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Supplementary Information

Anion-Engineered Cobalt Salts as Exogenous Modulators for Phase Tailoring in $CsPbBr_3$ Nanocrystals: Minimal Doping Towards Enhanced Color Fidelity, and stable White LEDs

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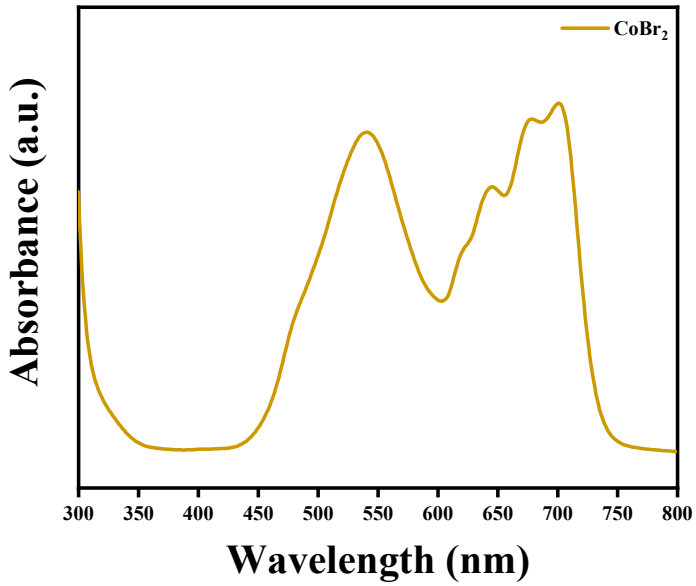

Fig. S1. Absorption spectrum of $CoBr_2$ precursor.

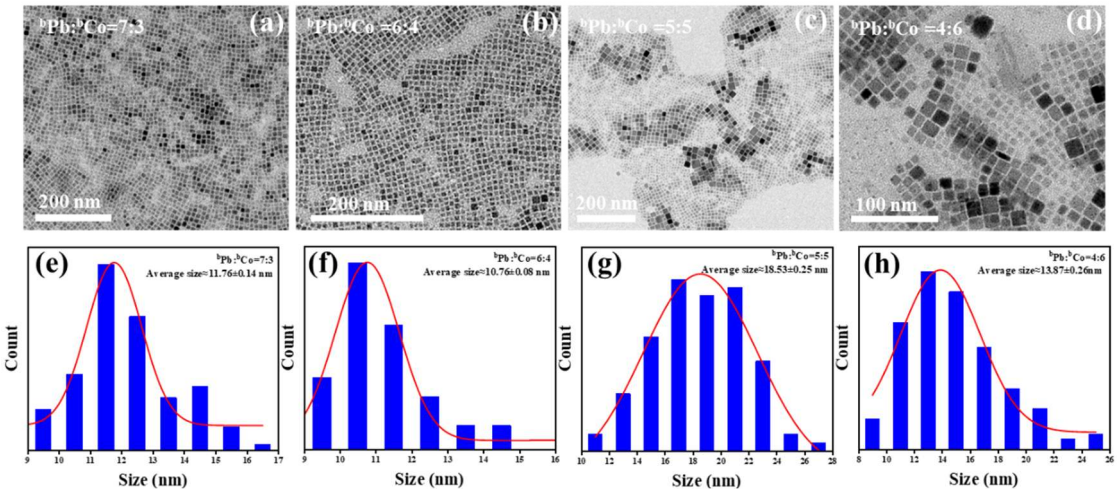

Fig. S2. TEM images of the ^{b}Co: $CsPbBr_3$ NCs with different ratios of ^{b}Pb:^{b}Co, where (a) ^{b}Pb:^{b}Co = 7:3. (b) ^{b}Pb:^{b}Co = 6:4. (c) ^{b}Pb:^{b}Co = 5:5. (d) ^{b}Pb:^{b}Co = 4:6. Panels (e-h) display the size distribution histograms for (a), (b), (c), and (d), respectively.

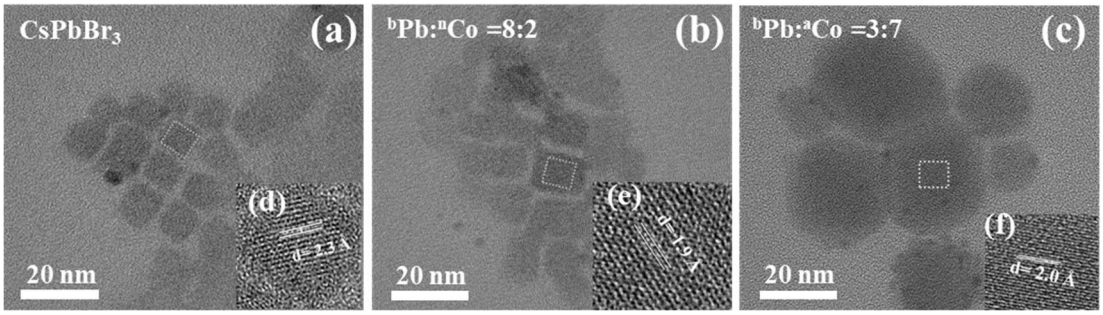

Fig. S3. TEM images of (a) pure $CsPbBr_3$ NCs, (b) ^{n}Co: $CsPbBr_3$ NCs prepared at ^{b}Pb:^{n}Co=8:2, (c) ^{a}Co: $CsPbBr_3$ NCs with ^{b}Pb:^{a}Co=3:7. Inset images (211) planes (d), (221) planes (e), and (114) planes (f) are high-resolution TEM images corresponding to (a), (b), and (c), respectively.

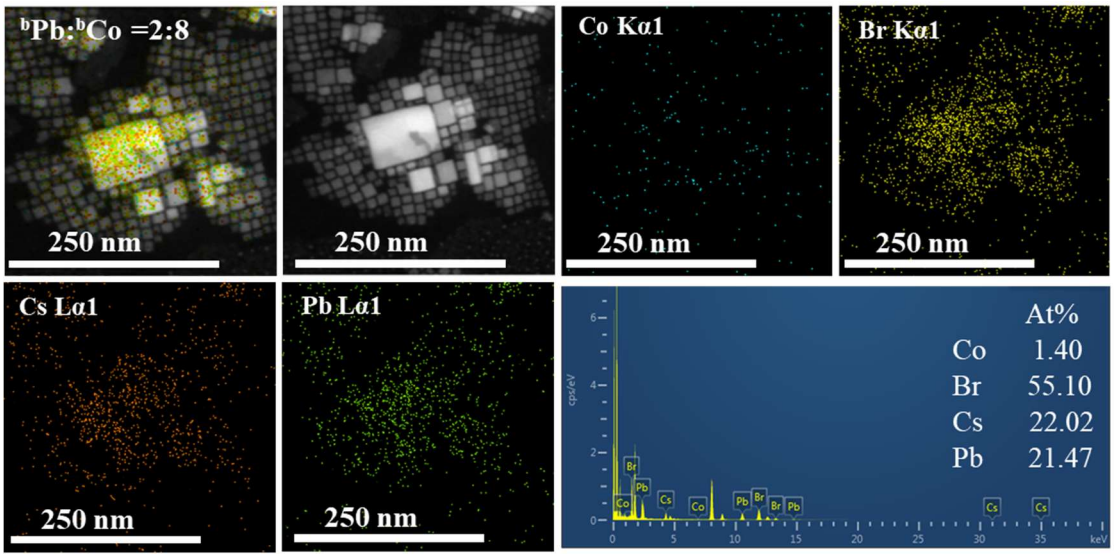

Fig. S4. STEM images and the corresponding elemental mapping and the Energy dispersive X-ray spectrum (EDS) of ^{b}Co: $CsPbBr_3$ NCs (^{b}Pb:^{b}Co = 2:8).

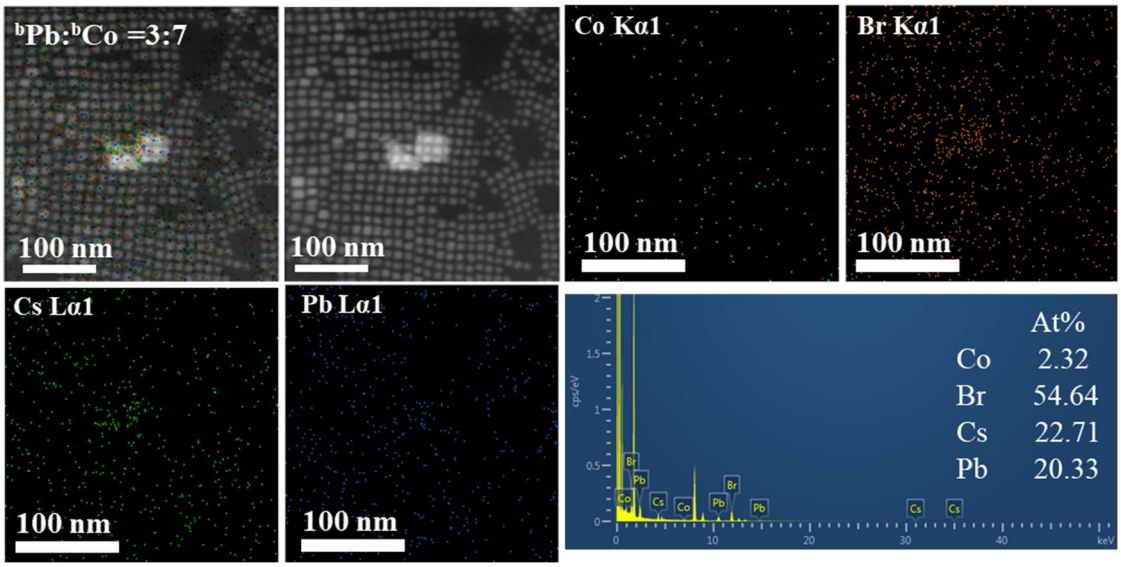

Fig. S5. STEM images and the corresponding EDS of ᵇCo: $CsPbBr_3$ NCs (ᵇPb:ᵇCo = 3:7).

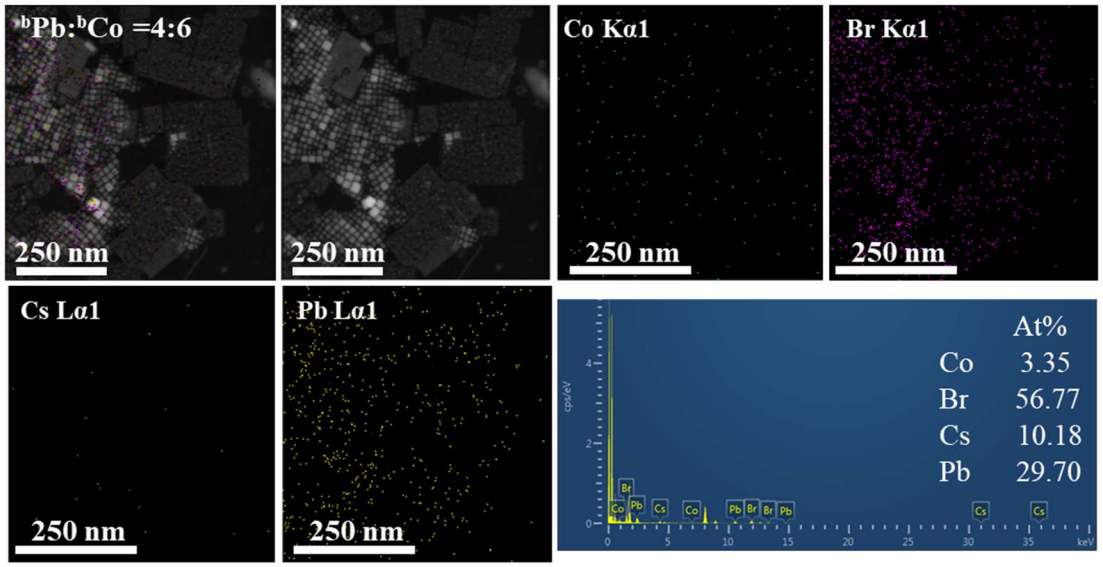

Fig. S6. STEM images and the corresponding EDS of ᵇCo: $CsPbBr_3$ NCs (ᵇPb:ᵇCo = 4:6).

