Electronic Supplementary Material (ESI) for ChemComm.

Supporting Information

Morphology Dependent Light-Induced Photoluminescence Enhancement of $CsPbBr_3$ Microcrystals

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1. Experimental Section

1.1 *Chemicals and materials*

Preparation of $CsPbBr_3$ Powders. The $CsPbBr_3$ Powders were prepared by grinding $CsPbBr_3$ crystals in an agate mortar. The $CsPbBr_3$ crystals were synthesized by a homemade thermal field-elevating melt growth technique as reported in our previous work.[1, 2] Halides and lead salts, including cesium bromide CsBr (99.999%) and $PbBr_2$ (99.999%) were purchased from the Sigma-Aldrich. $PbBr_2$ and CsBr (5 g and 2.899 g,) were fully mixed before being placed in an ampule. Then the ampule was placed in the growth furnace. In order to ensure an oxygen-free environment during crystal growth, the growth furnace chamber was subjected to three vacuuming and purging steps with argon gas. The high temperature zone and cold temperature zone were heated up to 620 °C and 450 °C, respectively. First, the ampule was located in the hot zone for 12 h. Then the oven was moved upward at the speed of 4 mm/h to cool the melting materials. Then the $CsPbBr_3$ crystals crystallized from the melt. When the crystallization process finished, the temperature of furnace cooled to room temperature at a rate of 5−15 °C/h.

1.2 Material characterization

Microscope Measurement. Optical images were obtained using a Nikon ELIPISE Ni inverted microscope system equipped with a Nikon LV-EPILED reflector and a Nikon DS-Ri2 photographic system. Fluorescence images were obtained using a Nikon Ti−U Inverted Microscope System equipped with a Nikon C-SHG 1 mercury lamp. The exposure time to acquire a bright photo on a fluorescence microscope for $CsPbBr_3$ cubes is as short as 30 ms and 100 ms for $CsPbBr_3$ prisms.

Electron Microscopy Measurement. Scanning electron microscopy (SEM) was obtained by a Hitachi S-4800 ultrahigh resolution (UHR) field emission (FE) scanning electron microscope, and the pictures were taken at an accelerating voltage of 5.0 kV.

Powder X-ray Diffraction. The X-ray diffraction pattern was collected with an X'Pert3 Powder&XRK-900 X-ray diffractometer with Cu Kα radiation (λ =1.54056 Å) in a room-temperature atmospheric environment.

PL spectra measurement. Steady-state fluorescence measurements were performed with an Edinburgh Instruments FLS980 spectrometer. Fluorescence quantum yields were determined with the FLS980 spectrometer using optically dense samples in an integrating sphere. Fluorescence lifetimes were measured by time-correlated single-photon counting (TCSPC) at the FLS980 spectrometer using pulsed laser diodes at 375 nm (EPL-375) as the excitation source.

Absorption spectra measurement. The absorption spectroscopy was carried out using a conventional UV/Vis spectrometer (Hitachi U-4100) equipped with an integrating sphere over the spectral range of 300–800 nm.

2. Data

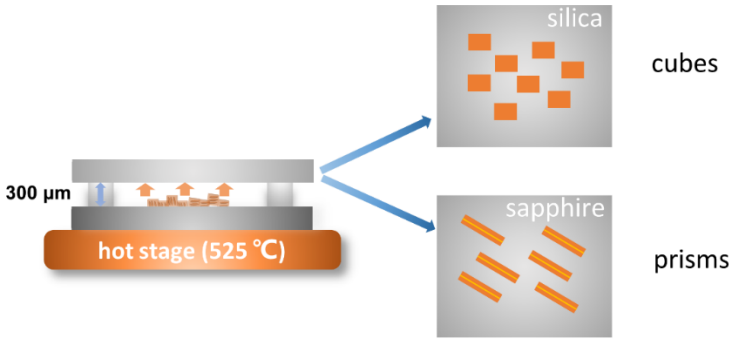

Fig. S1 Schematic diagram of the growth of $CsPbBr_3$ cubes and prisms on different substrates.

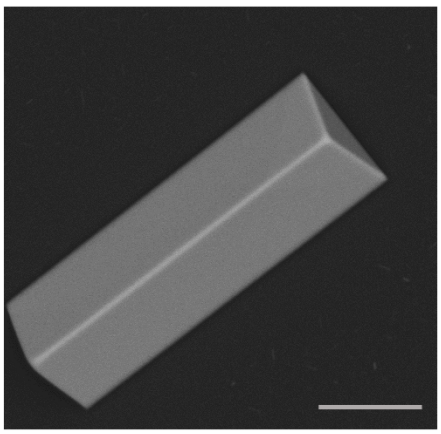

Fig. S2 Tilted SEM image of CsPbBr3 prism. (Scale bar: 5 μm).

