Electronic Supplementary Information

In-situ passivation of Pb^0 traps by fluoride acid-based ionic liquid enables enhanced emission and stability of $CsPbBr_3$ nanocrystals for efficient white light-emitting diodes

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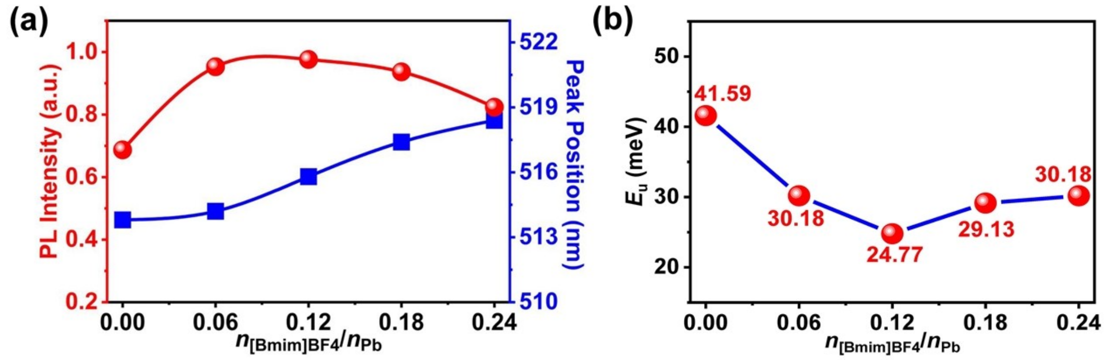

Fig. S1 (a) Evolution of PL intensity and peak positions and (b) calculated Urbach energy of $CsPbBr_3$ NCs with different $n_{[Bmim]BF4}/n_{Pb}$ ratios.

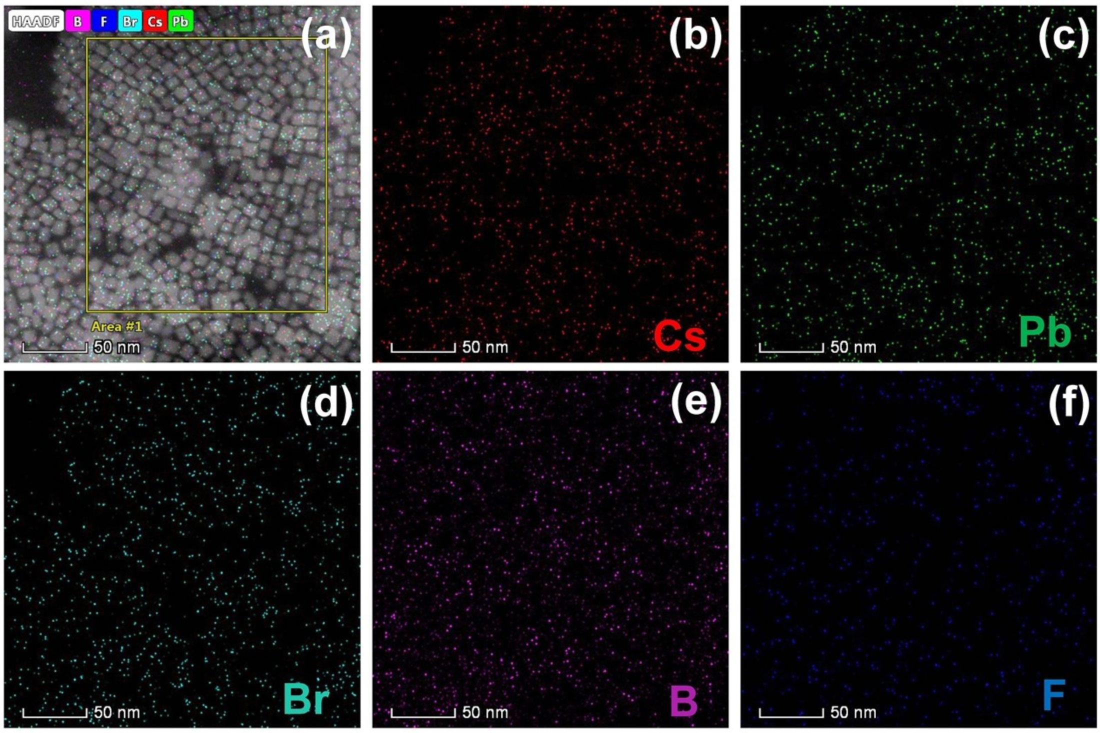

Fig. S2 (a) HAADF-STEM image, (b) Cs, (c) Pb, (d) Br, (e) B, and (f) F elemental maps of $CsPbBr_3$ NCs prepared with $n_{[Bmim]BF4}/n_{Pb}$=0.12.

