

Supporting Information

Lanthanide-Based Langmuir–Blodgett Multilayers: Multi-Emissive, Temperature-Dependent Thin Films

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General Experimental Details

All reagents, solvents and starting materials were purchased from Sigma–Aldrich. Ligand 1 and corresponding lanthanide complexes (Eu(1)₃, Tb(1)₃ and Dy(1)₃) have been previously confirmed and characterised in our previous paper. Langmuir–Blodgett measurements and film formation were measured on a Kibron G2 Microtrough and DyneProbe [8]. Photophysical measurements of LB films were carried out on a Shimadzu UV-1800 for UV/Vis measurements, Shimadzu RF-6000 Spectrofluorophotometer for steady-state fluorescence measurements and an Agilent Technologies Cary Eclipse spectrophotometer for phosphorescence time-resolved measurements. Unless otherwise state excitation wavelength 279 nm, with excitation and emission slit widths of 3,3 nm for fluorescence measurements and 5, 10 nm for phosphorescence measurements. Lifetime measurements were taken monitoring either 616 nm for Eu³⁺ and 545 nm for Tb³⁺ with an excitation wavelength of 279 nm and emission slit widths of 5,5 nm. Lifetime measurements were run in triplicate and averaged results have been reported.

Langmuir Blodgett Deposition

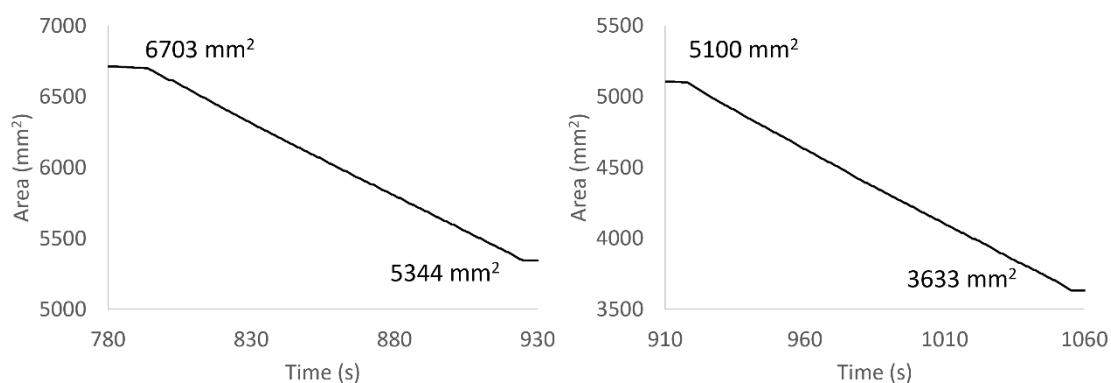


Figure S1. Zoomed in deposition plots of mixed multilayer $\text{Eu}(\mathbf{1})_3:\text{Tb}(\mathbf{1})_3$ (1:1) film. Initial $\text{Eu}(\mathbf{1})_3$ (Left) and final $\text{Tb}(\mathbf{1})_3$ layer (Right).

