

Supplementary Material

Improving performance of sky-blue perovskite light-emitting diodes by triple additives

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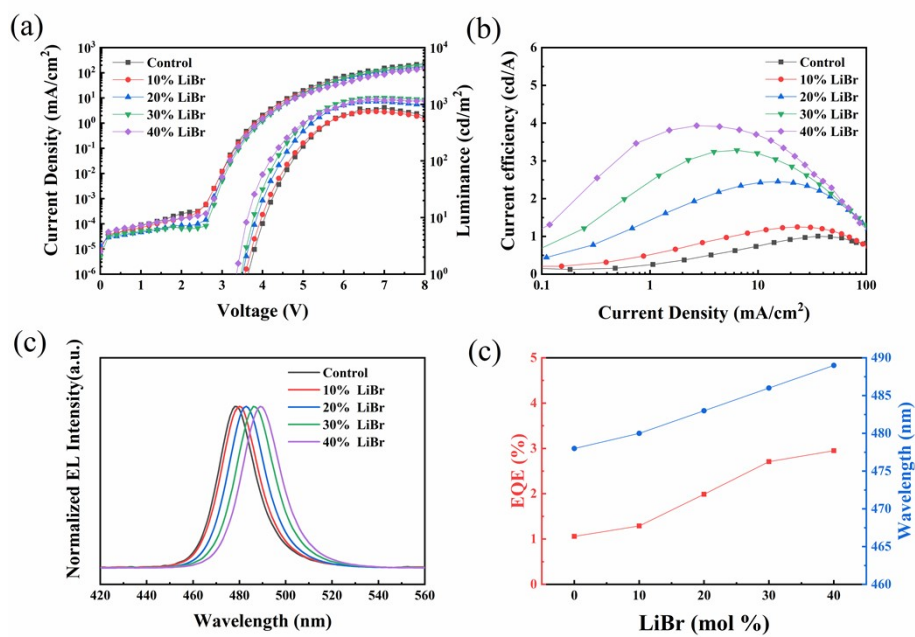


Figure S1. Device performance of PeLEDs with different concentrations of LiBr. (a) *J-V-L* characteristics, (b) CE-*J* characteristics, (c) EL spectra of PeLEDs at an operating voltage of 4 V, and (d) maximum EQE and EL peak wavelength.

