

Supplementary information

Eu²⁺ ions as an antioxidant additive for Sn-based perovskite light-emitting diodes

Xi Wang,^{a, b, #} Lihua Liu,^{c, #} Zhao Qian,^{d, #} Congcong Gao,^a Hongyan Liang^{a, b, *}

^a School of Materials Science and Engineering, Tianjin University, Tianjin 300350, P. R. China

^b Key Laboratory of Efficient Utilization of Low and Medium Grade Energy, Ministry of Education, Tianjin University, Tianjin 300350, P. R. China

^c College of Innovation and Entrepreneurship, Shanghai Jianqiao University, Shanghai 201306, P. R. China

^d Key Laboratory of Liquid-Solid Structural Evolution and Processing of Materials (Ministry of Education), Shandong University, Jinan 250061, P. R. China

Corresponding Author

* E-mail: hongyan.liang@tju.edu.cn

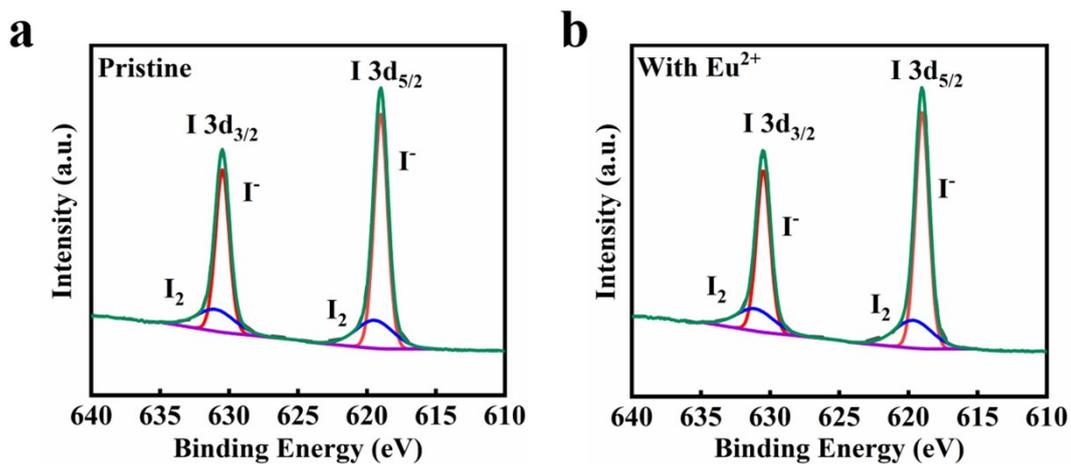


Figure S1. High-resolution XPS I 3d spectra of perovskite films (a) without and (b) with Eu²⁺ ions.

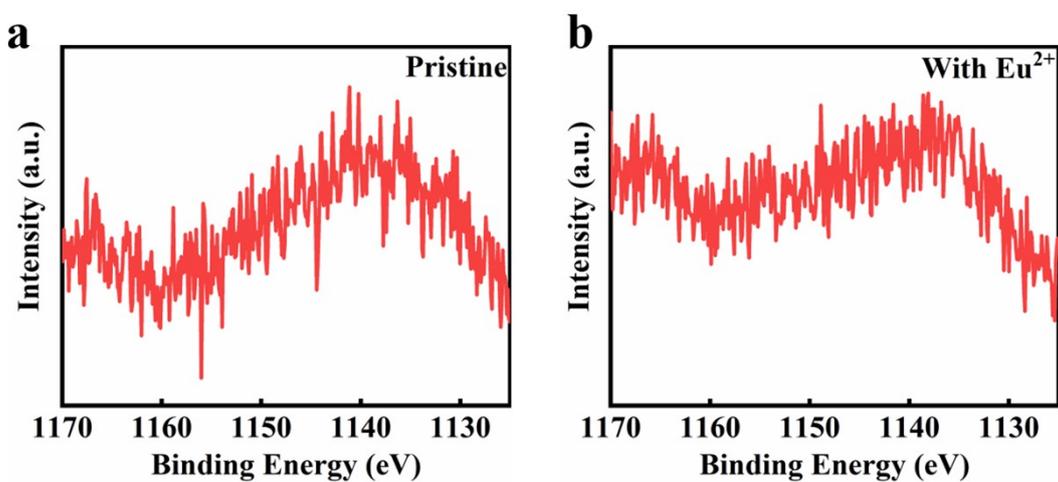


Figure S2. High-resolution XPS Eu 3d spectra of perovskite films (a) without and (b) with Eu²⁺ ions.