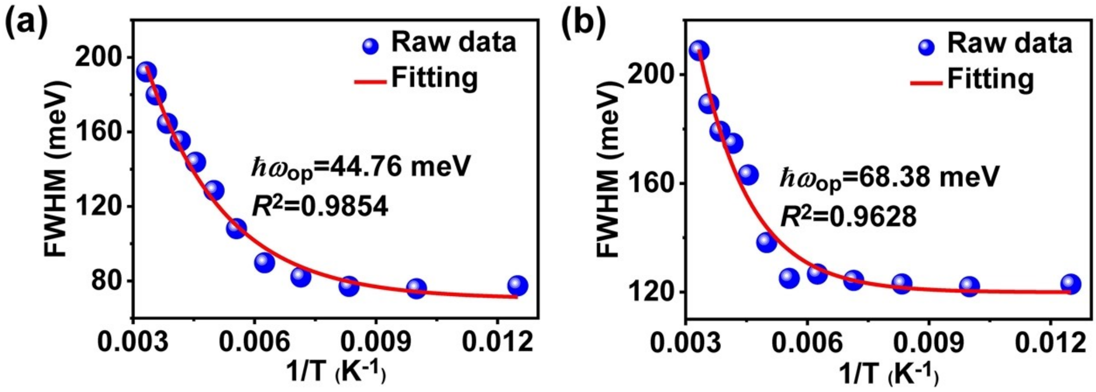

Fig. S3 Plot of the FWHM of $CsPbBr_3$ NCs prepared (a) without and (b) with the assistance of $[Bmim]BF_4$ as a function of 1/T.

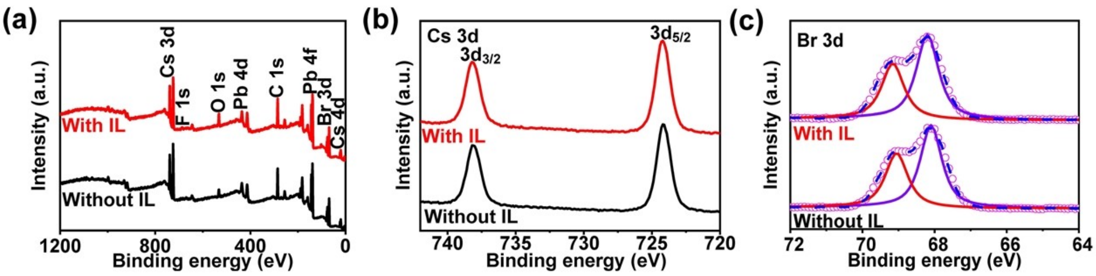

Fig. S4 XPS (a) survey spectra, and (b) Cs 3d core-level, and (c) Br 3d core-level spectra of $CsPbBr_3$ NCs prepared with and without the assistance of $[Bmim]BF_4$.

