Electronic supplementary information

Tunable ultra-uniform Cs_4PbBr_6 perovskites with efficient photoluminescence and excellent stability for high-performance white light-emitting diodes

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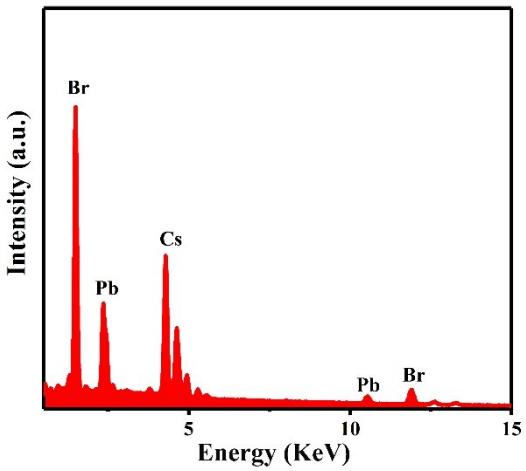

Fig. S1 Energy-dispersive X-ray (EDX) spectrum of Cs_4PbBr_6 MCs.

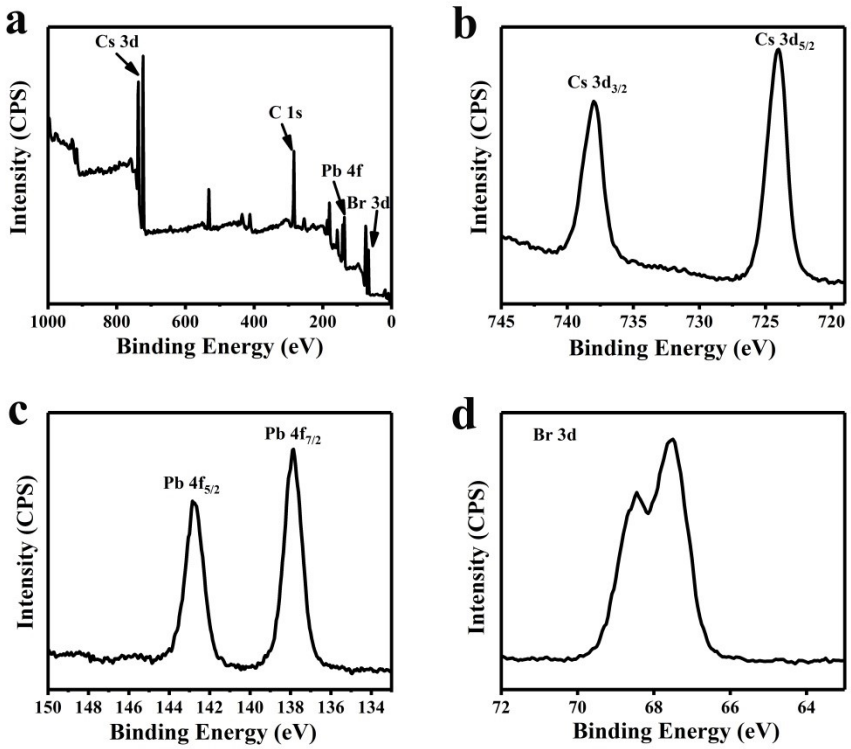

Fig. S2 X-ray photoelectron spectroscopy (XPS) of Cs_4PbBr_6: (a) survey, (b) Cs 3d, (c) Pb 4f, and (d) Br 3d.