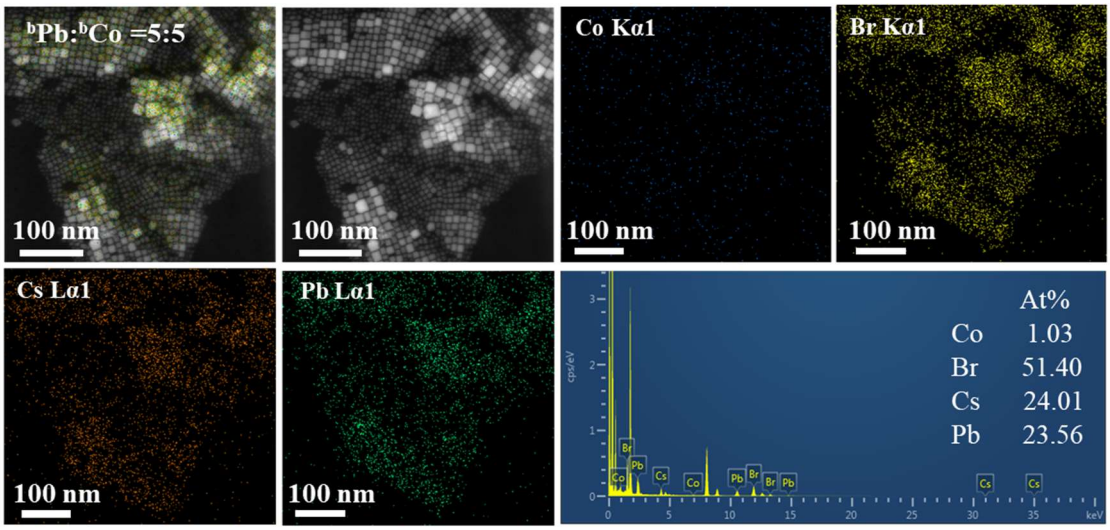

Fig. S7. STEM images and the corresponding EDS of ^{b}Co: $CsPbBr_3$ NCs (^{b}Pb:^{b}Co = 5:5).

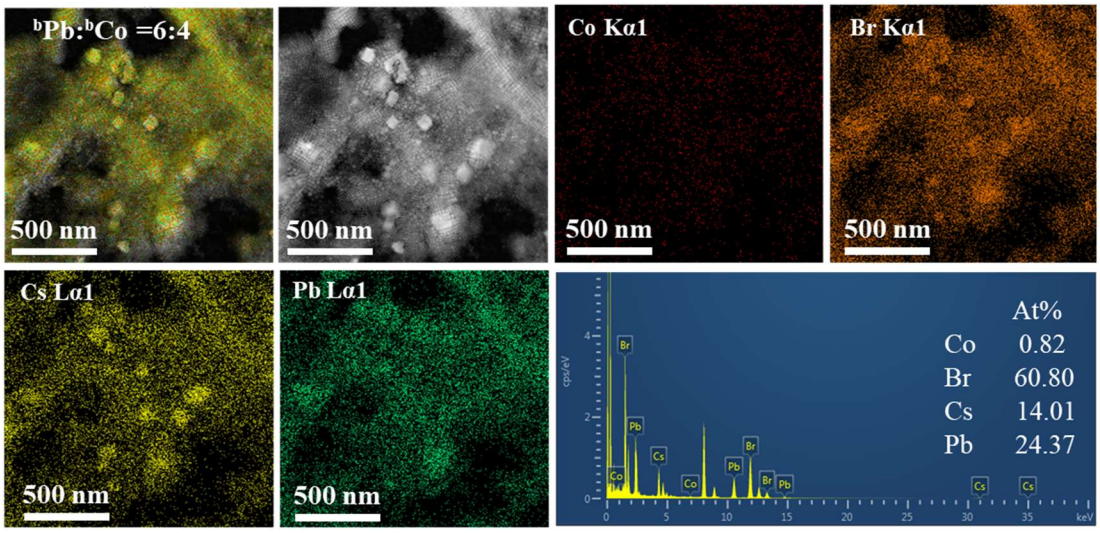

Fig. S8. STEM images and the corresponding EDS of ^{b}Co: $CsPbBr_3$ NCs (^{b}Pb:^{b}Co = 6:4).

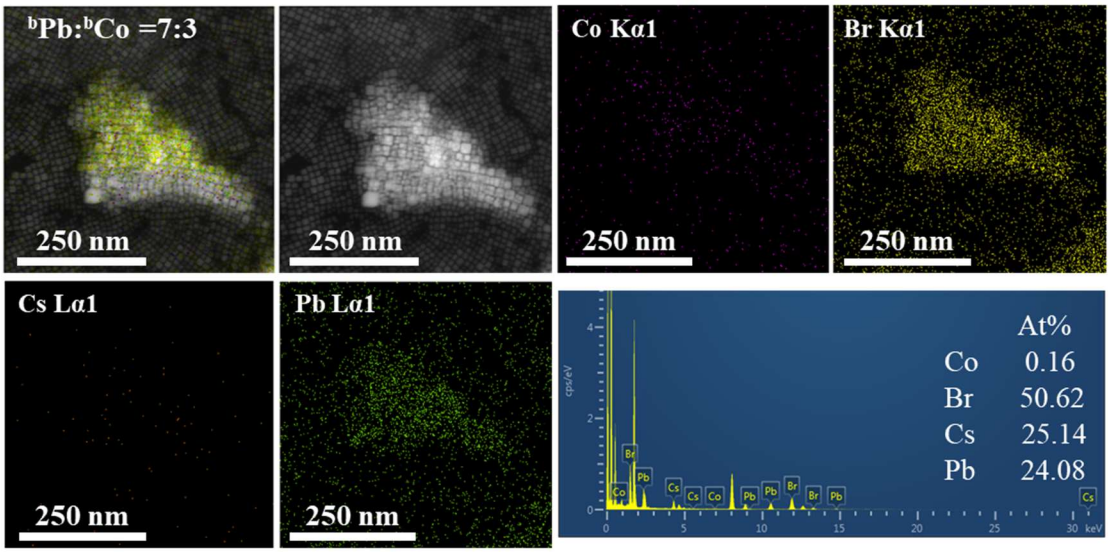

Fig. S9. STEM images and the corresponding EDS of ^{b}Co: $CsPbBr_3$ NCs (^{b}Pb:^{b}Co = 7:3).

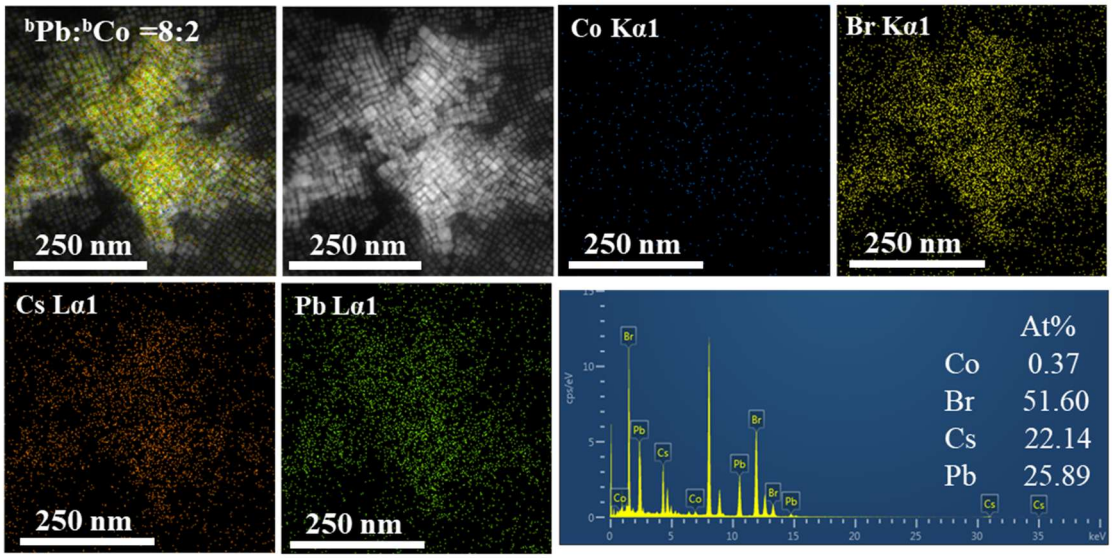

Fig. S10. STEM images and the corresponding EDS of ^{b}Co: $CsPbBr_3$ NCs (^{b}Pb:^{b}Co = 8:2).

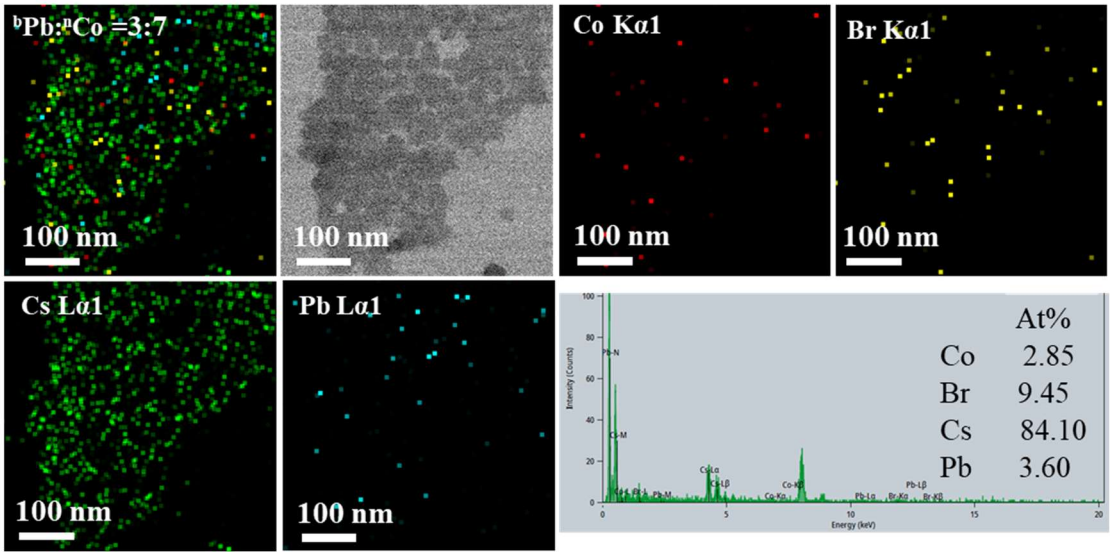

Fig. S11. STEM images and the corresponding EDS of ^{n}Co: $CsPbBr_3$ NCs (^{b}Pb:^{n}Co = 3:7).