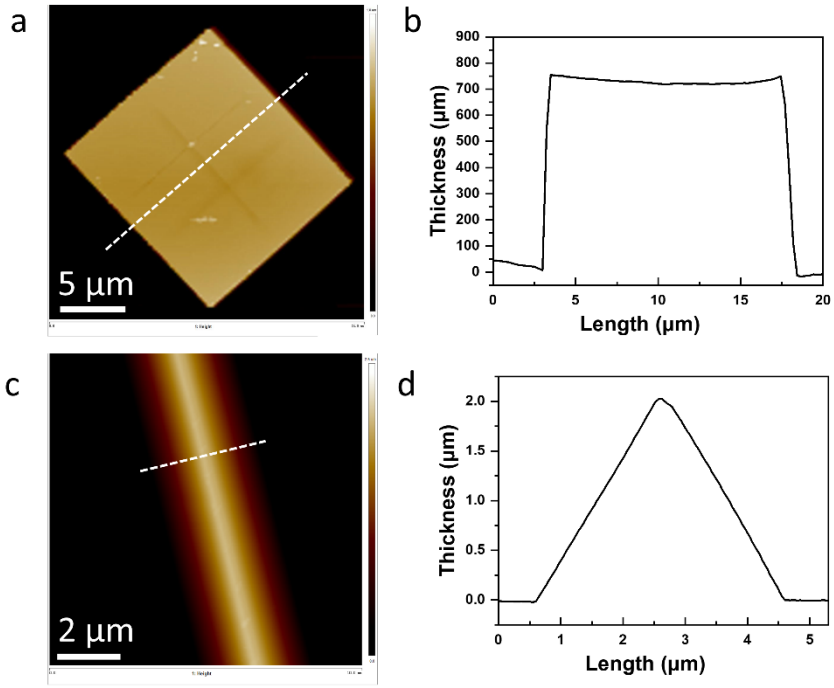

Fig. S3 (a and c) AFM images and cross-section thickness profile of CsPbBr3 cubes and prisms. (Scale bar: 5 μm for a, 2 μm for c).

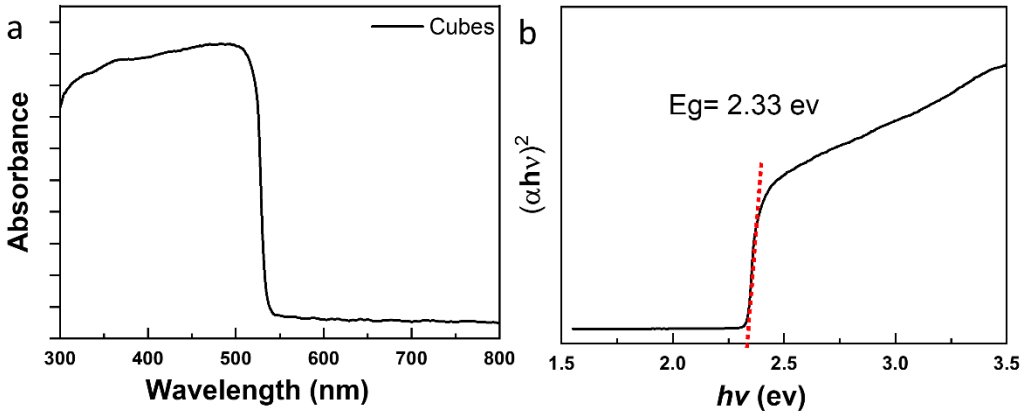

Fig. S4 (a) Absorption spectra of $CsPbBr_3$ cubes. (b) Absorbance versus photon energy and the determined bandgap E_g.

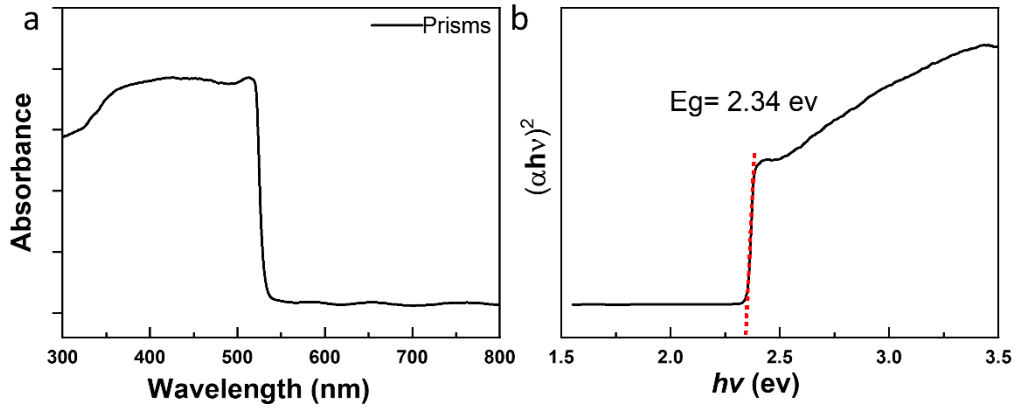

Fig. S5 (a) Absorption spectra of $CsPbBr_3$ prisms. (b) Absorbance versus photon energy and the determined bandgap E_g.

