Supporting Information

Low-Dimensional Phase Suppression and Defect Passivation of Quasi-2D Perovskites for Efficient Electroluminescence and Low-Threshold Amplified Spontaneous Emission

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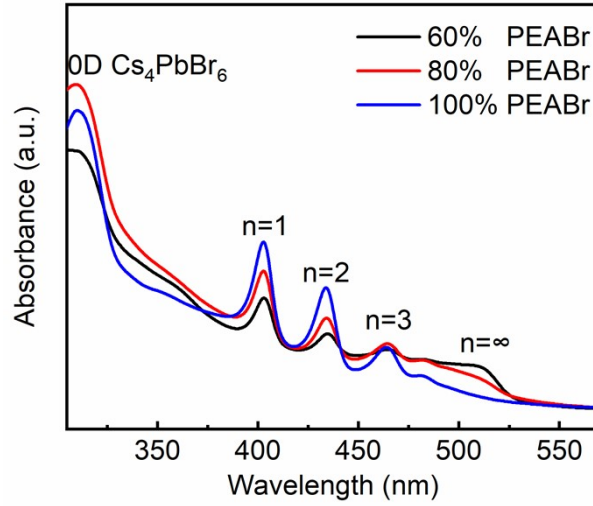
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Figure S1. Absorption of the pure PEA-based perovskite films with different contents of PEABr.
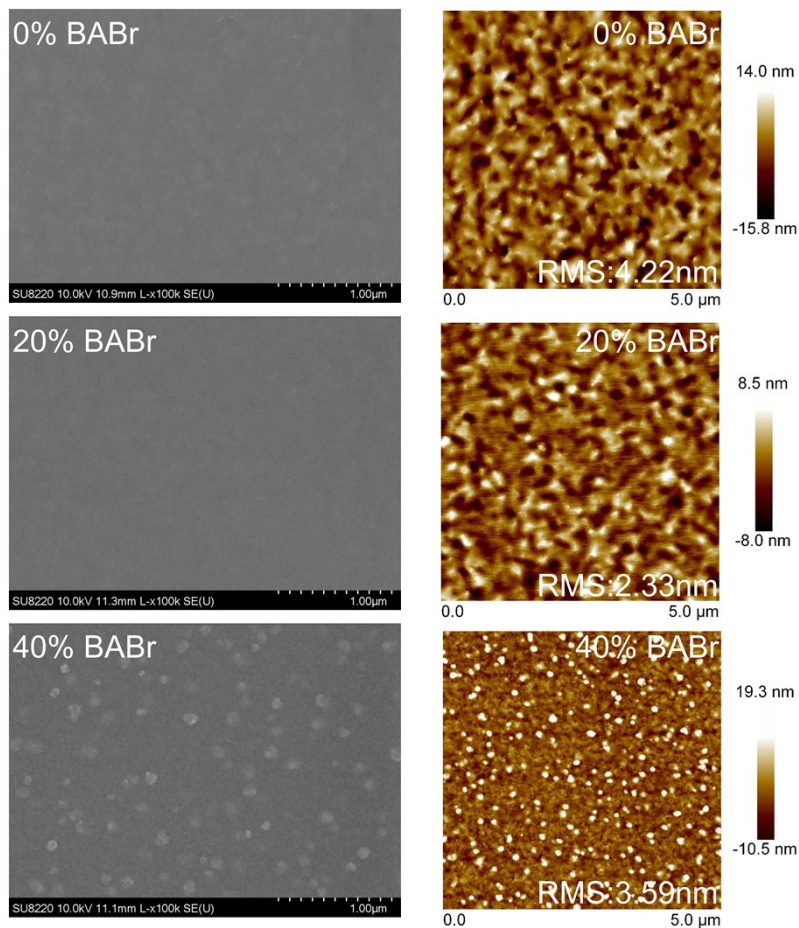

Figure S2. SEM and AFM images of the perovskite films with different contents of BABr.

Table S1. The FWHM of the diffraction peaks for the (200) planes of CsPbBr$_3$ determined from the XRD results.

sample	2θ (degree)	FWHM (degree)
0% BABr	30.98	0.41
10% BABr	30.95	0.51
20% BABr	30.89	0.53
40% BABr	30.94	0.74

Table S2. Lifetime fitting parameters obtained from TRPL decays of the perovskite films with different contents of BABr.