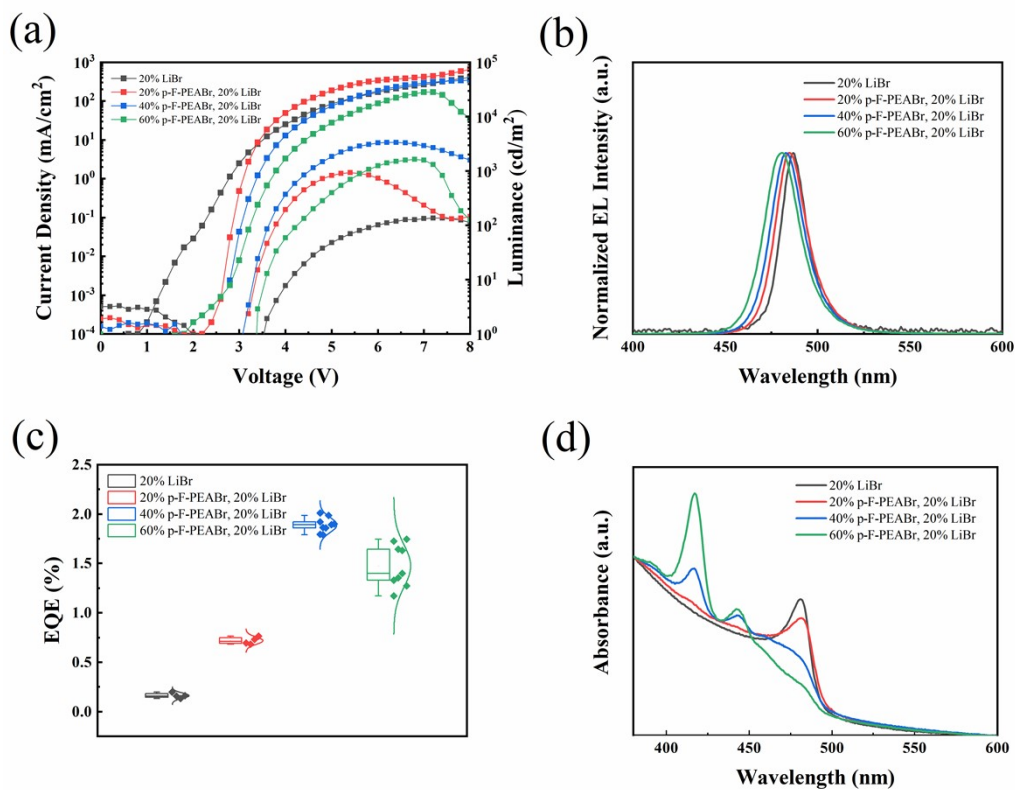


Figure S2. Device performance of PeLEDs with different concentrations of p-F-PEABr. (a) *J-V-L* characteristics, (b) EL spectra of PeLEDs at an operating voltage of 4 V, and (c) maximum EQE, and (d) UV-vis spectra of perovskite films.

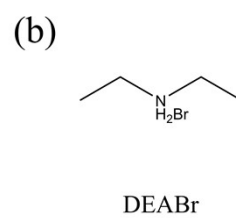
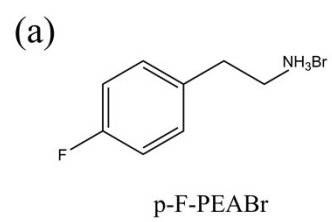


Figure S3. Molecular structures of p-F-PEABr and DEABr.

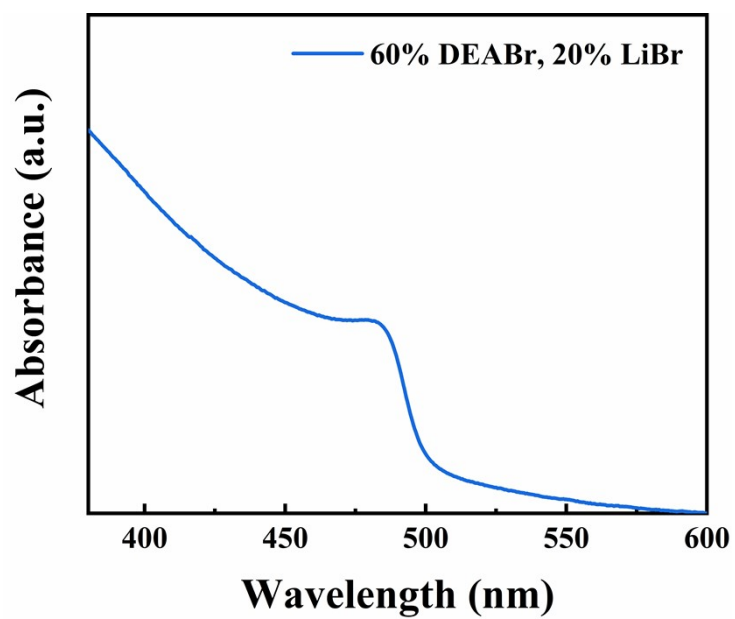


Figure S4. UV-vis spectra of 60% DEABr doped perovskite film.

