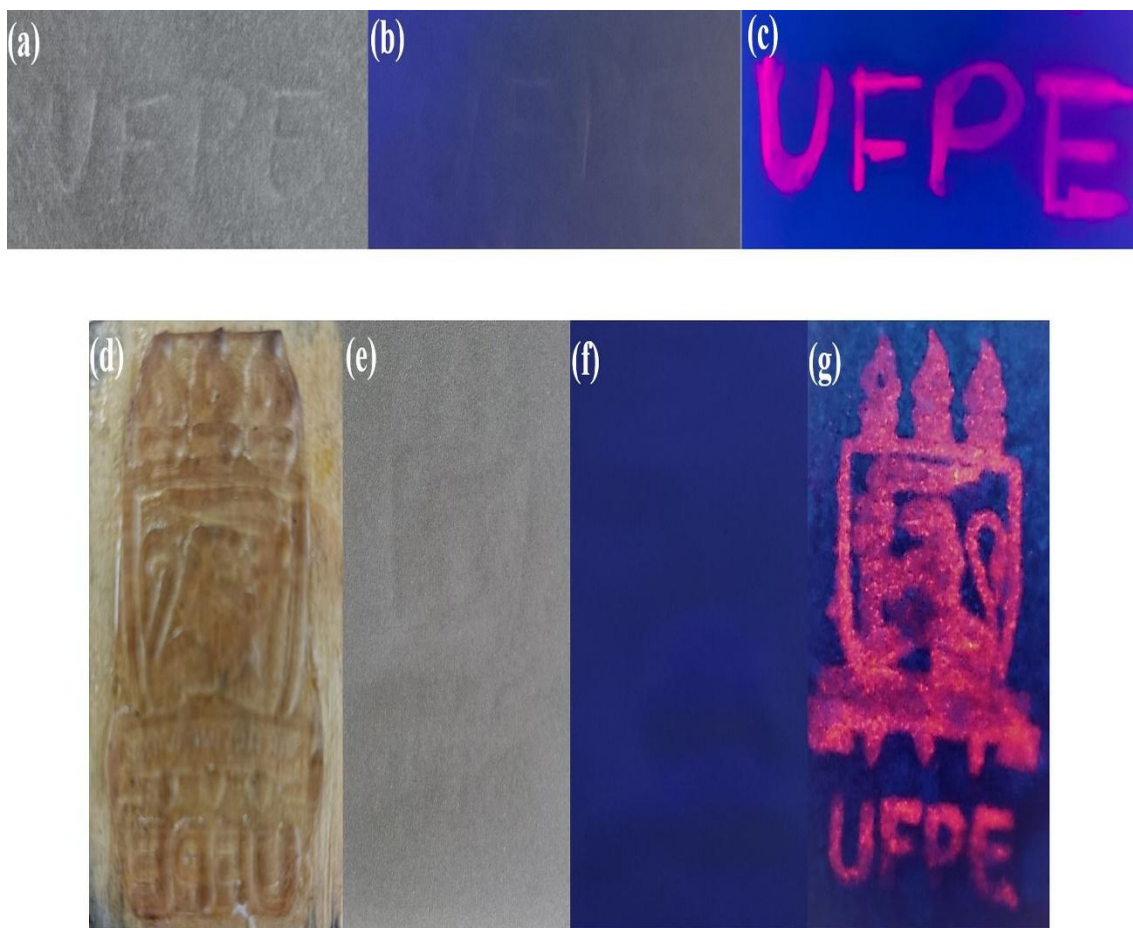


Figure S6. (a) Writing on tracing paper under natural light, (b) writing on tracing paper under ultraviolet light (365 nm), (c) writing on tracing paper under ultraviolet light (365 nm) after addition of BTFA, (d) stamp with the UFPE coat of arms, (e) stamp on tracing paper under natural light, (f) stamp on tracing paper under ultraviolet light (365 nm) and (g) stamp on tracing paper under ultraviolet light (365 nm) after addition of BTFA.

