Supporting Information for

Selective Stabilization and Photophysical Properties of Metastable Perovskite Polymorphs of $CsPbI_3$ in Thin Films

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Supporting Figures and Tables

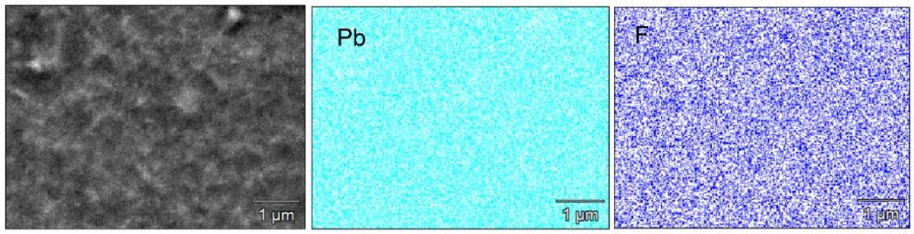

Figure S1. EDS mapping of a stabilized $CsPbI_3$ film using 4-fluorophenylethylammonium as the additive, which shows uniform distribution of the ligand in the sample. We note that the as-prepared film was less stable than the PEA-stabilized film

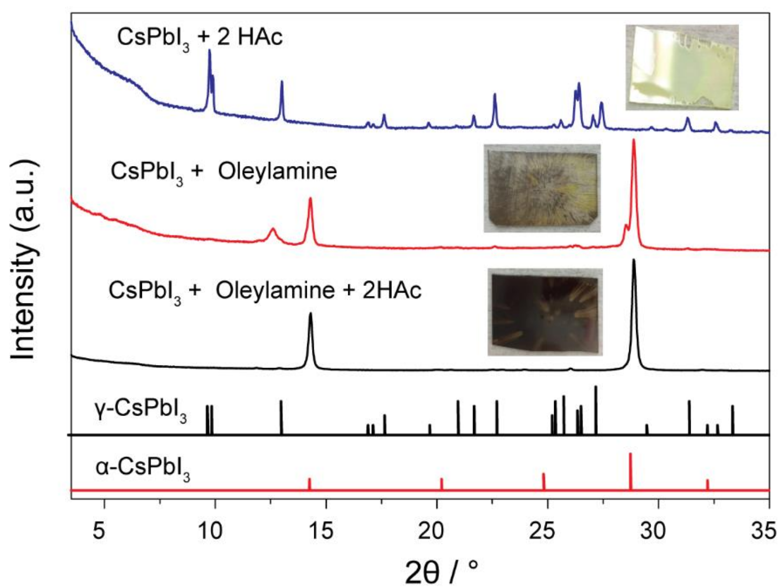

Figure S2. PXRD patterns of the as-deposited $CsPbI_3$ films with the additives of acetic acid (HAc, molar ratio $CsPbI_3$ to HAc = 1:2, blue curve), oleylamine (molar ratio $CsPbI_3$ to oleylamine = 1:1, red curve), and mixed oleylamine and HAc (molar ratio $CsPbI_3$ to oleylamine to HAc = 1:1:2) with the photos of the corresponding thin films shown as insets. We note that the addition of only oleylamine can partially stabilize the perovskite structure for a short time, but the film convert into the yellow γ-$CsPbI_3$ phase within 1 day. The recipe of $CsPbI_3$+HAc could produce the black phase after spin coating, but quickly transformed to the non-perovskite phase upon annealing.

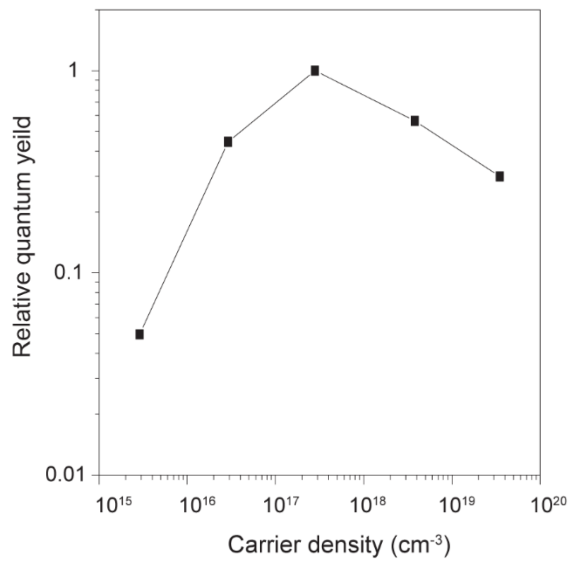

Figure S3. The relative PL quantum yield of the PEA-stabilized $CsPbI_3$ film under different injected carrier density.

