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Electronic Supplementary Information

Efficient pure-red perovskite light-emitting diodes using dual-Lewis-base molecules for interfacial modification

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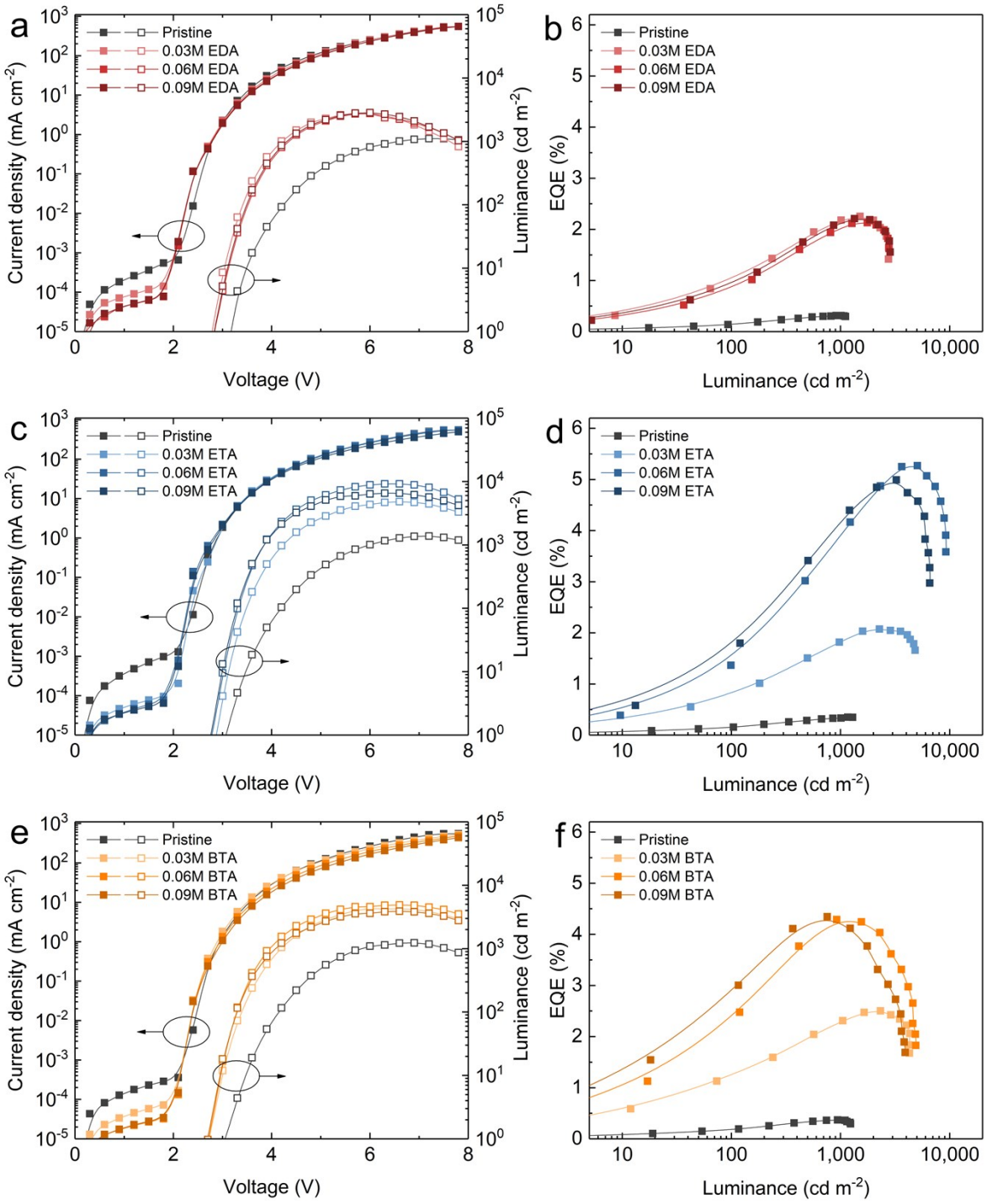

Figure S1. Device performance of pure-red PeLEDs based on different PEDOT:PSS modification with the doping concentration from 0 to 0.09 M. (a), (c) and (e) Current density-voltage-luminance (J-V-L) curves. (b), (d) and (f) EQE-luminance curves.