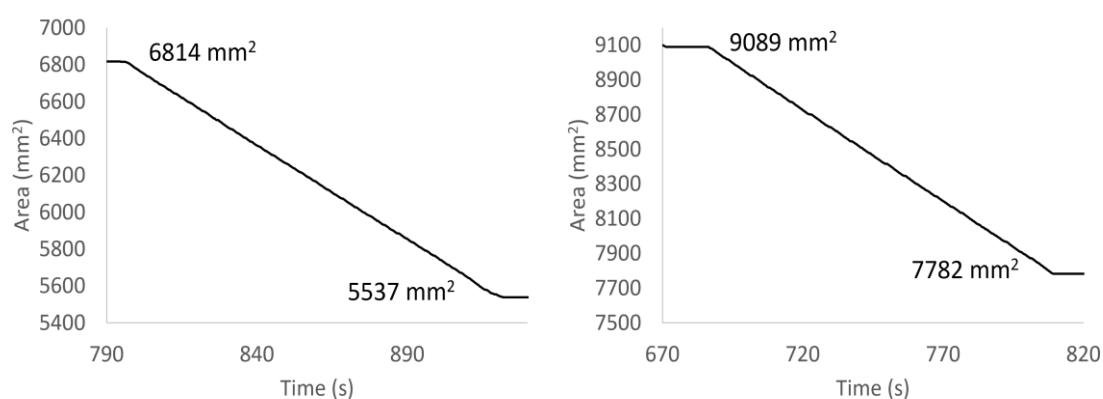


Figure S2. Zoomed in deposition plots of mixed multilayer $\text{Eu}(\mathbf{1})_3:\text{Dy}(\mathbf{1})_3$ (1:1) film. Initial $\text{Eu}(\mathbf{1})_3$ (Left) and final $\text{Dy}(\mathbf{1})_3$ layer (Right).

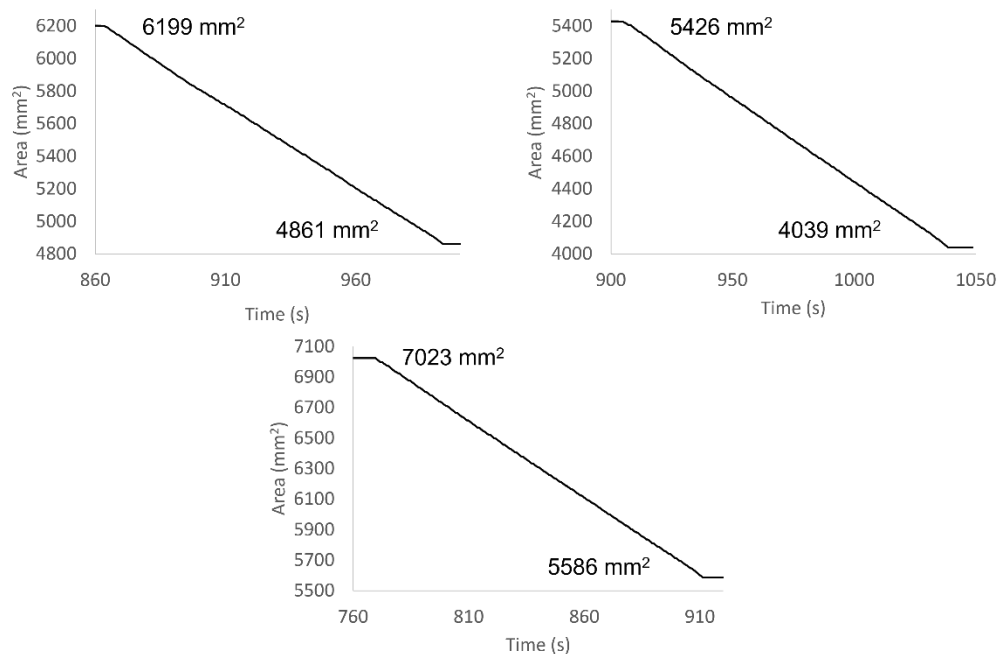


Figure S3. Zoomed in deposition plots of mixed multilayer $\text{Eu}(\mathbf{1})_3:\text{Tb}(\mathbf{1})_3:\text{Dy}(\mathbf{1})_3$ (1:1:1) film. Initial $\text{Eu}(\mathbf{1})_3$ layer (Top Left), middle layer $\text{Tb}(\mathbf{1})_3$ (Top Right) and top layer $\text{Dy}(\mathbf{1})_3$ (Bottom).