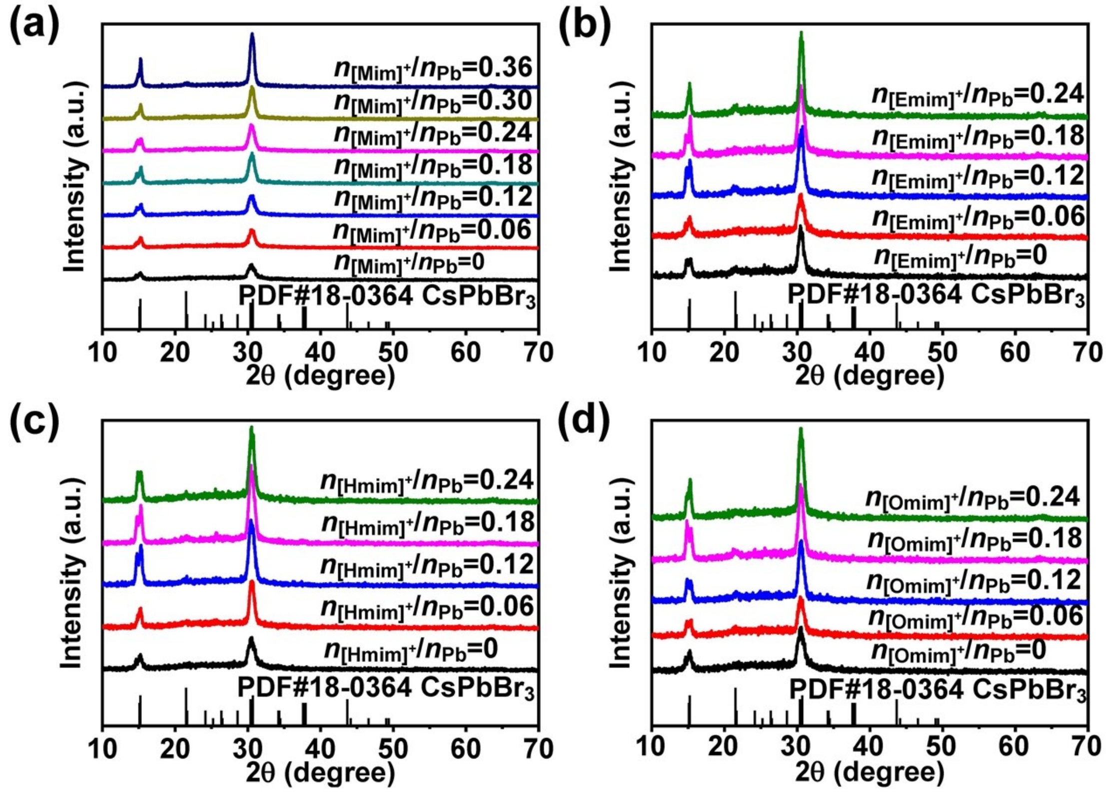

Fig. S5 XRD patterns of $CsPbBr_3$ NCs prepared with different chain length of ionic liquid: (a) [Mim]BF_4, (b) [Emim]BF_4, (c) [Hmim]BF_4, and (d) [Omim]BF_4.