Table S1. Transient PL curve fittings of perovskite films on modified PEDOT:PSS. The TRPL decay curves were fitted with a tri-exponential decay function of $I(t) = B_1 \times \exp[-t/\tau_1] + B_2 \times \exp[-t/\tau_2] + B_3 \times \exp[-t/\tau_3]$, where B_n is normalized coefficient and τ_n is time constant.

PEDOT:PSS modifiers	τ_1 [ns]	τ_2 [ns]	τ_3 [ns]	B_1 [%]	B_2 [%]	B_3 [%]	$\tau_{average}$ [ns]
Pristine	2.49	13.62	73.46	42.58	51.95	5.47	12.15
EDA	14.75	76.71	513.44	32.60	64.81	2.60	67.86
ETA	13.40	91.01	400.21	27.87	70.21	1.93	75.36
BTA	14.01	90.64	473.12	28.35	69.81	1.84	75.95

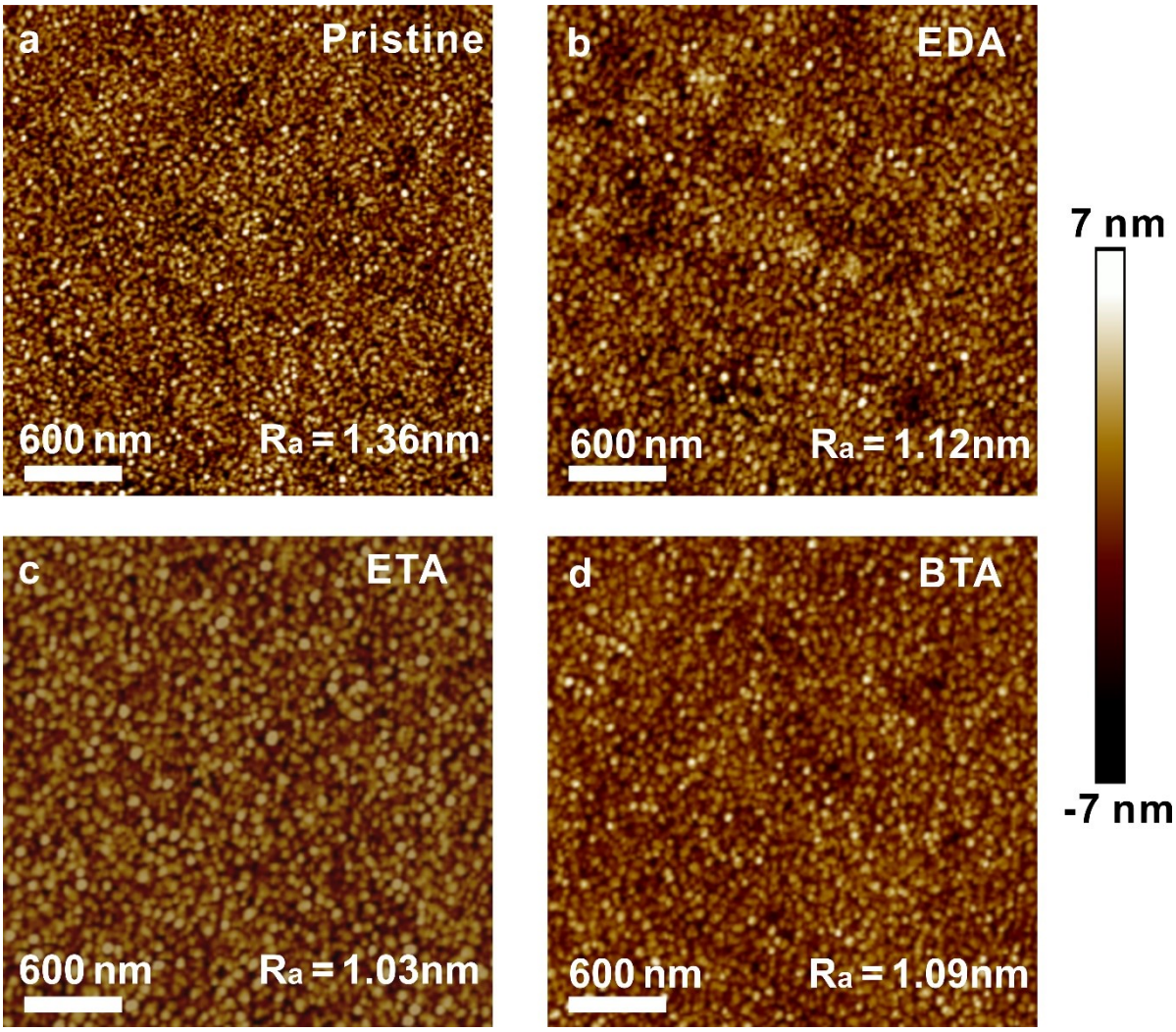

Figure S2. AFM images of perovskite films grown on different PEDOT:PSS.

