

Supporting Information

Reversible “On-Off” Converting and Ultra-High Temperature Sensitivity of Zero-Dimensional Lead-Free $\text{Cs}_2\text{InBr}_5(\text{H}_2\text{O})$: Sb^{3+} Perovskite

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1.1 Experimental steps

1.2 Raw material

InBr_3 (1 mmol, 99%, Sigma-Aldrich), CsBr (2 mmol, 99.9%, Sigma-Aldrich), and appropriate of SbBr_3 (99.9%, Wako Pure Chemical Corporation) were utilized without any purification.

1.3 Synthesis of $\text{Cs}_2\text{In}_{1-x}\text{Sb}_x\text{Br}_5(\text{H}_2\text{O})$

The detailed experimental procedure for the green synthesis of 0D $\text{Cs}_2\text{In}_{1-x}\text{Sb}_x\text{Br}_5(\text{H}_2\text{O})$ ($x=0, 0.05, 0.1, 0.5, 0.8, 1.4, \text{ and } 2.0\%$) is as follows: The raw materials used include InBr_3 , CsBr , and SbBr_3 , and distilled water serving as the solvent. Initially, InBr_3 (1-x mmol), CsBr (2 mmol), and x mmol of SbBr_3 are separately measured and added to the reaction vessel. Subsequently, 2-4 mL of distilled water is slowly added to the reaction vessel while stirring is employed to ensure the formation of a clear solution. The

solution is then concentrated to saturation using evaporation at temperatures. It is subsequently drop-cast onto glass slides or silicon substrates and undergoes in-situ crystallization.

2. Measurement and characterization

The XRD patterns were collected on an X-ray diffractometer (XRD, PANalytical Empyrean series 3) equipped with *Cu-K α* radiation, operating at 45 kV and 40 mA to study the structural information of the prepared samples. To minimize preferred orientation during XRD measurements, a rotating sample stage was employed. The crystal structure of in-situ solution crystallization was observed using a temperature-controllable station (Beijing Weiyi Vacuum Technology Co., Ltd.). The morphology and elemental distribution of the samples were analyzed using a scanning electron microscope (SEM, Hitachi S4800) equipped with an energy-dispersive X-ray spectrometer (EDS). Photoluminescence (PL) and temperature-dependent tests of the samples were conducted using a spectrometer (QE65Pro, USA) from Ocean Insight, with an excitation wavelength of 365 nm UV light source.

