Supporting Information

Efficient blue $CsPb(Br\text{-}Cl)_3$ nanoparticles enabled by strontium halides and amine halides synergetic optimization

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Table S1. The PLQY of $CsPb(Br\text{-}Cl)_3$ perovskite NPs with different ratios of NH_4^+/Cs^+ (*R*).

Samples	PLQY
R=0	5%
R=10%	12%
R=20%	13%
R=40%	12%

Table S2. ICP-OES analysis of strontium-based NPs.

Samples	**Sr^{2+}/Pb^{2+}**
Sr-0.1	0.6%
Sr-0.3	1.54%
Sr-0.5	3.6%

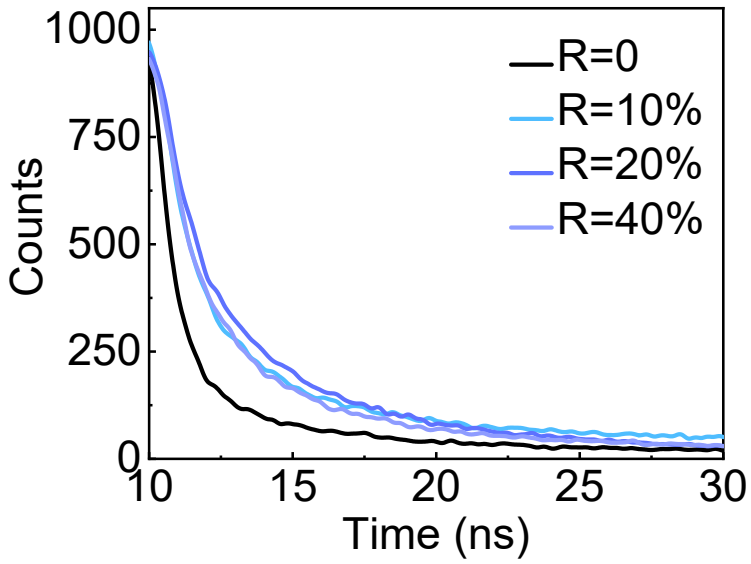

Figure S1. Time-resolved PL spectra for $CsPb(Br\text{-}Cl)_3$ perovskite NPs with different ratios of NH_4^+/Cs^+ (*R*).

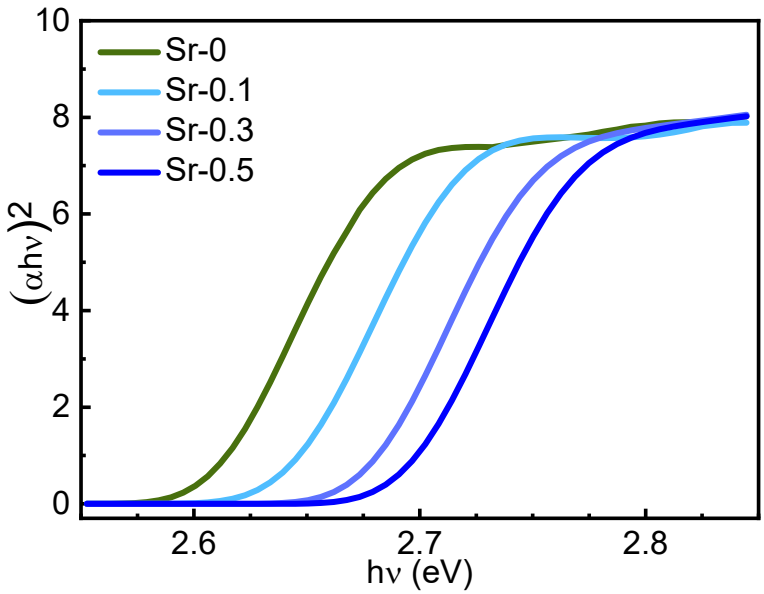

Figure S2. Tauc plot of Sr-j samples.