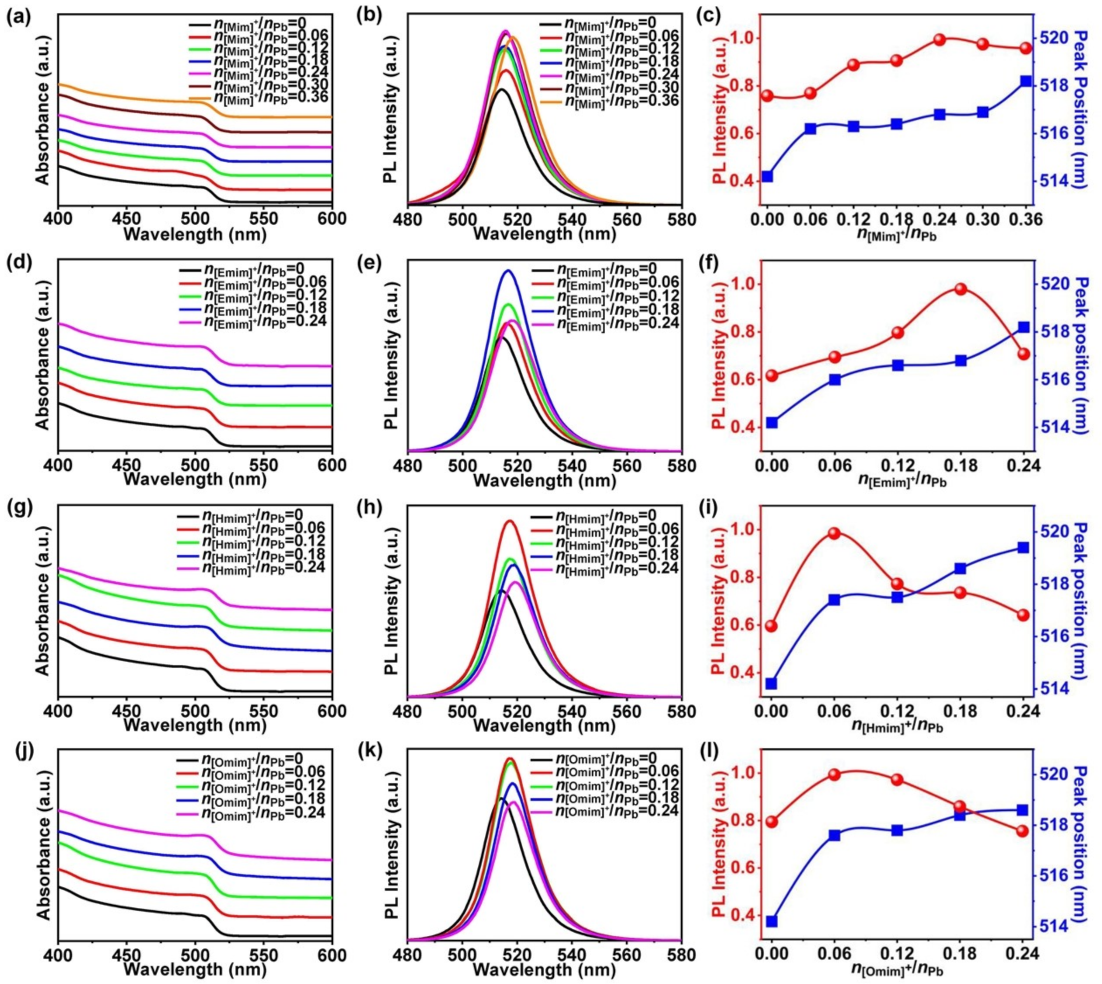

Fig. S6 Absorption spectra, PL spectra, and evolution of PL intensity and peak positions in dependence with the values of the molar ratios of (a-c) $n_{[Mim]^+}/n_{Pb}$, (d-f) $n_{[Emim]^+}/n_{Pb}$, (g-i) $n_{[Hmim]^+}/n_{Pb}$, (j-l) $n_{[Omim]^+}/n_{Pb}$.

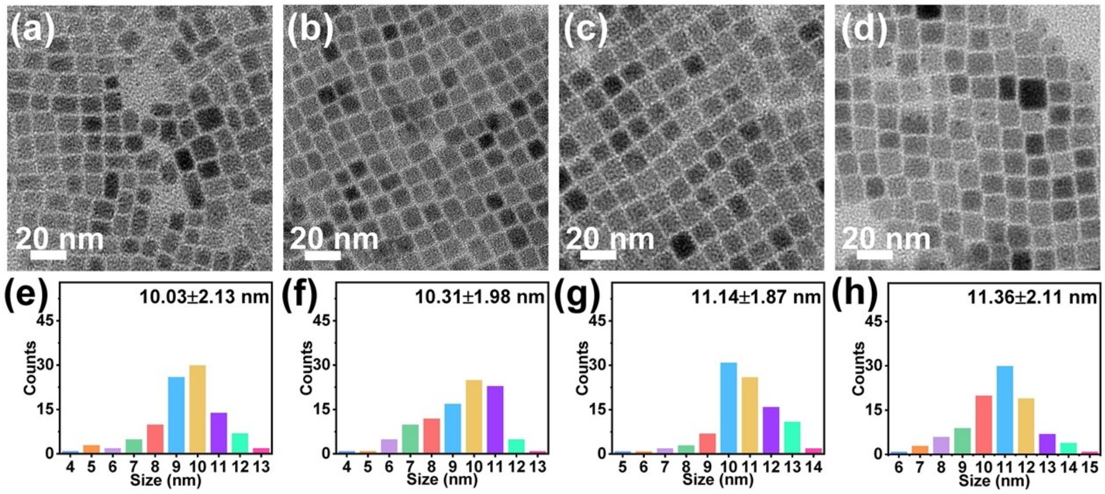

Fig. S7 TEM images and size distribution histograms of $CsPbBr_3$ NCs prepared by using ionic liquid with different chain length: (a, e) [Mim]BF_4, (b, f) [Emim]BF_4, (c, g) [Hmim]BF_4, and (d, h) [Omim]BF_4.