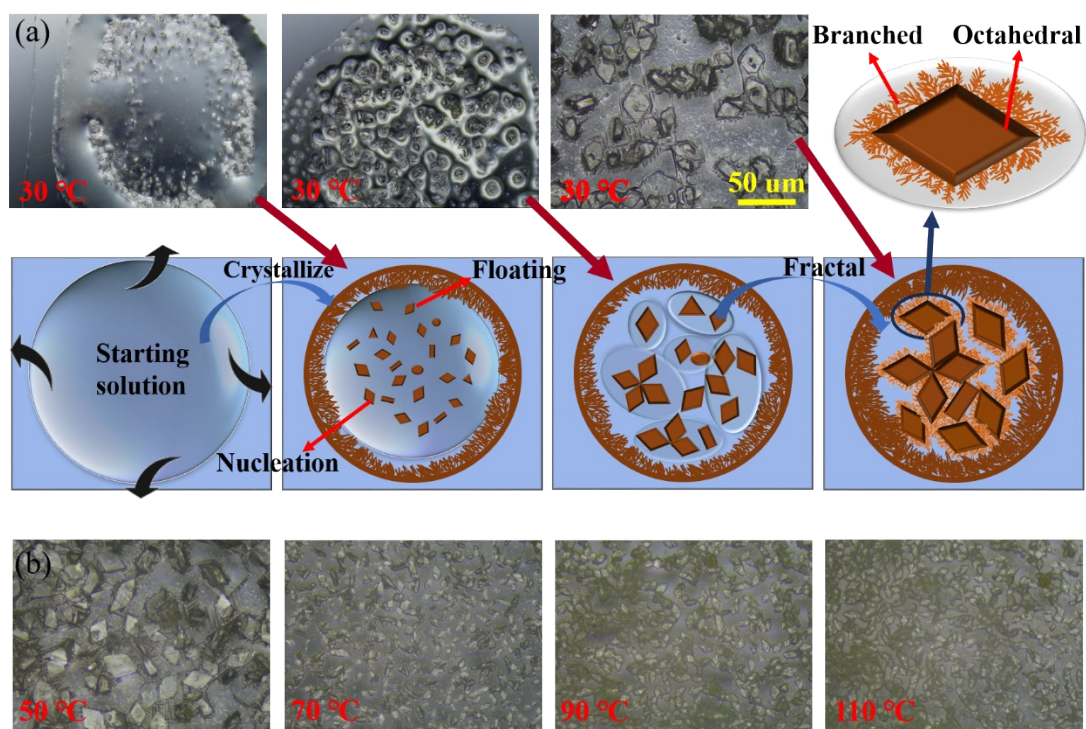


Figure S1. (a) Observation of the fractal structure growth process of $\text{Cs}_2\text{InBr}_5(\text{H}_2\text{O})\text{:Sb}^{3+}$ crystals using in-situ solution crystallization method under an optical microscope. (b) Schematic diagram of fractal structure formed by crystallization at different temperatures.

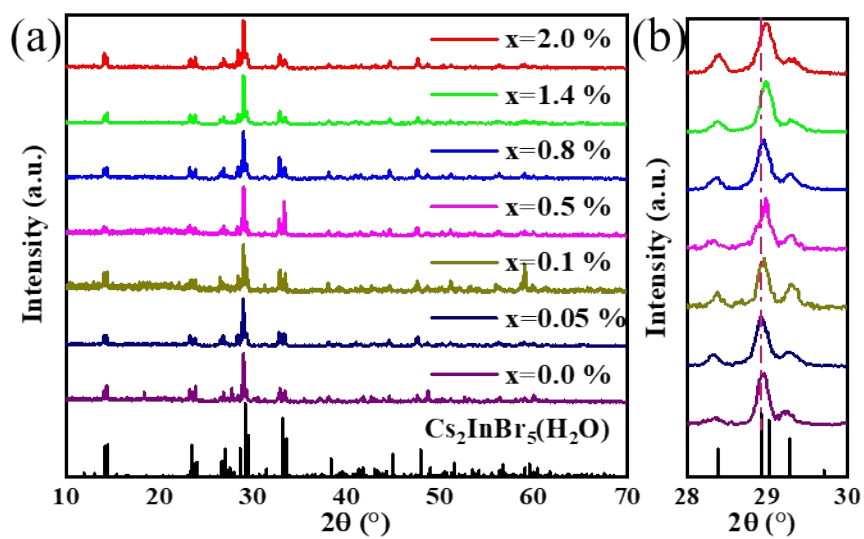


Figure S2. (a) XRD patterns of $\text{Cs}_2\text{In}_{1-x}\text{Sb}_x\text{Br}_5(\text{H}_2\text{O})$ samples ($x=0, 0.05, 0.1, 0.5, 0.8, 1.4,$ and 2.0%) and (b) local magnified region.

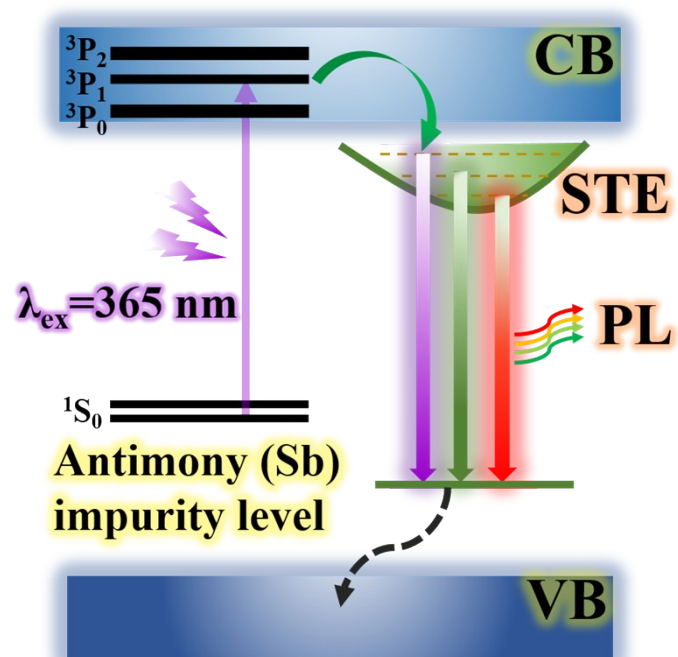


Figure S3. Schematic illustration of photoluminescence mechanism in $\text{Cs}_2\text{InBr}_5(\text{H}_2\text{O}):\text{Sb}^{3+}$

