Supporting information

Study on the optical stability of $CsPbBr_3$ with different dimensions (0D, 1D, 2D, 3D) under thermal environment

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Experimental Section

Materials

The cesium carbonate (Cs_2CO_3, 99.99%), lead (II) bromide ($PbBr_2$, 99.99%), oleic acid (OA, 85%), oleylamine (OAm, 80-90%), 1-octadecene (ODE, 90%), hexane (C_6H_{12}, 99.5%) were purchased from Aladdin. All the reagents were used without further purification.

Preparation of $CsPbBr_3$ with different dimensions (0D, 1D, 2D and 3D).

In this report, the traditional high temperature thermal injection method was employed to prepare $CsPbBr_3$ fluorescent materials. Subsequently, the conversion between the different dimensions (0D, 1D, 2D, 3D) of $CsPbBr_3$ was achieved by adjusting the ratio of the precursor solution, and controlling the time as well as the temperature of the high temperature reaction. Both Cs and Pb precursors were dried under vacuum at 120 ℃ for 30 mins, after which the precursors were heated to 140 ℃ in a nitrogen atmosphere to ensure complete dissolution. Finally, thermal injection operation was carried out under different reaction conditions. The crude product after the reaction was washed several times with C_6H_{12}, and dispersed in C_6H_{12} for storage. The specific preparation parameters listed in the table below.

Dimensions	Cs precursor	Pb precursor	Reaction temperature	Injection amount of Cs precursor	Reaction time
0D	160 mg Cs_2CO_3 6 mL ODE 0.5 mL OA	69 mg $PbBr_2$ 5 mL ODE 0.5 mL OA 0.5 mL OAm	150 ℃	0.4 mL	5 s
1D	200 mg Cs_2CO_3 7.5 mL ODE 0.6 mL OA	66 mg $PbBr_2$ 5 mL ODE 0.4 mL OA 0.3 mL OAm	150 ℃	0.6 mL	50 mins
2D	32 mg Cs_2CO_3 10 mL OA	13 mg $PbBr_2$ 10 mL ODE 0.25 mLOA 0.25 mL OAm	150 ℃	1 mL	5 mins

3D	160 mg Cs_2CO_3 6 mL ODE 0.5 mL OA	69 mg $PbBr_2$ 5 mL ODE 0.5 mL OA 0.5 mL OAm	100 ℃	0.5 mL	30 mins

Characterization Methods

The morphology and microstructure of the as-synthesized $CsPbBr_3$ with different dimensions (0D, 1D, 2D and 3D) were analyzed using a high-resolution TEM (JEOL JEM-F200). EDS spectra of powder samples were investigated by field emission scanning electron microscopy (SEM, FEI Quatan FEG 250) equipped with an energy dispersive spectrometer (EDS). The photoluminescence (PL) spectra, PL quantum yields (PLQYs) was recorded on an Edinburgh Instruments FLS 1000 spectrometer. The time-resolved PL (TRPL) decay curves were recorded on an Edinburgh Instruments FLS 1000 spectrometer by using a quartz glass tool to fix different powder samples respectively. The ultraviolet-visible (UV-Vis) absorption spectra were recorded by PE Lambda 950. The X-ray diffraction (XRD) patterns were obtained using the DB-ADVANCE X-ray diffraction analyzer diffractometer. The PL spectra of the samples at different temperatures were collected by Photo Research 670 spectrometer after heating the samples using a heater (MS7-H550-S, DLAB, China) and under 365 nm UV light irradiation.