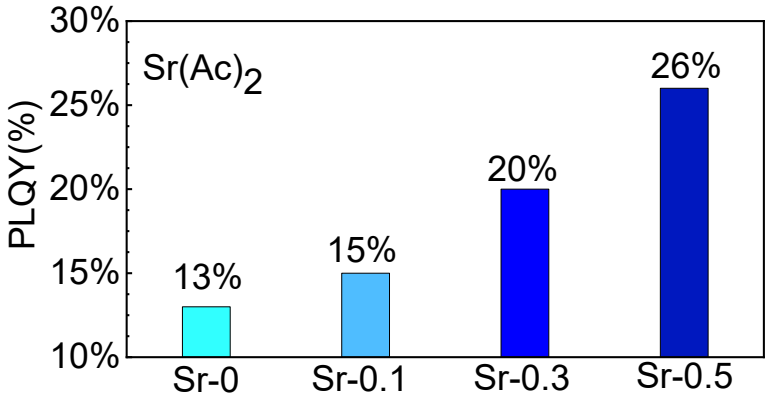

Figure S3. Absolute PLQYs of Sr-j based on $Sr(Ac)_2$.

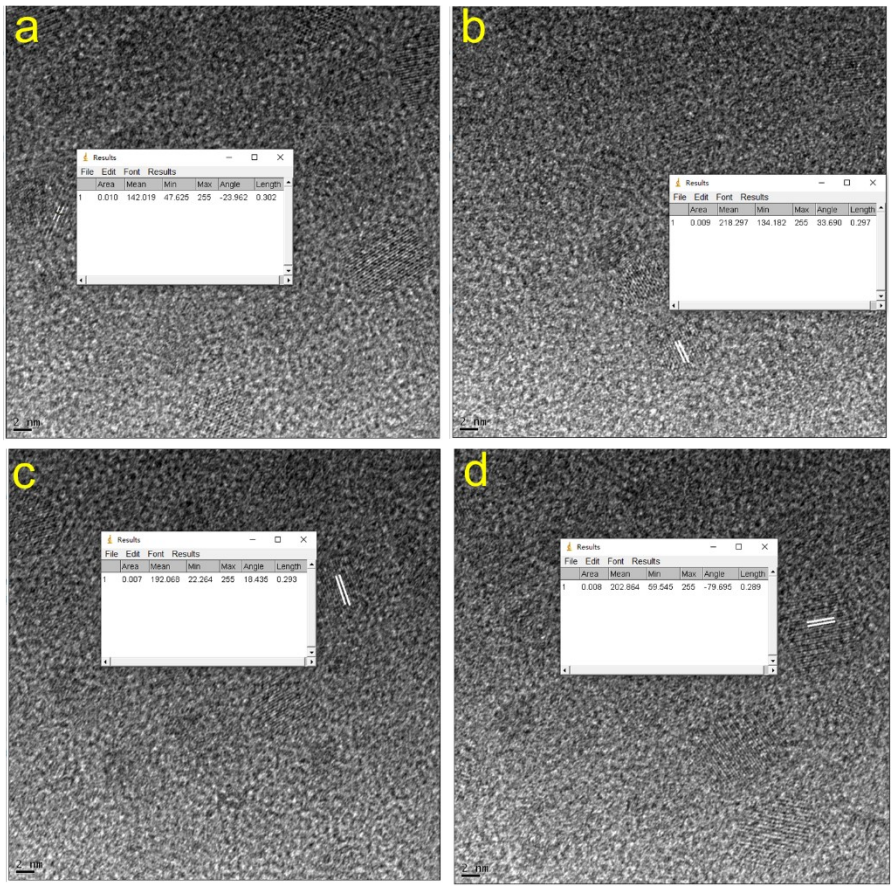

Figure S4. HRTEM images of Sr-j (0, 0.1, 0.3, 0.5).