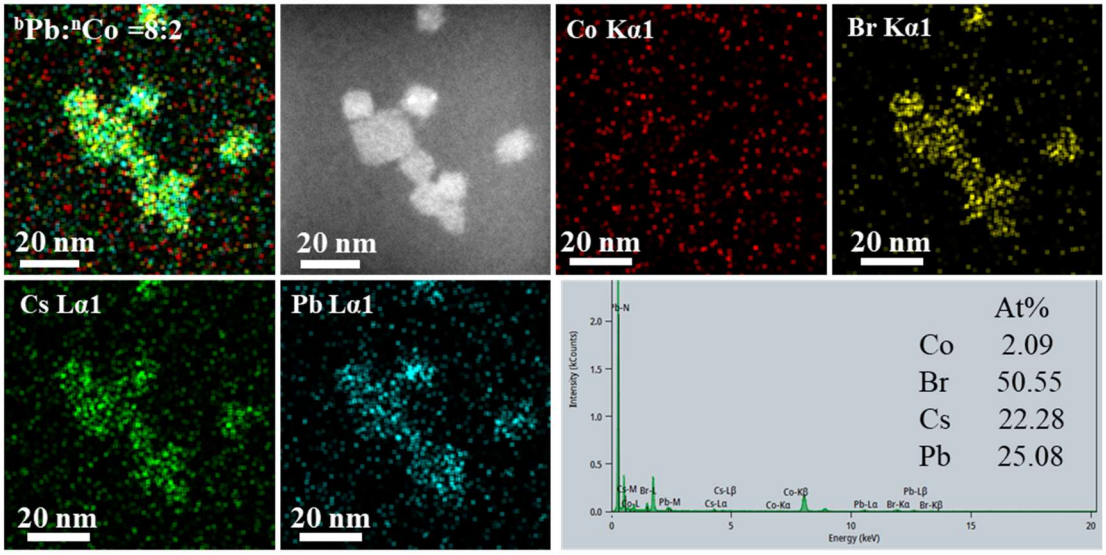

Fig. S12. STEM images and the corresponding EDS of ^{n}Co: $CsPbBr_3$ NCs (^{b}Pb:^{n}Co = 8:2).

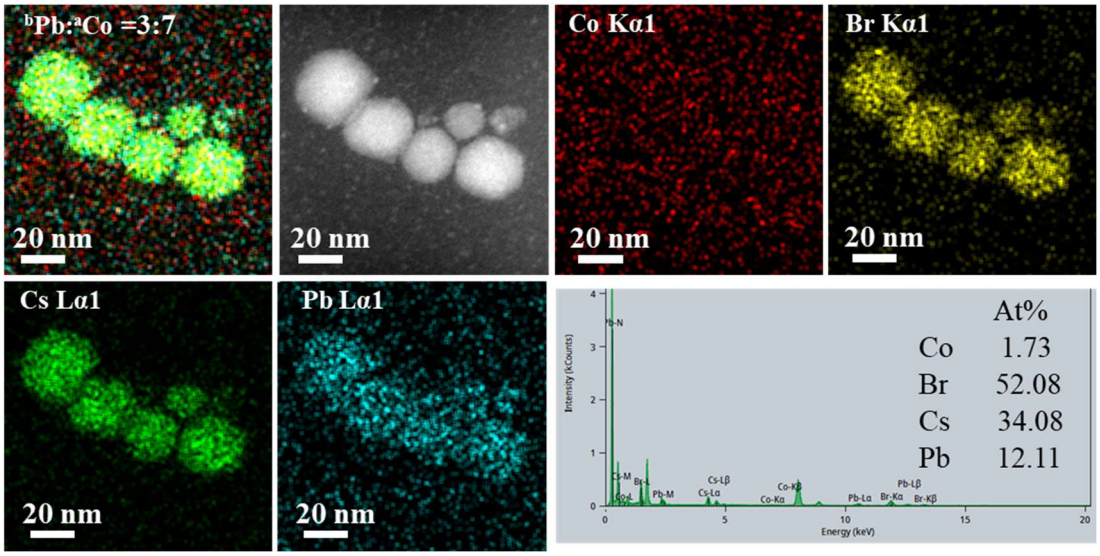

Fig. S13. STEM images and the corresponding EDS of ^{a}Co: $CsPbBr_3$ NCs (^{b}Pb:^{a}Co = 3:7).

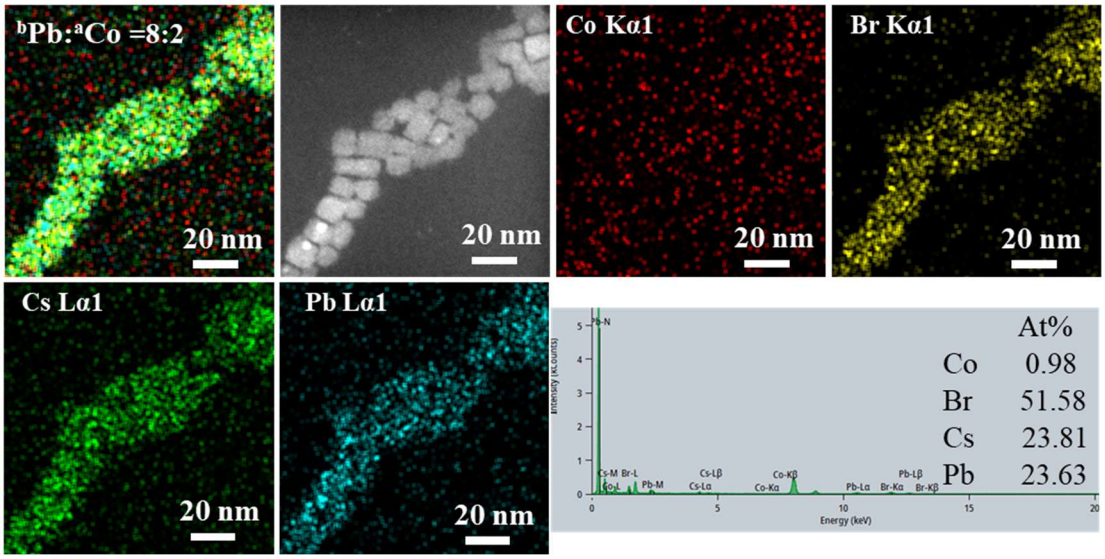

Fig. S14. STEM images and the corresponding EDS of ^{a}Co: $CsPbBr_3$ NCs (^{b}Pb:^{a}Co = 8:2).

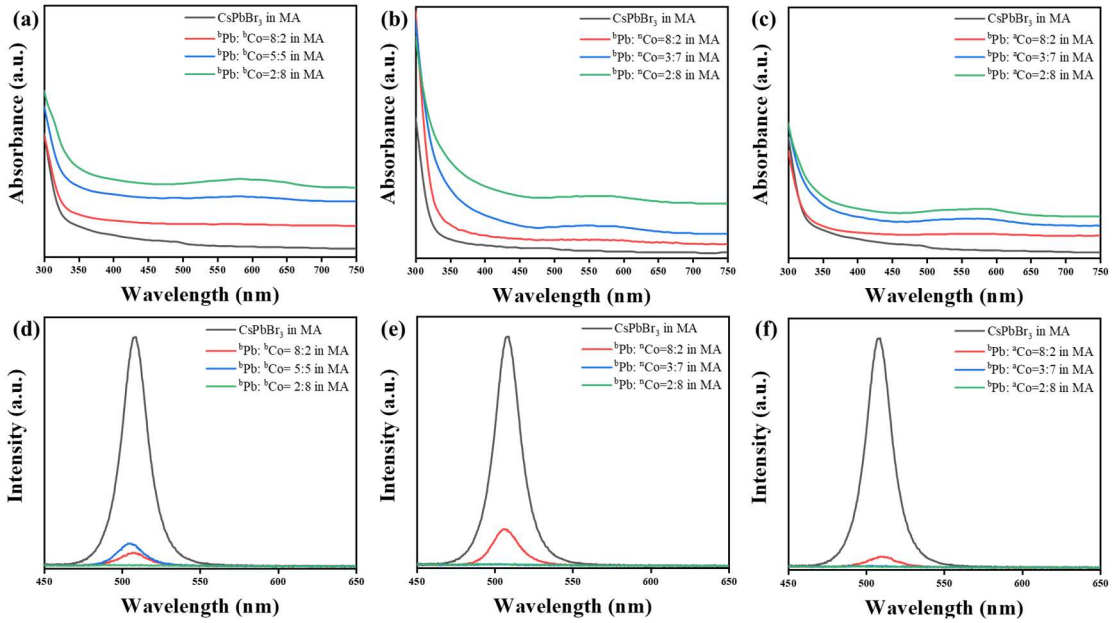

Fig. S15. UV-vis spectra of the supernatant collected during the washing process of pristine $CsPbBr_3$ NCs and doped NCs: (a) ^{b}Co:$CsPbBr_3$, (b) ^{n}Co:$CsPbBr_3$, and (c) ^{a}Co:$CsPbBr_3$. The NCs were washed with methyl acetate, and the supernatant spectra were measured using methyl acetate as the baseline. The corresponding PL spectra are shown in (d-f).

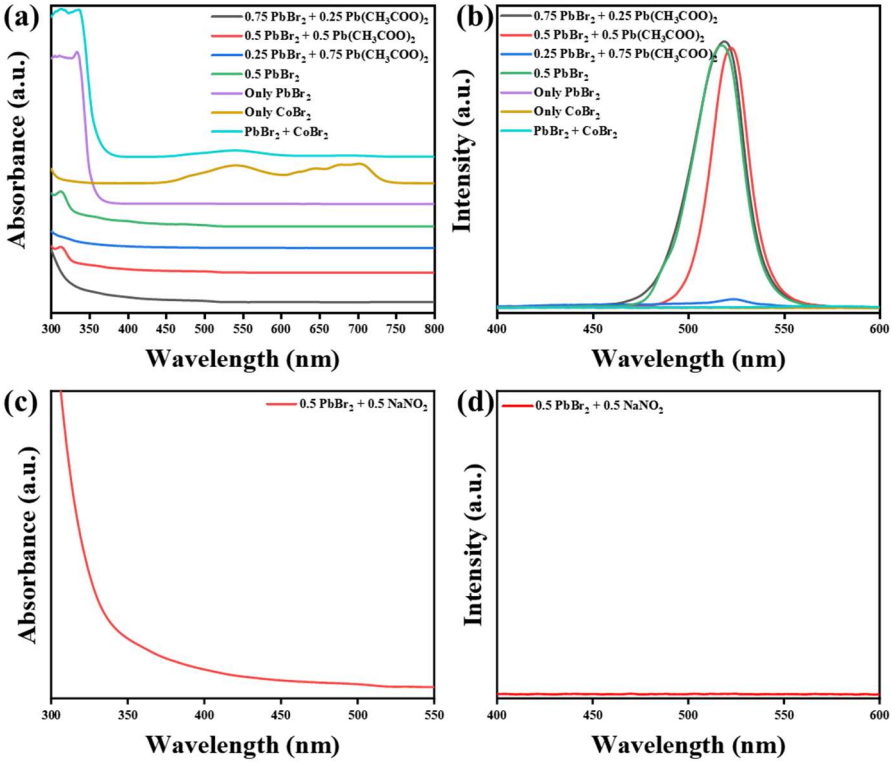

Fig. S16. UV-vis spectra showing the effect of (a) acetate and (c) nitrite on the formation of specific Cs-Pb-Br phases—either $CsPbBr_3$ NCs or Cs_4PbBr_6 NCs, respectively. The corresponding PL spectra are displayed in (b) and (d). The featureless spectrum in (c)

suggests complete decomposition or the absence of perovskite formation.