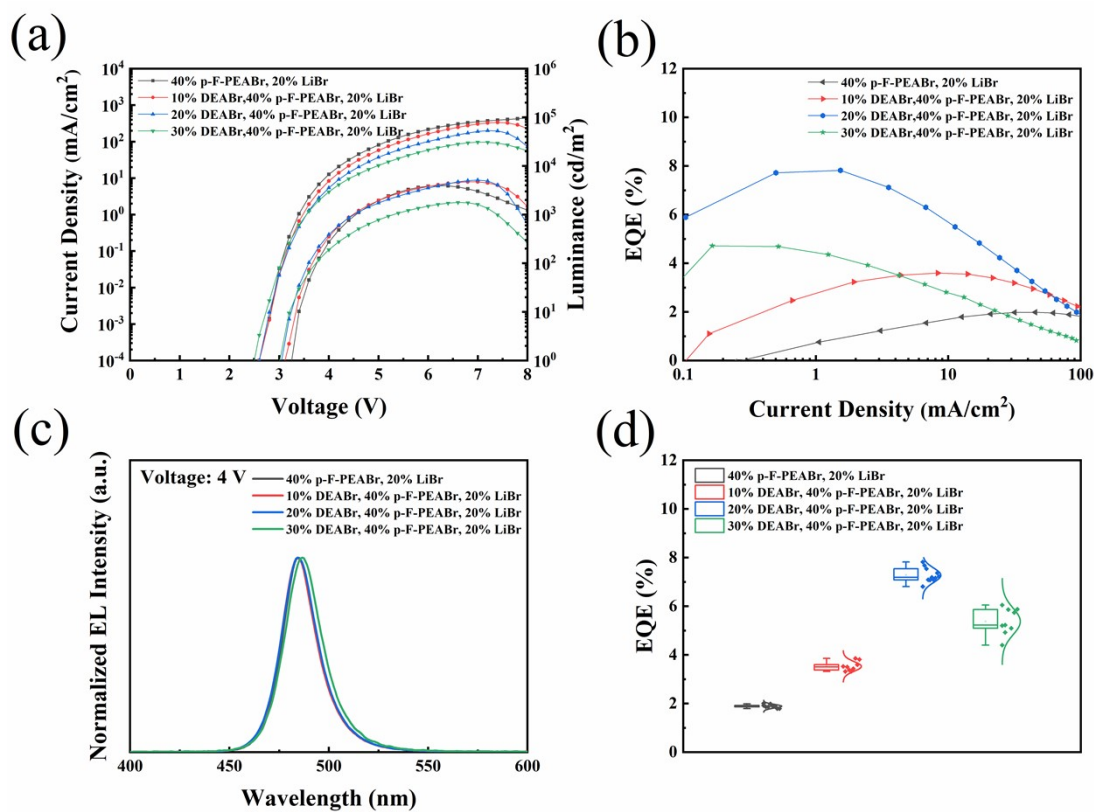


Figure S5. Device performance of PeLEDs with different concentrations of DEABr. (a) *J-V-L* characteristics, (b) EQE-*J* characteristics, (c) EL spectra of PeLEDs at an operating voltage of 4 V, and (d) maximum EQE.

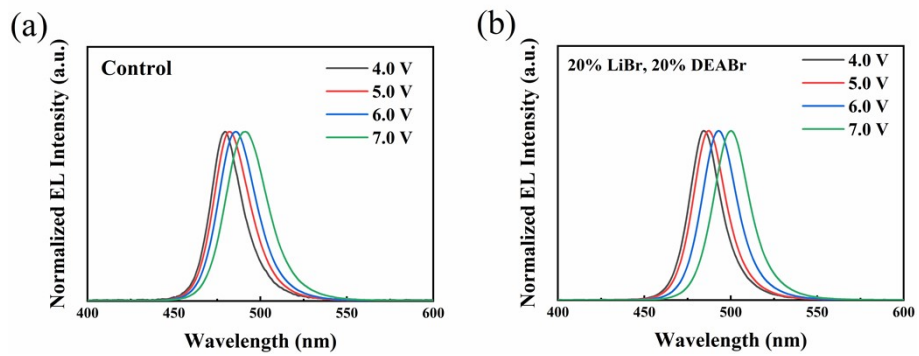


Figure S6. EL spectra under different bias voltages.