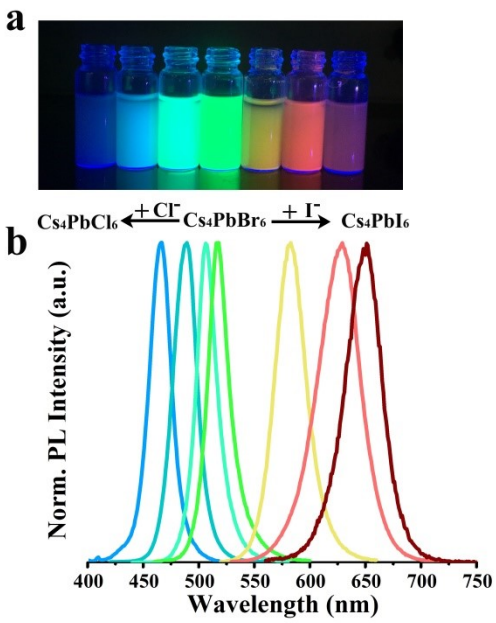

Fig. S3 (a) Photographs of Cs_4PbX_6 (X = Cl, Br, I, or their mixture) cyclohexane dispersion solution under UV light irradiation (λ = 365 nm). (b) PL spectra of Cs_4PbX_6 (X = Cl, Br, I, or their mixture).

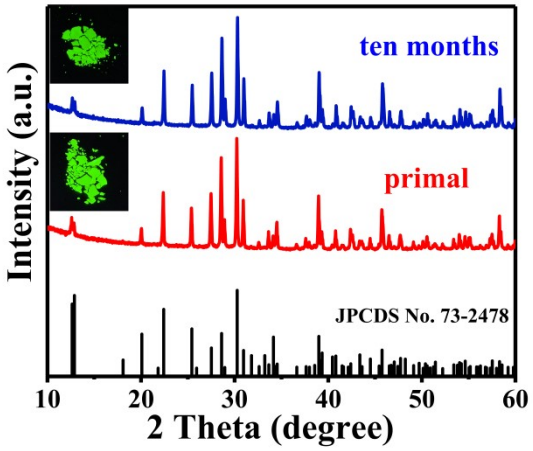

Fig. S4 XRD patterns of Cs_4PbBr_6 tested at different time (red line: primal Cs_4PbBr_6; blue line: Cs_4PbBr_6 storages for 10 months). The insets show the photoluminescence photographs of corresponding samples excited at 365 nm.

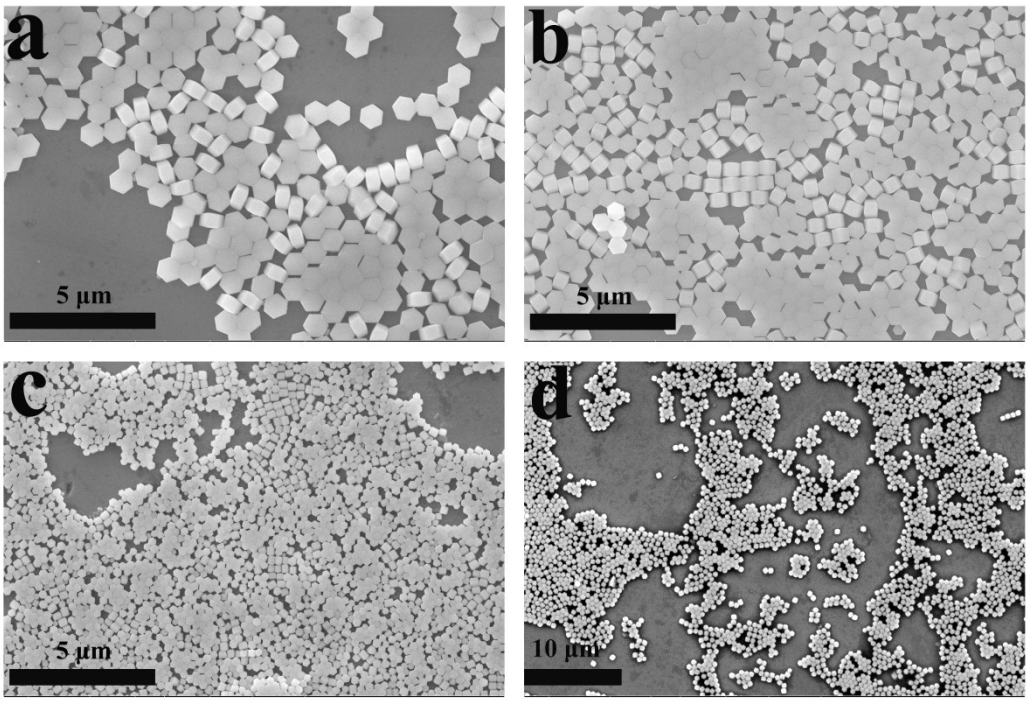

Fig. S5 Low magnification SEM images of Cs_4PbBr_6 MCs.