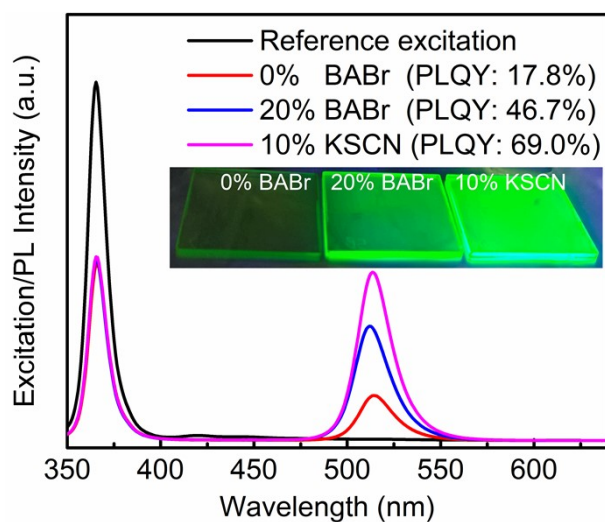| Sample	A_1	τ_1 [ns]	A_2	τ_2 [ns]	A_3	τ_3 [ns]	τ_{avg} [ns]
0% BABr	0.39	6.6	0.47	35.7	0.14	169.4	43.1
10% BABr	0.13	10.0	0.65	73.2	0.22	343.3	124.4
20% BABr	0.11	10.0	0.64	91.3	0.25	428.6	166.7
40% BABr	0.26	13.3	0.61	43.4	0.13	123.8	46.0

Figure S3. PLQY of the perovskite films with 0% BABr(pristine), 20% BABr and 10% KSCN (co-addition of 20% BABr). Inset: their images under 365 nm ultraviolet lamp excitation.
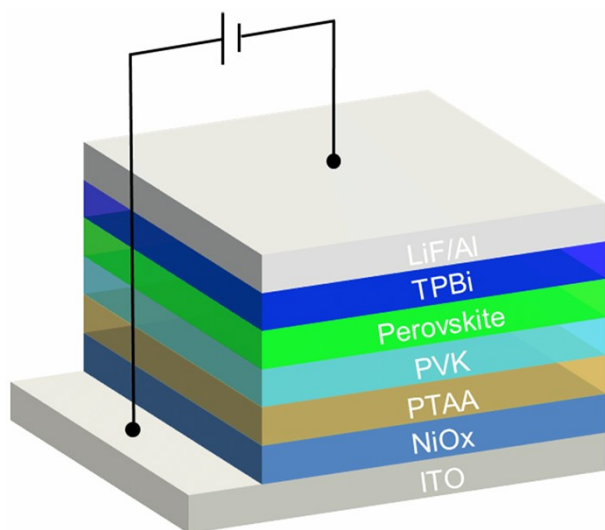

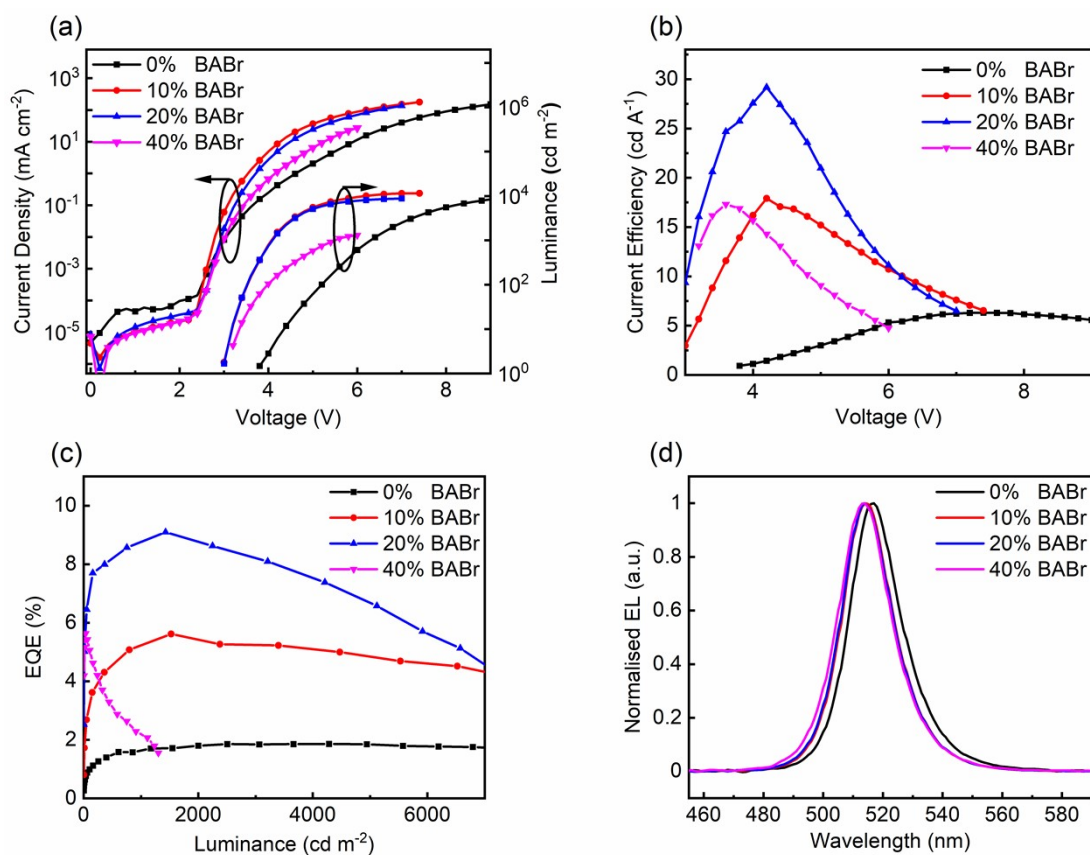Figure S4. Device configuration diagram of the green perovskite LEDs.