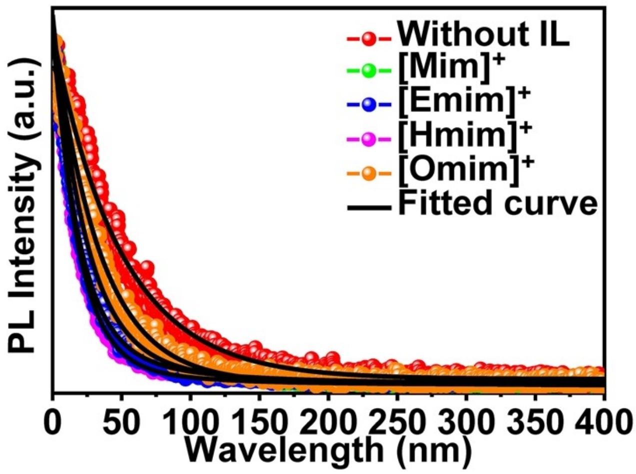

Fig. S8 Decay curves of $CsPbBr_3$ NCs prepared by using ionic liquid with different chain length.

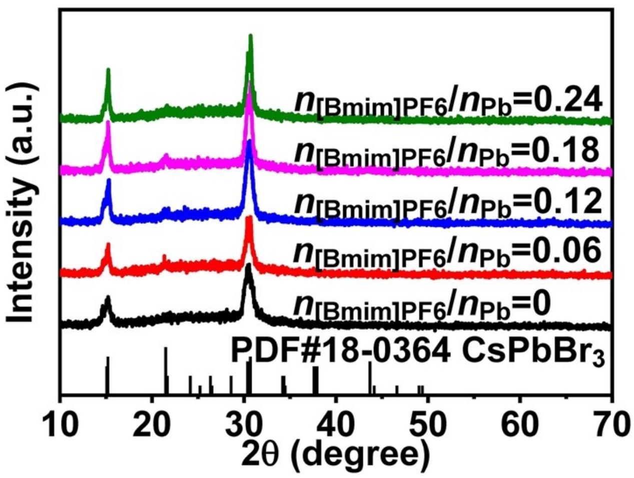

Fig. S9 XRD patterns of $CsPbBr_3$ NCs prepared with different $n_{[Bmim]PF6}/n_{Pb}$ ratios of 0, 0.06, 0.12, 0.18, and 0.24.

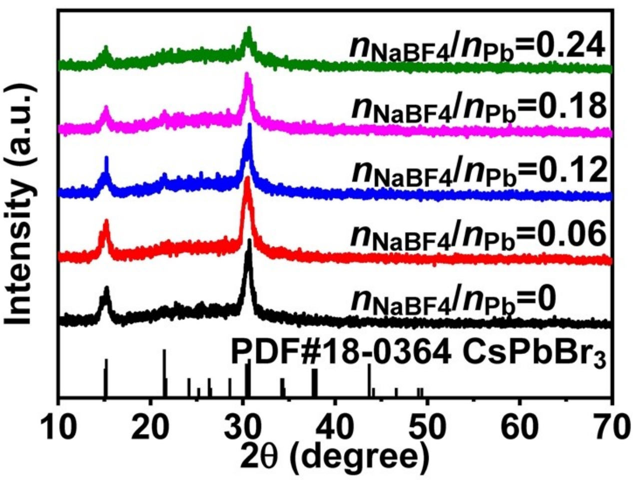

Fig. S10 XRD patterns of $CsPbBr_3$ NCs prepared with different n_{NaBF4}/n_{Pb} ratios of 0, 0.06, 0.12, 0.18, and 0.24.