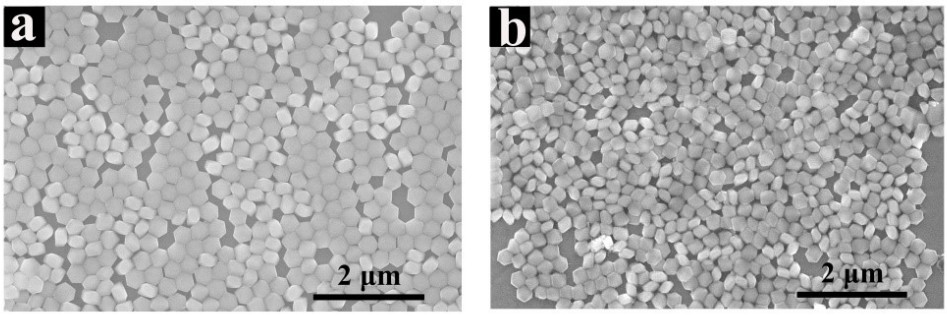

Fig. S6 SEM images of Cs_4PbBr_6 samples synthesized with Cs:Pb ratios of (a) 1.33:1.5 and (b) 1.33:1.75.

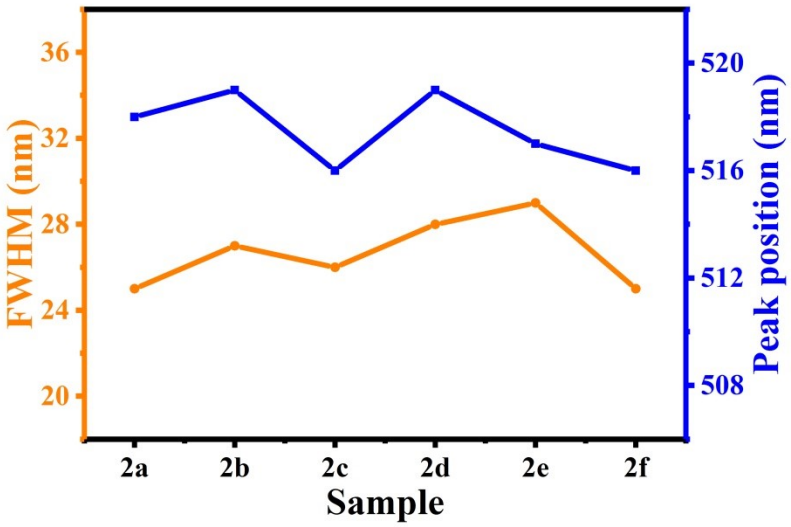

Fig. S7 PL peak position and FWHM of samples 2a-2f.

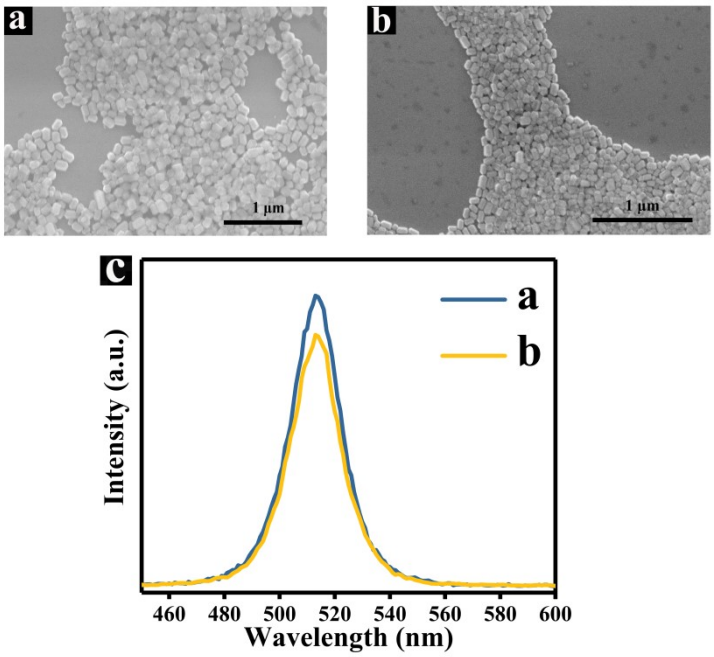

Fig. S8 SEM images of Cs_4PbBr_6 samples synthesized with oleic acid:n-octylamine (μL) ratios of (a) 600:160 and (b) 200:80. (c) PL spectra of samples a and b.

