Electronic Supplementary Material (ESI) for Nanoscale.

Supporting Information

Improved Performance of $CsPbBr_3$ Perovskite Light-Emitting Devices by Both Boundary and Interface Defects Passivation

Li Song,[ab] Xiaoyang Guo,[*a] Yongsheng Hu,[a] Ying Lv,[a] Jie Lin,[a] Yi Fan,[a] Nan Zhang,[a] and Xingyuan Liu[*,a]

[a] *State Key Laboratory of Luminescence and Applications, Changchun Institute of Optics, Fine Mechanics and Physics, Chinese Academy of Sciences, Changchun 130033, China*

[b] *University of Chinese Academy of Sciences, Beijing 100049, China*

Corresponding Author:
*E-mail: guoxy@ciomp.ac.cn; liuxy@ciomp.ac.cn

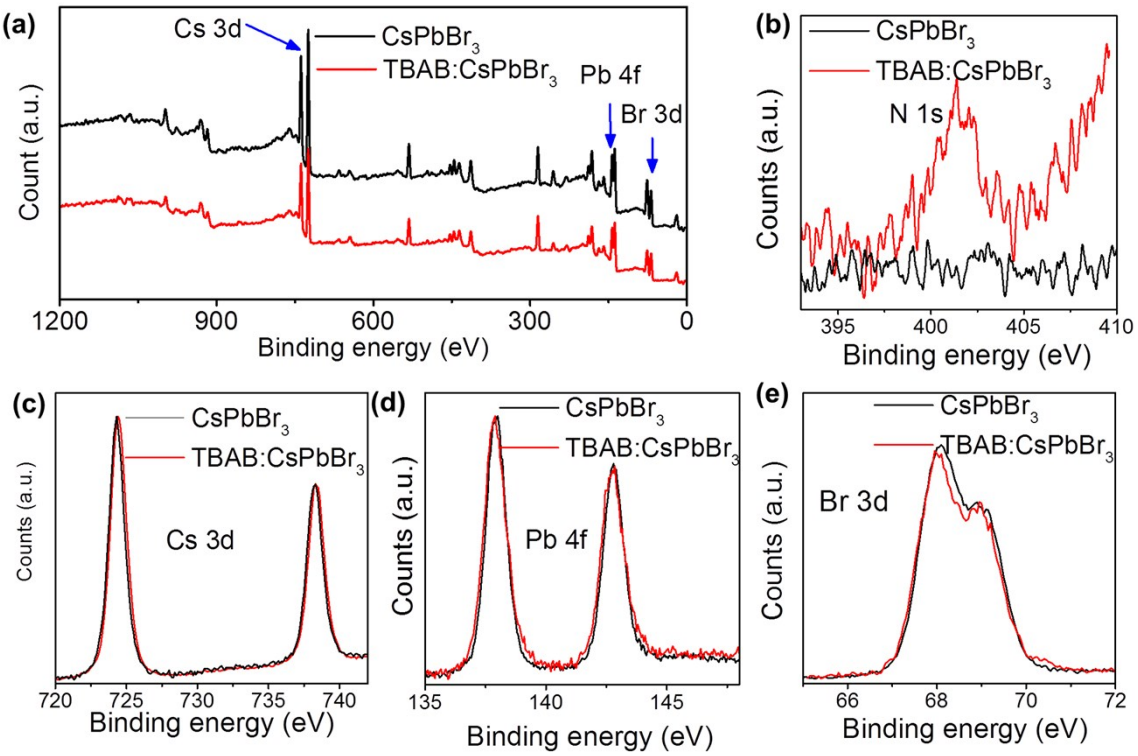

Figure S1. (a) XPS survey for the pure $CsPbBr_3$ and TBAB:$CsPbBr_3$ films. High resolution XPS spectra for (b) N 1s, (c) Cs 3d, (e) Pb 4f and (f) Br 3d.