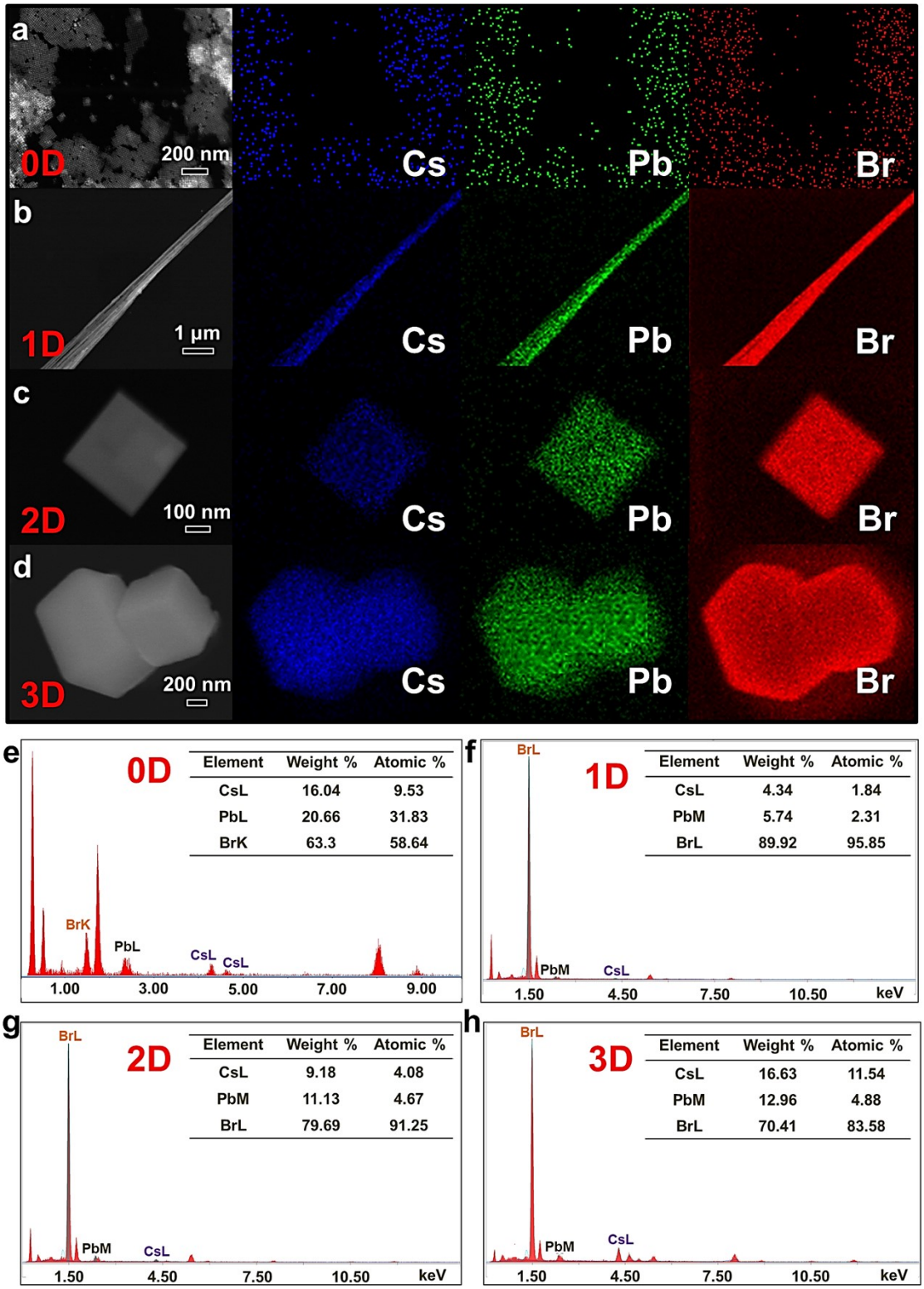

Fig. S1 TEM images of 0D $CsPbBr_3$ QDs (a), SEM images of 1D $CsPbBr_3$ NWs (b), 2D $CsPbBr_3$ NPs (c) and 3D $CsPbBr_3$ MCs (d), with corresponding EDS mapping and spectra (e-h) of Cs (blue), Pb (green) and Br (red), respectively.

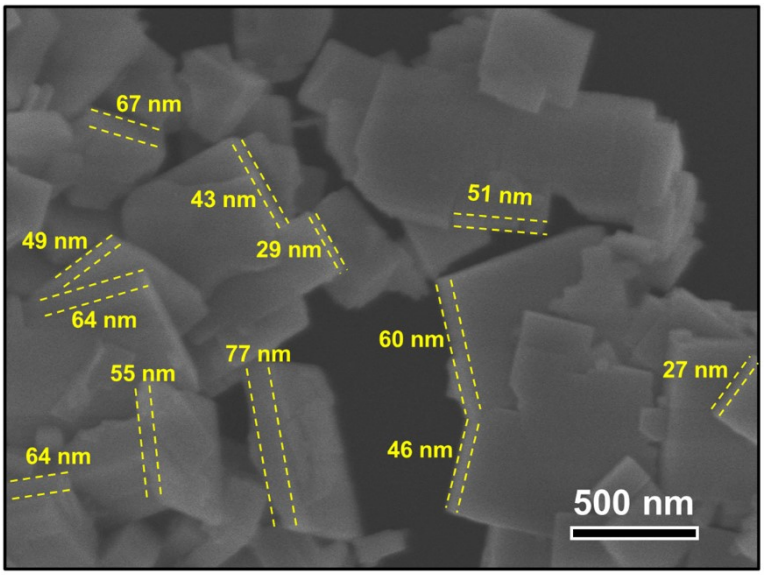

Fig. S2 Thickness count of 2D $CsPbBr_3$ NPs.