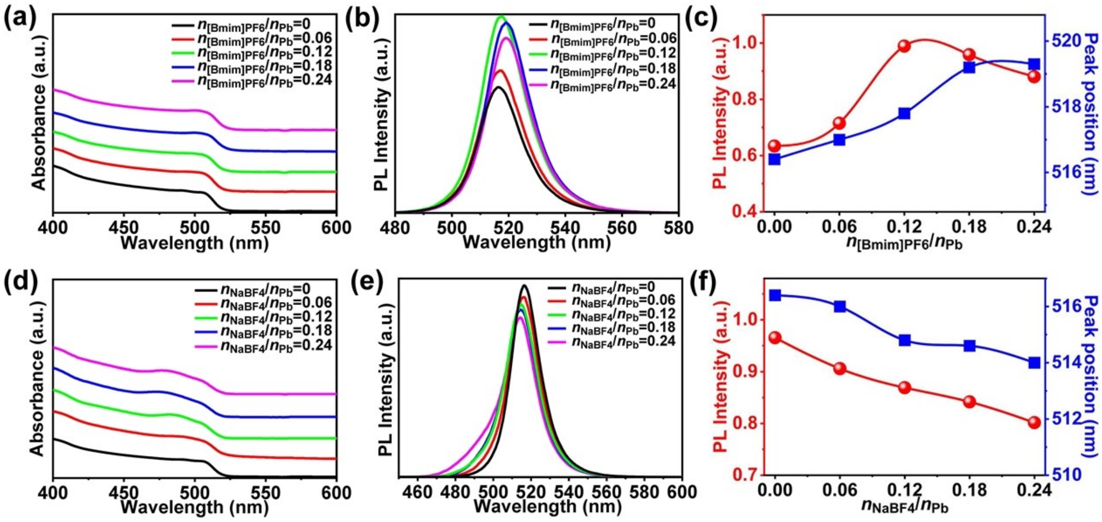

Fig. S11 Absorption spectra, PL spectra, and evolution of PL intensity and peak positions in dependence with the values of the molar ratios of (a-c) $n_{[Bmim]PF6}/n_{Pb}$, (d-f) n_{NaBF4}/n_{Pb}.

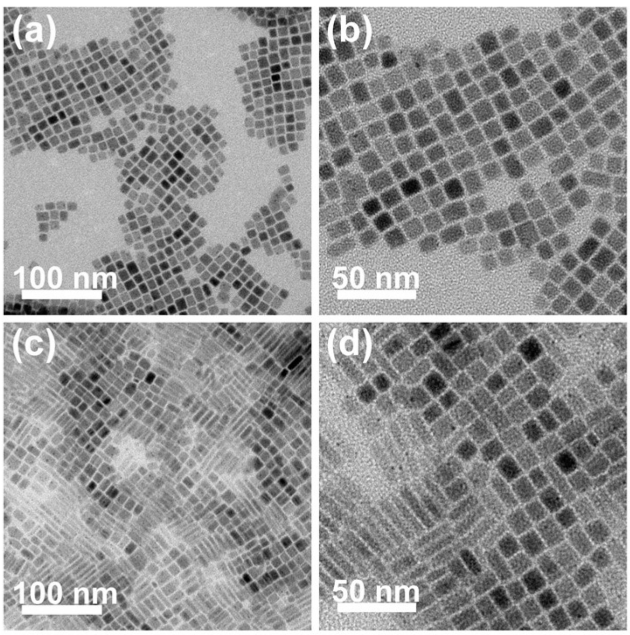

Fig. S12 TEM images of $CsPbBr_3$ NCs prepared using (a, b) $[Bmim]PF_6$, and (c, d) $NaBF_4$ as additives.

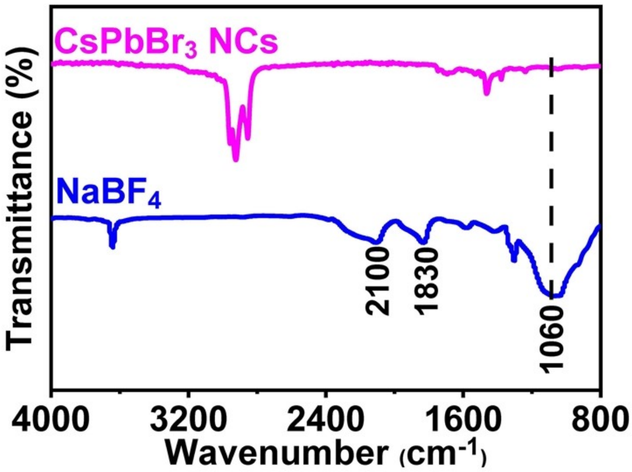

Fig. S13 FT-IR spectra of $NaBF_4$ and $CsPbBr_3$ NCs prepared with the assistance of $NaBF_4$.