Figure S5. Device performances of the perovskite LEDs with different contents of BABr, here the content of PEABr is fixed at 40%. (a) J-L-V curves. (b) CE-V curves, (c) EQE-L curves, (d) EL spectra of the devices.
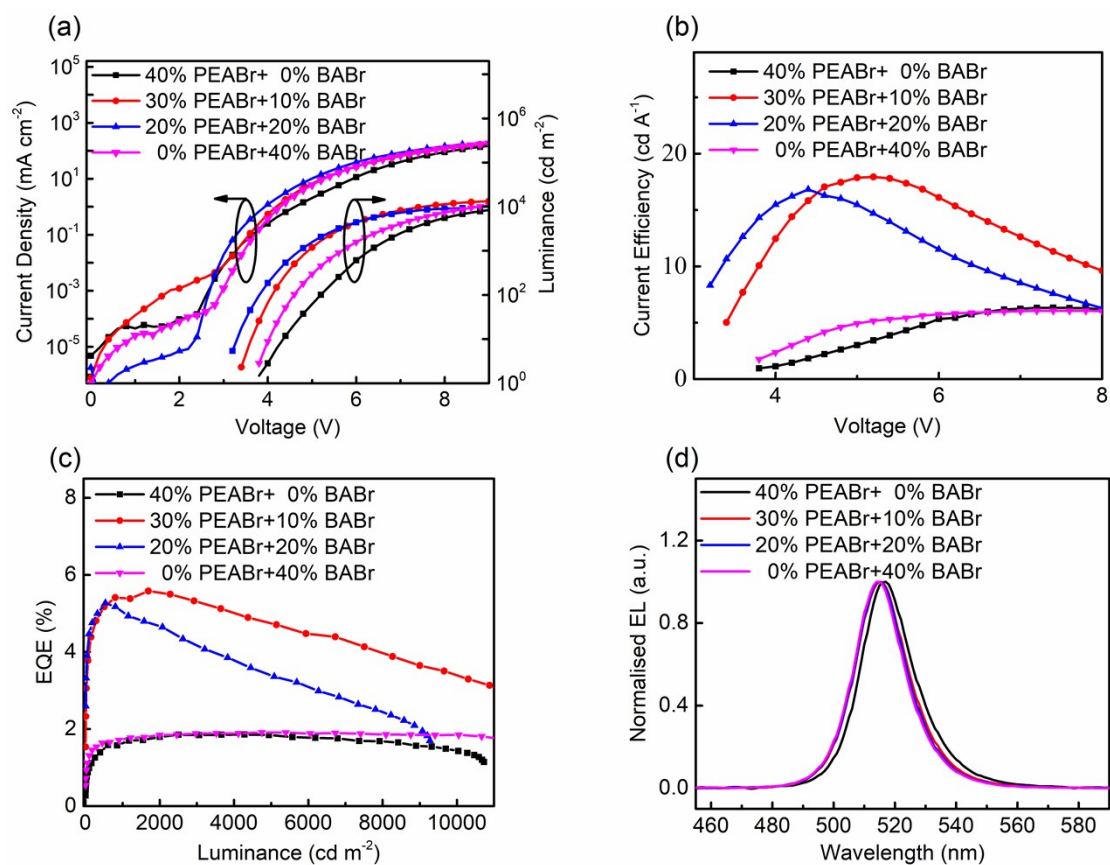
Figure S6. The device performance of the perovskite LEDs with different ratio of BABr:PEABr, here the total content of organic spacers is fixed at 40%. (a) J-L-V curves. (b) CE-V curves, (c) EQE-L curves, (d) EL spectra of the devices.
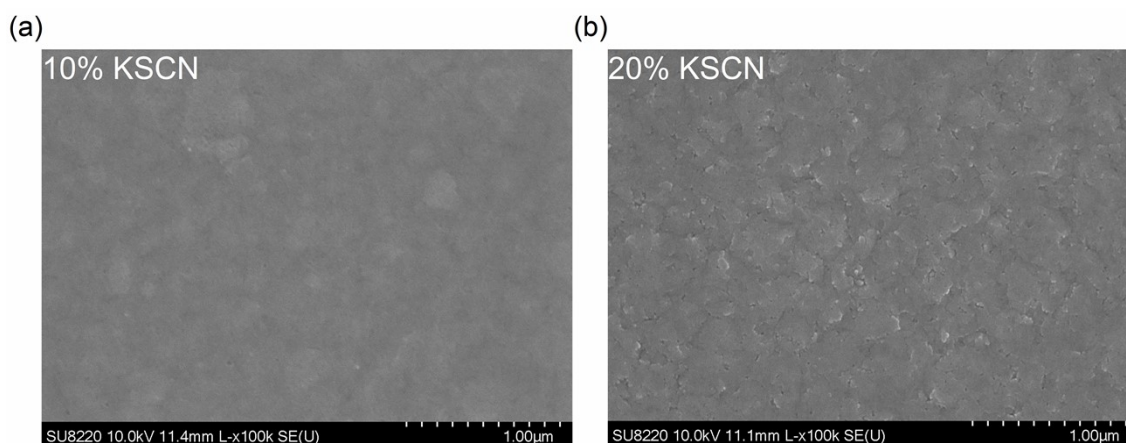