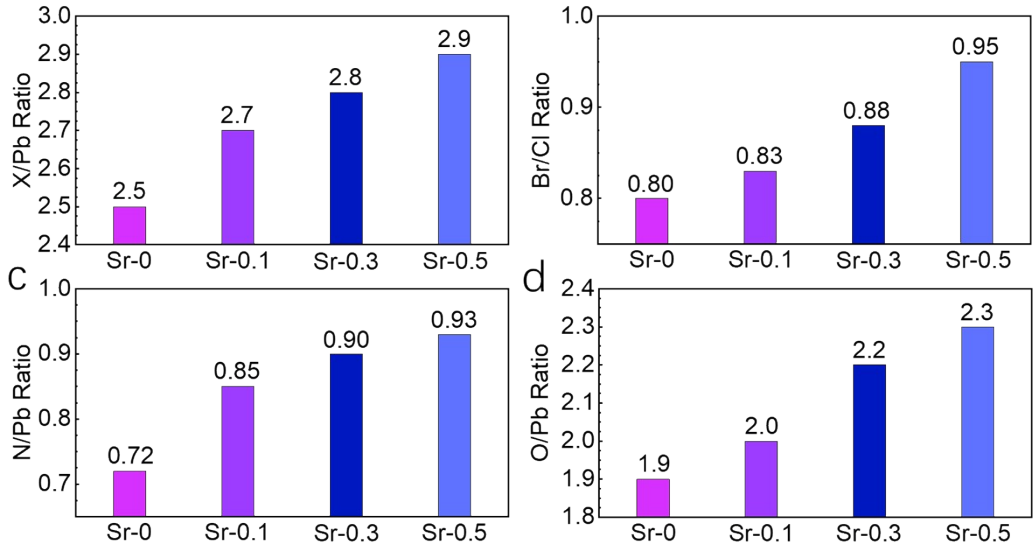

Figure S5. Quantitative XPS results of Sr-j, for (a) X to Pb ratio (b) Br to Cl ratio (c) N to Pb ratio (d) O to Pb ratio.

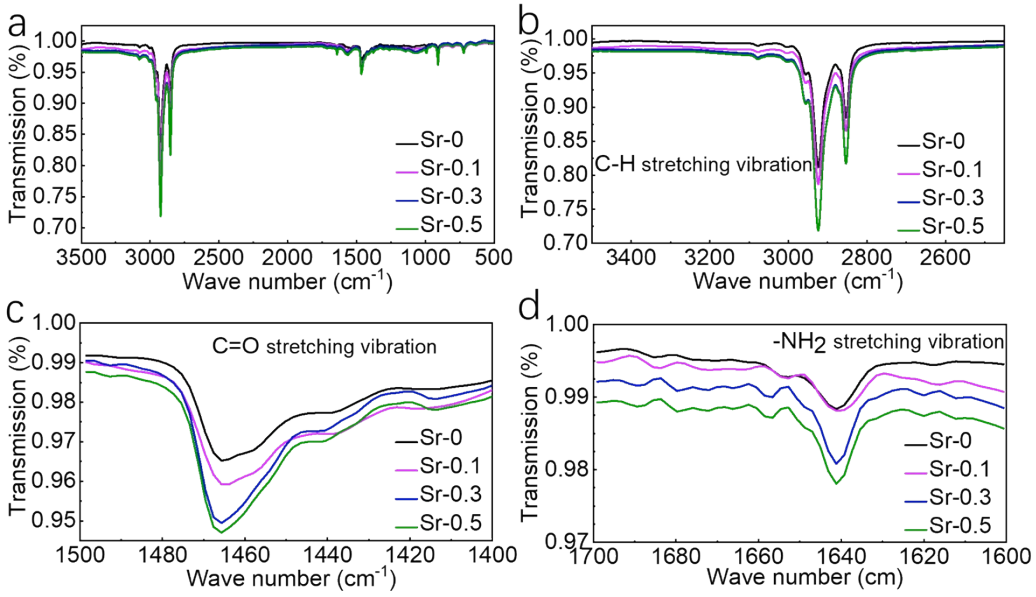

Figure S6. Fourier transform infrared spectroscopy (FTIR) spectra of Sr-j.

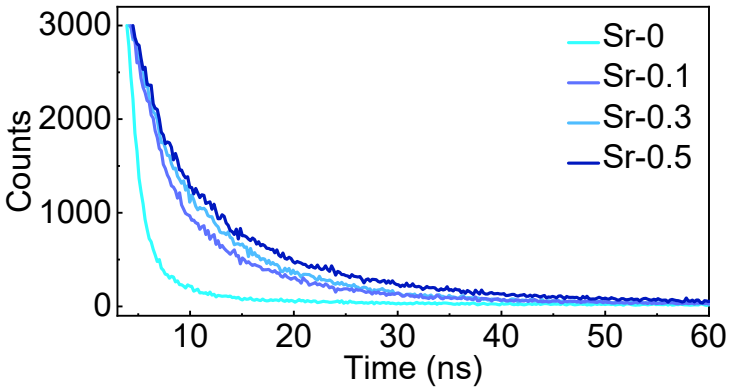

Figure S7. Time-resolved PL spectra of Sr-j.

