

## Supporting Information

### **Synergistic interaction of multi-functional additives at the buried interface for efficient blue perovskite light-emitting diodes**

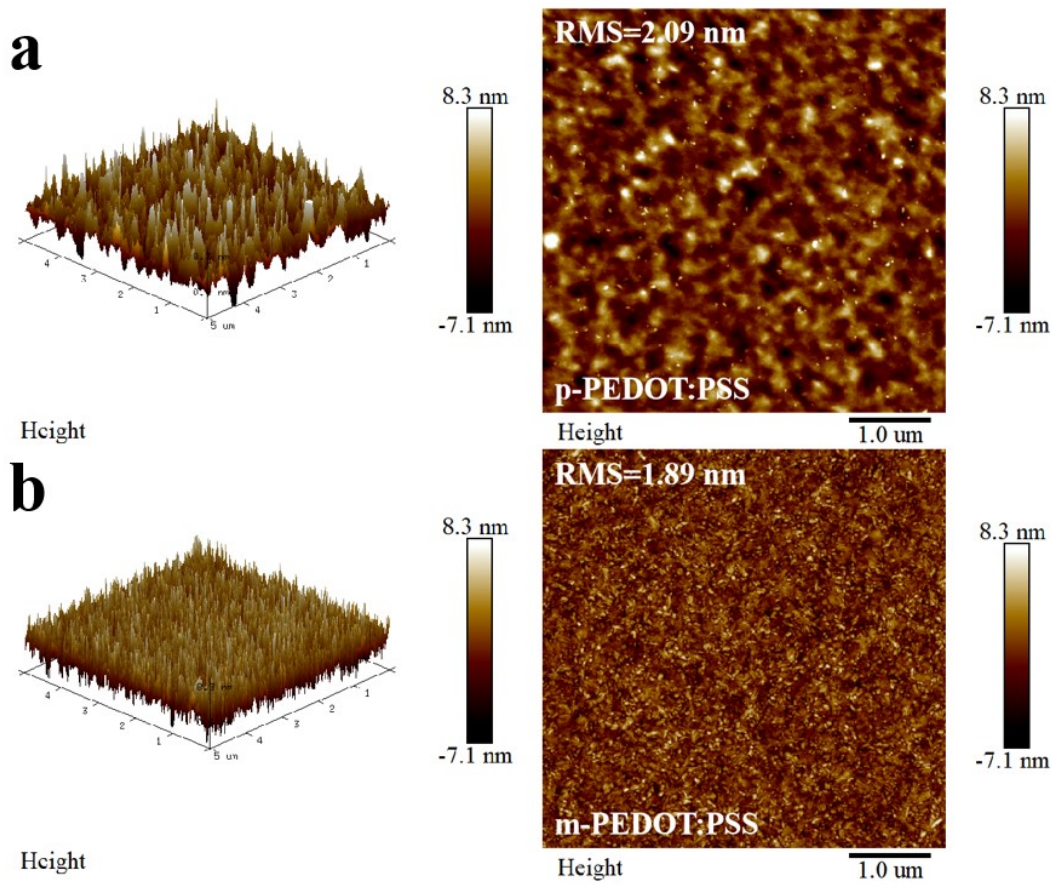
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*Li<sup>1,2\*</sup>*

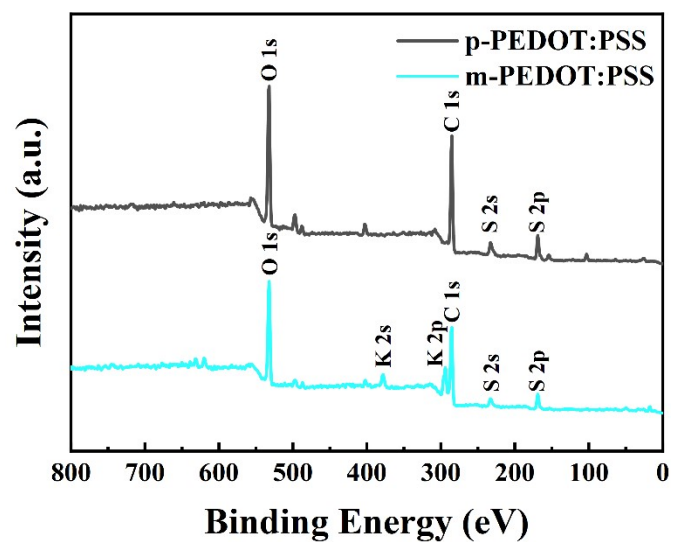
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People's Republic of China