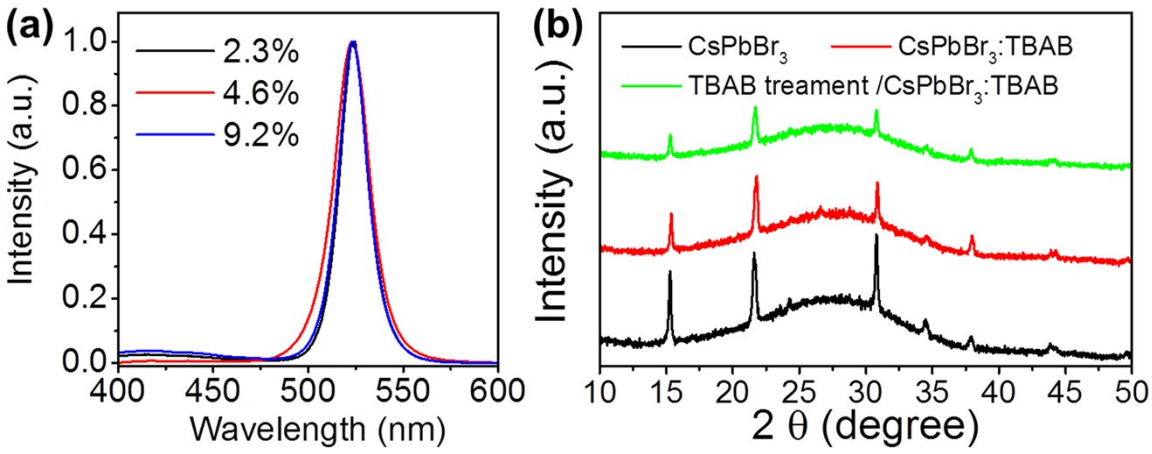

Figure S2. (a) PL spectra for TBAB:$CsPbBr_3$ films with different weight ratios. (b) XRD spectra for different perovskite films.

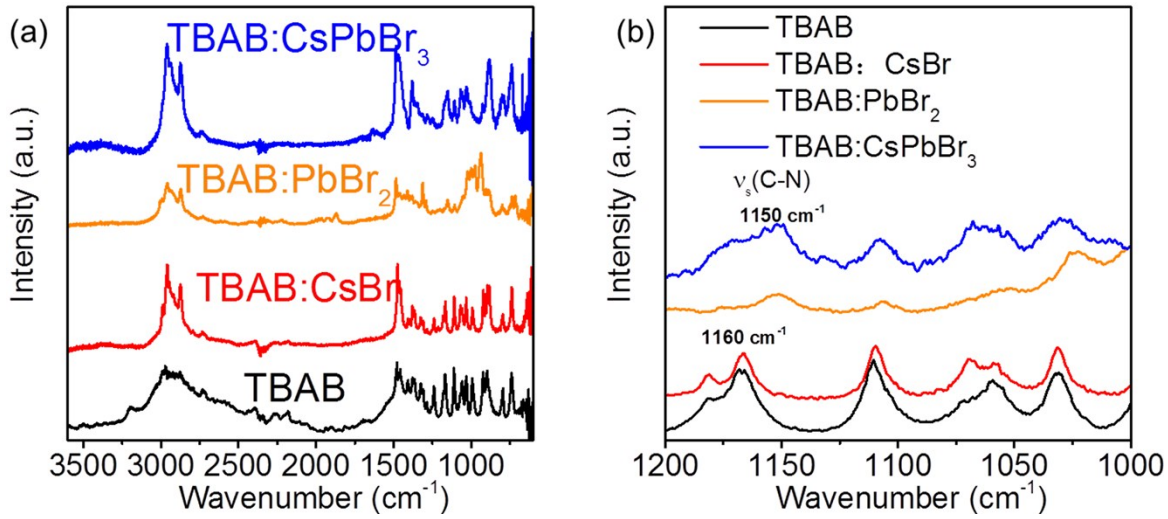

Figure S3. ATR-FTIR spectra for powdered TBAB, TBAB:CsBr, TBAB:$PbBr_2$, TBAB:$CsPbBr_3$.

For pure TBAB and TBAB:CsBr compound, the C-N stretching vibration frequency appears at 1160 cm^{-1} (Figure S3b), while for TBAB:$PbBr_2$ and TBAB:$CsPbBr_3$ powders, the C-N stretching vibration frequency shifted to 1150 cm^{-1}. These results demonstrate that the TBAB mainly interact with Pb atom to reduce the defects orginated from the Pb^{2+}.