Lanthanide LB Film Characterisation

Eu(1)₃:Tb(1)₃ Multilayered Film Data

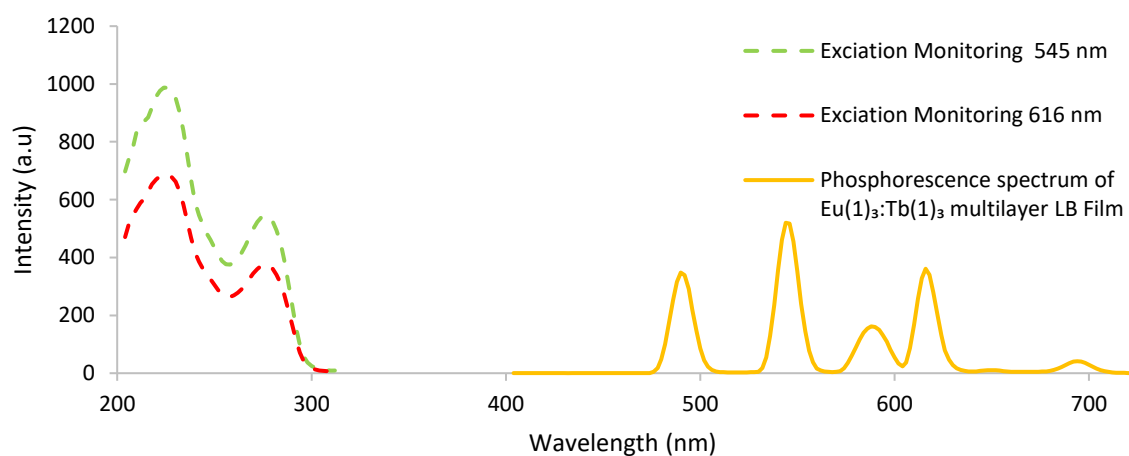


Figure S4. Eu(1)₃:Tb(1)₃ LB film phosphorescence emission and excitation spectra, with phosphorescence emission from both Ln³⁺ with distinct emission transitions and excitation resembling PDC absorbance.

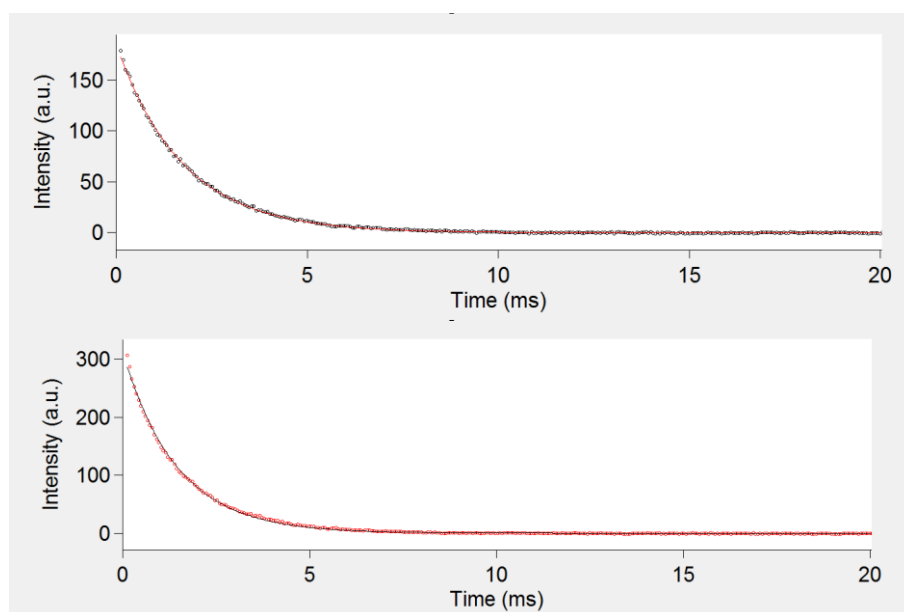


Figure S5. Lifetime of multilayered LB films of Eu(1)₃:Tb(1)₃ best fit to a single exponential and monitoring (Top) 616 nm and (Bottom) 545 nm band.

Table S1. Single exponential lifetimes of Eu(1)₃ and Tb(1)₃ complexes on multilayered LB films of Eu(1)₃:Tb(1)₃.