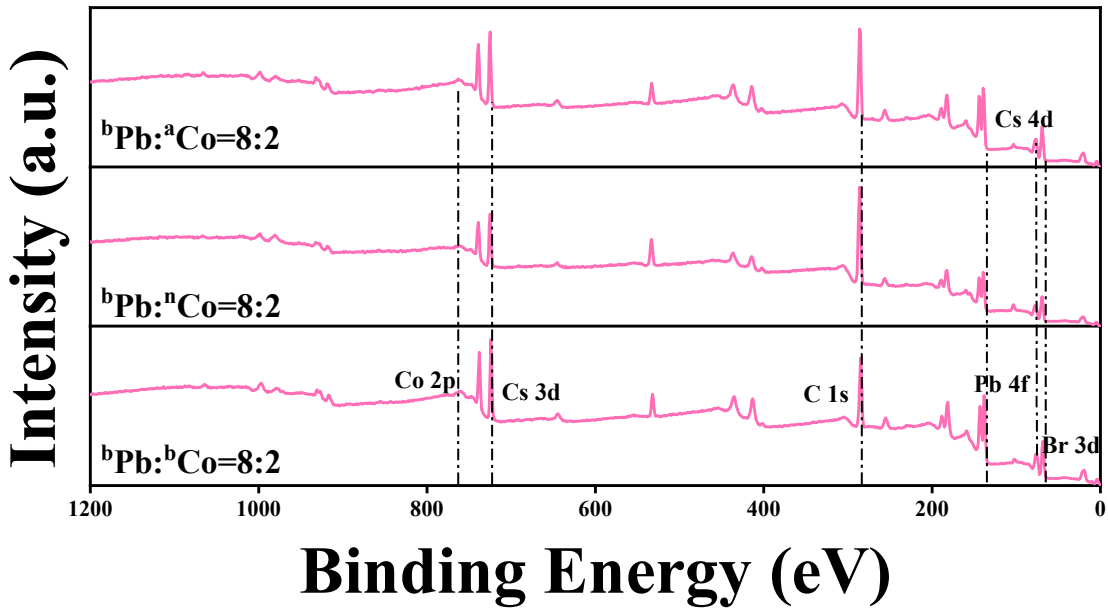

Fig. S17. XPS survey spectra of Co: $CsPbBr_3$ NCs with ^{b}Pb:^{b}Co = 8:2, ^{b}Pb:^{n}Co = 8:2, and ^{b}Pb:^{a}Co = 8:2. The survey spectra show the peaks typical of Co, Cs, Pb, and Br peaks, indicating that Co is successfully doped into $^{b, n, a}$Co: $CsPbBr_3$ NCs.

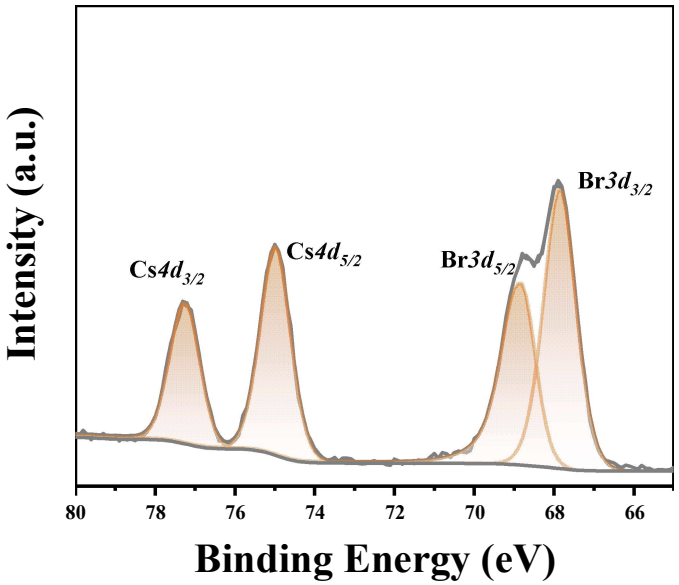

Fig. S18. High-resolution XPS spectra of ^{b}Co:$CsPbBr_3$ NCs (8:2) in the region of Cs 4d and Br 3d levels.

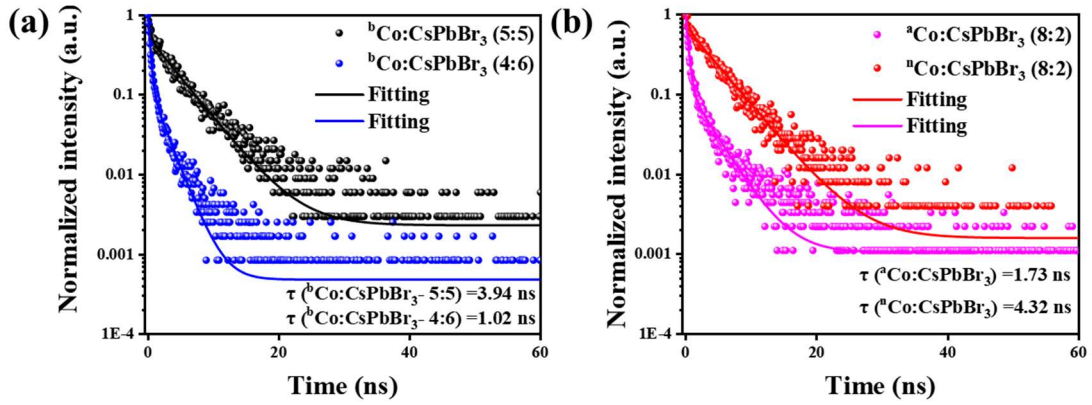

Fig. S19. TRPL measurement of (a) ^{b}Co-CsPbBr$_3$ NCs (5:5 and 4:6) and (b) ^{a}Co-CsPbBr$_3$ NCs (8:2) and ^{n}Co-CsPbBr$_3$ NCs (8:2).

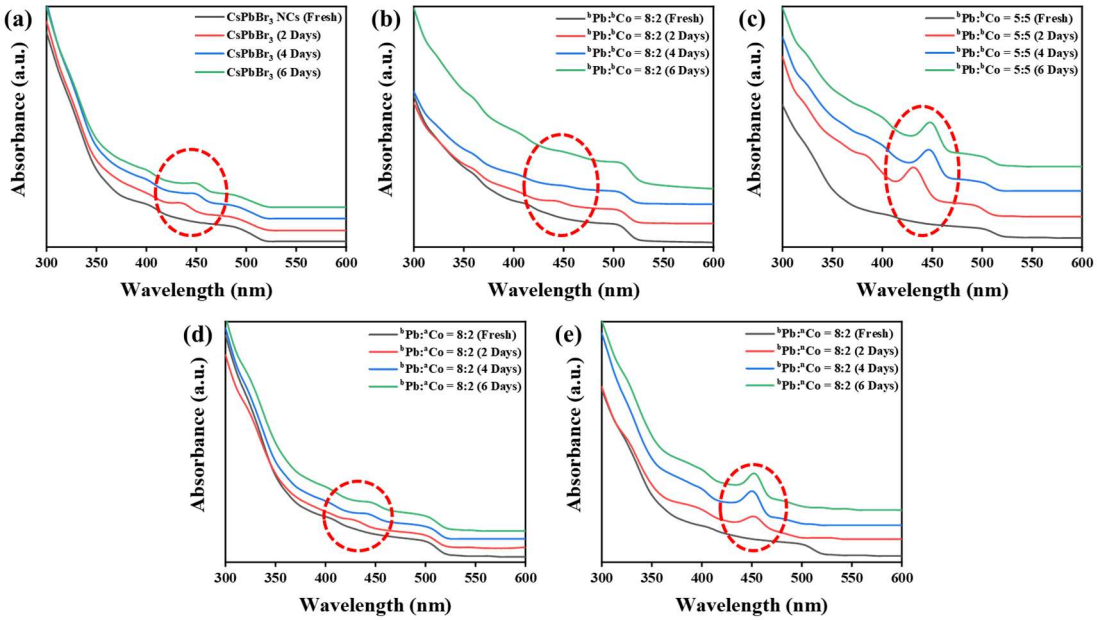

Fig. S20. Time-dependent UV-vis absorption spectra of (a) CsPbBr$_3$ NCs, (b) ^{b}Co:CsPbBr$_3$, (^{b}Pb:^{b}Co=8:2), (c) ^{b}Co:CsPbBr$_3$ NCs (^{b}Pb:^{b}Co=5:5), (d) ^{a}Co:CsPbBr$_3$ NCs (^{b}Pb:^{a}Co=8:2), and (e) ^{n}Co:CsPbBr$_3$ NCs (^{b}Pb:^{n}Co=8:2). Spectra were recorded every two days over one week to monitor stability.

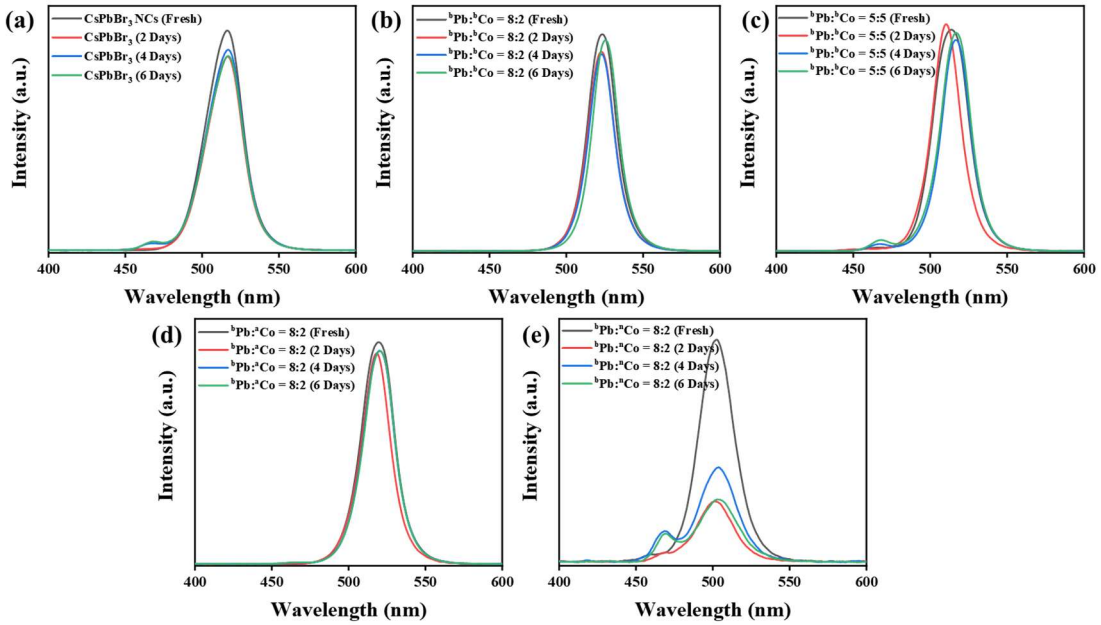

Fig. S21. Time-dependent PL spectra of (a) $CsPbBr_3$ NCs, (b) ^{b}Co:$CsPbBr_3$, (^{b}Pb:^{b}Co=8:2), (c) ^{b}Co:$CsPbBr_3$ NCs (^{b}Pb:^{b}Co=5:5), (d) ^{a}Co:$CsPbBr_3$ NCs (^{b}Pb:^{a}Co=8:2), and (e) ^{n}Co:$CsPbBr_3$ NCs (^{b}Pb:^{n}Co=8:2). Spectra were recorded every two days over one week to monitor stability.