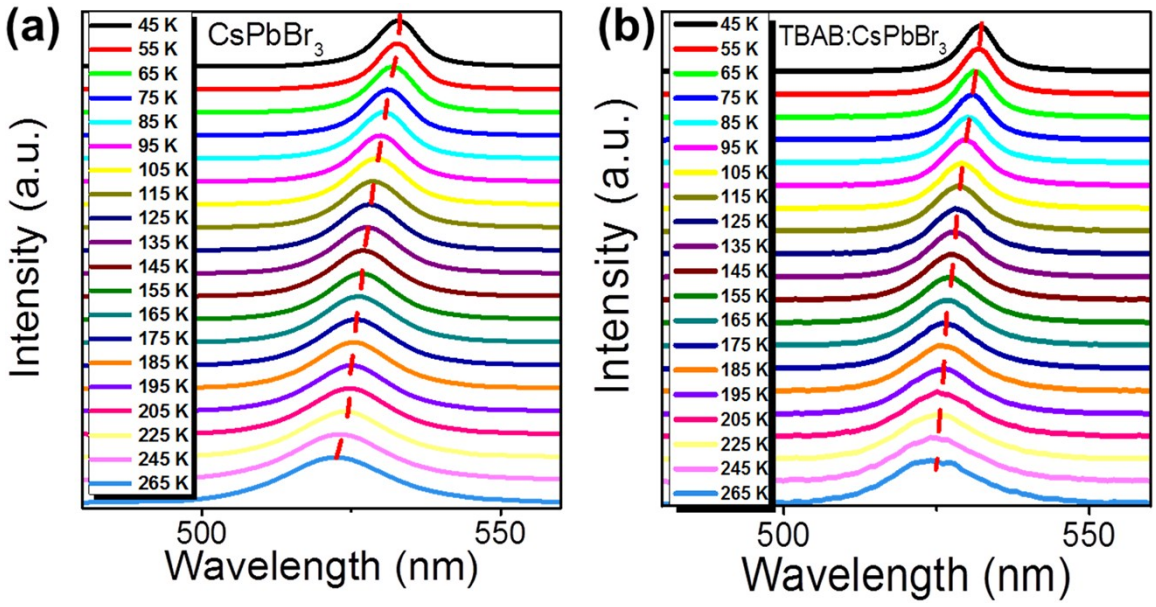

Figure S4. Temperature dependent PL spectra for (a) pure $CsPbBr_3$ and (b) TBAB:$CsPbBr_3$ films with temperatures ranging from 45 K to 265 K.

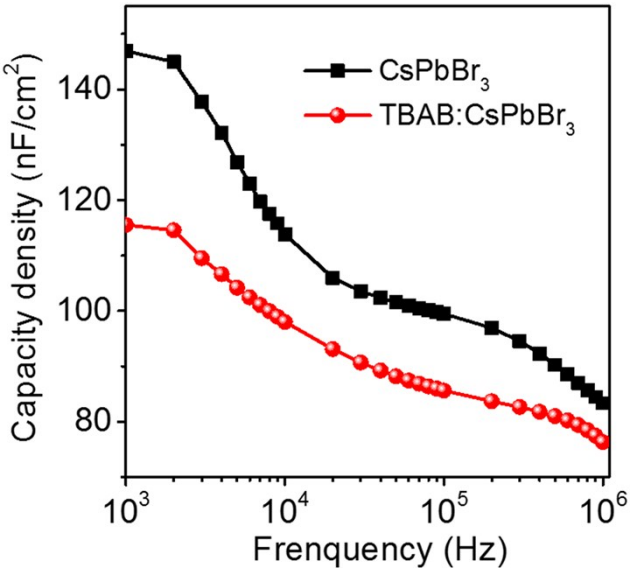

Figure S5. Capacity density-frequency curves for the ITO/PEDOT:PSS/Perovskite/TPBI/Li/Al device. Apart from the difference in the perovskite layers, the other function layer are the same.

The total capacity density of the device can be regarded as the series connection of PEDOT:PSS, perovskite and TPBI capacitors. The total capacity density (C) for the $CsPbBr_3$ device is higher than that for the TBAB:$CsPbBr_3$ as shown in Figure S5 indicating the smaller capacity density of the TBAB:$CsPbBr_3$ since the PEDOT:PSS and TPBI are almost the same in our preparation. Determined by the equation of $\varepsilon = Cd$, where d is the thickness of the perovskite layer, which can be regarded the same for the $CsPbBr_3$ and TBAB:$CsPbBr_3$ film. Clearly, the ε for the perovskite decreased after TBAB doping.