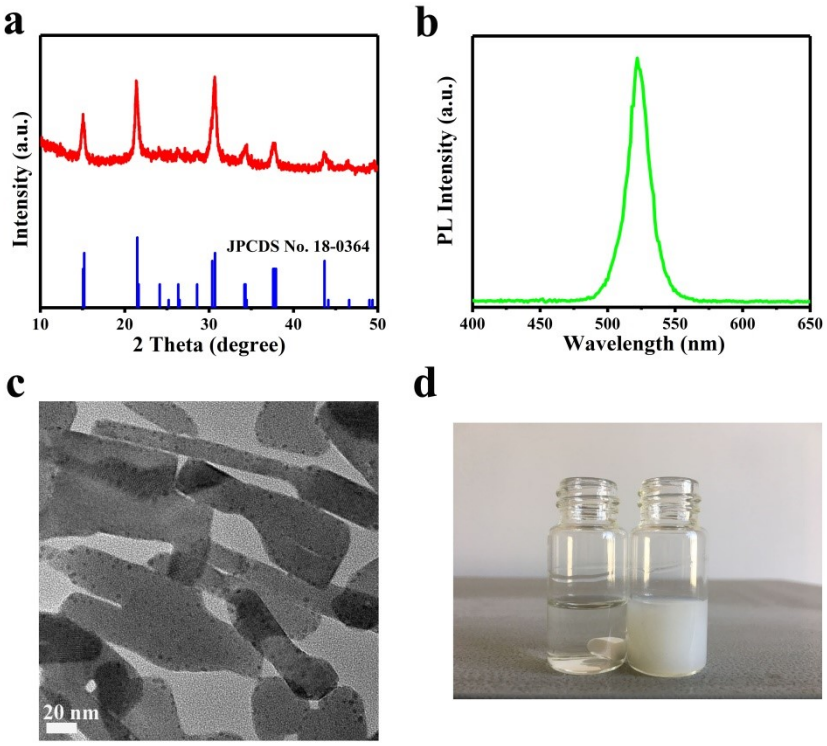

Fig. S9 (a) XRD pattern of $CsPbBr_3$. (b) PL spectrum of $CsPbBr_3$. (c) TEM image of $CsPbBr_3$ perovskites. (d) Photograph of the 'oil phase' solution with same n-octylamine content (80 μL) and different oleic acid content: 600 μL (left) and 1.2 mL (right).

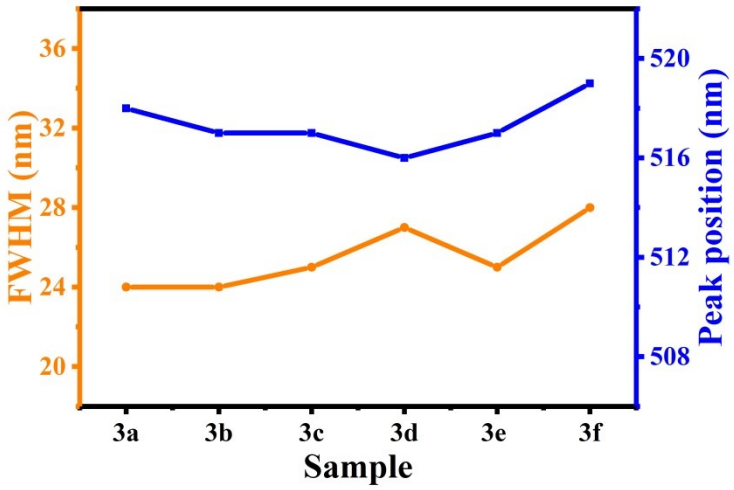

Fig. S10 PL peak position and FWHM of samples 3a-3f.