Figure S7. SEM images of the BABr-incorporated perovskite films with 10% and 20% KSCN.
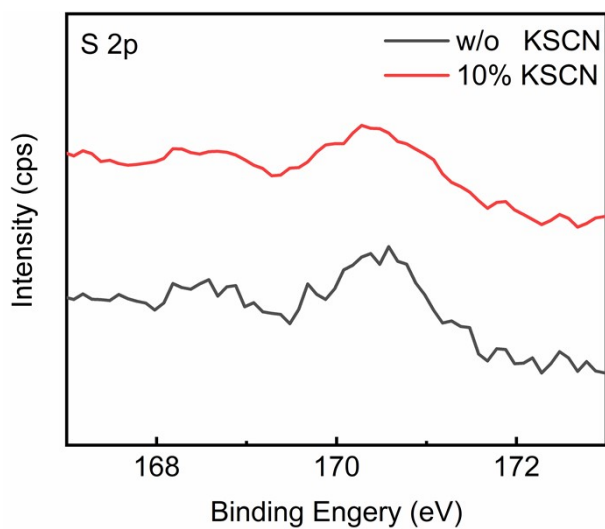
Figure S8. XPS spectra of S 2p for the BABr-incorporated perovskite films without and with 10% KSCN.
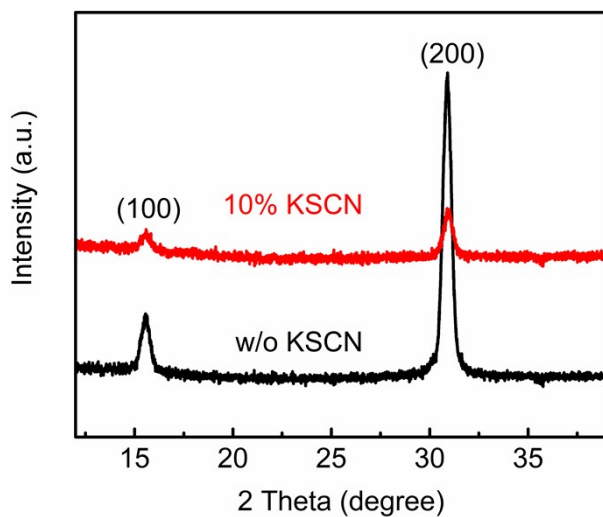

Figure S9. XRD spectra of the BABr-incorporated perovskite films without and with 10% KSCN.
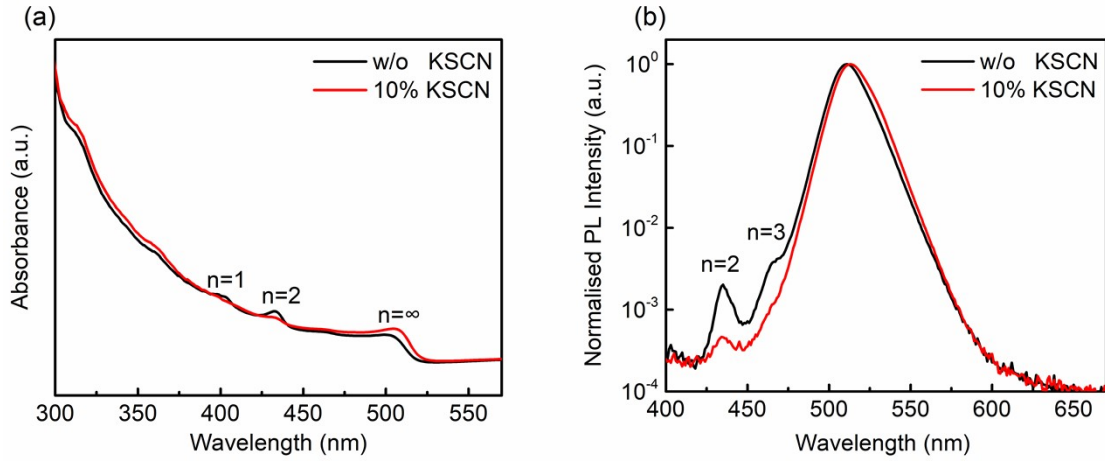
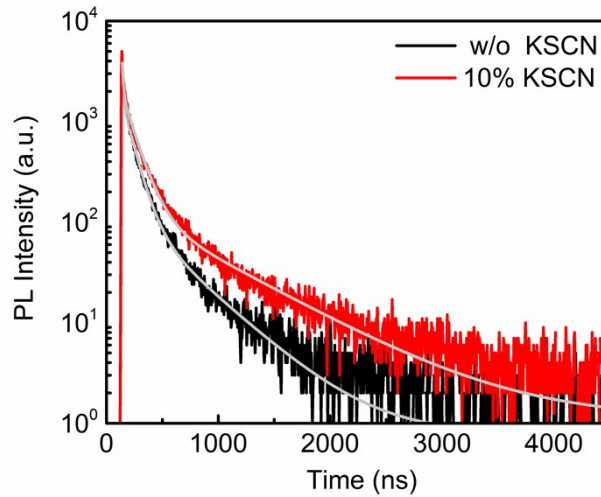Figure S10. Absorption and PL spectra of the BABr-incorporated perovskite films without and with 10% KSCN.