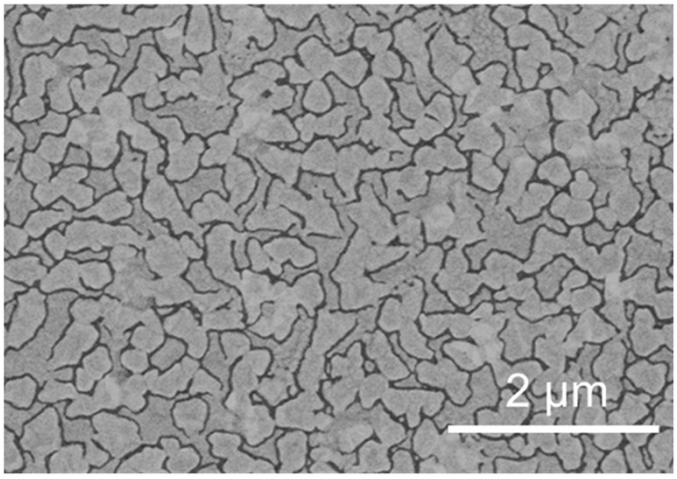

Figure S6. SEM image of the TBAB:$CsPbBr_3$ film formed on the TBAB treated PEDOT:PSS.

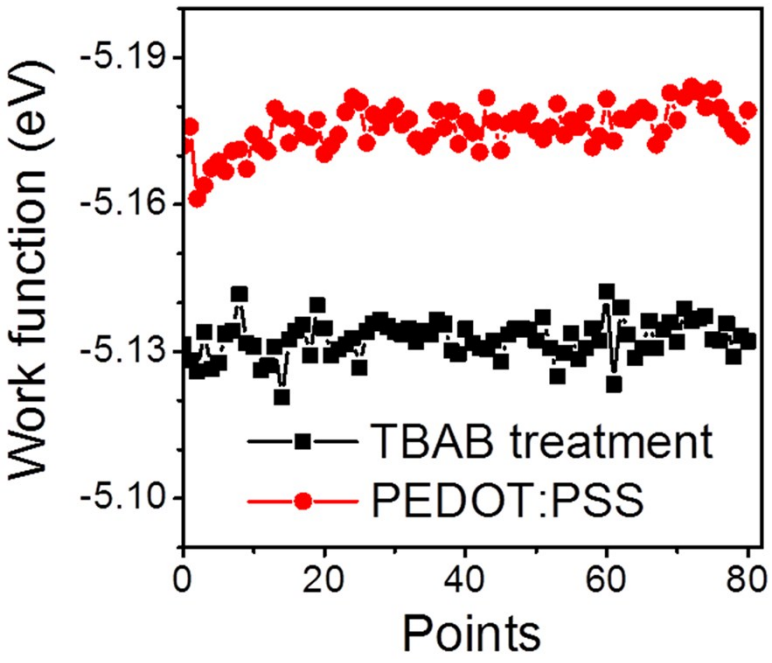

Figure S7. Work function of the PEDOT:PSS films with and without TBAB treatment measured by Kelvin Probe with gold work function (-5.1 eV) as a reference.