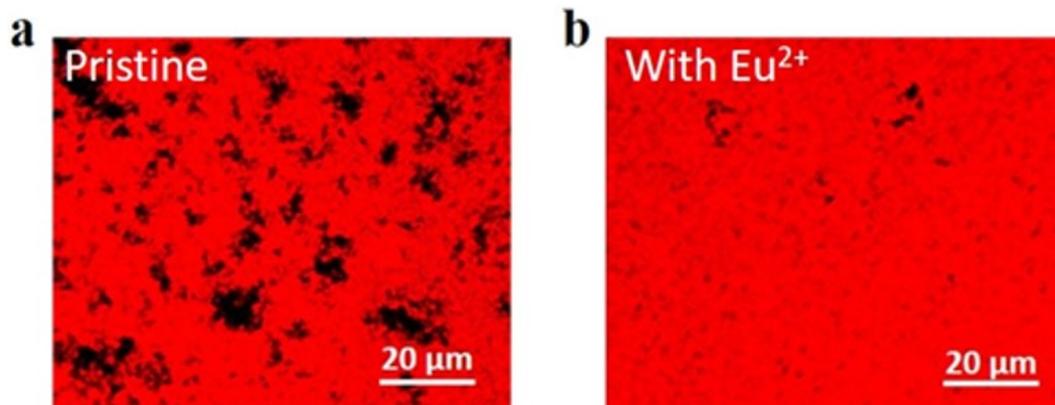


Figure S3. Photoluminescent images of perovskite film (a) without and (b) with Eu^{2+} ions under confocal microscope.

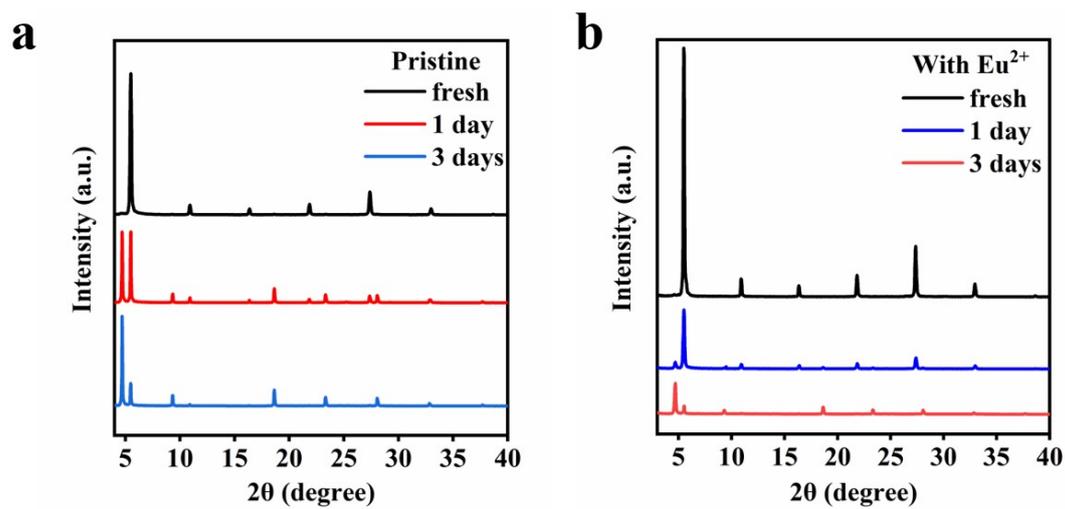


Figure S4. XRD patterns of perovskite films (a) without and (b) with Eu^{2+} ions at different air-exposure times.

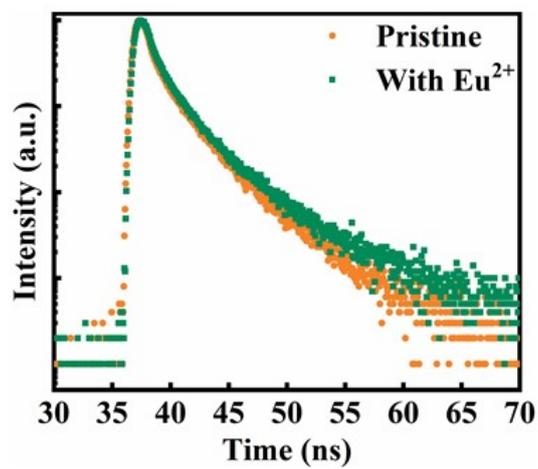


Figure S5. TRPL spectra of perovskite films without (orange) and with (green) Eu²⁺ ions.