Table S3. Summary of the time-resolved PL decay fitting parameters of Sr-j.

Samples	PLQY (%)	A_1	τ_1 (ns)	A_2	τ_2 (ns)	τ_{avg} (ns)
Sr-0	13%	0.9936	1.328	0.0064	10.382	1.764
Sr-0.1	29%	0.8469	3.323	0.1531	11.981	6.739
Sr-0.3	48%	0.7216	4.043	0.2784	11.164	7.716
Sr-0.5	60%	0.7597	4.018	0.2403	14.809	9.827

Table S4. Summary of the corresponding fs-TA time constants of Sr-0 and Sr-0.5.

Samples	P_1	τ_1 (ps)	P_2	τ_2 (ps)	P_3	τ_3 (ns)
Sr-0	0.828	1.393	0.060	48.297	0.112	3098.029
Sr-0.5	0.532	22.227	0.194	240.236	0.274	3580.387

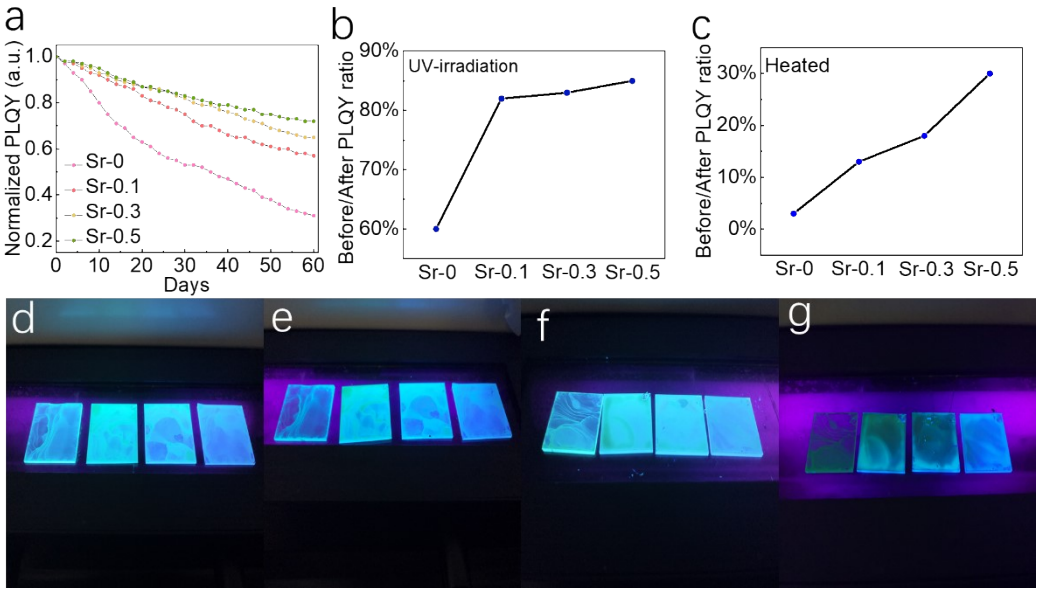

Figure S8. PLQY record for Sr-j samples (a) varied with days under atmosphere condition, (b) remained after continuous UV-irradiation and (c) remained after heated. (d, e) Images of Sr-j before, after UV irradiation. (f, g) Images of Sr-j before, after thermally treated on the hot plate.