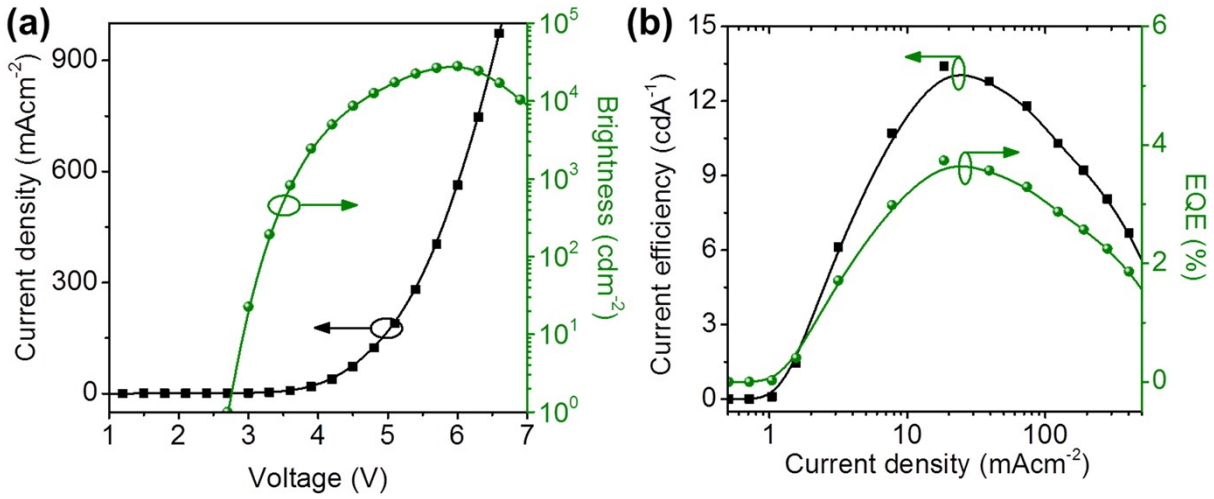

Figure S8. (a) J-V and L-V, (b) CE-J and EQE-J curves for the TBAB:$CsPbBr_3$ (4.6%) with PEDOT:PSS treated by CB mixed DMSO (10:1 v/v).

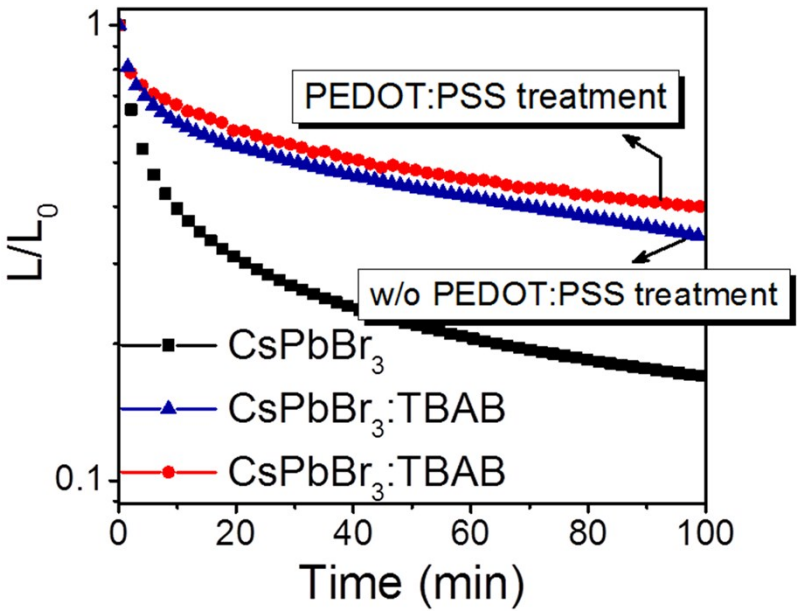

Figure S9. Stability of the unencapsulated PeLEDs with initial luminance (L_0) of 1000 cd m^{-2} under ambient condition (30 ℃, 40% relative humidity).

Table S1. Summary of the representative $CsPbBr_3$ based PeLEDs.

Perovskite emitter	EL peak (nm)	V_{on} (V)	L_{max} (cd/m^2)	Max. EQE (%)	Max. CE (cd/A)	Ref
$CsPbBr_3$ thin film	520	2.6	67300	6.28	22.5	This work
$CsPbBr_3$ thin film	521	2.5	53525	4.26	15.67	1
$CsPbBr_3$ thin film	527	NA	10700	0.93	2.90	2
$CsPbBr_3$ thin film	528	3.0	407	NA	0.035	3
$CsPbBr_3$ thin film	527	2.8	7267	0.15	0.57	4
$CsPbBr_3$ NCs	516	3.5	1377	0.06	0.19	5
$CsPbBr_3$ QDs	512	3.4	15185	6.27	13.3	6
$CsPbBr_3$ thin film	525	2.6	51890	4.76	21.38	7
$CsPbBr_3$ thin film	522	NA	13752	1.37	5.39	8

QDs (quantum dots), NCs (nanocrystals), V_{on} (turn on voltage), L_{max} (maximum luminance), NA (not available)

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