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Information of China, Fuzhou, People's Republic of China.

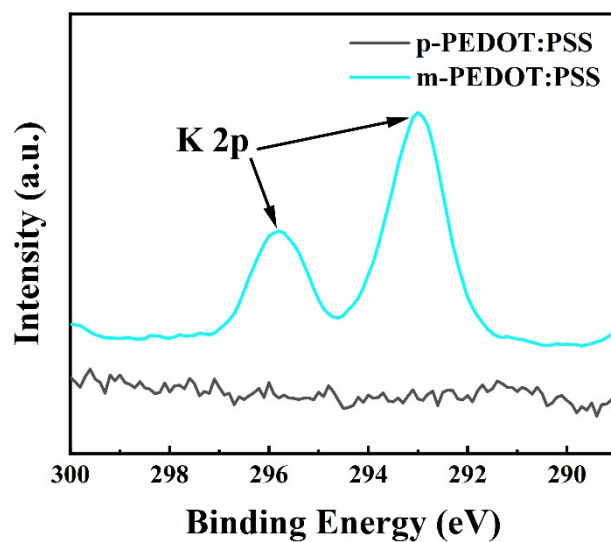
E-mail addresses: [fsli@fzu.edu.cn](mailto:fsli@fzu.edu.cn) (F. Li)



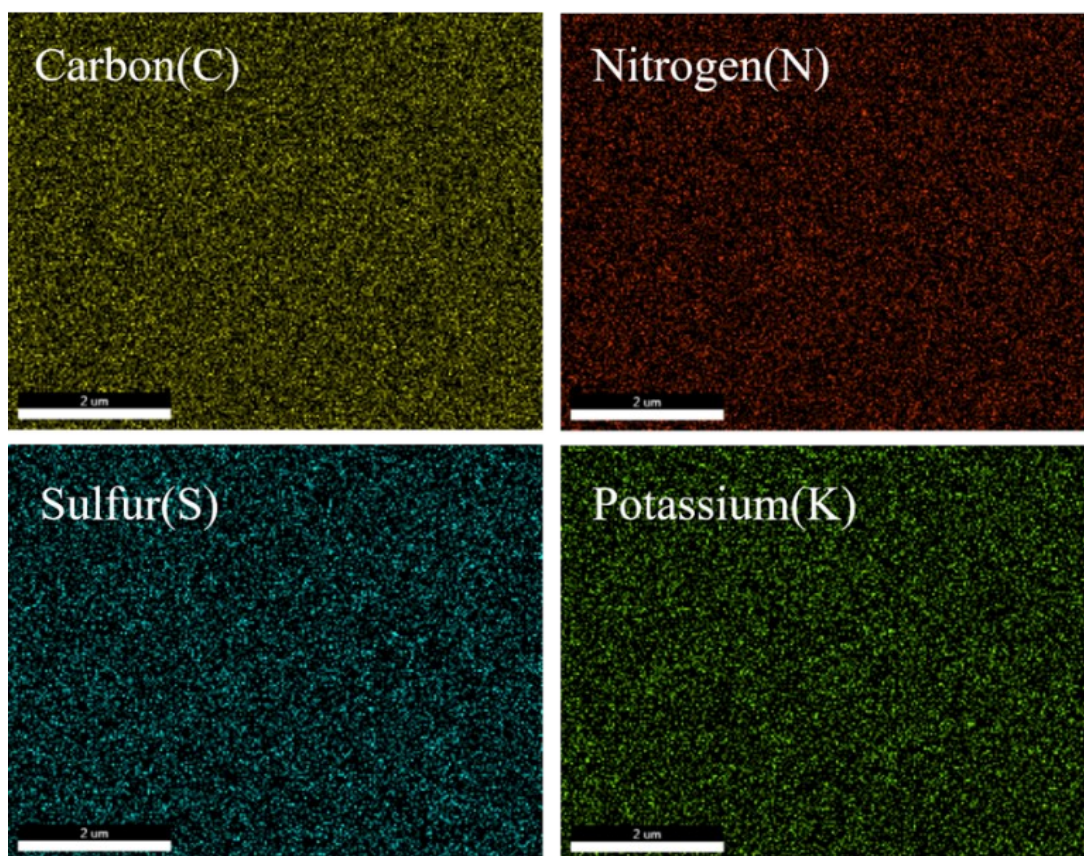
**Figure S1.** AFM characterization of perovskite films with (a) p-PEDOT:PSS and (b) m-PEDOT:PSS surfaces. Three-dimensional (3D) images (left) and height images (right).