Films	Single Exponential Lifetimes (ms)	Average (ms)
Eu(1) ₃ :Tb(1) ₃ multilayered film Eu ³⁺ 616 nm life times	1.732	1.763
	1.843	
	1.715	
Eu(1) ₃ :Tb(1) ₃ multilayered film Tb ³⁺ 545 nm life times	1.447	1.443
	1.449	
	1.432	

Eu(1)₃:Dy(1)₃ Multilayered Film Data

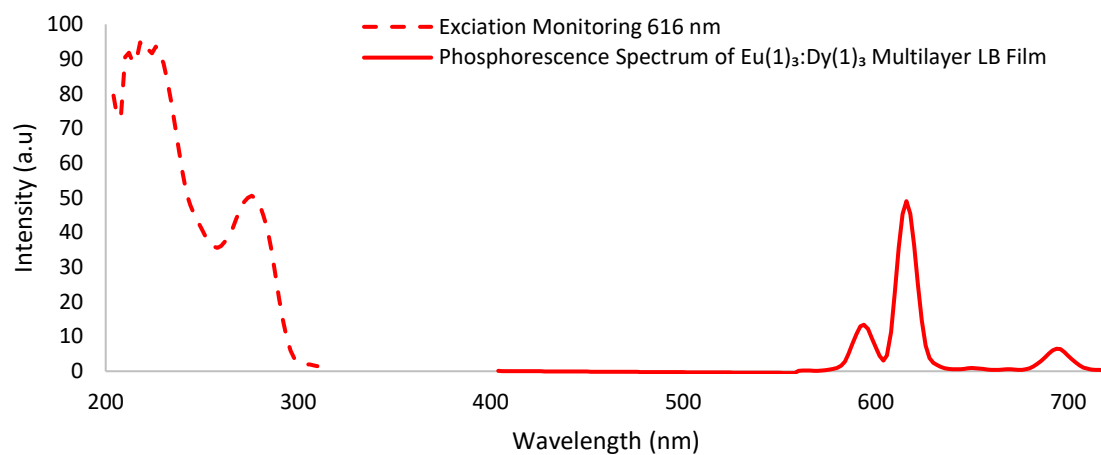


Figure S6. Eu(1)₃:Dy(1)₃ LB film phosphorescence emission and excitation spectra. Phosphorescence emission was only visible for Eu³⁺ and excitation resembling PDC absorbance.

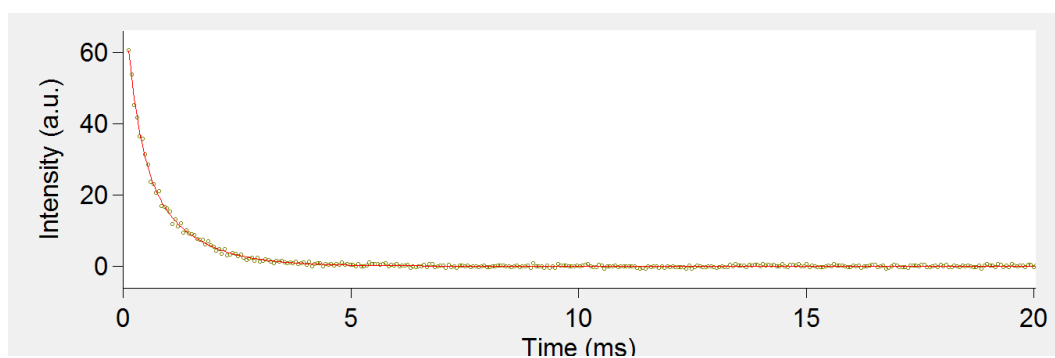


Figure S7. Lifetime of multilayered LB films of Eu(1)₃:Dy(1)₃ best fit to a single exponential and monitoring 616 nm band. Lifetimes measured were 0.867 ms, 0.685 ms and 0.857 ms, with an average of 0.803 ms.