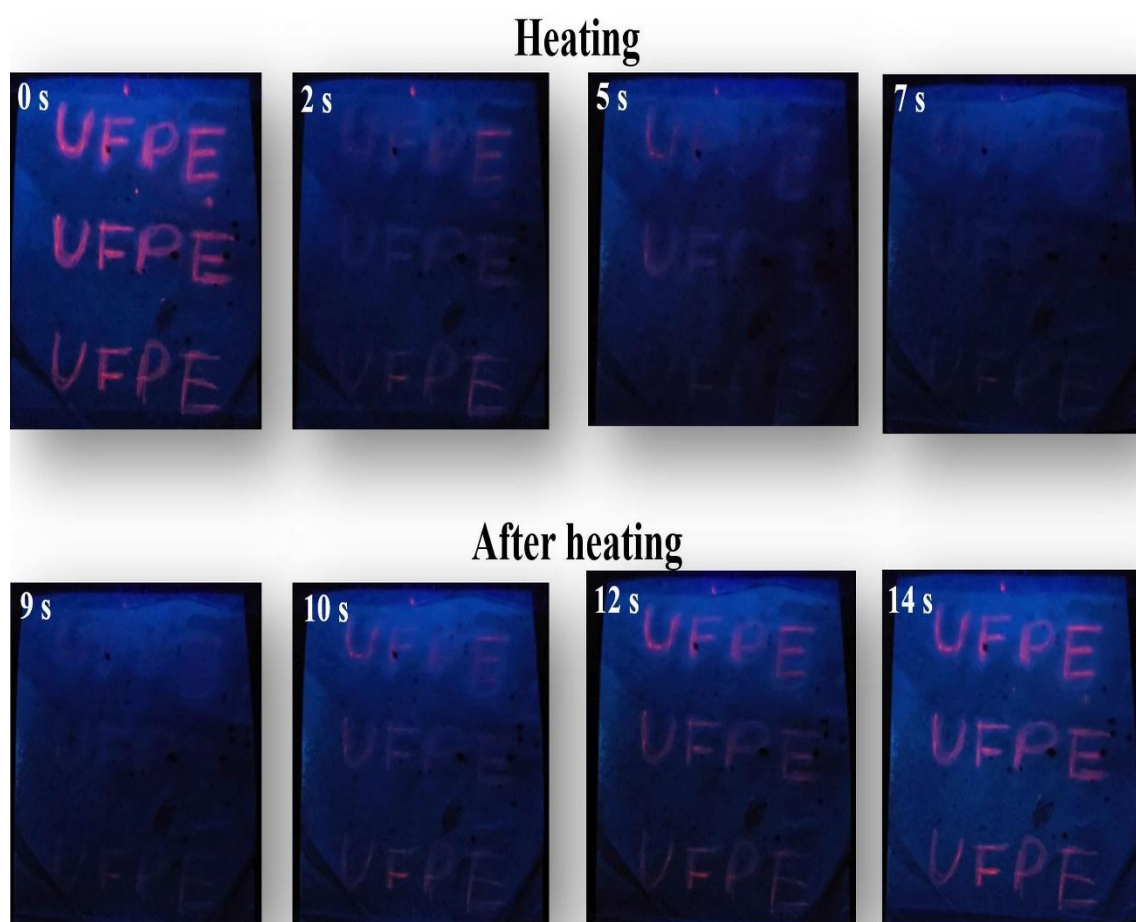
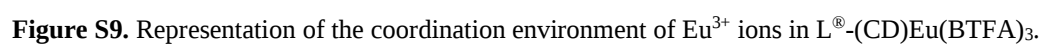
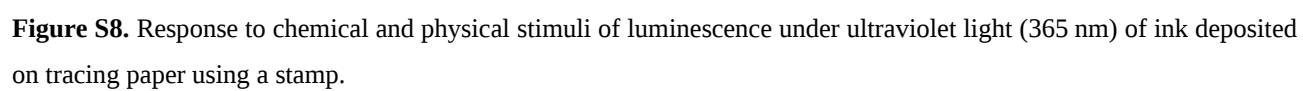


Figure S7. Response to chemical and physical stimuli of luminescence under ultraviolet light (365 nm) of ink deposited on tracing paper using a pen.