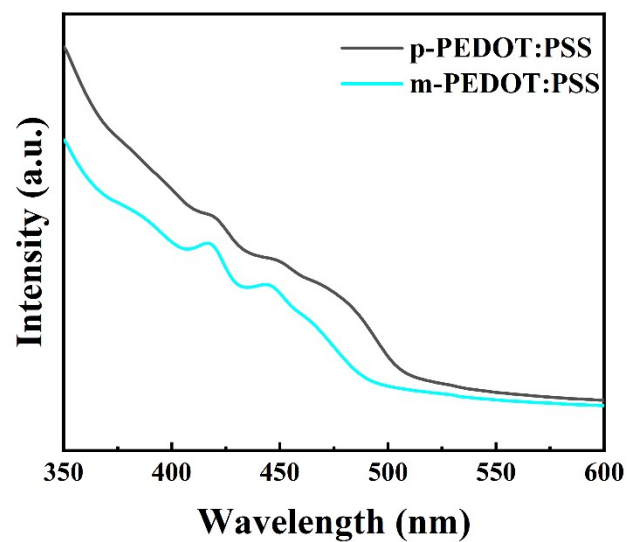
**Figure S2.** XPS wide spectra of p-PEDOT:PSS and m-PEDOT:PSS films.



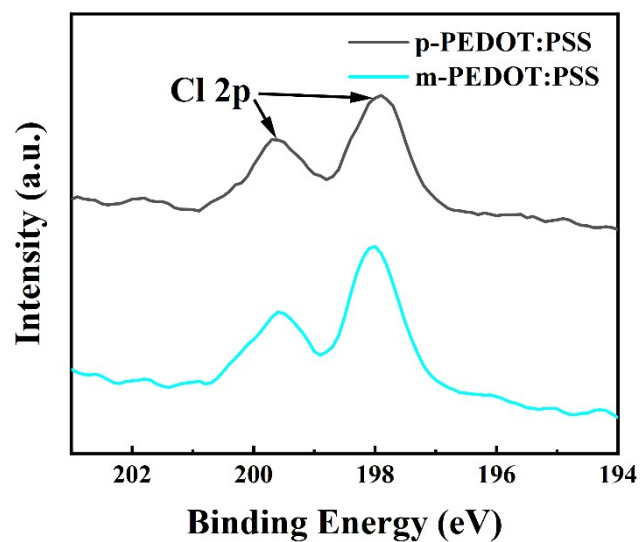
**Figure S3.** XPS spectra of the p-PEDOT:PSS and m-PEDOT:PSS, XPS K 2p spectra.