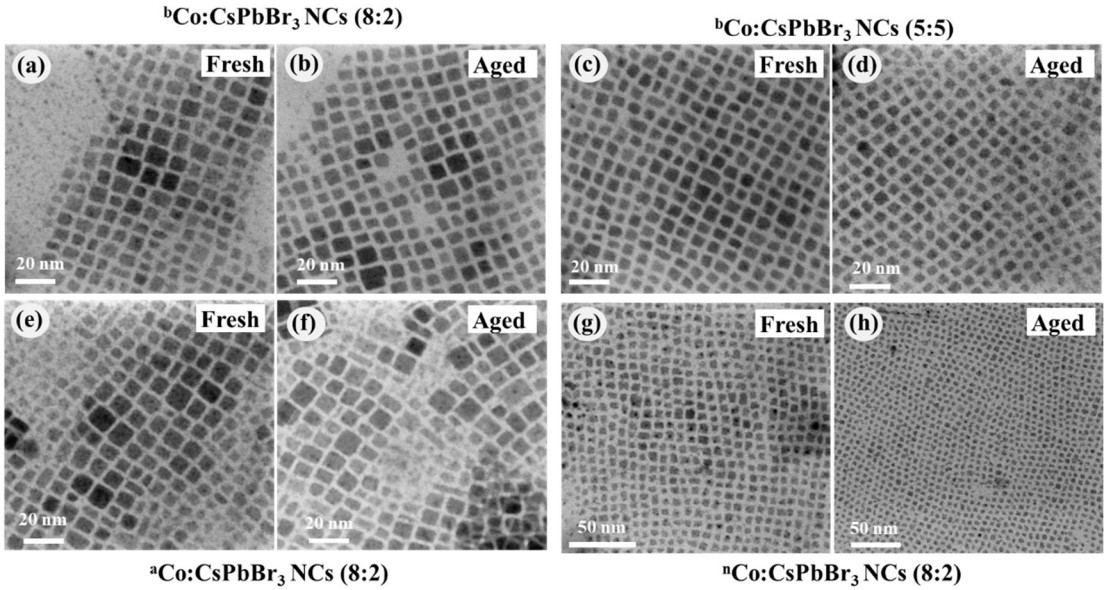

Fig. S22. TEM images of selected ^{b}Co:$CsPbBr_3$ NCs (a-d), ^{a}Co:$CsPbBr_3$ NCs (e, f), and ^{n}Co:$CsPbBr_3$ NCs (g, h) in both freshly prepared and aged (1-week) conditions. Corresponding NCs are labeled for comparison.

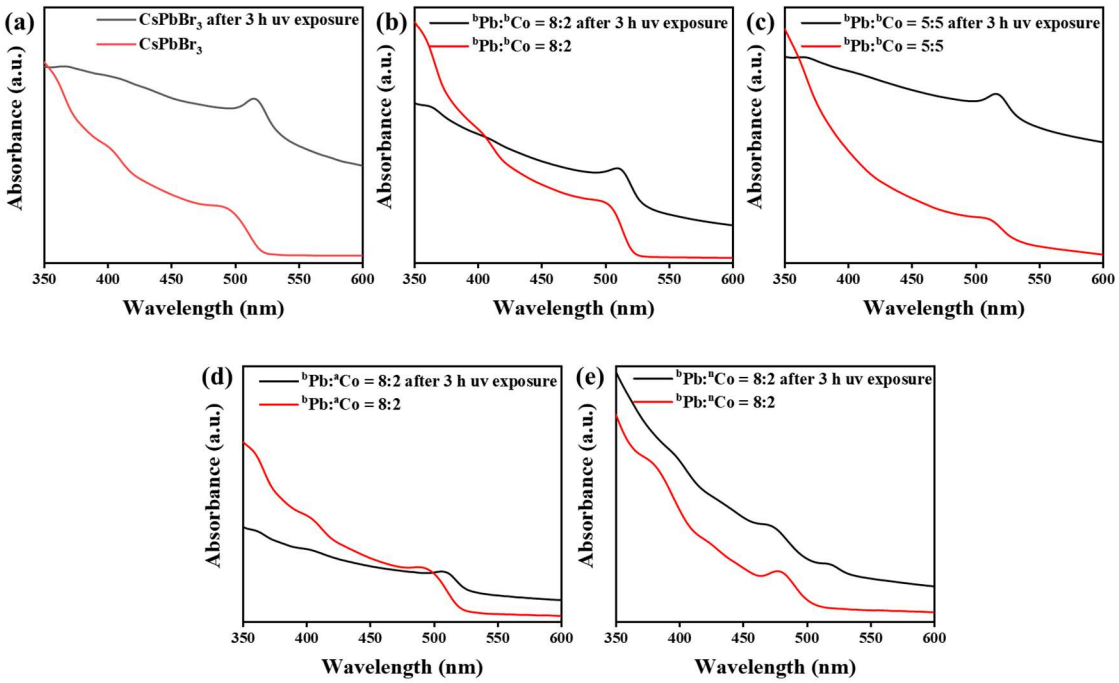

Fig. S23. UV-vis absorption spectra of (a) $CsPbBr_3$ NCs, (b) ^{b}Co:$CsPbBr_3$, (^{b}Pb:^{b}Co=8:2), (c) ^{b}Co:$CsPbBr_3$ NCs (^{b}Pb:^{b}Co=5:5), (d) ^{a}Co:$CsPbBr_3$ NCs (^{b}Pb:^{a}Co=8:2), and (e) ^{n}Co:$CsPbBr_3$ NCs (^{b}Pb:^{n}Co=8:2) in both freshly prepared and after UV exposure.

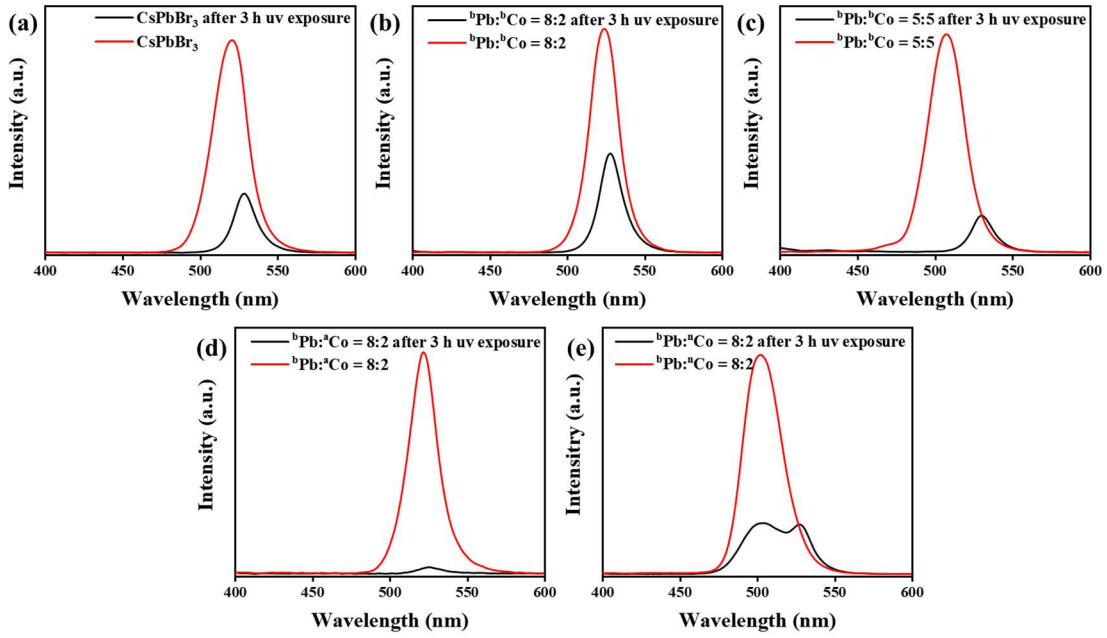

Fig. S24. PL spectra of (a) $CsPbBr_3$ NCs, (b) ^{b}Co:$CsPbBr_3$, (^{b}Pb:^{b}Co=8:2), (c) ^{b}Co:$CsPbBr_3$ NCs (^{b}Pb:^{b}Co=5:5), (d) ^{a}Co:$CsPbBr_3$ NCs (^{b}Pb:^{a}Co=8:2), and (e) ^{n}Co:$CsPbBr_3$ NCs (^{b}Pb:^{n}Co=8:2) in both freshly prepared and after UV exposure.

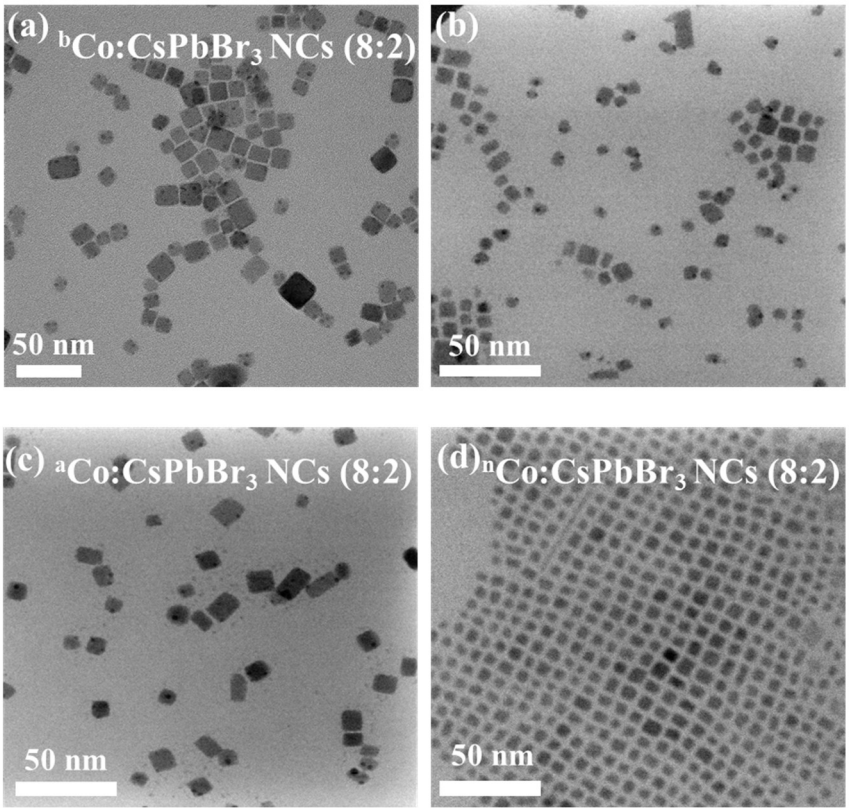

Fig. S25. TEM images of (a) ^{b}Co:CsPbBr$_3$ (8:2), (b) ^{b}Co:CsPbBr$_3$ (5:5), (c) ^{a}Co:CsPbBr$_3$ NCs (8:2), and (d) ^{n}Co:CsPbBr$_3$ NCs (8:2) after UV exposure.

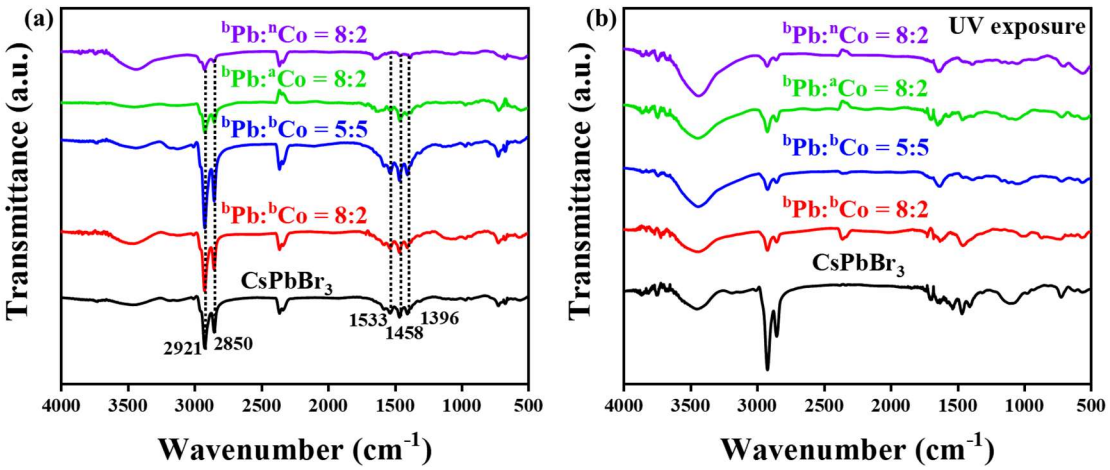

Fig. S26. FTIR spectra of CsPbBr$_3$ NCs, ^{b}Co:CsPbBr$_3$, (^{b}Pb:^{b}Co=8:2 and ^{b}Pb:^{b}Co=5:5), ^{a}Co:CsPbBr$_3$ NCs (^{b}Pb:^{a}Co=8:2), and ^{n}Co:CsPbBr$_3$ NCs (^{b}Pb:^{n}Co=8:2) at initial state (a) and after UV exposure (b).