After heating



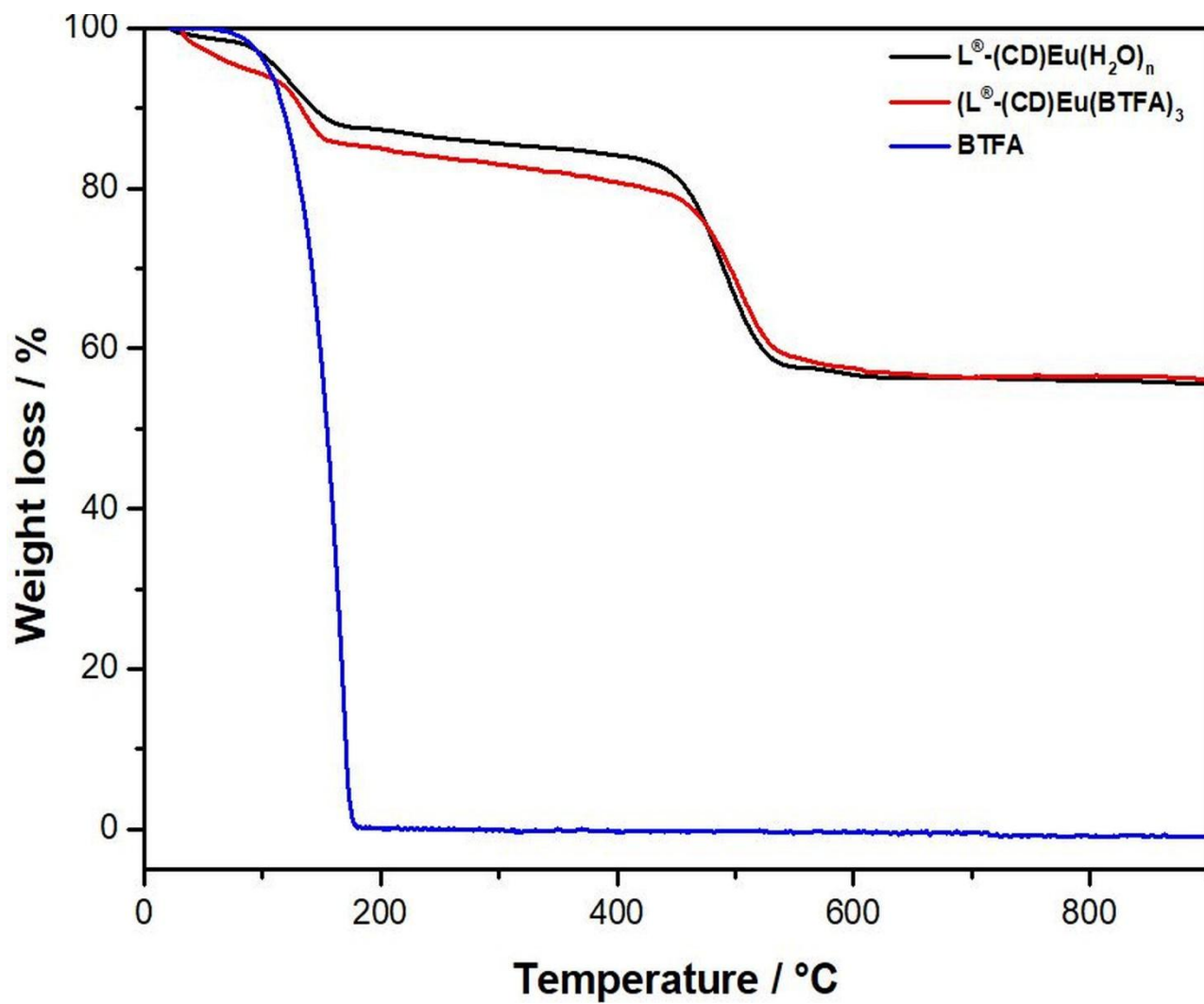


Figure S10. Thermogravimetric curves of BTFA, $L^{\circ}-(CD)Eu(H_2O)_n$ and $L^{\circ}-(CD)Eu(BTFA)_3$.