Figure S11. TRPL decays of the BABr-incorporated perovskite films without and with 10% KSCN.

Table S3. Summary of the fitting parameters obtained from TRPL decays and the determined k_{rad} and k_{nonrad} of the BABr-incorporated perovskite films without and with 10% KSCN.

Sample	A_1	τ_1 [ns]	A_2	τ_2 [ns]	A_3	τ_3 [ns]	τ_{avg} [ns]	k_{rad}[10^6 s^{-1}]	K_{nonrad} [10^6 s^{-1}]
0% KSCN	0.11	10.0	0.64	91.3	0.25	428.6	166.7	2.80	3.20
10% KSCN	0.09	10.0	0.61	111.5	0.30	706.9	281.0	2.46	1.10

Table S4. Summary of the performance parameters for the perovskite LEDs without and with 10% KSCN.

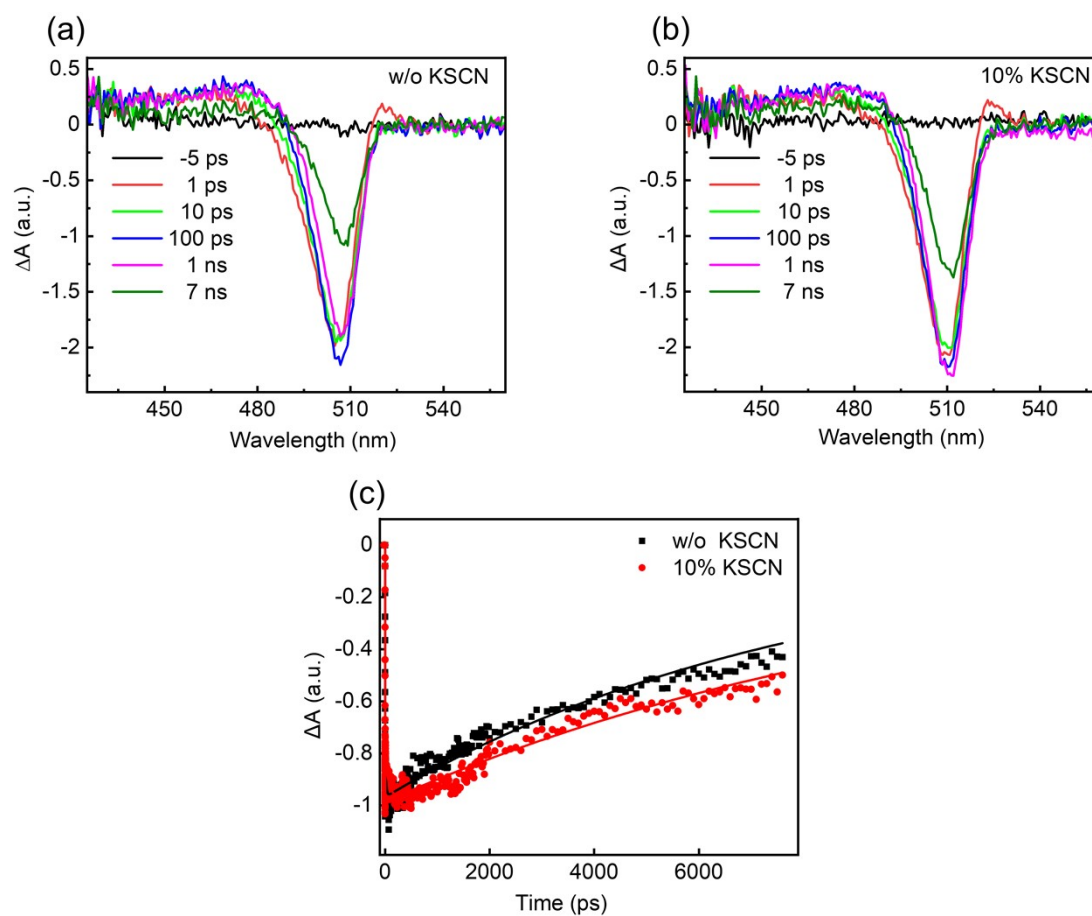| Device	V_{on} [V]	L_{max} [cd m^{-2}]	CE_{max} [cd A^{-1}]	EQE_{max} [%]	EQE_{avg} [%]	EL peak [nm]
w/o KSCN	3.0	8794	29.2	9.1	7.3	514
10% KSCN	3.0	22040	59.7	16.3	15.1	521