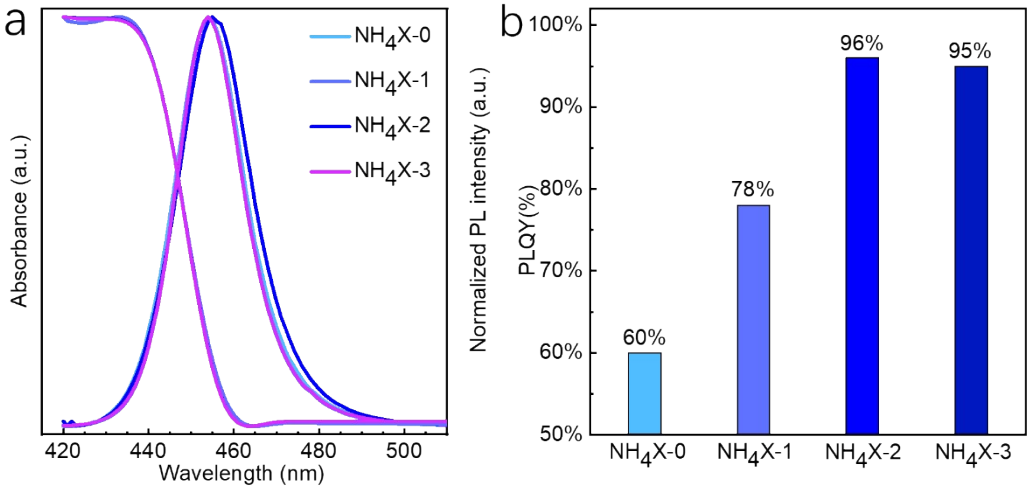

Figure S9. (a) Normalized PL and optical absorption spectra of each NH_4X-m NPs sample. (b) Absolute PLQYs of NH_4X-m.

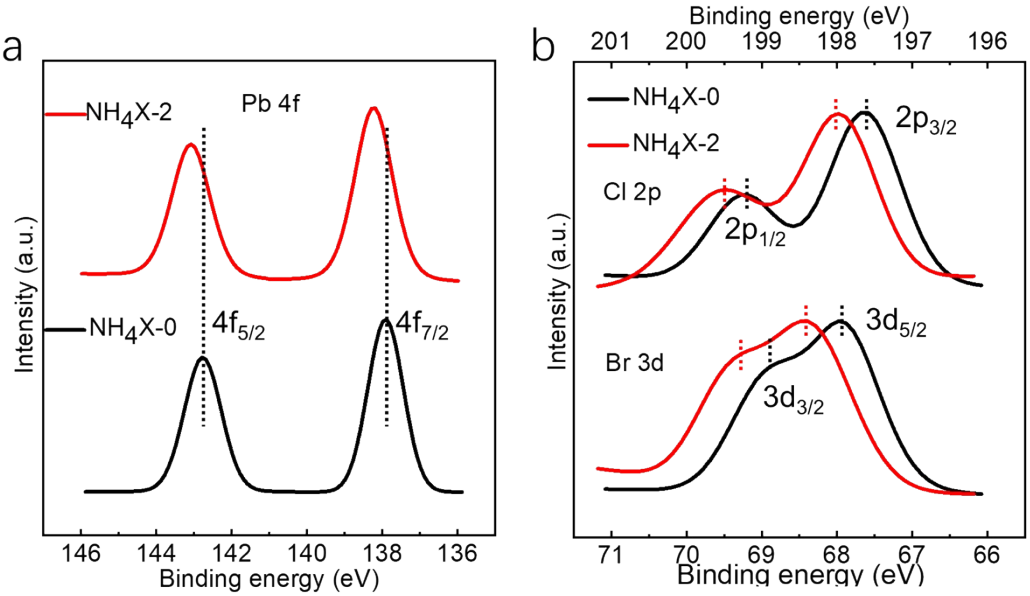

Figure S10. XPS spectra of NH_4X-0 and NH_4X-2 samples.