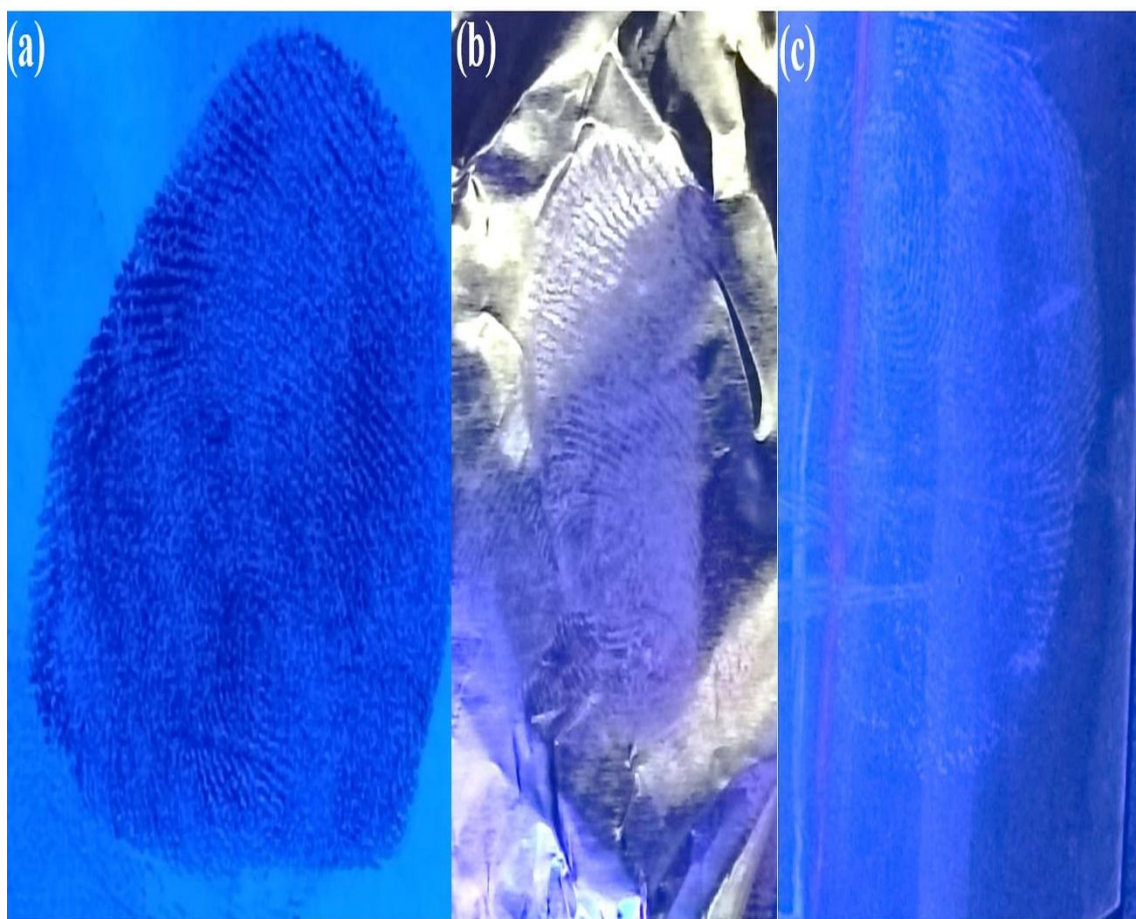


Figure S11. Fingerprints identified under ultraviolet light: (a) sheet of paper, (b) aluminum foil and (c) plastic bottle.