Table S2. Performance summary of reported pure-red PeLEDs (emission peak from 620 nm to 640 nm).

Perovskite material	EL peak (nm)	EQE (%)	L_{max} (cd m^{-2})	V_{on}(V)	Refs
$CsPbI_3$ nanowire	620	6.2	13644	2.8	1
$MAPbI_{3-x}Br_x$ nanocrystals	620	20.28	627	2.8	2
$CsPbI_{3-x}Br_x$ nanocrystals	625	12.9	3382	2.3	3
$(BTm)_2SnI_4$ film	627	3.33	3466	~3	4
$MAPbI_{1.05}Br_{1.95}$ film	635	5.79	1000	1.65	5
$CsPbI_{3-x}Br_x$ nanocrystals	637	3.55	2671	3.6	6
$CsPbI_{3-x}Br_x$ film	637	4.5	3100	2.9	7
(Cs/K/PEA)$PbI_{3-x}Br_x$ film	634	5.27	9218	2.7	This work

References

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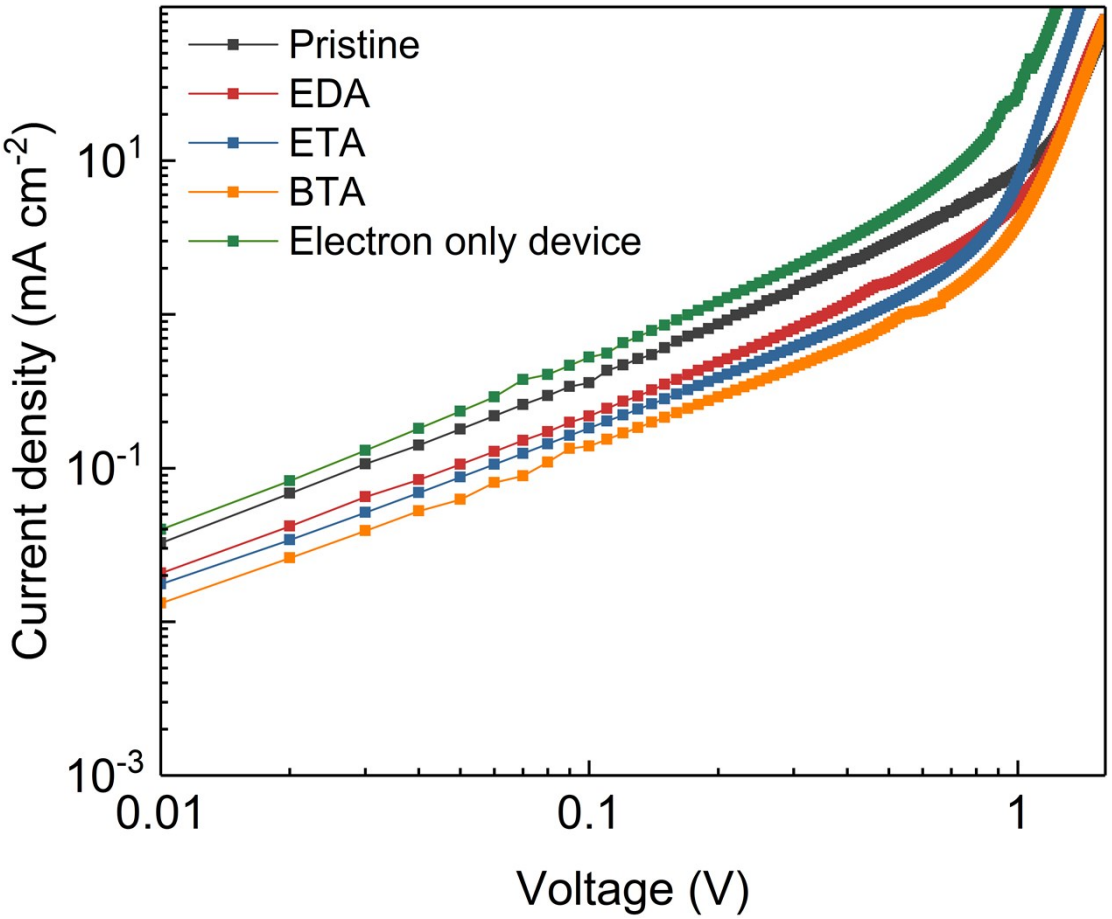