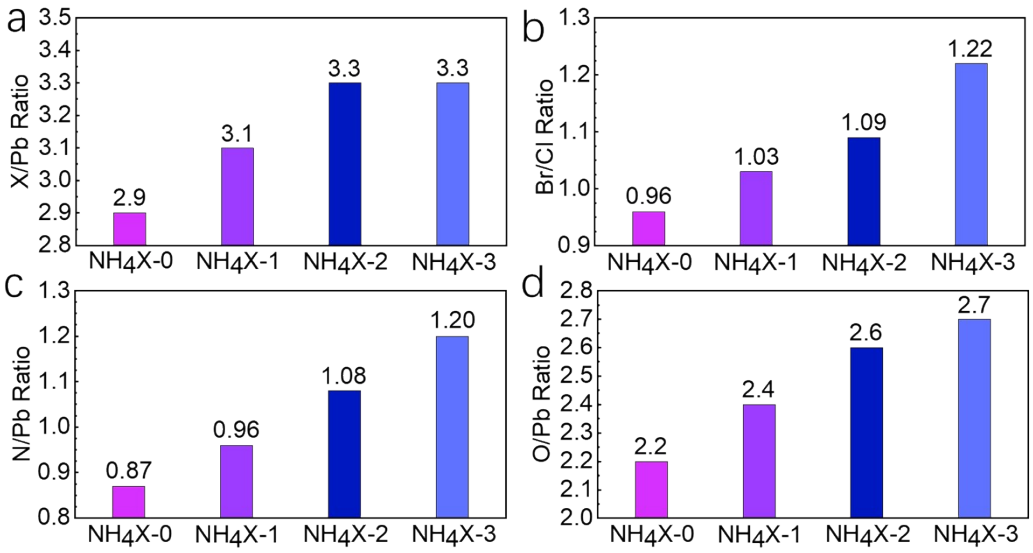

Figure S11. Quantitative XPS results of NH_4X-m, for (a) X to Pb ratio (b) Br to Cl ratio (c) N to Pb ratio (d) O to Pb ratio.

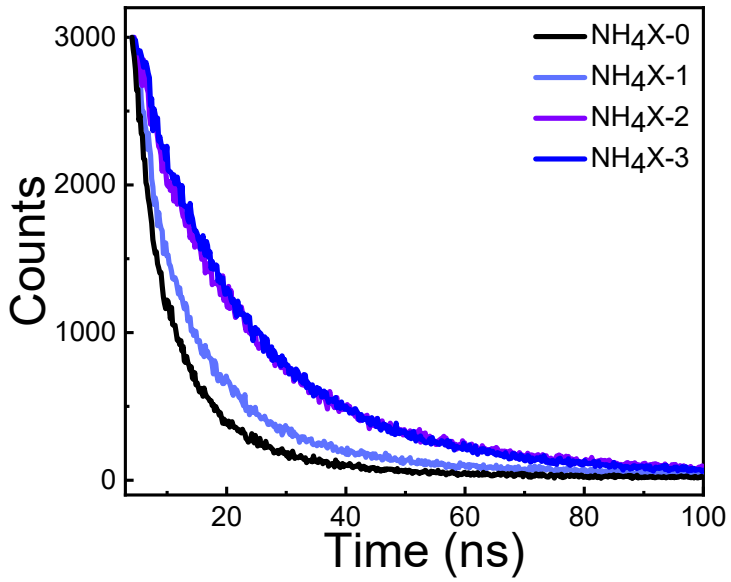

Figure S12. Time-resolved PL spectra of NH_4X-m.

73 **Table S5.** Summary of the time-resolved PL decay fitting parameters of NH_4X-m.

Samples	PLQY (%)	A_1	τ_1 (ns)	A_2	τ_2 (ns)	τ_{avg} (ns)
NH_4X-0	60%	0.7906	4.261	0.2094	14.172	8.902
NH_4X-1	78%	0.7605	6.119	0.2395	19.759	12.997
NH_4X-2	96%	0.7762	14.883	0.2238	32.202	21.537
NH_4X-3	95%	0.6510	12.409	0.3490	29.743	22.157

74

75 **Table S6.** List of some reported blue perovskite NPs performance.

Samples	Peak (nm)	PLQY (%)
$MAPbCl_{0.5}Br_{2.5}$	458	38.4%
$CsPbCl_{1.5}Br_{1.5}$	455	37%
$CsPbBr_3$: Al^{3+}	456	42%
$CsPbBr_3$: Cd^{2+}	452	60%
$CsPb_{0.93}Cu_{0.07}(Br/Cl)_3$	455	80%
$CsPbBr_3$: xNd^{3+}	459	90%
This work	455	96%