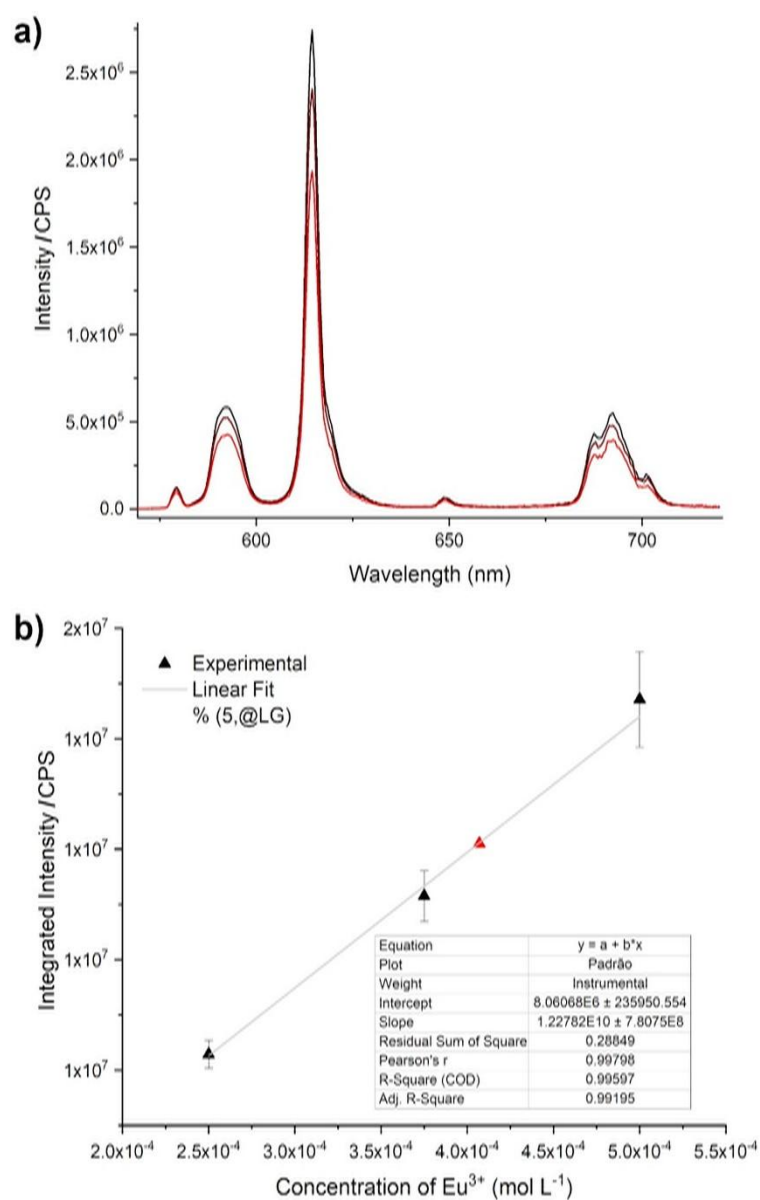


Figure S12. Emission spectra of the L[®]-(CD)Eu(BTFA)₃ changing concentration and calibration curve to quantify amount of Eu load in the L[®]-(CD)Eu(BTFA)₃ hybrid. Axis y is the integrated intensity of the emission related to the ⁵D₀ → ⁷F₂ transition.