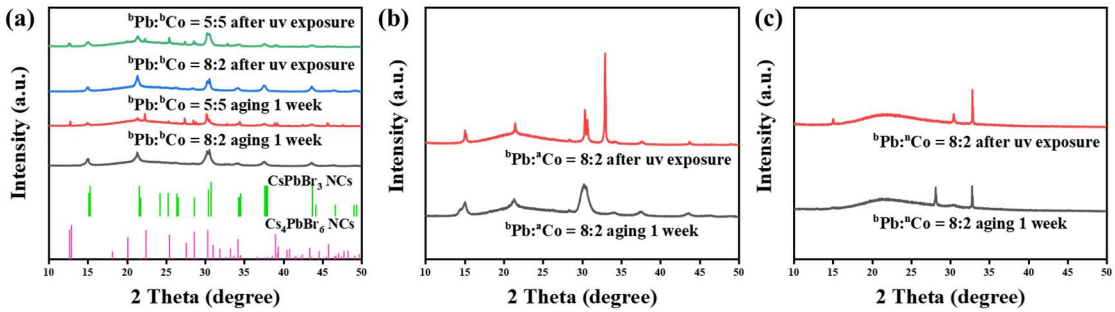

Fig. S27. XRD pattern of (a) ^{b}Co:CsPbBr$_3$ (^{b}Pb:^{b}Co=8:2 and ^{b}Pb:^{b}Co=5:5), (b) ^{a}Co:CsPbBr$_3$ NCs (^{b}Pb:^{a}Co=8:2), and (c) ^{n}Co:CsPbBr$_3$ NCs (^{b}Pb:^{n}Co=8:2) aged 1 week and after UV exposure.

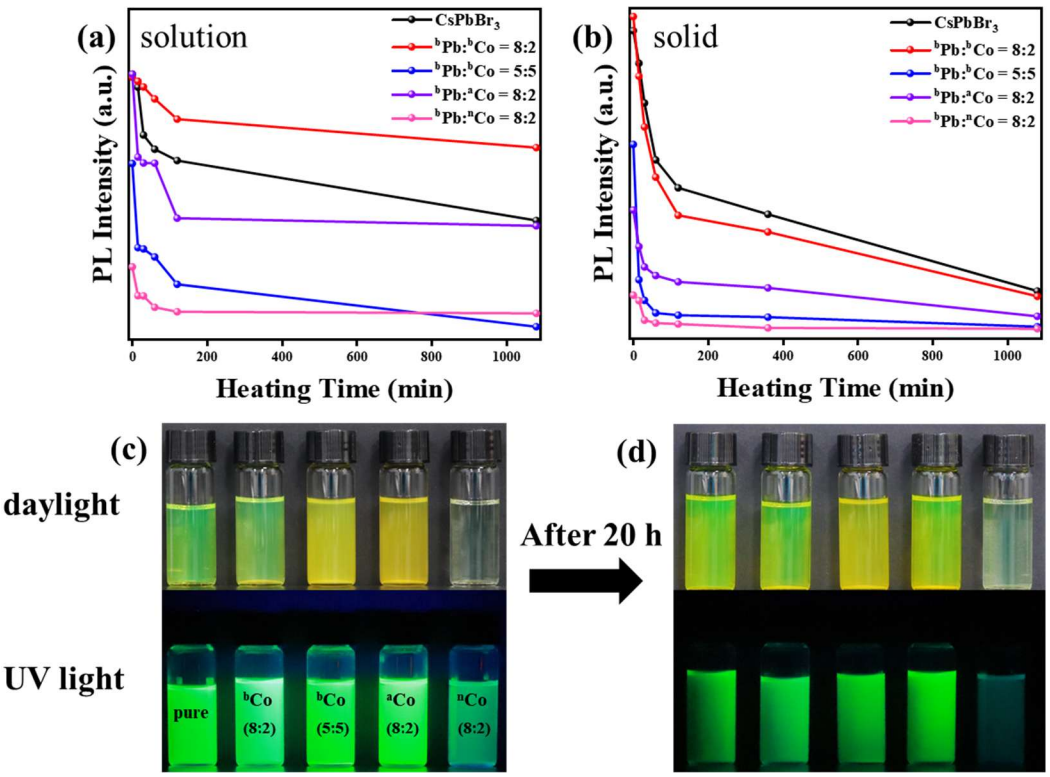

Fig. S28. Temperature-dependent PL intensity of CsPbBr$_3$, ^{b}Co:CsPbBr$_3$ (^{b}Pb:^{b}Co=8:2 and ^{b}Pb:^{b}Co=5:5), ^{a}Co:CsPbBr$_3$ NCs (^{b}Pb:^{a}Co=8:2), and ^{n}Co:CsPbBr$_3$ NCs (^{b}Pb:^{n}Co=8:2) in solution (a) and solid (b) state. UV photos of CsPbBr$_3$, ^{b}Co:CsPbBr$_3$ (^{b}Pb:^{b}Co=8:2 and ^{b}Pb:^{b}Co=5:5), ^{a}Co:CsPbBr$_3$ NCs (^{b}Pb:^{a}Co=8:2), and ^{n}Co:CsPbBr$_3$ NCs (^{b}Pb:^{n}Co=8:2) in solution before heating (c) and after heating 18 h at 50 °C (d).

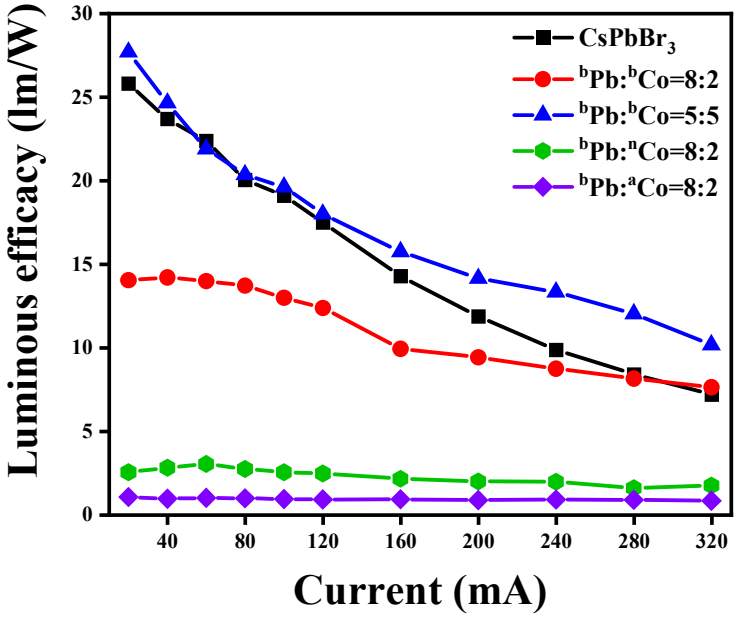

Fig. S29. Changes of luminous efficacy of $CsPbBr_3$ NCs and $^{b, n, a}$Co:$CsPbBr_3$ with ^{b}Pb:^{b}Co = 8:2, ^{b}Pb:^{b}Co =5:5, ^{b}Pb:^{n}Co = 8:2, ^{b}Pb:^{a}Co = 8:2 under different currents.

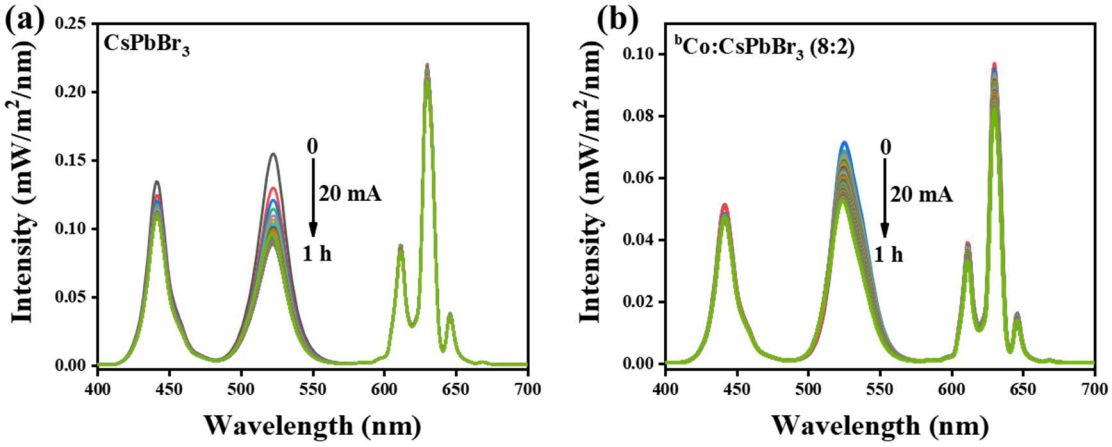

Fig. S30. Changes of PL intensity of WLEDs fabricated by (a) $CsPbBr_3$ NCs and (b) ^{b}Co: $CsPbBr_3$ (8:2) under 20 mA over 1 h testing.

Tables S1. Detailed TRPL of $CsPbBr_3$ and Co-doped $CsPbBr_3$ NCs.

$CsPbBr_3$	^{b}Pb:^{b}Co =8:2	^{b}Pb:^{b}Co =5:5	^{b}Pb:^{b}Co =4:6	^{b}Pb:^{a}Co =8:2	^{b}Pb:^{n}Co =8:2
τ_1=0.4 ns	τ_1=0.4 ns	τ_1=0.3 ns	τ_1=0.3 ns	τ_1=0.4 ns	τ_1=0.5 ns
A_1=0.8	A_1=0.7	A_1=0.5	A_1=0.9	A_1=0.9	A_1=0.3
τ_2=3.5 ns	τ_2=4.5 ns	τ_2=4.2 ns	τ_2=2 ns	τ_2=3.3 ns	τ_2=4.5 ns
A_2=0.2	A_2=0.3	A_2=0.5	A_2=0.1	A_2=0.1	A_2=0.7
τ=2.53 ns	τ=3.80 ns	τ=3.94 ns	τ=1.02ns	τ=1.73 ns	τ=4.32 ns

Table S2. The values of luminous efficacy of $CsPbBr_3$ NCs, and Co-doped $CsPbBr_3$ NCs ($^{b}Pb:^{b}Co$=8:2, $^{b}Pb:^{b}Co$ =5:5, $^{b}Pb:^{n}Co$ =8:2, $^{b}Pb:^{a}Co$ =8:2) under different currents.