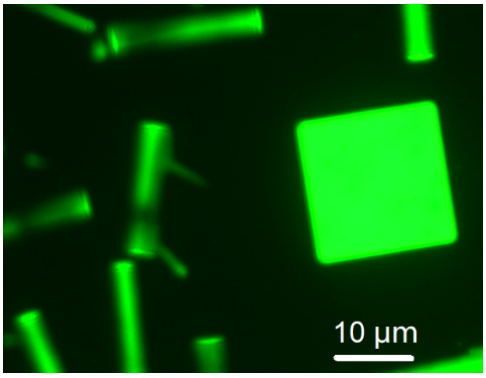

Fig. S6 Fluorescence microscope images of $CsPbBr_3$ cubes and prisms.

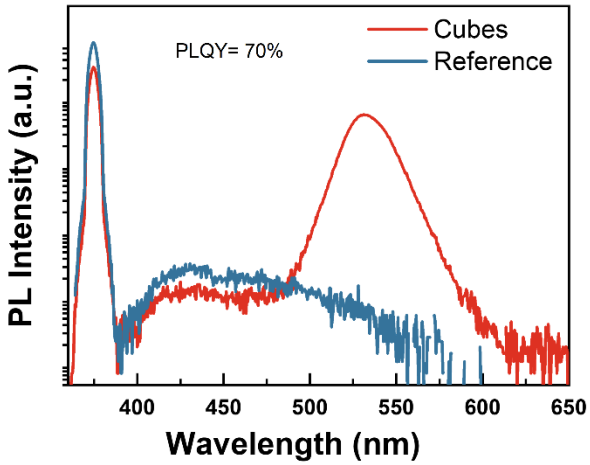

Fig. S7 PLQY of $CsPbBr_3$ cubes.

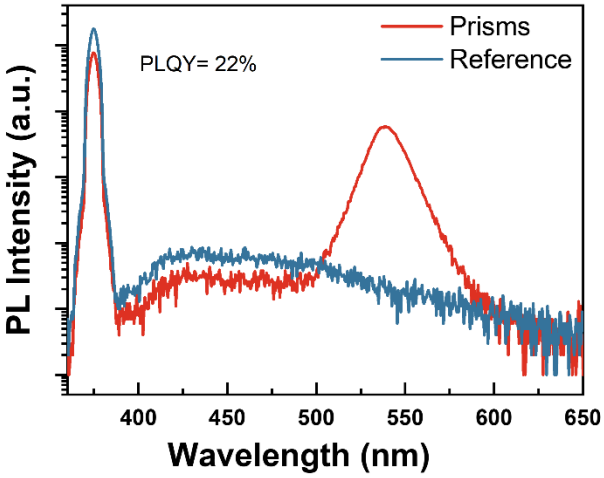

Fig. S8 PLQY of $CsPbBr_3$ prisms.

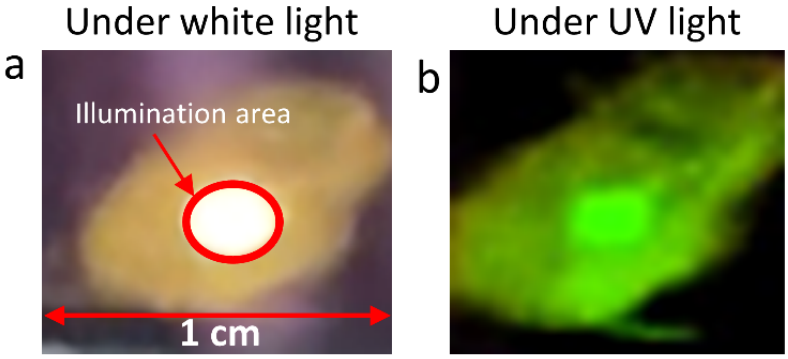

Fig. S9 Photograph of $CsPbBr_3$ crystals. (a) The crystals are partially illuminated under white light. The red circle indicates the illumination area. (b) The crystals are under UV light.