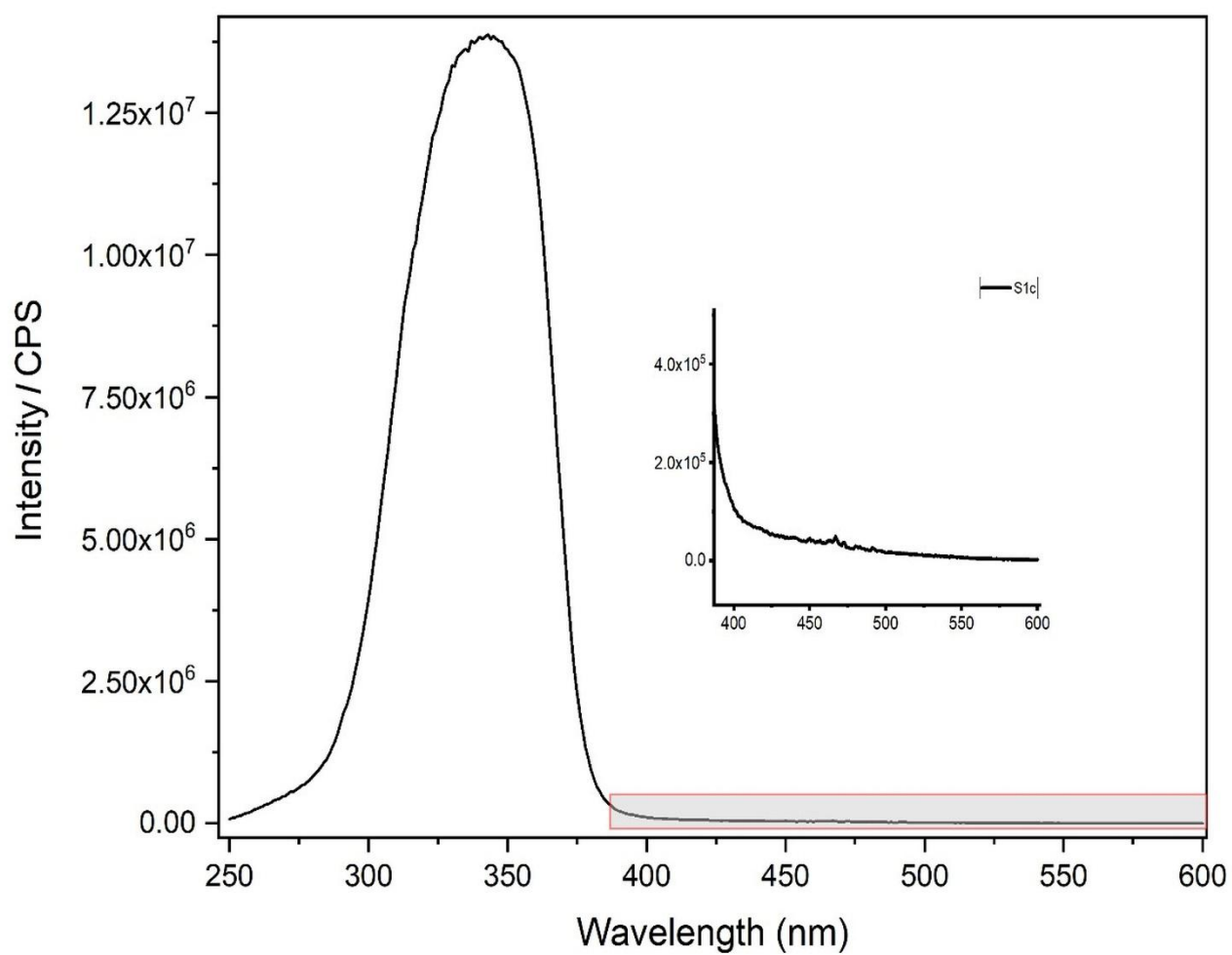


Figure S13. Excitation spectrum (λ_{Ex} 611 nm) of L[®]-(CD)Eu(BTFA)₃ hybrid.