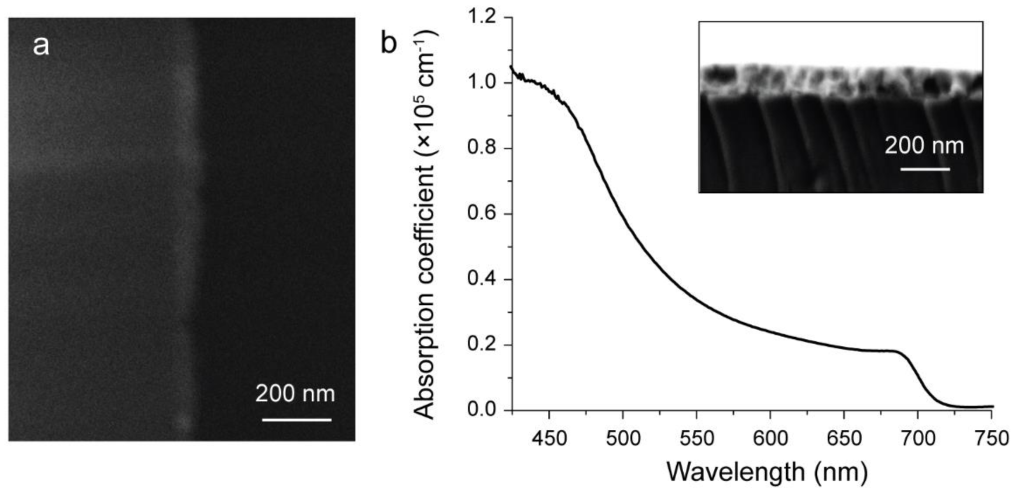

Figure S4. (a) Cross-section SEM image of the PEA-stabilized $CsPbI_3$ thin film used for the TRPL and PL quenching experiments; (b) Absorption coefficient of the PEA-stabilized $CsPbI_3$ thin film. The absorption coefficient at 639 nm is 2.0×10^4 cm^{-1}. Inset is the cross-section SEM image of the PEA-stabilized $CsPbI_3$ thin film sample with a thickness of 75 nm used to collect the absorption spectrum.

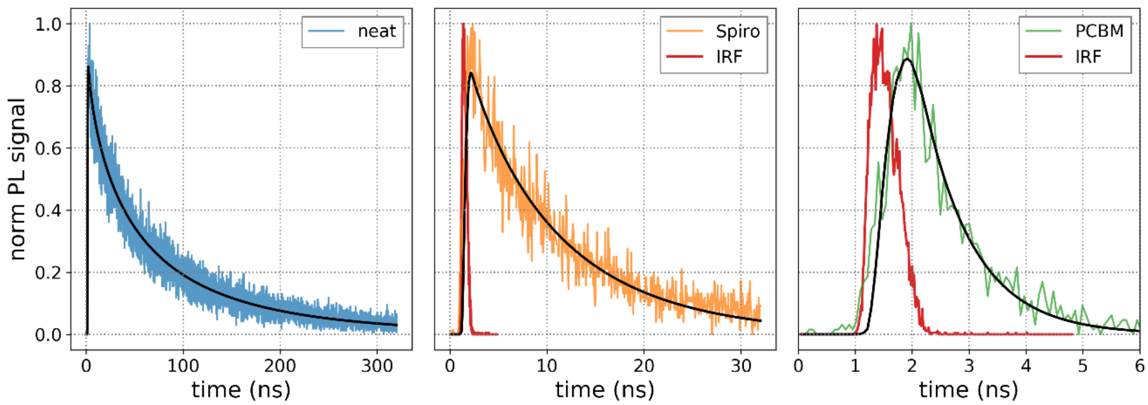

Figure S5. TRPL spectra of the neat $CsPbI_3$, $CsPbI_3$/PCBM, and $CsPbI_3$/spiro-OMeTAD films under the same injected carrier density of 2.9×10^{15} cm^{-3}, along with the stretched exponential fit for the neat $CsPbI_3$ film, the fits to one-dimensional diffusion model for $CsPbI_3$/PCBM and $CsPbI_3$/spiro-OMeTAD films, and the IRF.

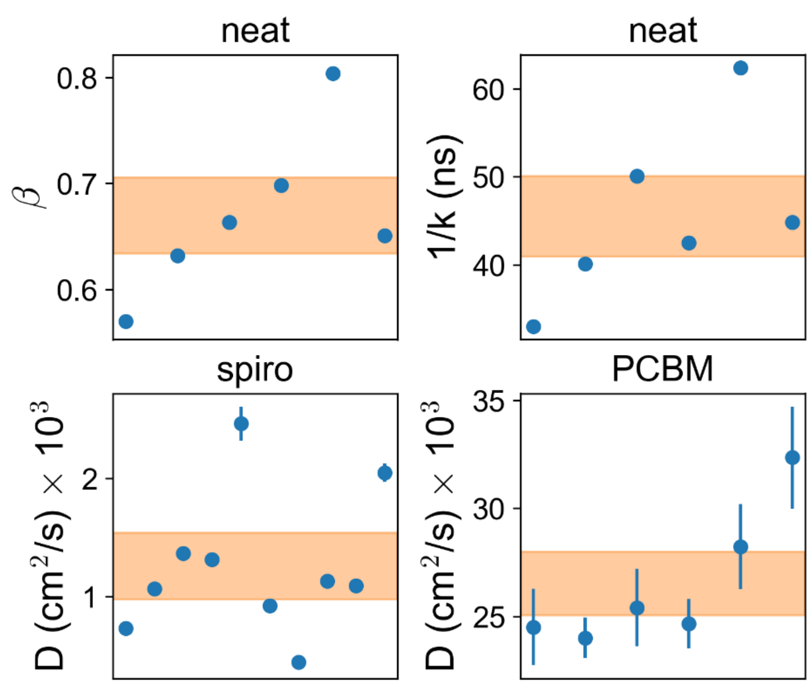

Figure S6. Histograms of the fitting values of β and $1/k_{neat}$ for the neat $CsPbI_3$ sample, and electron and hole diffusion coefficient for the quenched samples. The statistical distributions of these values give rise to the standard deviations reported in Table S1.

Table S1. Fitting results of the TRPL quenching experiments.

	Average value	Standard deviation
$1/k_{neat}$ (ns)	45	9
β	0.67	0.07
D_{spiro} (cm^2/s)	0.0013	0.0006
D_{PCBM} (cm^2/s)	0.027	0.003
L_{spiro} (nm)	80	20
L_{PCBM} (nm)	350	40