Luminous efficacy (lm/W) / Current(mA)	$CsPbBr_3$ NCs	$^{b}Pb:^{b}Co$ 8:2	$^{b}Pb:^{b}Co$ 5:5	$^{b}Pb:^{n}Co$ 8:2	$^{b}Pb:^{a}Co$ 8:2
20	25.81	14.04	27.7	2.54	1.05
40	23.69	14.2	24.65	2.81	0.95
60	22.38	13.99	21.9	3.03	1
80	20.04	13.71	20.36	2.73	0.98
100	19.1	12.99	19.62	2.54	0.93
120	17.5	12.38	18	2.46	0.91
160	14.29	9.93	15.75	2.15	0.92
200	11.88	9.42	14.14	1.99	0.87
240	9.87	8.74	13.33	1.97	0.9
280	8.4	8.15	12.03	1.59	0.88
320	7.2	7.63	10.16	1.74	0.83

Table S3. The fidelity index (Rf) of $CsPbBr_3$ NCs, and $^{b, n, a}Co:CsPbBr_3$ with $^{b}Pb:^{b}Co$ = 8:2, $^{b}Pb:^{b}Co$ =5:5, $^{b}Pb:^{n}Co$ = 8:2, $^{b}Pb:^{a}Co$ = 8:2 under different currents.

Fidelity Index (Rf) / Current(mA)	$CsPbBr_3$ NCs	$^{b}Pb:^{b}Co$ 8:2	$^{b}Pb:^{b}Co$ 5:5	$^{b}Pb:^{n}Co$ 8:2	$^{b}Pb:^{a}Co$ 8:2
20	55.89	61.15	56.44	67.2	62.44
40	52.89	61.17	54.81	63.04	59.92
60	49.86	62.08	53.57	63.37	59.88
80	45.24	61.83	51.81	60.93	58.66
100	42.47	60.61	51.43	58.27	57.24
120	39.57	59.81	51.09	54.94	55.99
160	32.42	57.04	48.89	46.38	56.21
200	28.61	56.21	48.18	32.57	54.99
240	25.81	54.84	46.75	21.58	53.71
280	22.24	54.7	45.87	9.48	53.13
320	17.56	53.6	43.95	3.71	52.03

Table S4. White light-emitting diode (WLEDs) devices based on $CsPbBr_3$ NCs, and ^{b,n,a}Co: $CsPbBr_3$ NCs with ^{b}Pb:^{b}Co = 8:2, ^{b}Pb:^{b}Co =5:5, ^{b}Pb:^{n}Co = 8:2, ^{b}Pb:^{a}Co = 8:2, and their coordinates corresponding to the 1931 Gamut (Rec. 2020 %) and 1931 Gamut (NTSC%) International Commission on Illumination (CIE).

Type of NCs	1931 Gamut (Rec. 2020 %)	1931 Gamut (NTSC% %)
$CsPbBr_3$ NCs	98.4%	131.7%
^{b}Pb:^{b}Co =8:2	90.5%	121.2%
^{b}Pb:^{b}Co =5:5	91.7%	122.9%
^{b}Pb:^{n}Co =8:2	83.8%	112.3%
^{b}Pb:^{a}Co =8:2	80.5%	107.8%

Table S5. The color rendering index (Ra) of $CsPbBr_3$ NCs under different currents as well as R1(Light Red), R2(Gray - Yellow), R3(Saturated Yellow), R4(Light Green), R5(Saturated Green), R6(Light Blue), R7(Saturated Blue), R8(Light Purple), R9(Saturated Red), R10(Saturated Yellow - Green), R11(Saturated Green - Blue), R12(Saturated Blue - Purple), R13(White - skinned C - Tone), R14(Leaf Green), R15(Asian Skin Tone)

Current (mA)	Ra	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15
20	33	5	68	52	12	38	72	47	-29	-100	49	-6	71	18	65	-9
40	21	-12	55	51	-5	20	57	46	-42	-100	24	-27	61	0	63	-28
60	11	-25	45	49	-20	4	43	47	-53	-100	4	-46	48	-13	60	-44
80	-1	-42	34	45	-38	-12	32	44	-69	-100	-16	-68	37	-30	56	-65
100	-8	-55	23	47	-46	-20	25	42	-80	-100	-37	-79	29	-44	56	-81
120	-17	-64	16	42	-62	-35	12	43	-87	-100	-51	-98	19	-53	51	-93
160	-34	-100	-21	59	-74	-53	-5	38	-100	-100	-100	-100	-5	-97	57	-100
200	-44	-100	-32	64	-91	-79	-35	47	-100	-100	-100	-100	-34	-100	57	-100
240	-52	-100	-56	65	-84	-94	-62	49	-100	-100	-100	-100	-72	-100	66	-100
280	-63	-100	-78	31	-73	-100	-87	45	-100	-100	-100	-100	-100	-100	66	-100
320	-74	-100	-100	-15	-58	-100	-100	34	-100	-100	-100	-98	-100	-100	51	-100

Table S6. The color rendering index (Ra) of ^{b}Co-$CsPbBr_3$ NCs (8:2) under different currents as well as R1(Light Red), R2(Gray - Yellow), R3(Saturated Yellow), R4(Light Green), R5(Saturated Green), R6(Light Blue), R7(Saturated Blue), R8(Light Purple), R9(Saturated Red), R10(Saturated Yellow - Green), R11(Saturated Green - Blue), R12(Saturated Blue - Purple), R13(White - skinned C - Tone), R14(Leaf Green), R15(Asian Skin Tone)

Current (mA)	Ra	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15
20	46	30	85	48	28	52	81	53	-7	-100	80	13	73	44	65	18
40	46	30	85	49	25	51	81	52	-7	-100	79	11	76	44	66	18
60	44	45	97	34	9	35	63	63	7	-100	92	-4	86	64	56	34
80	45	37	91	43	17	43	73	58	0	-100	86	3	84	53	62	25
100	42	25	82	49	17	44	76	52	-11	-100	71	1	84	39	65	13
120	39	21	80	49	13	41	74	51	-14	-100	67	-4	85	35	65	9
160	31	5	69	50	4	33	71	44	-29	-100	49	-16	81	18	65	-8
200	26	1	66	47	-7	22	60	47	-32	-100	42	-28	73	15	62	-13
240	22	-3	64	46	-13	16	56	47	-35	-100	37	-36	67	11	61	-17
280	19	-7	60	47	-18	9	49	48	-37	-100	29	-42	57	6	61	-22
320	17	-10	57	47	-21	7	48	47	-40	-100	25	-46	54	3	61	-26

Table S7. The color rendering index (Ra) of ^{b}Co-$CsPbBr_3$ NCs (5:5) under different currents as well as R1(Light Red), R2(Gray - Yellow), R3(Saturated Yellow), R4(Light Green), R5(Saturated Green), R6(Light Blue), R7(Saturated Blue), R8(Light Purple), R9(Saturated Red), R10(Saturated Yellow - Green), R11(Saturated Green - Blue), R12(Saturated Blue - Purple), R13(White - skinned C - Tone), R14(Leaf Green), R15(Asian Skin Tone)

Current (mA)	Ra	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15
20	45	28	80	61	25	48	69	53	-6	-100	55	6	79	41	73	19
40	36	11	69	63	14	38	66	48	-22	-100	37	-9	77	23	73	0
60	28	0	62	62	2	27	59	46	-32	-100	25	-23	70	13	72	-11
80	22	-8	59	59	-10	16	52	45	-39	-100	18	-37	62	5	69	-19
100	18	-10	58	56	-18	9	45	47	-40	-100	15	-45	54	4	67	-21
120	14	-19	48	61	-20	4	41	45	-47	-100	1	-49	43	-8	69	-31
160	5	-34	34	69	-29	-9	28	43	-58	-100	-25	-64	18	-26	72	-46
200	3	-31	35	67	-38	-21	13	52	-51	-100	-27	-74	2	-22	70	-42
240	1	-47	10	86	-25	-21	2	53	-53	-100	-71	-67	-40	-48	86	-55
280	2	-34	16	86	-34	-38	-24	74	-28	-100	-68	-76	-77	-34	85	-38
320	3	-30	8	73	-24	-42	-44	85	-6	-100	-86	-71	-100	-37	90	-28

Table S8. The color rendering index (Ra) of ^{n}Co-$CsPbBr_3$ NCs (8:2) under different currents as well as R1(Light Red), R2(Gray - Yellow), R3(Saturated Yellow), R4(Light Green), R5(Saturated Green), R6(Light Blue), R7(Saturated Blue), R8(Light Purple), R9(Saturated Red), R10(Saturated Yellow - Green), R11(Saturated Green - Blue), R12(Saturated Blue - Purple), R13(White - skinned C - Tone), R14(Leaf Green), R15(Asian Skin Tone)

Current (mA)	Ra	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15
20	65	69	94	33	67	90	81	63	28	-67	56	66	33	77	57	47
40	69	64	95	37	72	85	87	75	34	-100	72	67	38	69	60	37
60	76	61	76	77	89	82	85	88	48	-100	68	75	62	59	83	33
80	70	48	62	81	85	85	85	77	34	-100	44	70	69	44	87	18
100	71	52	64	87	89	75	73	86	45	-100	70	76	65	48	89	22
120	64	41	39	67	85	78	66	85	48	-100	-12	79	54	27	89	9
160	48	46	24	30	70	69	33	52	60	-100	-63	64	20	27	71	11
200	30	47	1	-19	43	69	11	27	61	-100	-100	38	-15	18	45	10
240	22	44	-10	-41	31	70	4	19	59	-100	-100	27	-29	10	33	6
280	14	44	-18	-57	24	66	-8	7	53	-100	-100	20	-46	7	25	4
320	9	39	-25	-65	24	62	-14	4	51	-100	-100	22	-55	1	21	-1

Table S9. The color rendering index (Ra) of ^{a}Co-$CsPbBr_3$ NCs (8:2) under different currents as well as R1(Light Red), R2(Gray - Yellow), R3(Saturated Yellow), R4(Light Green), R5(Saturated Green), R6(Light Blue), R7(Saturated Blue), R8(Light Purple), R9(Saturated Red), R10(Saturated Yellow - Green), R11(Saturated Green - Blue), R12(Saturated Blue - Purple), R13(White - skinned C - Tone), R14(Leaf Green), R15(Asian Skin Tone)

Current (mA)	Ra	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15
20	68	85	74	33	75	74	53	76	74	59	12	54	8	78	59	87
40	68	92	77	26	79	80	55	73	63	25	13	61	9	85	54	77
60	67	88	75	27	76	77	53	73	68	41	9	57	9	81	55	83
80	67	87	74	26	75	76	52	73	69	42	7	57	9	80	54	83
100	65	81	69	22	76	77	51	73	72	52	-2	57	7	72	53	86
120	65	86	72	22	73	75	50	72	69	43	1	55	7	79	52	83
160	66	86	72	23	74	76	51	74	71	48	1	58	11	79	53	85
200	64	83	71	24	73	73	47	72	72	60	-1	56	9	77	54	86
240	64	81	68	22	71	72	49	75	77	74	-7	55	10	74	52	90
280	63	77	66	22	67	70	47	74	78	86	-10	52	9	71	53	91
320	67	80	71	27	68	73	53	79	82	85	-1	53	17	75	55	90

Table S10. The color rendering index (Ra) of $CsPbBr_3$ NCs under 20 mA with long time testing as well as R1(Light Red), R2(Gray - Yellow), R3(Saturated Yellow), R4(Light Green), R5(Saturated Green), R6(Light Blue), R7(Saturated Blue), R8(Light Purple), R9(Saturated Red), R10(Saturated Yellow - Green), R11(Saturated Green - Blue), R12(Saturated Blue - Purple), R13(White - skinned C - Tone), R14(Leaf Green), R15(Asian Skin Tone).