76

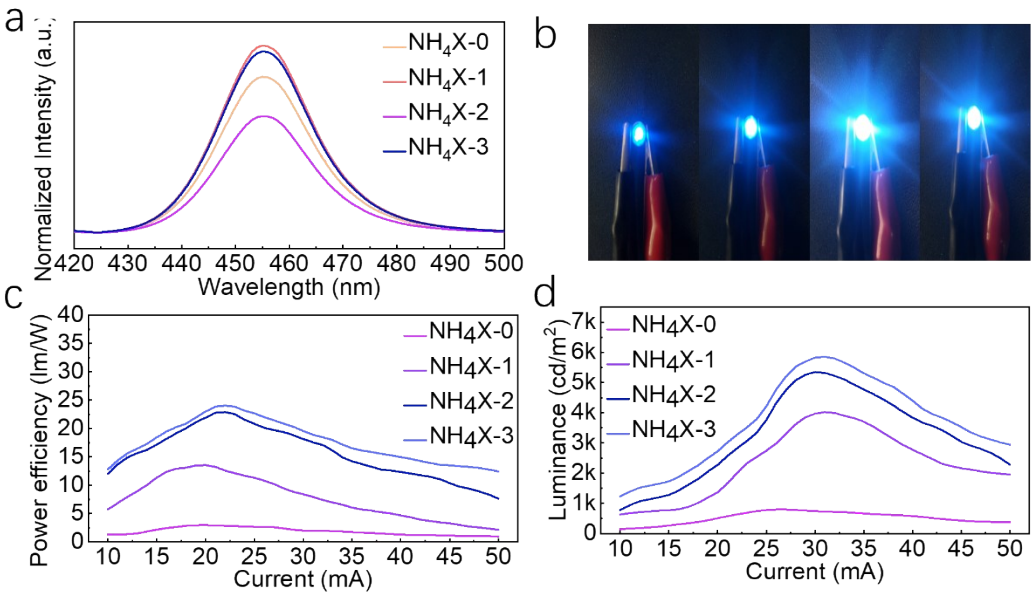

Figure S13. (a) PL spectra of blue device based on NH_4X-m. (b) Images for blue emitting. (c) Power efficiency vs current curves. (d) Luminescence vs current curves.

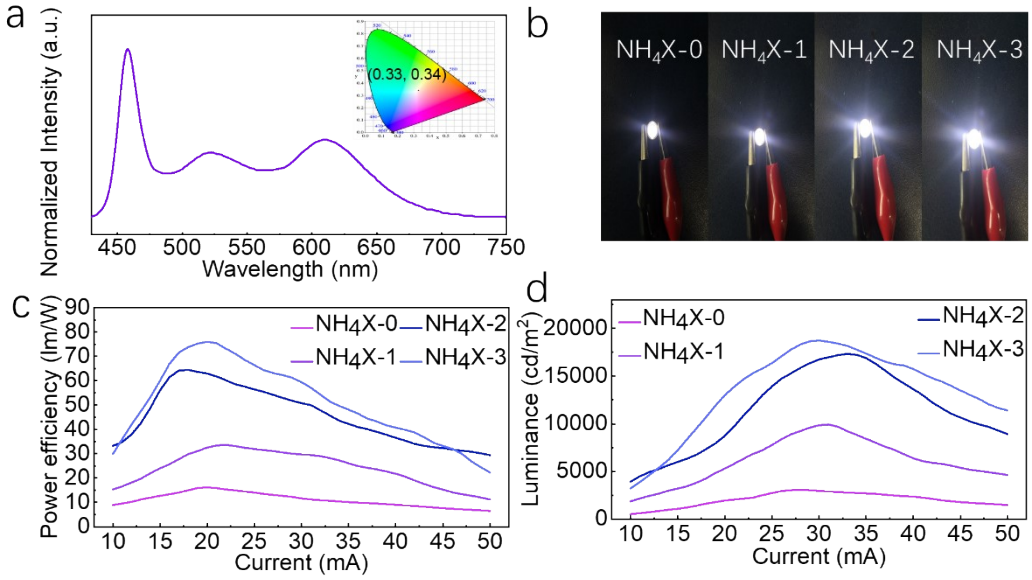

Figure S14. (a) PL spectra of photoluminescent WLED based on NH_4X-m mixed with commercial phosphors (Ca,Sr)$AlSiN_3$:Eu and $(Sr,Ba)_2SiO_4$:Eu. (b) Images for white emitting. (c) Power efficiency vs current curves. (d) Luminescence vs current curves.