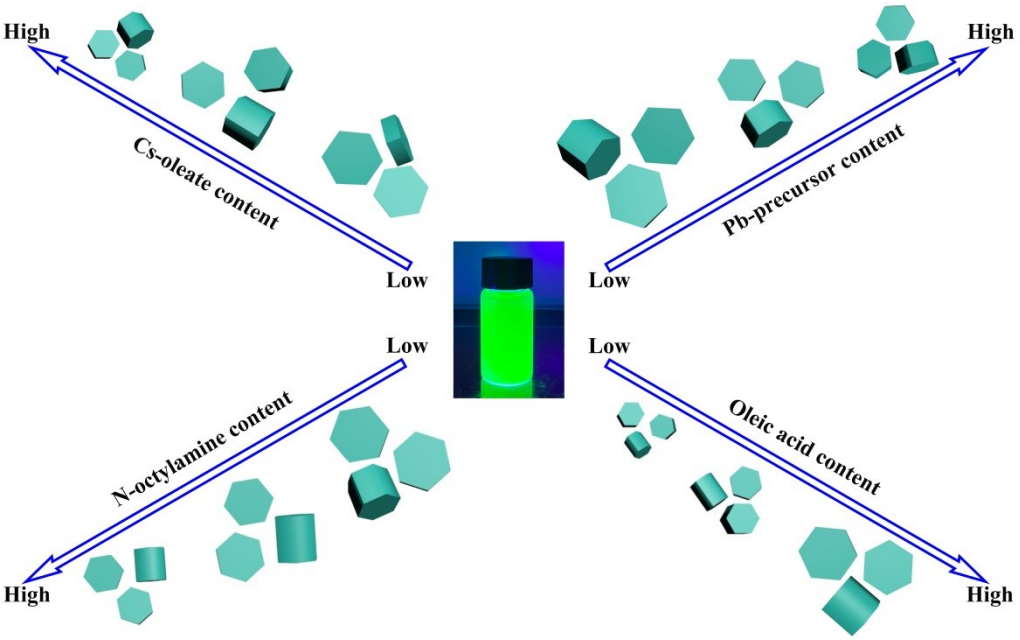

Fig. S11 Summary of the shape and size of Cs_4PbBr_6 MCs dependence on the content of Cs-oleate, Pb-precursor, n-octyamine and oleic acid.

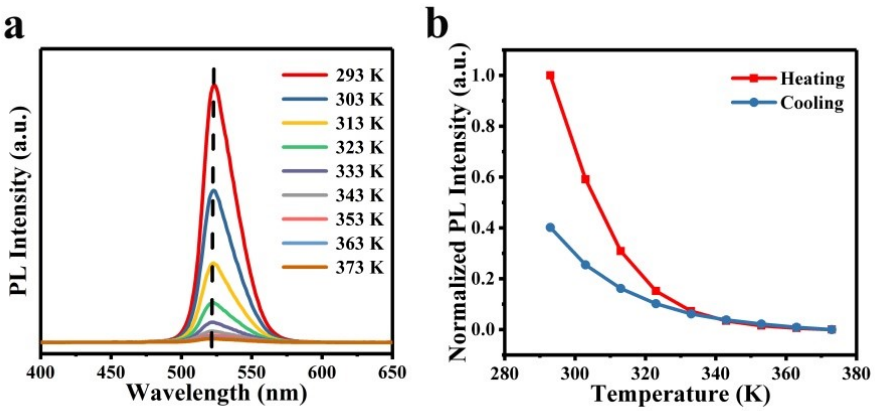

Fig. S12 (a) PL spectra of $CsPbBr_3$ from 293 to 373 K. (b) Plots of normalized PL intensity of $CsPbBr_3$ with the thermal cycling testing in the temperature range of 293 to 373 K.