Figure S3. J-V curves of the hole-only devices based on various HTL with a structure of ITO/pristine or modified PEDOT:PSS/perovskite/ MoOx/Ag, and the J-V curve of the electron only device with a structure of ITO/ZnO/perovskite/TPBi/Liq/Al.

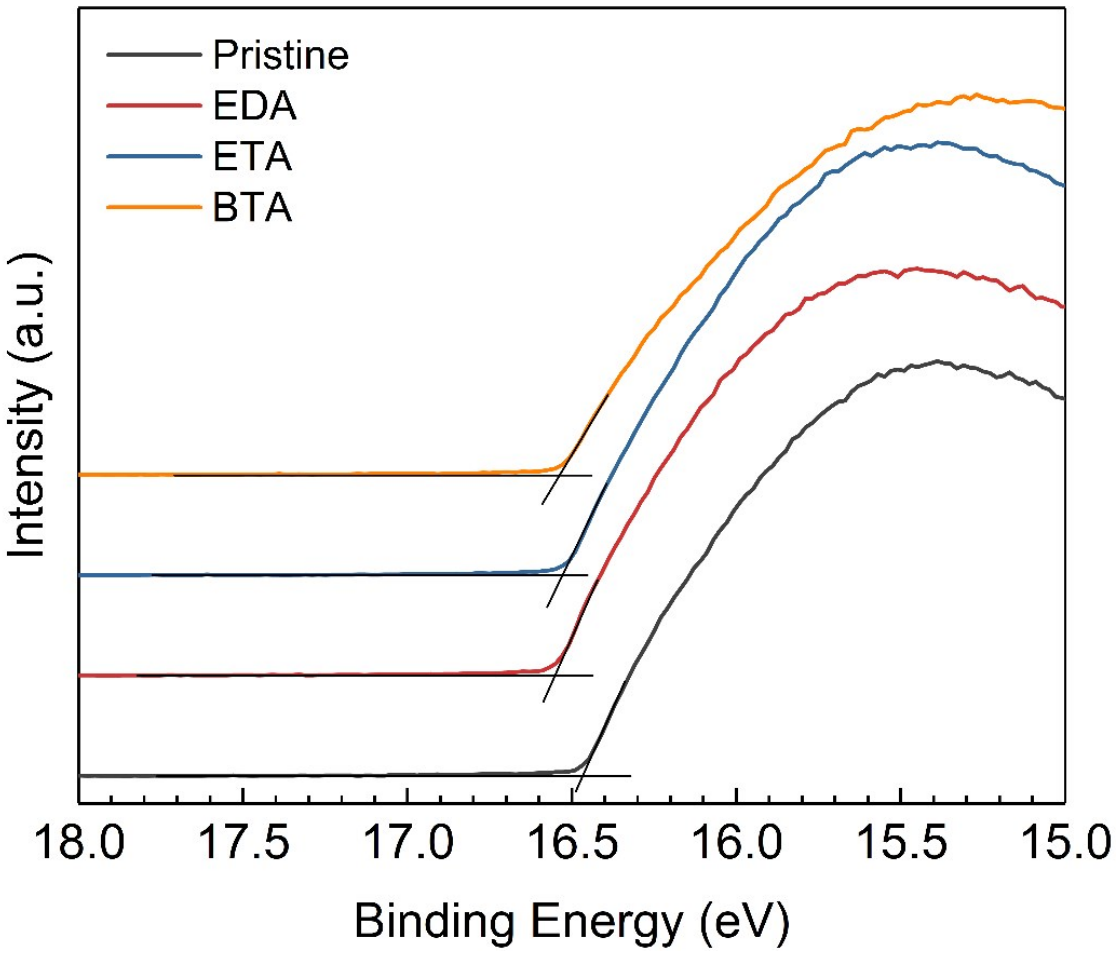

Figure S4. Secondary-electron cutoff region of the UPS spectra of pristine and modified PEDOT:PSS layers.