Time (min)	Ra	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15
1	42	32	93	50	3	43	75	46	-5	-100	77	-17	68	50	68	26
2	31	13	82	49	-14	29	69	40	-24	-100	58	-38	66	32	66	5
3	25	6	78	48	-22	21	64	39	-31	-100	48	-49	61	24	65	-3
4	22	0	75	48	-29	15	60	38	-35	-100	42	-57	57	19	64	-8
5	19	-4	72	48	-33	11	56	38	-39	-100	36	-63	53	15	64	-12
6	16	-7	69	48	-37	7	53	37	-42	-100	31	-67	49	11	64	-15
7	14	-10	67	48	-39	4	51	37	-44	-100	27	-71	46	8	64	-18
8	13	-12	66	49	-42	2	49	37	-46	-100	23	-74	43	6	64	-20
9	12	-13	65	49	-44	-1	47	37	-47	-100	21	-78	40	5	64	-21
10	10	-15	63	49	-46	-2	46	36	-49	-100	18	-80	39	2	64	-23
11	10	-16	63	49	-47	-4	44	37	-49	-100	17	-82	37	2	64	-24
12	9	-17	62	49	-49	-5	43	36	-50	-100	15	-84	35	0	64	-26
13	8	-18	61	50	-49	-6	42	37	-51	-100	14	-85	34	0	64	-26
14	8	-19	61	50	-50	-7	41	37	-51	-100	13	-86	33	-1	64	-27
15	7	-20	60	50	-51	-8	41	37	-52	-100	11	-87	32	-2	64	-28
16	7	-20	60	50	-52	-8	40	37	-52	-100	10	-88	32	-2	64	-28
17	6	-20	59	50	-52	-9	39	37	-53	-100	9	-89	31	-3	64	-29
18	6	-21	59	50	-53	-10	39	36	-54	-100	8	-90	30	-4	64	-30
19	6	-21	59	50	-53	-10	38	37	-53	-100	8	-90	30	-3	64	-29
20	6	-21	59	50	-54	-11	38	37	-53	-100	8	-91	29	-4	64	-30
21	5	-22	58	50	-54	-11	38	37	-54	-100	7	-91	29	-4	64	-30
22	5	-22	58	50	-54	-11	38	37	-54	-100	7	-92	28	-4	64	-30
23	5	-22	58	50	-54	-11	38	36	-54	-100	6	-92	28	-5	64	-31
24	5	-22	58	50	-54	-11	38	37	-54	-100	7	-92	28	-4	64	-30
25	5	-22	58	50	-54	-11	37	37	-54	-100	6	-92	28	-5	64	-30
26	5	-22	58	50	-55	-11	38	36	-54	-100	6	-92	28	-5	64	-31
27	5	-22	58	50	-54	-11	38	37	-54	-100	6	-92	28	-5	64	-30
28	5	-22	58	50	-55	-11	37	36	-54	-100	6	-92	28	-5	64	-31
29	5	-22	58	50	-54	-11	38	36	-54	-100	6	-92	28	-5	64	-30
30	5	-22	58	50	-54	-11	38	36	-54	-100	7	-92	29	-4	64	-30
31	5	-22	59	50	-54	-11	38	37	-54	-100	7	-91	29	-4	64	-30
32	6	-22	59	50	-54	-10	38	36	-54	-100	7	-91	29	-4	64	-30
33	6	-21	59	50	-53	-10	39	37	-53	-100	7	-91	29	-4	64	-29
34	6	-21	59	50	-53	-10	39	36	-54	-100	7	-90	30	-3	64	-29
35	6	-20	60	50	-53	-10	39	37	-53	-100	8	-90	30	-3	64	-29

36	6	-20	60	50	-52	-9	39	37	-53	-100	9	-89	31	-3	64	-29
37	6	-20	60	50	-53	-9	389	37	-53	-100	9	-90	31	-2	64	-28
38	7	-19	60	50	-52	-9	40	37	-52	-100	10	-89	31	-2	64	-28
39	7	-19	61	50	-52	-8	40	37	-52	-100	10	-88	32	-1	64	-27
40	7	-19	61	50	-51	-8	41	37	-52	-100	10	-88	323	-1	64	-27
41	7	-19	61	50	-51	-8	41	37	-52	-100	11	-88	32	-1	-64	-27
42	8	-19	61	50	-51	-7	41	36	-52	-100	11	-87	33	-1	64	-27
43	8	-18	61	50	-50	-7	41	37	-51	-100	12	-86	33	0	64	-26
44	8	-18	61	50	-50	-6	42	37	-51	-100	12	-86	34	0	64	-26
45	8	-18	62	50	-50	-6	42	37	-51	-100	12	-86	34	0	64	-26
46	9	-17	62	50	-49	-6	42	37	-50	-100	13	-85	34	1	64	-25
47	9	-17	62	50	-49	-6	42	37	-50	-100	13	-85	35	1	64	-25
48	9	-17	62	50	-49	-5	43	37	-50	-100	13	-84	35	1	64	-25
49	9	-17	62	50	-48	-4	43	37	-50	-100	13	-84	35	2	65	-25
50	9	-16	63	50	-48	-4	43	37	-49	-100	14	-83	36	2	64	-24
51	9	-16	63	50	-48	-4	43	37	-49	-100	14	-83	36	2	65	-24
52	10	-15	63	50	-47	-3	44	37	-49	-100	15	-83	36	3	65	-24
53	10	-15	-63	50	-47	-3	44	37	-49	-100	15	-82	37	3	65	-23
54	10	-15	63	50	-47	-3	44	37	-49	-100	15	-82	37	3	65	-23
55	10	-15	64	50	-47	-3	45	37	-48	-100	15	-82	37	3	65	-23
57	10	-15	64	50	-47	-2	45	37	-49	-100	15	-81	37	3	65	-23
58	11	-14	64	50	-46	-2	45	38	-47	-100	16	-81	37	4	65	-22
59	11	-14	64	50	-46	-2	45	37	-48	-100	16	-81	37	4	65	-22
60	11	-14	64	50	-46	-2	45	37	-48	-100	16	-80	38	4	65	-22

Table S11. The color rendering index (Ra) of ^{b}Co-$CsPbBr_3$ NCs (8:2) under 20 mA with long time testing as well as R1(Light Red), R2(Gray - Yellow), R3(Saturated Yellow), R4(Light Green), R5(Saturated Green), R6(Light Blue), R7(Saturated Blue), R8(Light Purple), R9(Saturated Red), R10(Saturated Yellow - Green), R11(Saturated Green - Blue), R12(Saturated Blue - Purple), R13(White - skinned C - Tone), R14(Leaf Green), R15(Asian Skin Tone)

Time (min)	Ra	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15
1	56	68	80	40	37	71	74	51	28	-42	50	30	49	80	63	64
2	55	64	83	41	36	71	75	49	24	-49	56	29	51	78	64	60
3	55	64	83	40	35	70	76	49	23	-53	57	27	52	78	64	59
4	55	63	84	41	34	69	76	49	22	-56	58	26	53	77	64	58
5	55	63	84	41	33	69	76	49	22	-57	59	25	53	77	64	57
6	54	62	85	41	33	69	76	48	21	-59	60	25	54	77	64	56
7	54	61	85	41	33	69	77	48	21	-60	60	25	54	76	64	56
8	54	62	85	41	32	68	77	49	21	-60	60	24	54	77	64	56
9	54	61	85	41	32	67	77	49	20	-62	61	23	55	76	64	56
10	54	60	86	42	32	68	77	48	20	-63	62	24	55	75	64	55

11	54	60	86	42	32	68	78	48	19	-64	63	23	56	75	64	54
12	54	59	86	41	32	68	78	48	19	-66	64	22	56	75	64	54
13	53	59	86	41	30	67	78	48	18	-68	64	21	57	75	64	53
14	53	59	87	41	30	67	79	48	18	-69	65	21	57	74	64	53
15	53	58	87	41	30	67	79	48	18	-70	65	21	57	74	64	52
16	53	57	88	41	29	66	79	47	17	-72	66	20	58	73	64	51
17	53	57	87	40	28	65	79	48	17	-73	66	19	58	73	63	51
18	53	56	88	41	28	66	80	47	16	-74	68	19	59	72	64	50
19	53	56	88	41	28	65	80	47	15	-76	68	18	59	72	64	50
20	52	55	89	41	27	65	80	47	15	-77	69	18	60	72	64	49
21	52	56	89	40	26	64	80	47	14	-78	69	17	60	72	63	49
22	52	55	89	40	26	64	80	47	14	-79	69	16	60	72	63	49
23	52	55	89	40	26	64	81	47	14	-81	70	16	61	71	63	48
24	52	54	90	40	25	64	81	47	13	-82	71	16	61	70	63	47
25	52	54	90	40	25	64	81	47	13	-82	71	15	61	70	63	47
26	51	53	90	40	24	63	81	47	12	-84	71	14	61	70	63	46
27	51	53	90	40	24	62	81	47	12	-85	72	14	62	70	63	46
28	51	52	91	41	24	63	81	46	11	-86	74	14	62	68	63	45
29	51	52	90	40	24	63	82	46	12	-86	73	14	62	69	63	46
30	51	52	91	40	23	62	82	64	10	-88	74	13	63	69	63	44
31	50	52	91	39	22	61	82	46	11	-89	73	12	63	69	62	44
32	50	51	91	39	22	61	82	46	10	-90	74	12	63	68	62	44
33	50	51	91	39	22	61	82	46	9	-91	75	11	64	68	62	43
34	50	50	92	39	21	60	82	46	9	-92	75	11	64	68	62	43
35	50	51	91	38	20	60	83	46	10	-92	74	10	64	68	62	43
36	50	50	92	39	21	61	83	46	9	-93	76	11	64	67	62	42
37	50	49	92	39	21	60	83	45	8	-95	76	10	65	66	62	42
38	50	49	93	39	20	60	83	45	8	-96	77	10	65	66	62	41
39	49	49	92	39	19	58	82	46	7	-98	77	8	65	66	62	40
40	49	48	93	39	20	60	84	45	7	-97	77	9	65	66	62	41
41	49	48	93	39	19	59	84	45	7	-98	78	8	66	65	62	40
42	49	48	93	39	19	60	84	45	7	-99	79	8	66	65	62	40
43	49	47	93	39	19	59	84	45	6	-100	79	8	66	65	62	39
44	49	47	93	38	18	58	93	45	6	-100	79	6	66	65	61	39
45	49	47	93	38	17	58	84	45	6	-100	79	6	66	65	62	39
46	48	47	93	38	17	57	83	45	5	-100	79	6	66	65	61	39
47	49	46	94	39	18	58	84	45	5	-100	80	6	67	64	62	38
48	48	46	94	38	17	58	84	45	5	-100	80	6	67	64	62	38
49	48	46	94	38	16	57	83	45	4	-100	81	5	67	63	61	37
50	48	45	94	39	17	58	85	44	4	-100	81	5	68	63	62	37
51	48	45	95	39	17	58	85	44	4	-100	82	5	68	62	62	37
52	48	45	95	38	16	57	85	44	3	-100	82	5	68	62	62	36
53	47	45	94	38	15	56	84	45	3	-100	82	3	68	63	61	36
54	48	45	95	38	15	56	85	44	3	-100	82	4	68	62	61	36

55	48	44	95	38	15	56	85	44	3	-100	82	4	69	62	61	36
57	47	45	94	37	14	55	84	54	3	-100	82	2	68	63	61	36
58	47	44	95	38	15	56	85	44	3	-100	83	3	69	61	61	35
59	47	44	95	38	14	55	85	44	2	-100	83	2	69	62	61	35
60	47	43	95	38	14	55	85	44	2	-100	83	2	69	61	61	35