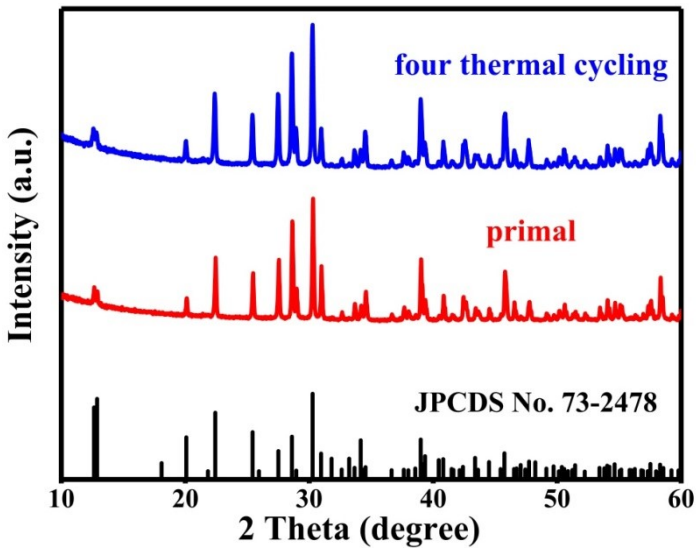

Fig. S13 XRD patterns of Cs_4PbBr_6 tested before and after four successive heating/cooling cycles. (red line: before; bule line: after).

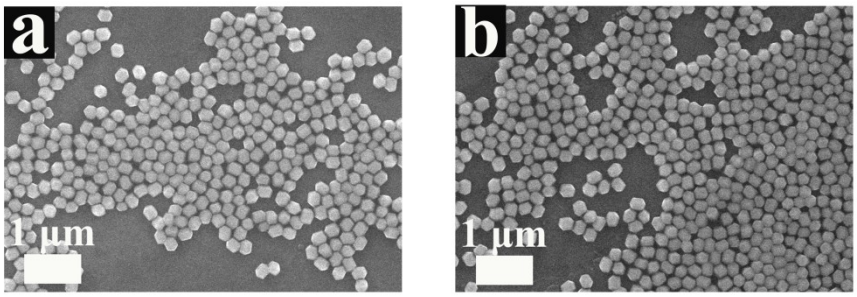

Fig. S14 SEM images of Cs_4PbBr_6 tested before (a) and after (b) four successive heating/cooling cycles.

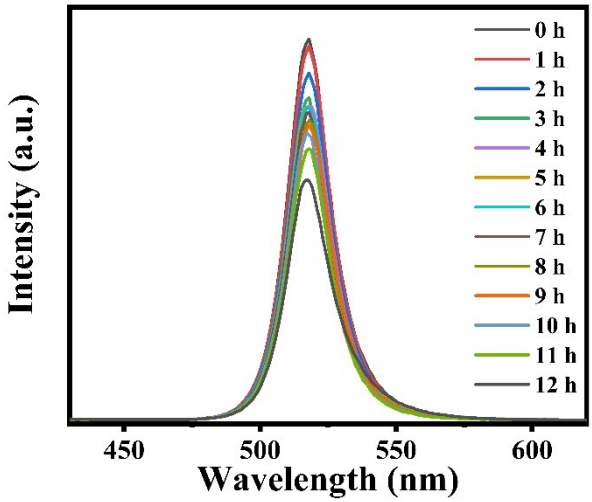

Fig. S15 PL spectra of Cs_4PbBr_6 at 373 K at different time points.

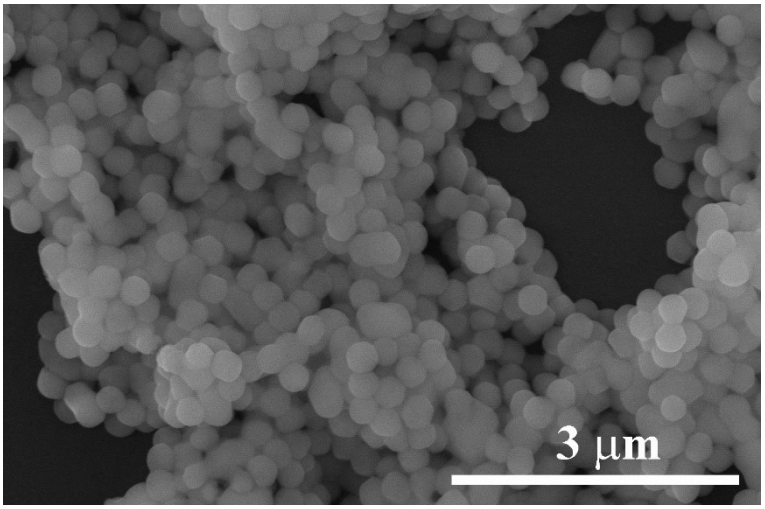

Fig. S16 SEM image of Cs_4PbBr_6 at 373 K for 12 h.