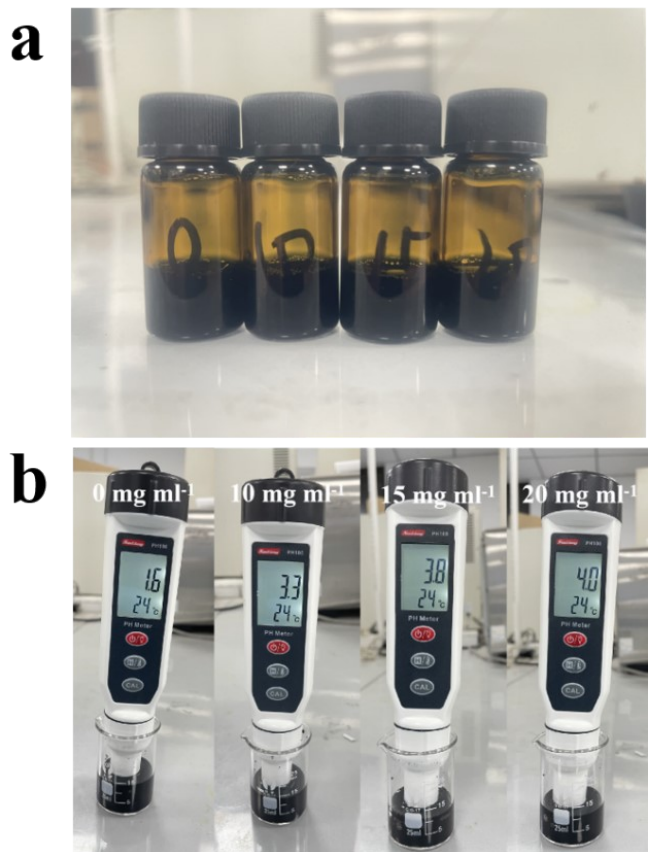
**Figure S4.** SEM image, Energy dispersive spectroscopy (EDS) mapping of carbon (C), Nitrogen(N),sulfur (S), Potassium (K) for m-PEDOT:PSS. Scale bar is 2  $\mu\text{m}$ .