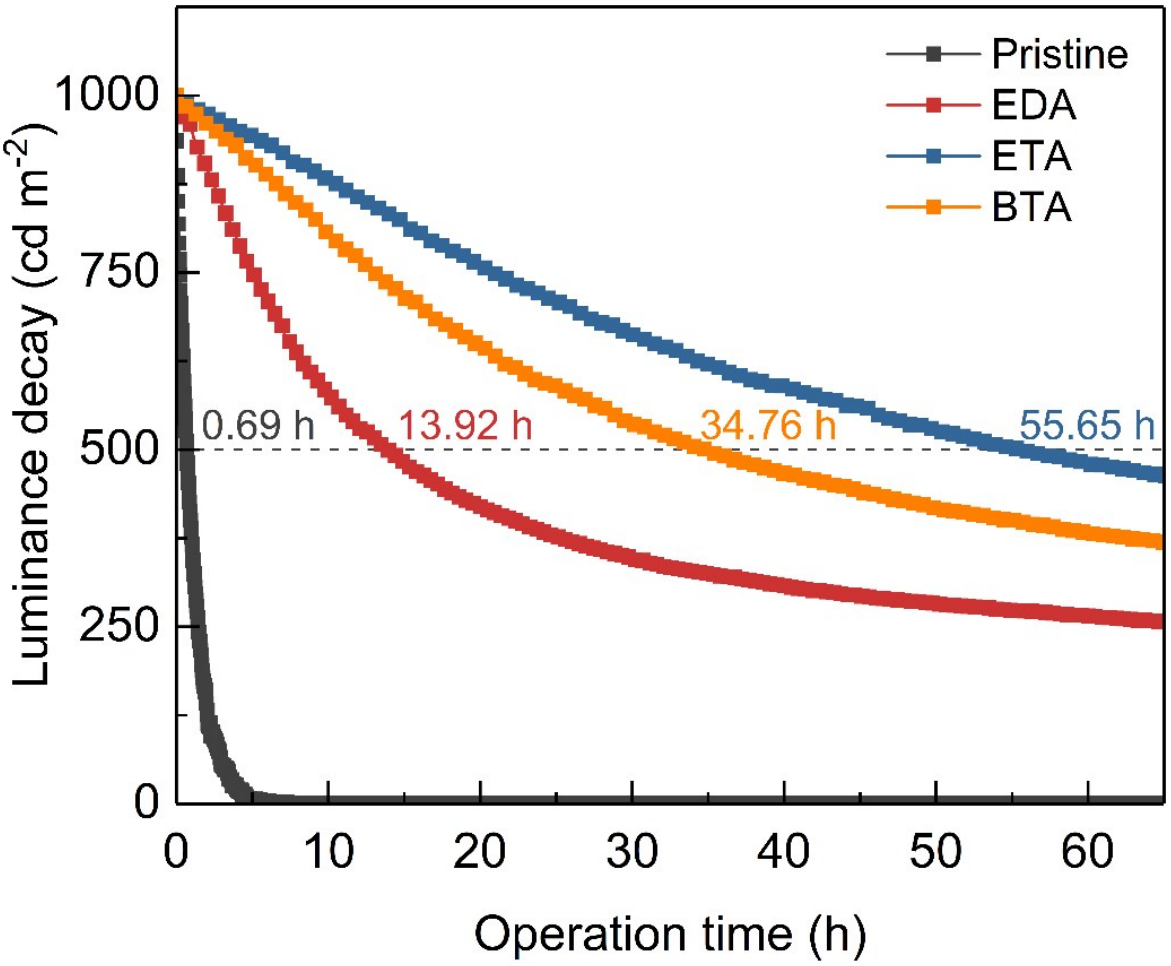

Figure S5. The operation lifetime of PeLEDs with the initial brightness of 1000 cd m^{-2}.