Eu(1)₃:Tb(1)₃:Dy(1)₃ Multilayered Film Data

SS

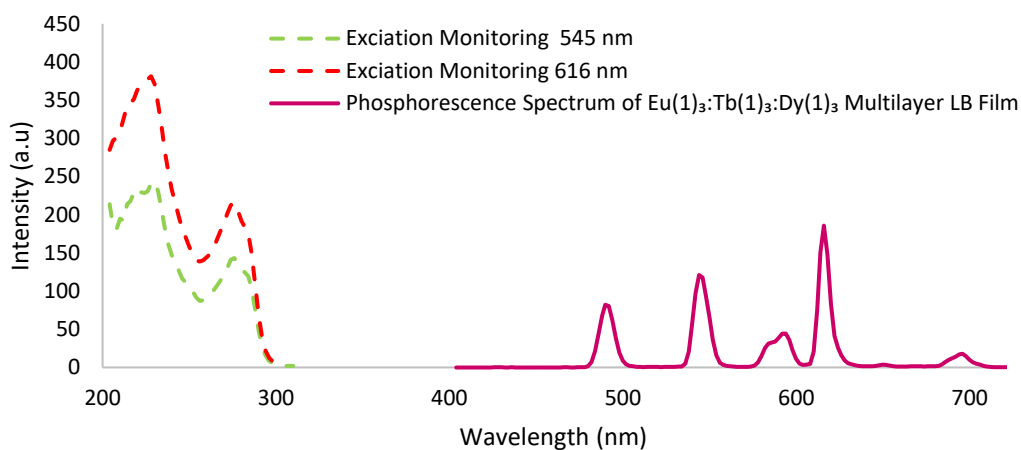


Figure S8. Eu(1)₃:Tb(1)₃:Dy(1)₃ LB film phosphorescence emission and excitation spectra. Phosphorescence emission was only visible for Eu³⁺ and Tb³⁺. Excitation and emission slit widths of 5,5 nm.

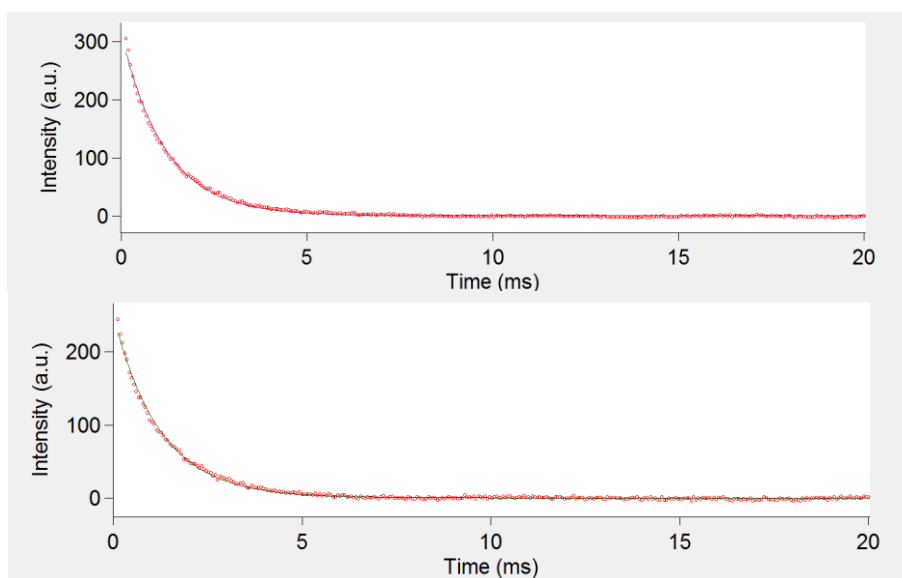


Figure S9. Lifetime of multilayered LB films of Eu(1)₃:Tb(1)₃:Dy(1)₃ best fit to a single exponential and monitoring (Top) 616 nm and (Bottom) 545 nm band.

Table S2. Single exponential lifetimes of Eu(1)₃ and Tb(1)₃ complexes on multilayered LB films of Eu(1)₃:Tb(1)₃:Dy(1)₃.

Films	Single Exponential Lifetimes (ms)	Average (ms)
Eu(1) ₃ :Tb(1) ₃ :Dy(1) ₃ multilayered film Eu ³⁺ 616 nm life times	1.186	1.187
	1.178	
	1.197	
Eu(1) ₃ :Tb(1) ₃ :Dy(1) ₃ multilayered film Tb ³⁺ 545 nm life times	1.248	1.247
	1.277	
	1.216	