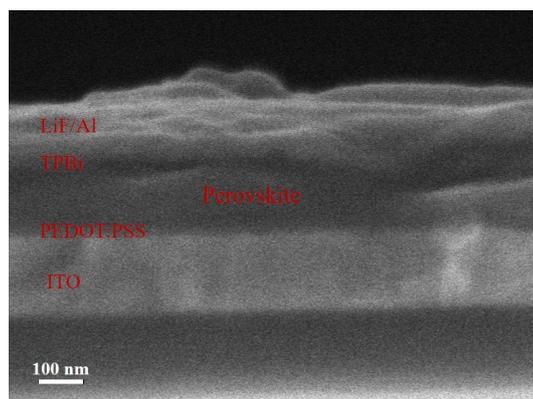


Figure S6. Cross-sectional SEM image of the tin-based LEDs.

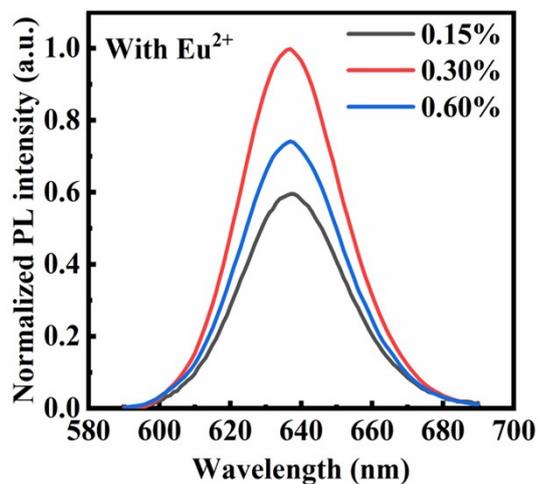


Figure S7. Steady-state PL spectra of perovskite film with different concentration of Eu^{2+} ions.

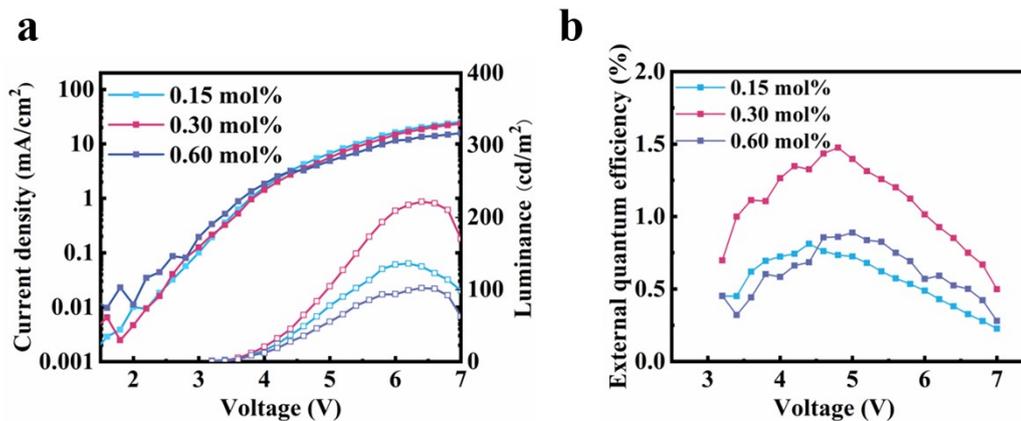


Figure S8. I-V and L-V curves (a) and EQE characteristics (b) of LEDs with different concentration of Eu^{2+} ions.

Table S1. TA decay parameters of perovskite films without and with Eu²⁺ ions.

Sample	τ_1 (ps)	A ₁ %	τ_2 (ps)	A ₂ %	τ_{ave} (ps)
Pristine	61.4245	50.06	420.6911	30.573	351.37
With Eu ²⁺	68.2022	44.106	575.3293	32.88	505.75

Table S2. TRPL decay parameters of perovskite films without and with Eu²⁺.

Sample	τ_1 (ns)	A ₁ %	τ_2 (ns)	A ₂ %	τ_3 (ns)	A ₃ %	τ_{ave} (ns)	χ^2
Pristine	1.50368	37.88	0.12864	41.24	4.00589	20.88	2.89	1.00595
With Eu ²⁺	1.67516	47.41	5.29	16.55	0.1565	36.04	3.48	1.04461