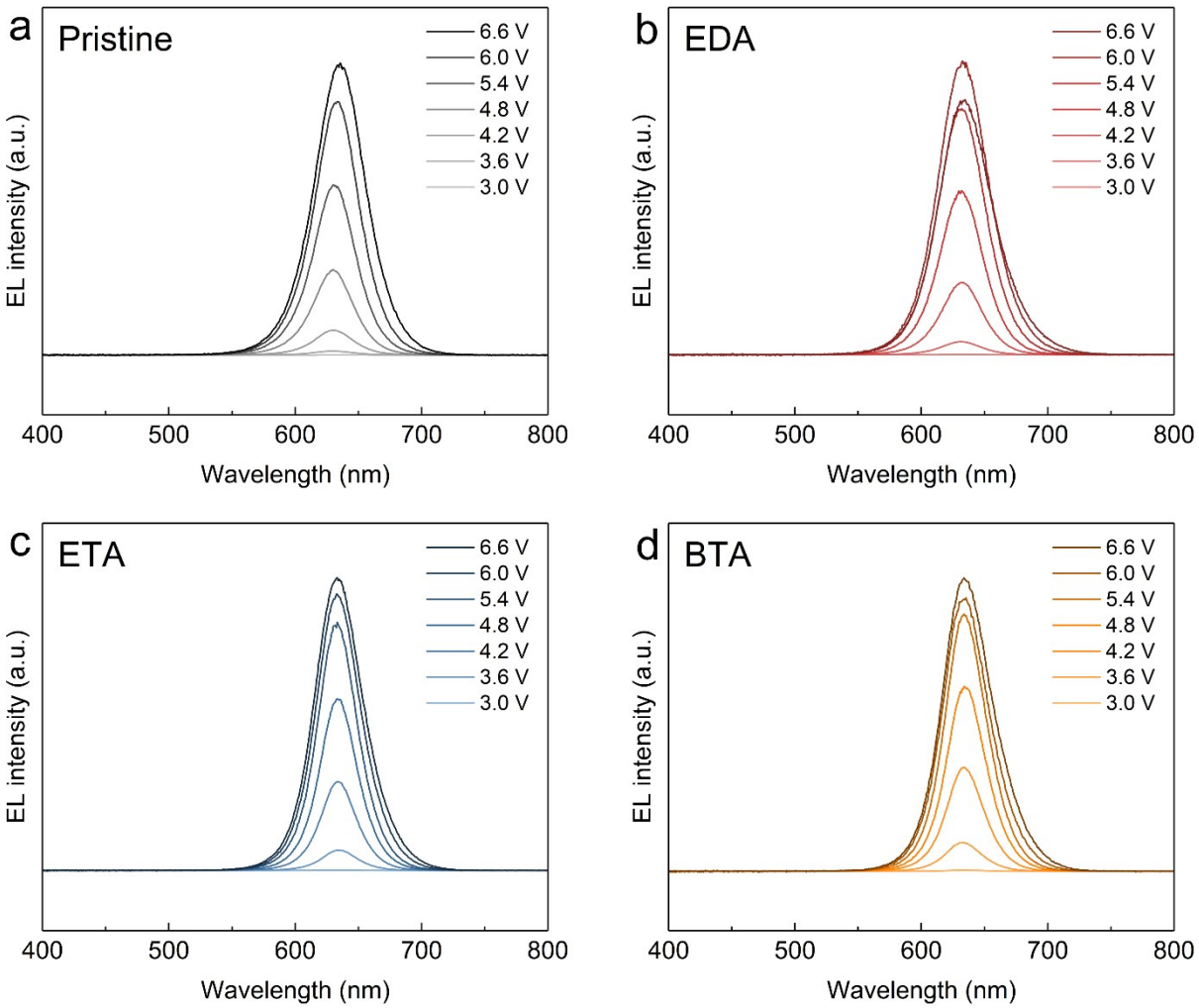

Figure S6. The EL spectra of PeLEDs with the bias from 3 V to 6.6 V.