**Figure S5.** Absorption spectra of perovskite films deposited on p-PEDOT:PSS and m-PEDOT:PSS.

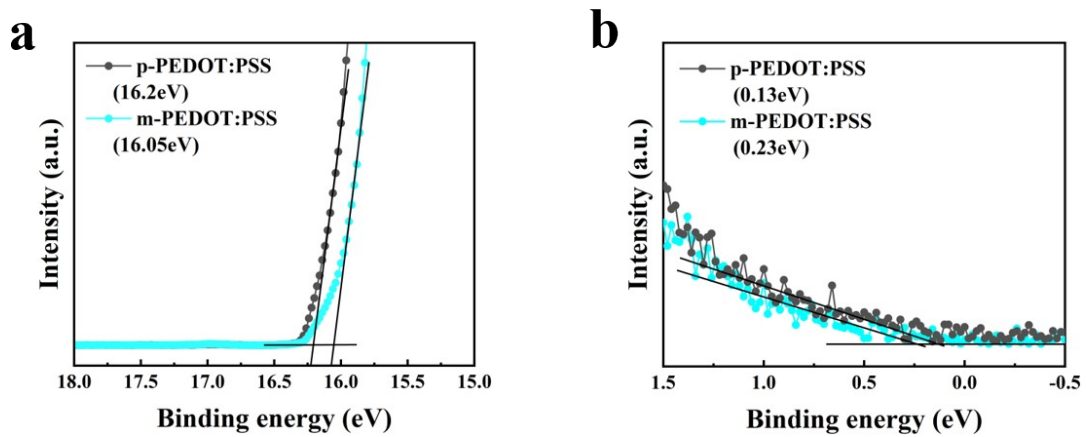


**Figure S6.** XPS spectra of the perovskite film on p-PEDOT:PSS and m-PEDOT:PSS. XPS Cl 2p spectra.

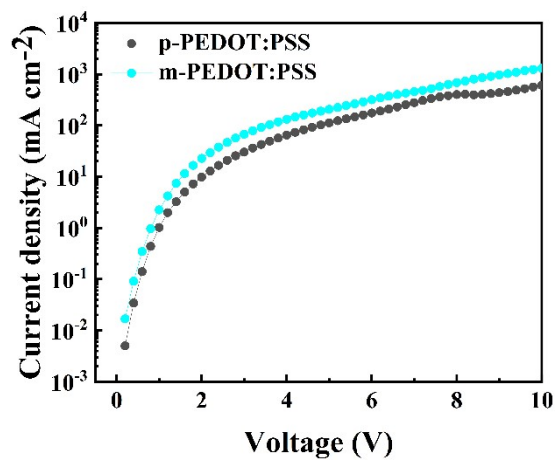


**Figure S7.** (a) Pictures of p-PEDOT:PSS and m-PEDOT:PSS solutions. (b) Pictures of acidimeter at different PLAK concentrations.

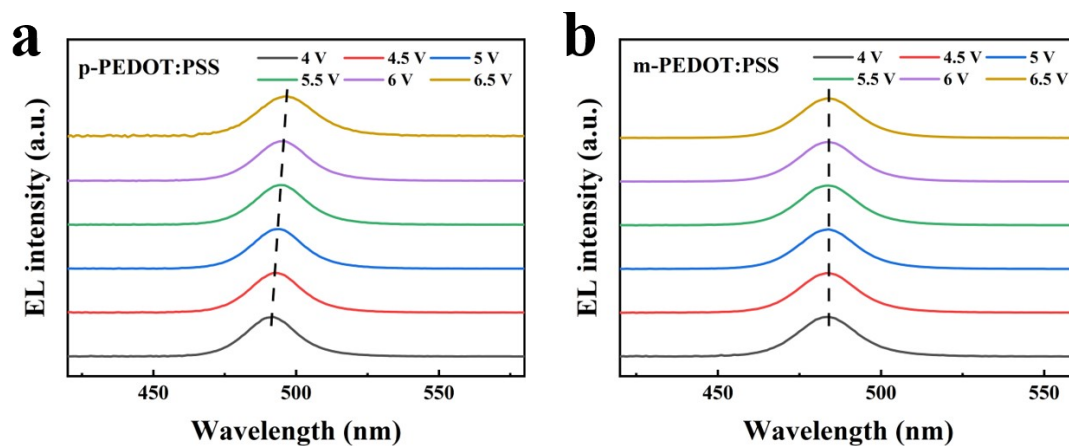




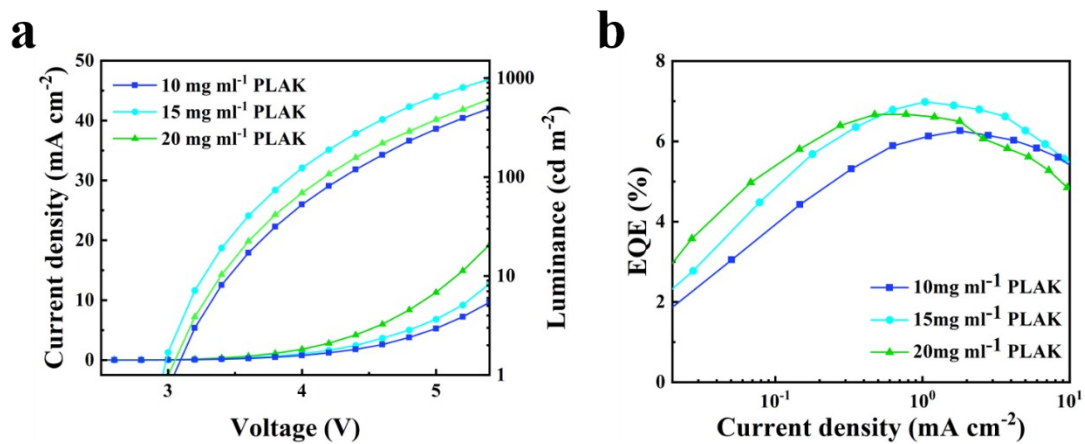
**Figure S8.** UPS spectra of p-PEDOT:PSS and m-PEDOT:PSS. (a) Secondary edge region and (b) valence band edge plotted relative to an Au reference.