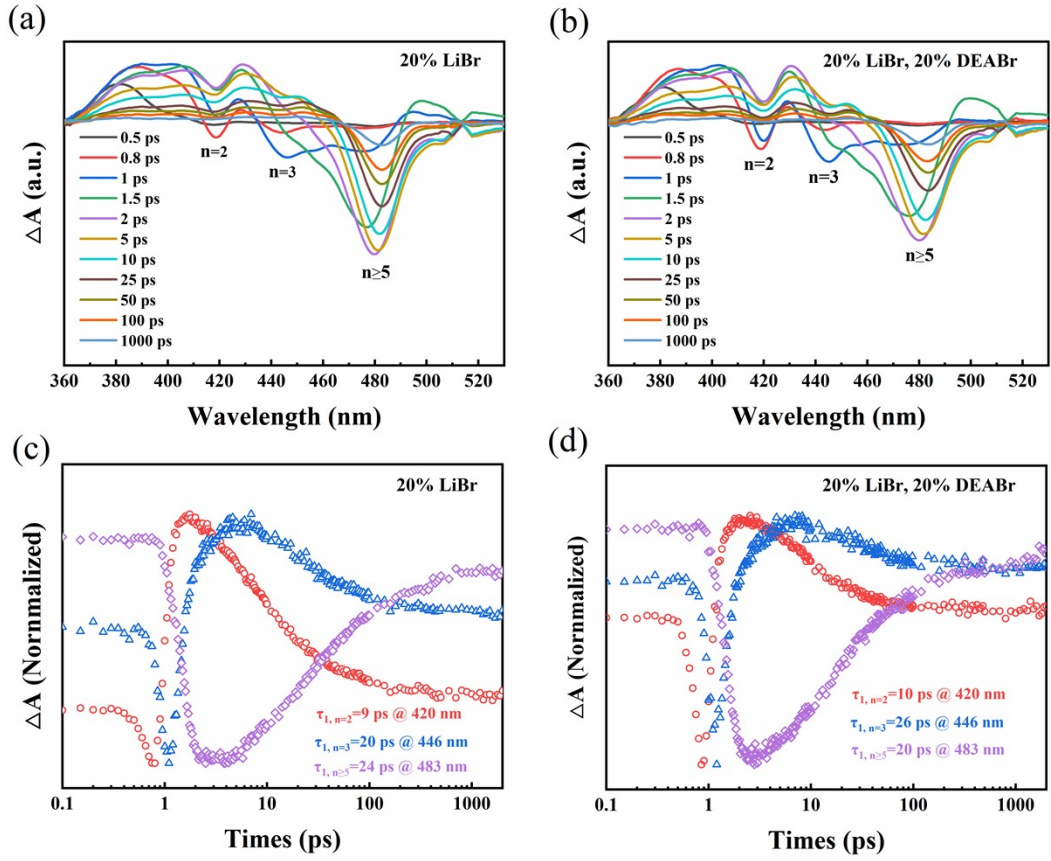


Figure S7. TA spectra of a) 20% LiBr, and b) 20% LiBr, 20% DEABr perovskite films at selected probe delay times. TA spectra of c) 20% LiBr, and d) 20% LiBr, 20% DEABr perovskite films at different wavelength as a function of delay time.

TABLE S1. Fitting parameters for the kinetics shown in Fig. S7 c), d).

Additive	Phase	GSB (nm)	τ_1 (ps)	τ_2 (ps)
20% LiBr	n = 2	420	8.92	122.87
	n = 3	446	20.49	234.71
20% LiBr, 20% DEABr	n = 2	420	10.02	79.64
	n = 3	446	26.41	246.87

The kinetics are fitted by the bi-exponential function!: $\frac{\Delta A(t)}{A} = C_1 e^{-t/\tau_1} + C_2 e^{-t/\tau_2}$,

where C_1 , and C_2 are the amplitudes; τ_1 and τ_2 are the decay time constants. The fast decay τ_1 is attributed to the energy transfer from the low n phases to the high n phases. The slow decay τ_2 is attributed to the nonradiative recombination.

1. B. Wang, Y.-H. Zhou, S. Yuan, Y.-H. Lou, K.-L. Wang, Y. Xia, C.-H. Chen, J. Chen, Y.-R. Shi, Z.-K. Wang and L.-S. Liao, *Angew. Chem. Int. Ed.*, 2023, **62**, e202219255.