Figure S12. Selected TA spectra of the perovskite films without (a) and with 10% KSCN (b). (c) The transition kinetics for bleach peaks of the perovskite films without and with 10% KSCN at 506 nm and 510 nm, respectively.
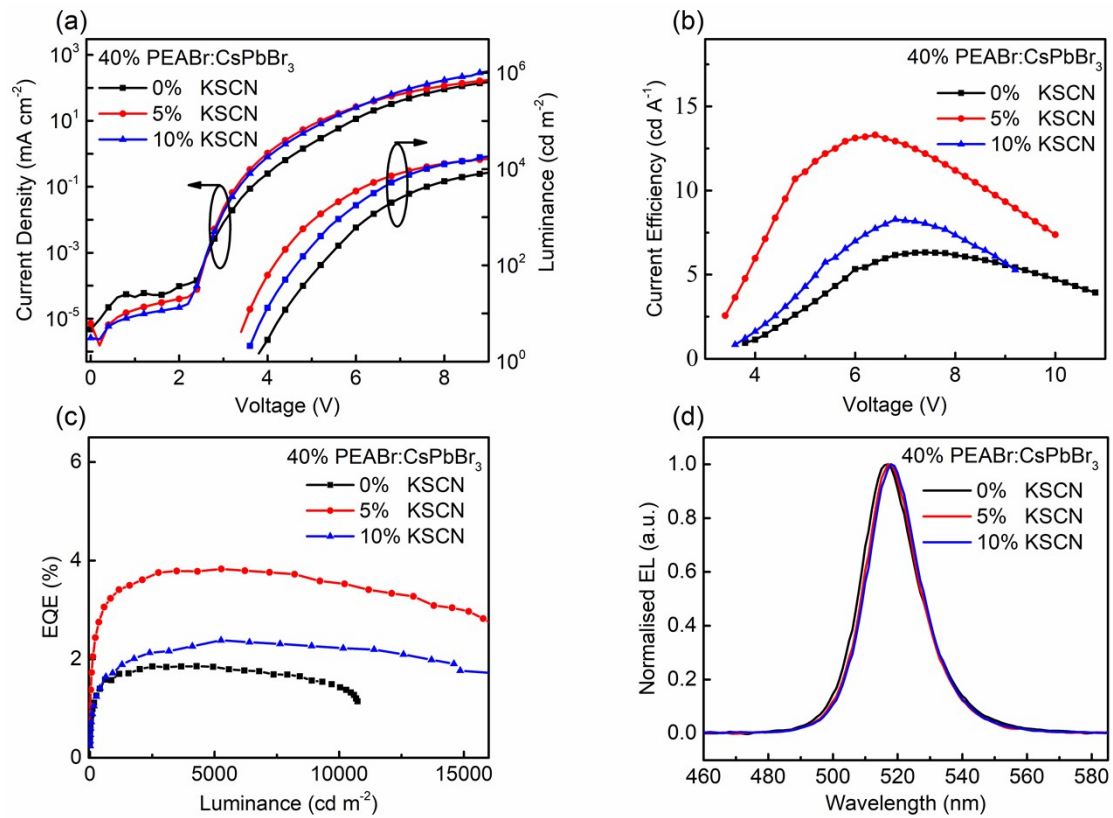
Figure S13. Device performances of the perovskite LEDs with different contents of KSCN alone. (a) J-L-V curves. (b) CE-V curves, (c) EQE-L curves, (d) EL spectra of the devices.
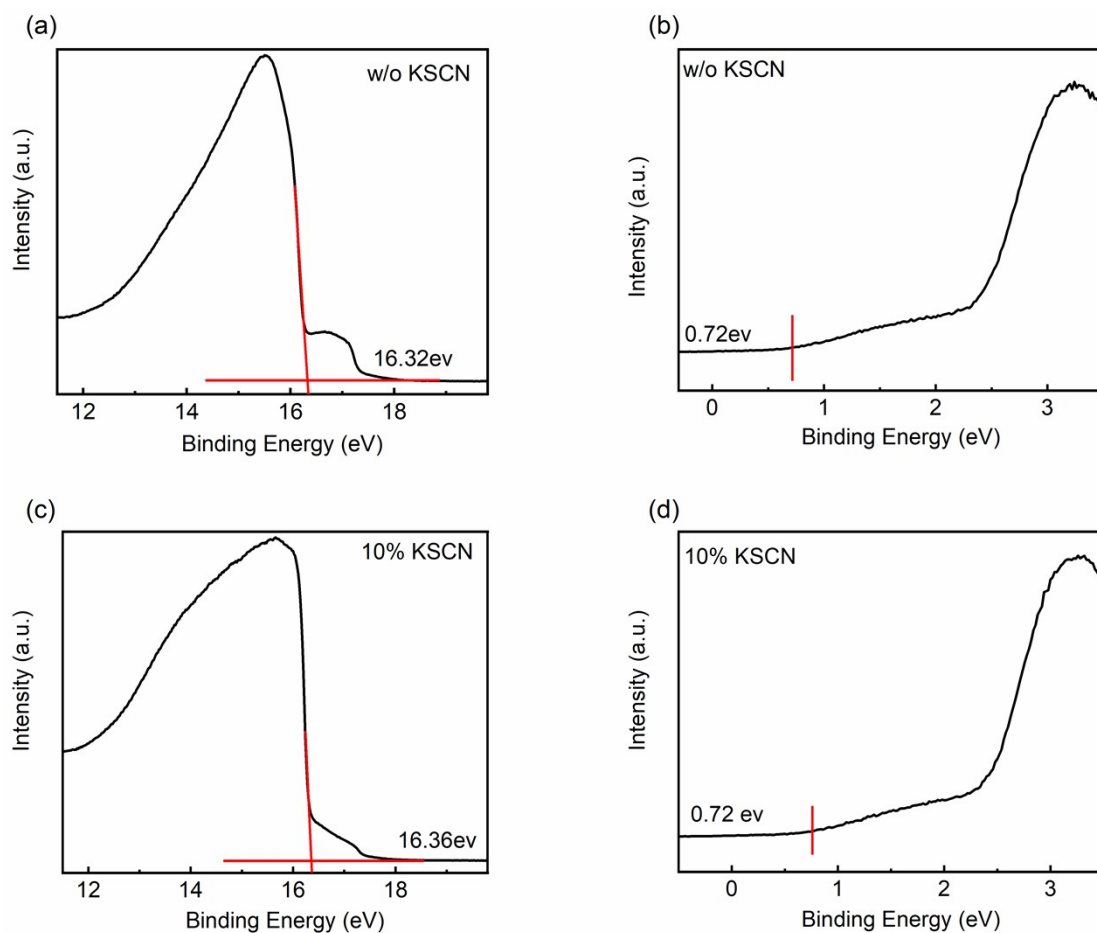
Figure S14. UPS secondary-electron cutoff and VB-edge regions of the BABr-incorporated perovskite films without and with 10% KSCN.
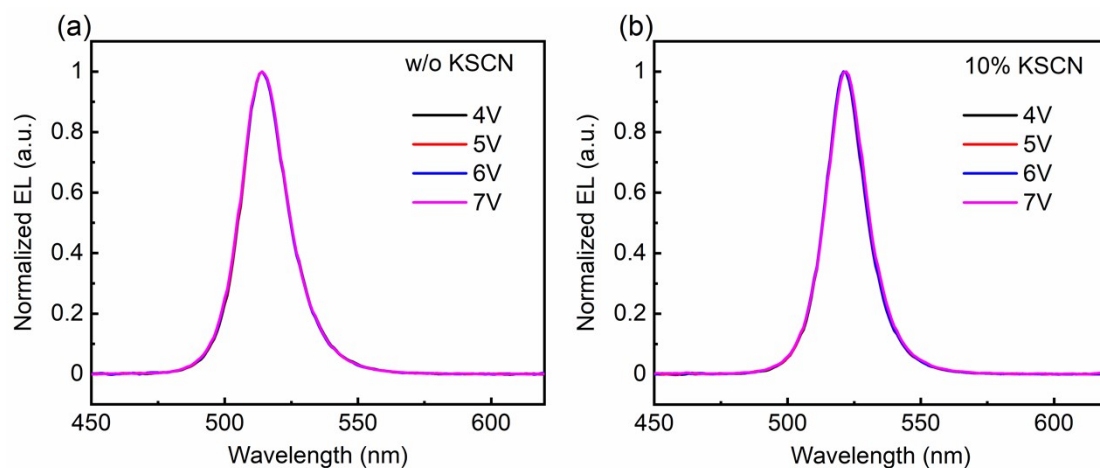