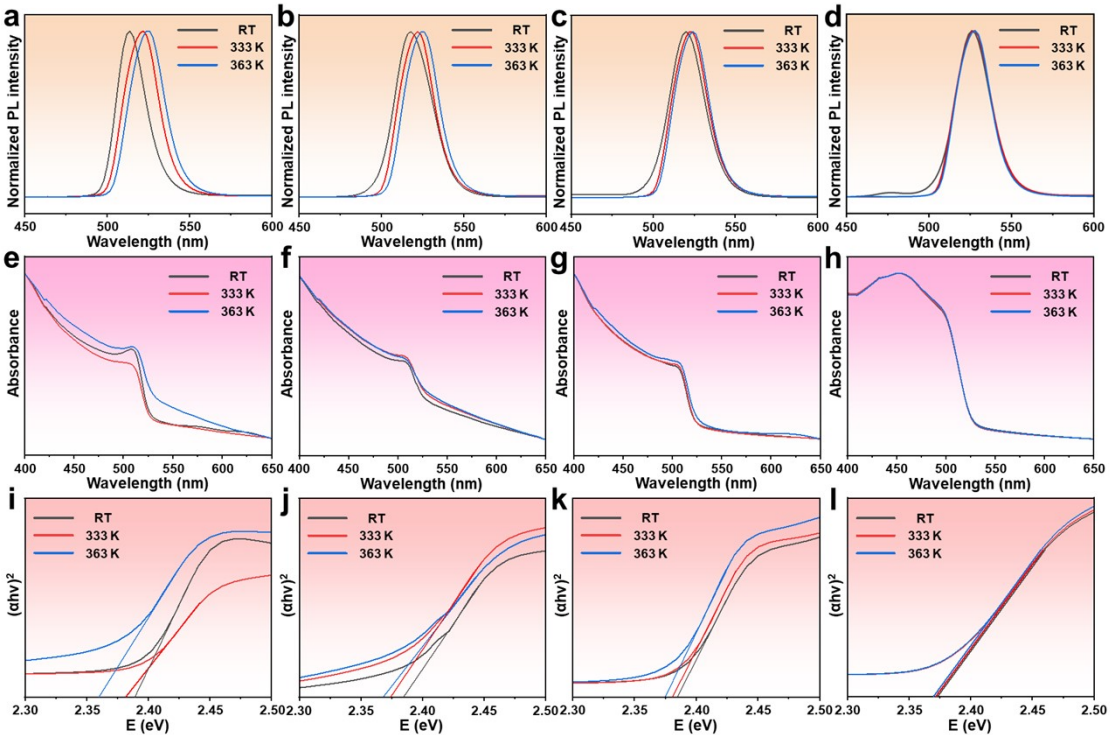

Fig. S3 Normalized PL spectra (a-d), absorption spectra (e-h) and corresponding $(\alpha h\nu)^2$ vs photon energy (eV) curves (i-l) of 0D $CsPbBr_3$ QDs, 1D $CsPbBr_3$ NWs, 2D $CsPbBr_3$ NPs and 3D $CsPbBr_3$ MCs after annealing at 333 K and 373 K for 20 mins.

Table. S1. Double exponential fitting results of PL decays for $CsPbBr_3$ with different dimensions (0D, 1D, 2D and 3D)

Dimension	τ_1 (ns)	A_1 (%)	τ_2 (ns)	A_2 (%)	τ_{ave} (ns)
0D	5.21	38.5	27.71	61.5	25.34
1D	5.78	41.3	25.73	58.7	23.01
2D	4.12	46.1	22.71	53.9	20.21
3D	3.2	57.2	15.92	42.8	13.23

Table. S2. Double exponential fitting results of PL decays for $CsPbBr_3$ with different dimensions (0D, 1D, 2D and 3D) after annealing at 373K for 20 mins

Dimension	τ_1 (ns)	A_1 (%)	τ_2 (ns)	A_2 (%)	τ_{ave} (ns)
0D	2.32	70.9	9.00	29.1	6.42
1D	2.38	66.9	9.71	33.1	7.28
2D	2.95	62.7	13.76	37.3	10.9
3D	2.13	60.7	15.16	39.3	12.84

The PL decay curves of different samples were studied and the decay traces for the samples were well fitted with double exponential function Y(t) based on nonlinear least-squares, using the following expression.

$$Y(t) = A_1 exp(-t/\tau_1) + A_2 exp(-t/\tau_2)$$

where A_1, A_2 are fractional contributions of time-resolved emission decay lifetimes τ_1, τ_2.

The average lifetime (τ_{ave}) of the different samples can be obtained by the following equation.

$$\tau_{ave} = \frac{A_1\tau_1^2 + A_2\tau_2^2}{A_1\tau_1 + A_2\tau_2}$$