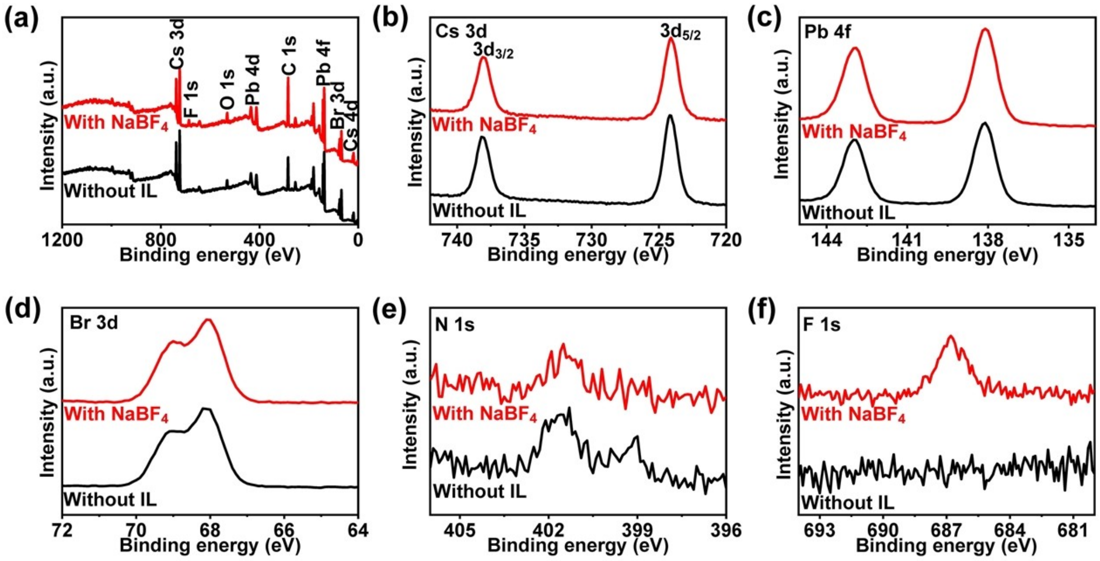

Fig. S14 XPS (a) survey spectra, and (b) Cs 3d core-level, (c) Pb 4f core-level, (d) Br 3d core-level, (e) N 1s core-level, and (f) F 1s core-level spectra of $CsPbBr_3$ NCs prepared with and without the assistance of $NaBF_4$.

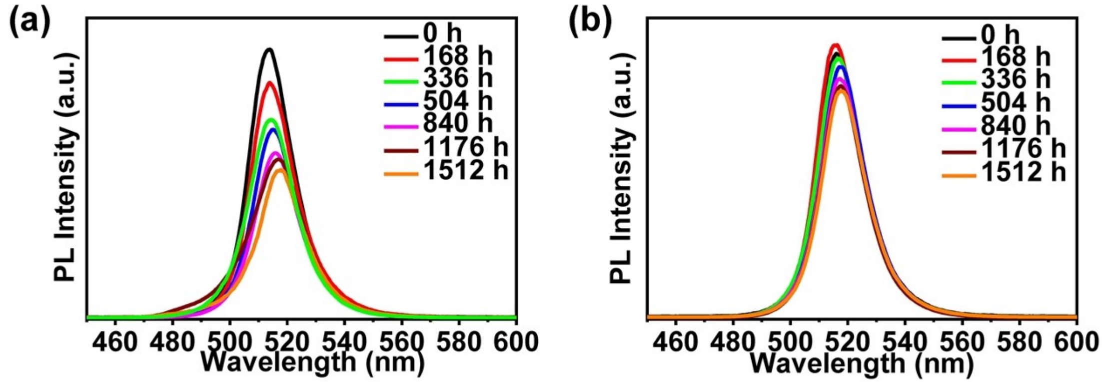

Fig. S15 PL spectra of $CsPbBr_3$ NCs prepared (a) without and (b) with the assistance of [Bmim]BF_4 in dependence with the storage time.