Fig. S15. EL spectra of the PeLEDs based on the BABr-incorporated films without and with 10% KSCN at the driven voltages ranging from 4 to 7V.
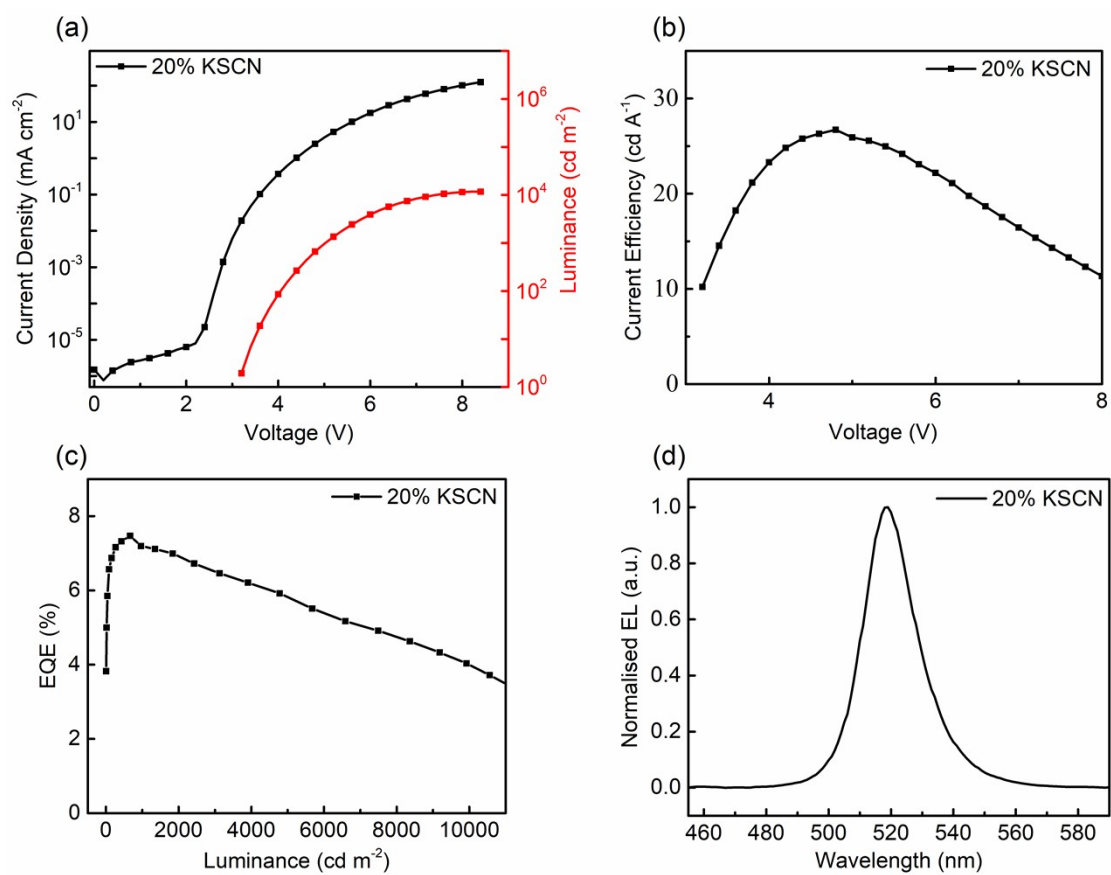
Figure S16. Device performances of the perovskite LEDs based on the BABr-incorporated film with 20% KSCN. (a) J-L-V curves. (b) CE-V curve, (c) EQE-L curve, (d) EL spectrum of the device.