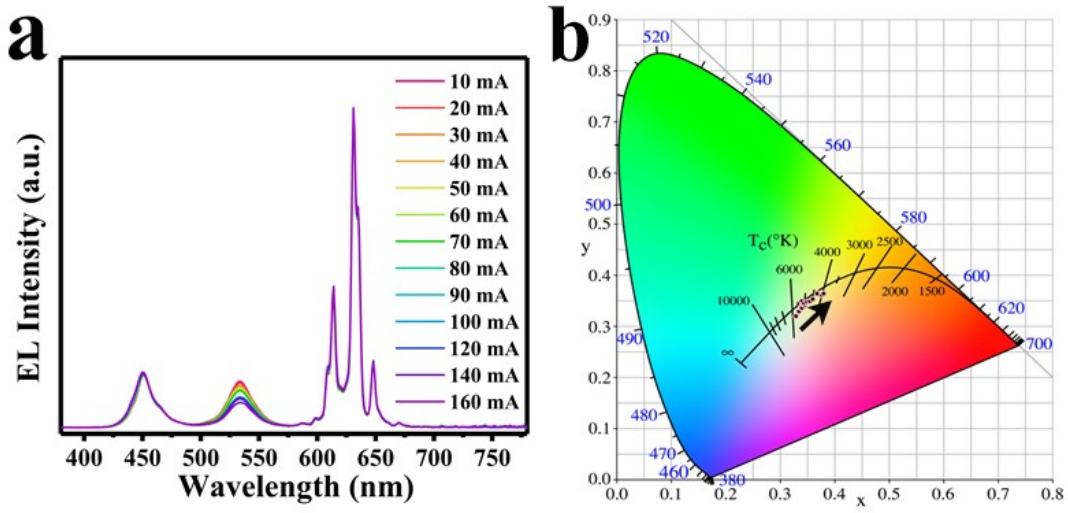

Fig. S17 (a) Electroluminescence spectra of the WLED device under different drive currents. (b) The corresponding chromaticity coordinates in the CIE diagram.

Table S1. Summary of experiment parameters of all samples.

Sample	Pb-precursor (μL)	Cs-oleate (μL)	Oleic acid (μL)	n-Octylamine (μL)
2a	100	300	600	80
2b	100	500	600	80
2c	100	700	600	80
2d	75	400	600	80
2e	100	400	600	80
2f	125	400	600	80
3a	100	600	600	40
3b	100	600	600	60
3c	100	600	600	100
3d	100	600	400	80
3e	100	600	600	80
3f	100	600	800	80
S5a	150	400	600	80
S5b	175	400	600	80
S7a	100	600	600	160
S7b	100	600	200	80
S8c	100	600	1200	80

Table S2. The fitted decay time of samples.

Sample	A_1	τ_1 (ns)	A_2	τ_2 (ns)	τ_{ave} (ns)
2a	4334.29557	16.66689	880.998	132.46012	88.2
2b	4792.62205	18.97191	588.59493	179.59139	105.3
2c	4418.13883	16.24515	802.37541	90.46198	53.6
2d	4884.62209	19.32562	538.41051	210.23156	123.4
2e	4214.36458	15.72434	930.23851	120.60113	81.7
2f	4416.25981	15.25617	816.40216	107.93178	67.8
3a	3793.85214	20.70603	1123.68365	208.50307	161.3
3b	4316.24004	16.21599	884.20554	129.06623	86.2
3c	4529.14762	18.25483	834.56421	95.24795	56.0
3d	4412.86315	17.24518	842.10624	105.23697	64.6
3e	4432.10506	16.67893	874.32549	142.16059	95.4
3f	4737.46634	16.88722	653.31589	168.77274	104.9