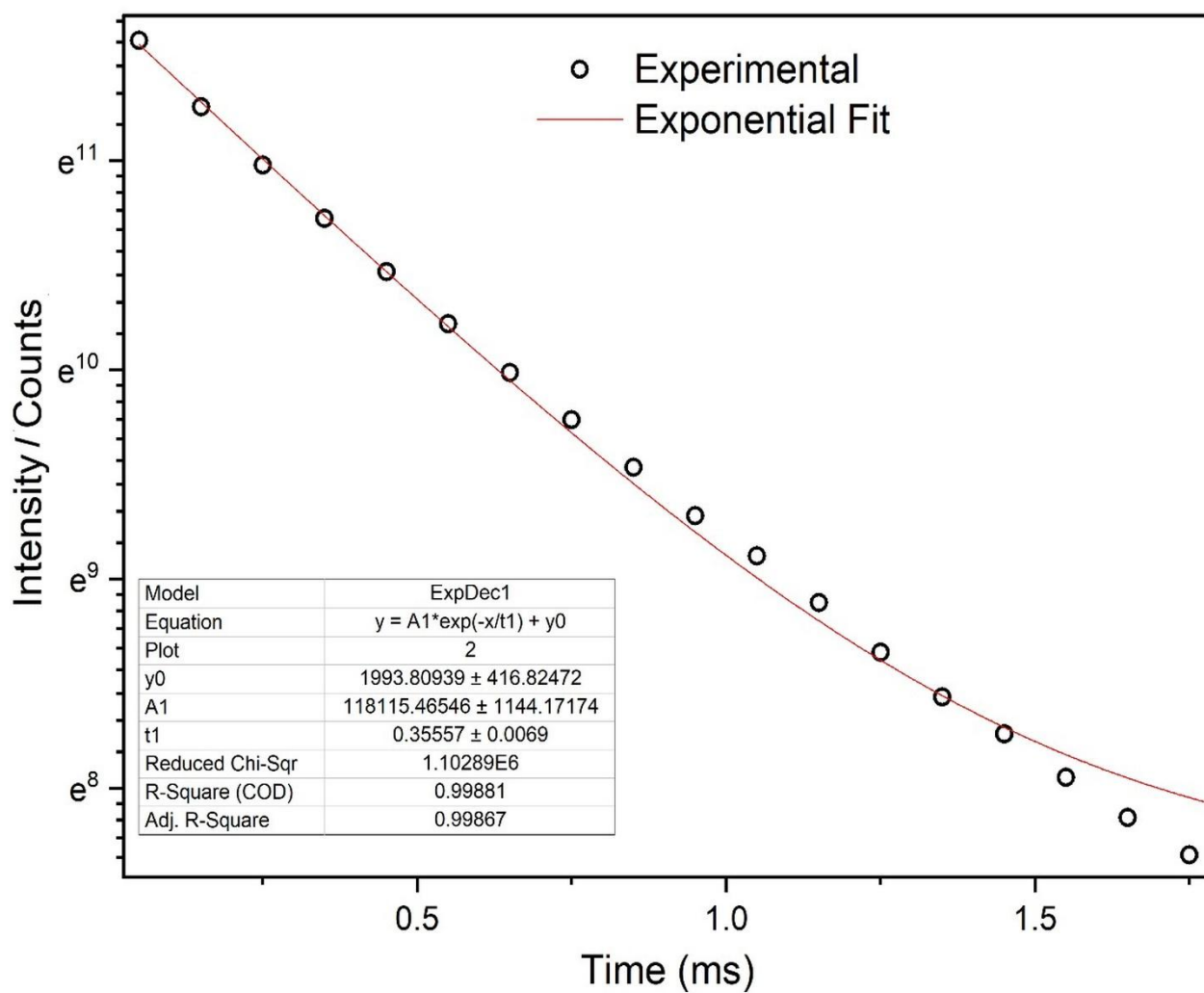


Figure S14. Luminescence decay curve of L[®]-(CD)Eu(BTFA)₃ printed label after excitation at 345 nm and monitoring emission at 611 nm.