Table S5. Summary of ASE properties of green quasi-2D perovskite thin films reported in the literature.

Gain material	Pump source	ASE Emssion peak (nm)	ASE threshold ($\mu J\ cm^{-2}$)	Ref.
BABr:MAPbBr$_3$	150fs, 400nm	543	13.6	1
NMABr:FAPbBr$_3$	150fs, 400nm	530	8.5	2
BABr:FAPbBr$_3$	150fs, 400nm	550	21.5	3
PEABr:FAPbBr$_3$	150fs, 400nm	542	4.2	4
PEABr:FAPbBr$_3$	3ns, 337nm	550	33.1	5
NMABr:FAPbBr$_3$	3ns, 337nm	555	16.7	5
OABr:CsPbBr$_3$	1ns, 355nm	535	14.9	6
PEABr:CsPbBr$_3$	35fs, 400nm	534	2.6	7
PEABr:CsPbBr$_3$	230fs, 343nm	525	12.5	This work
BABr:PEABr:CsPbBr$_3$	230fs, 343nm	527	9.8	This work
KSCN:BABr:PEABr:CsPbBr$_3$	230fs, 343nm	530	2.6	This work

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2   M. Li, Q. Gao, P. Liu, Q. Liao, H. Zhang, J. Yao, W. Hu, Y. Wu, H. Fu, *Adv. Funct. Mater.,* 2018, **28**, 1707006.

3   H. H. Zhang, Y. S. Wu, Q. Liao, Z. Y. Zhang, Y. P. Liu, Q. G. Gao, P. Liu, M. L. Li, J. N. Yao, H. B. Fu, *Angew.Chem. Int.Ed.,* 2018, **57**, 7748.

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7   M. Cui, C. Qin, Y. Jiang, M. Yuan, L. Xu, D. Song, Y. Jiang, Y. Liu, *J. Phys. Chem. Lett.,* 2020, **11**, 5734.