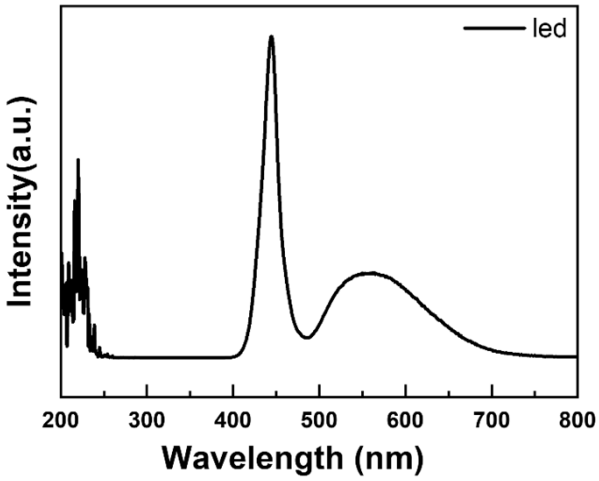

Fig. S10 Luminescence spectrum of the white LED.

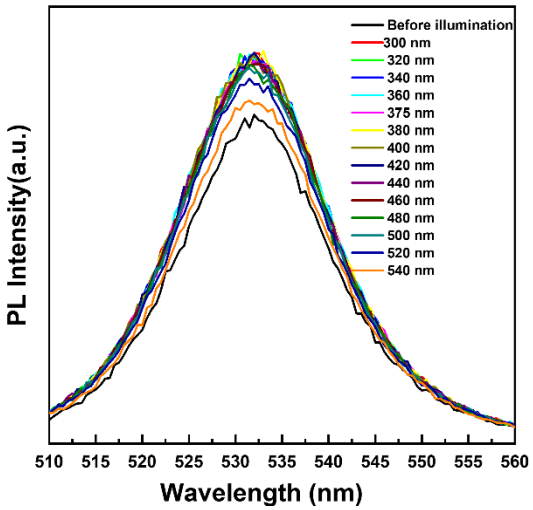

Fig. S11 PL spectra of CsPbBr3 cubes after illumination with various wavelengths.

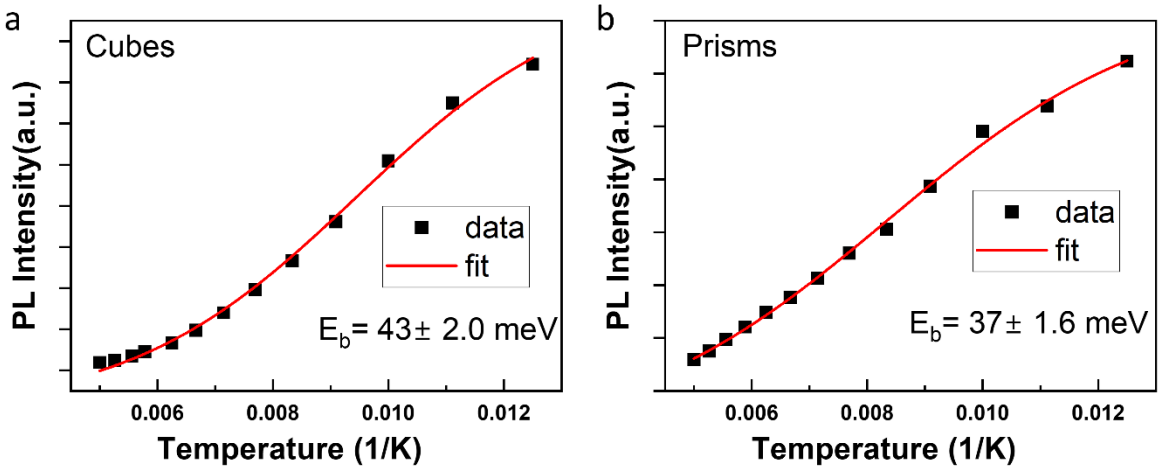

Fig. S12 PL emission intensity plotted as a function of temperature. The squares are experiment data and the red lines are fitting curves. The exciton binding energy can be fitted using equations,

$I = \frac{I_0}{1 + Ae^{-E_b / k_B T}}$, in which I_0 is the PL emission intensity at T= 0 K, A is temperature-independent constant, E_b is the exciton binding energy of ±, and k_B is the Boltzmann constant. The exciton binding energy (Eb) is extracted as 43 ± 2.0 meV and 37 ± 1.6 meV for cubes and prisms respectively from the data fitting process.

References

1. S. Cui, T. Zhu, L. Zhang, X. Ye, Q. Han, C. Ge, Q. Guo, X. Zheng, Q. Lin and C. Li, Advanced Optical Materials, 2022, 2102355.
2. P. Zhang, Q. Sun, Y. Xu, X. Li, L. Liu, G. Zhang and X. Tao, Crystal Growth & Design, 2020, 20, 2424-2431.