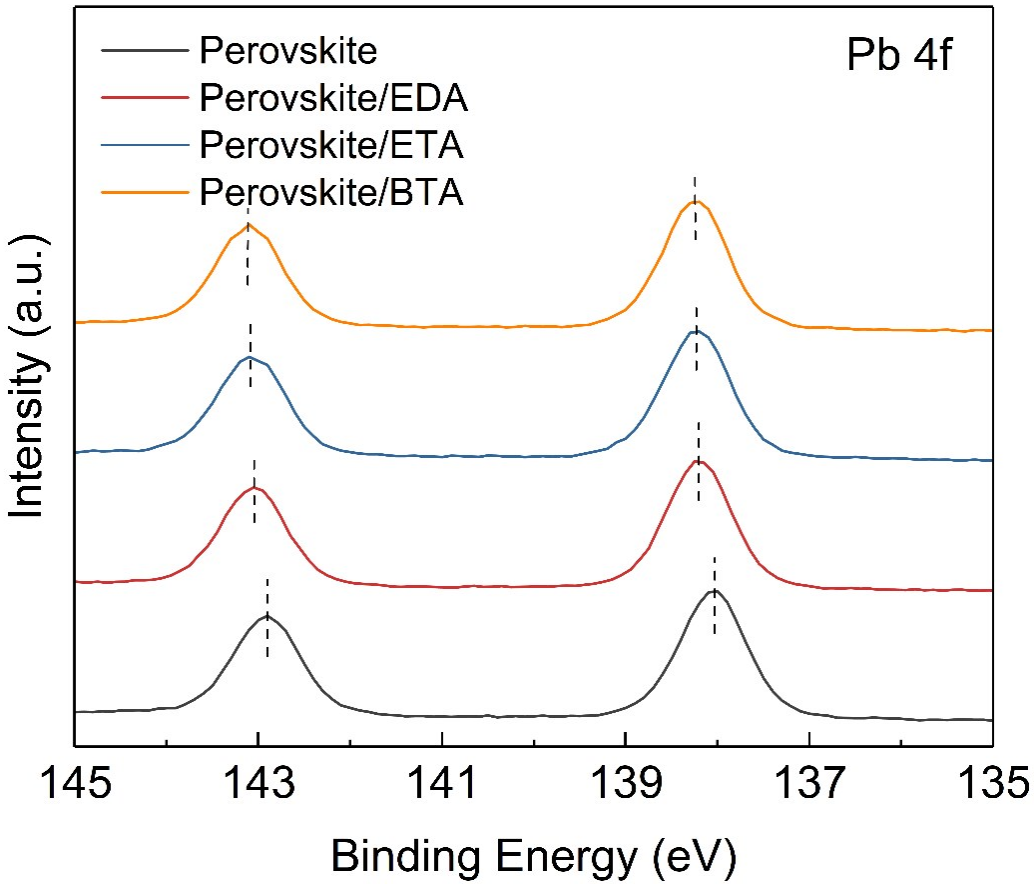

Figure S7. X-ray photoelectron spectroscopy (XPS) spectra of Pb 4f for undoped and EDA, ETA or BTA doped perovskites.

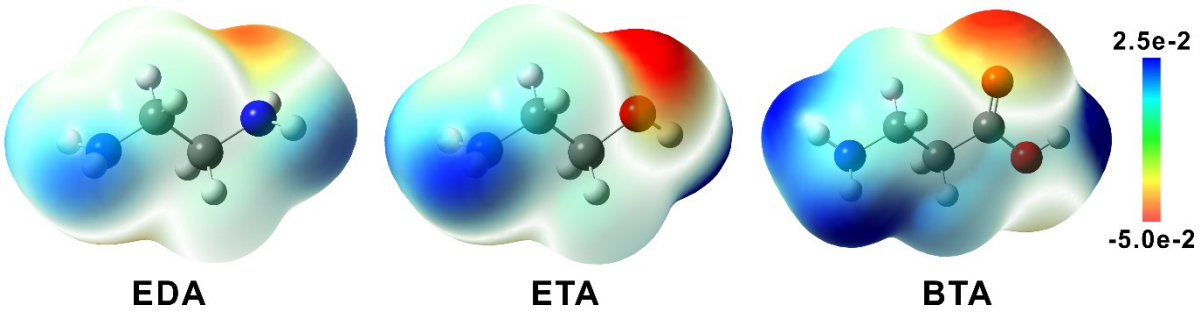

Figure S8. Computed electrostatic potential maps of EDA, ETA, and BTA. Quantitative values of electrostatic potentials are in au. The Gaussian 09 package and density functional theory (DFT) method were used to obtain the data.