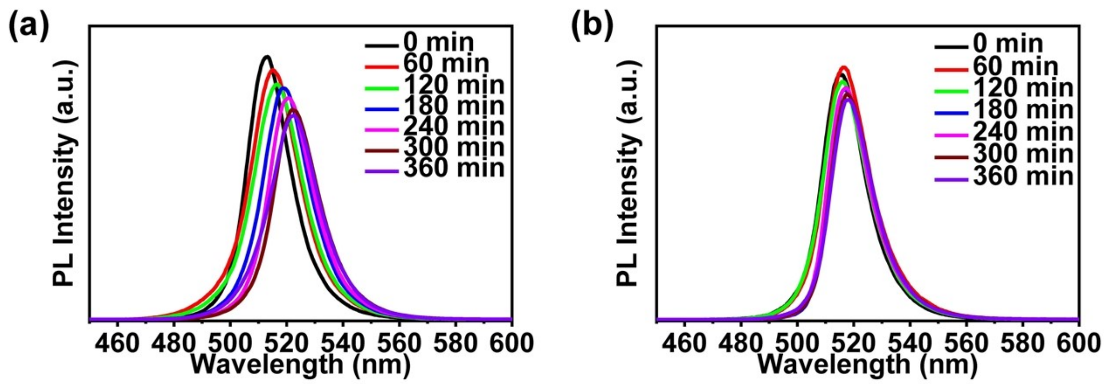

Fig. S16 PL spectra of $CsPbBr_3$ NCs prepared (a) without and (b) with the assistance of [Bmim]BF_4 in dependence with the irradiation time of UV light.

Table S1 FWHM data and calculated average size of $CsPbBr_3$ NCs prepared with different $n_{[Bmim]BF4}/n_{Pb}$ ratios.

$n_{[Bmim]BF4}/n_{Pb}$	Plane	FWHM/°	Calculated Size[a]/nm	Intensity
0	(200)	0.806	10.11	119
0.06	(200)	0.788	10.34	135
0.12	(200)	0.727	11.21	208
0.18	(200)	0.695	11.72	243
0.24	(200)	0.580	14.05	414

[a] Calculated size is obtained from Scherrer equation: $D=K\lambda/B\cos\theta$, where D represents the particle size of NCs, B represents the FWHM of (200) plane, and θ represents the diffraction angle. K is equal to 0.89.

Table S2 Fitting parameters of PL decay curves and calculated k_r and k_{nr} of $CsPbBr_3$ NCs with different $n_{[Bmim]BF4}/n_{Pb}$ ratios.

$n_{[Bmim]BF4}/n_{Pb}$	τ_1/ns	B_1/%	τ_2/ns	B_2/%	χ^2	τ_{av}/ns	k_r/s^{-1}	k_{nr}/s^{-1}
0	12.88	80.12	120.87	19.88	0.9965	88.43	7.22×10^6	4.09×10^6
0.06	10.67	92.13	60.73	7.87	0.9845	27.05	3.46×10^7	2.38×10^5
0.12	10.13	95.32	65.70	4.68	0.9850	23.55	4.01×10^7	2.32×10^5
0.18	14.65	88.61	78.27	11.39	0.9946	40.55	2.23×10^7	2.39×10^5

Table S3 Fitting parameters of PL decay curves of $CsPbBr_3$ NCs prepared by using ionic liquid with different chain length.

Sample	τ_1/ns	B_1/%	τ_2/ns	B_2/%	χ^2	τ_{av}/ns
Without IL	12.88	80.12	120.87	19.88	0.9965	88.43
$[Mim]BF_4$	12.73	89.15	80.01	10.85	0.9952	41.89
$[Emim]BF_4$	12.55	92.41	85.73	7.59	0.9968	38.85
$[Hmim]BF_4$	11.69	94.49	75.72	5.51	0.9962	29.24
$[Omim]BF_4$	34.47	85.37	87.33	14.63	0.9840	50.47

Table S4 Storage, UV light, and water stability of perovskite NCs.

Materials	Storage	UV light	Water	Ref
$CsPbBr_3@SiO_2$ Janus NCs	The NC film presents bright emission after storage in air for 4 days	The NC film shows slight drop (~2%) of PL intensity	Maintaining 80% of PL intensity after being treated water for 7 days	[66]
Quasi-2D $CsPbBr_3$ NCs	–	Keeping more than 85% of PL intensity after 120 min UV light irradiation	Remaining 87% of PL intensity after 168 h water treatment	[67]
$CsPbBr_3$/Pb-MA composite	–	Maintaining 43% of initial PL intensity after 36 h UV light irradiation	Holding 83% of PL intensity after being immersed in water for 192 h	[68]
4-Bromo-butyric acid passivated $CsPbBr_3$ NCs	–	–	Maintaining 79% of PL intensity after 72 h in aqueous solution	[69]
$[Bmim]BF_4$ passivated $CsPbBr_3$ NCs	Holding 85% of initial PL intensity after storage 1512 h	Retaining ~90% of initial intensity after continuous irradiation under a UV light for 360 min	Reserving 67.5% of initial emission intensity after 21 days water treatment	This work