**Figure S9.** Current density-voltage curves of devices assembled by ITO/p-PEDOT:PSS and m-PEDOT:PSS/MoO<sub>3</sub>/Al.



**Figure S10.** Electroluminescence spectra of PeLEDs prepared on (a) p-PEDOT:PSS and (b) m-PEDOT:PSS under various applied voltages.



**Figure S11.** (a) Current density–luminance–voltage curves. (b) EQE–current density curves of PeLEDs prepared on PEDOT:PSS with different concentrations of PLAK addition.

**Table S1.** Double fitting parameters for PL lifetimes of quasi-2D perovskite films deposited on PEDOT:PSS w/o and w PLAK on ITO substrates.

	$A_1$	$\tau_1$ (ns)	$A_2$	$\tau_2$ (ns)	$\tau_{ave}$ (ns)
w/o PLAK	0.42	1.13	0.58	5.69	3.77
w PLAK	0.37	3.54	0.63	16.03	11.41

(a) The decay curves are fitted by the tri-exponential function:

$$I(t) = A_1 * e^{\left(-\frac{t}{\tau_1}\right)} + A_2 * e^{\left(-\frac{t}{\tau_2}\right)},$$

where,  $I$  is the normalized PL intensity,  $A_1$ , and  $A_2$  are the decay amplitudes and  $A_1 + A_2 = 1$ .

(b)  $\tau_1$  and  $\tau_2$  correspond to the lifetime constants of a fast component, a middle component, and a slow component, respectively. The  $\tau_{ave}$  is given by the formula:

$$\tau_{ave} = \frac{A_1\tau_1 + A_2\tau_2}{A_1 + A_2}$$

**Table S2.** Device performance of PeLEDs without and with PLAK addition.

	<b>EL peak</b>	<b>Max. EQE</b>	<b>Max. L</b>	<b>V<sub>T</sub></b>
	[nm]	[%]	[cd m <sup>-2</sup> ]	[V]
Without PLAK	492	3.05	493	3.2
With PLAK (10 mg ml <sup>-1</sup> )	488	6.26	494	3.1
With PLAK (15 mg ml <sup>-1</sup> )	484	6.98	976	2.9
With PLAK (20 mg ml <sup>-1</sup> )	484	6.67	614	2.9

EQE: external quantum efficiency, L: luminance, V<sub>T</sub>: turn-on voltage.

**Table S3** Summary of sky-blue PeLED performance with interface engineering.

PeLED structure	EL peak [nm]	FWHM [nm]	EQE [%]	V <sub>T</sub> [V]	T <sub>50</sub> [s]	Ref
ITO/CPE/PVSK/TPBi/LiF/Al	489	24	2.6	3.4	996	1
ITO/(APDO) doped						
PEDOT:PSS/PVSK/TPBi/LiF/A	490	*	9.2	3.5	740	2
1						
ITO/PVK/PVSK/ IL/TPBi/LiF/Al	492	24	9.0	3.0	261	3
ITO/PEDOT:PSS/PVSK/ CsAc/POT2T/LiF/Al	486	21	9.2	3.6	50	4
ITO/(L-Phenylalanine) doped						
PEDOT:PSS/PVSK/TPBi/LiF/A	480	23	10.98	3.0	460	5
1						
ITO/(PLAK) doped						
PEDOT:PSS/PVSK/TPBi/LiF/A	<b>484</b>	<b>20</b>	<b>6.98</b>	<b>2.9</b>	<b>312</b>	<b>This work</b>
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