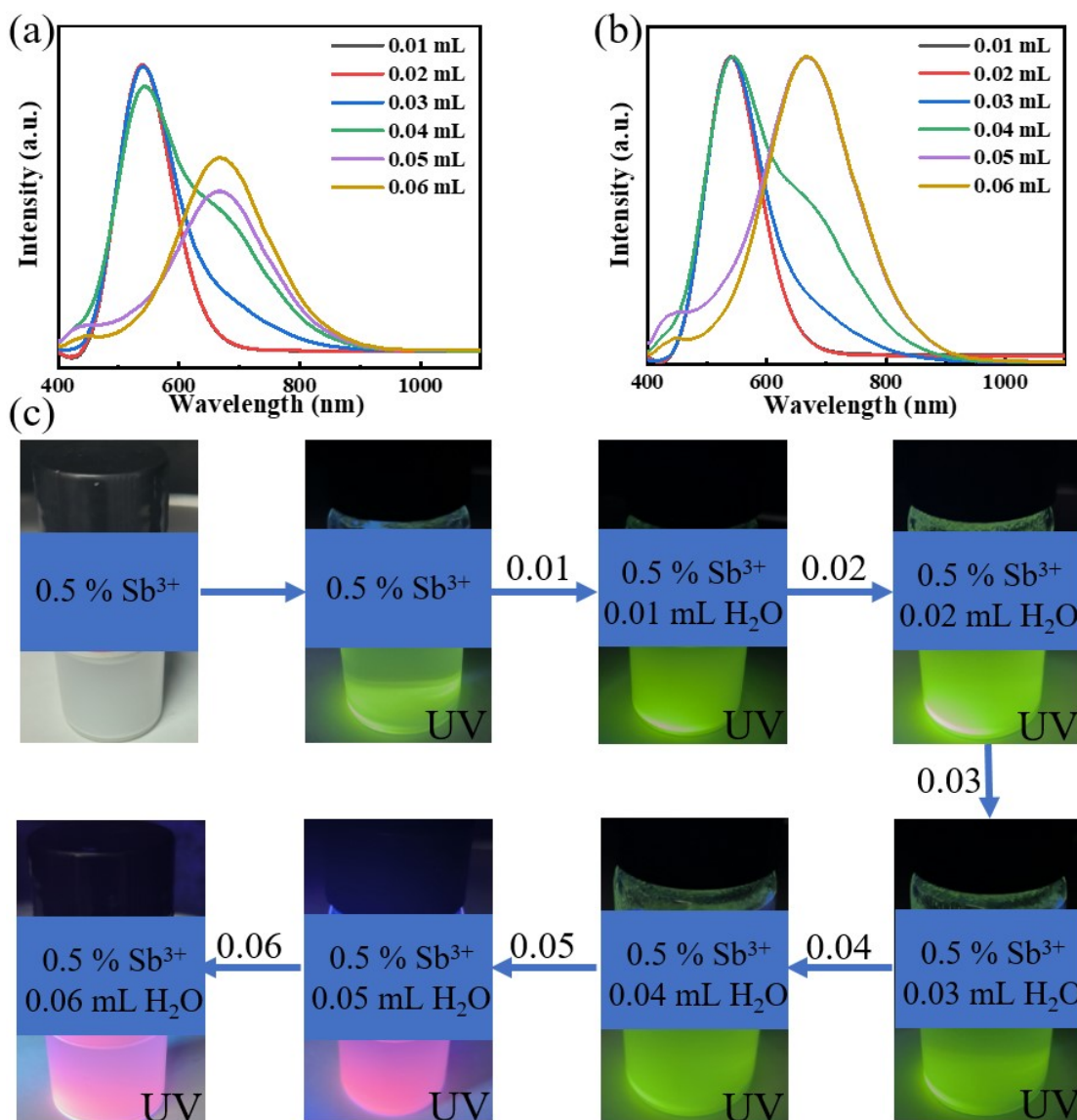


Figure S4. Dropwise addition of distilled water changes the luminescence color of $\text{Cs}_2\text{In}_{1-x}\text{Sb}_x\text{Br}_5(\text{H}_2\text{O})$. (a) (b) represents the position and intensity change of the emission peak with the amount of distilled water added (intensity normalization); (c) 0.01-0.06 mL of distilled water changes the luminescence color.

Figure S4 depicts the process of grinding the $\text{Cs}_2\text{In}_{0.995}\text{Sb}_{0.005}\text{Br}_5(\text{H}_2\text{O})$ sample, transferring a small amount into a container, whereupon the precipitate emits red light. Subsequently, 5 mL of anhydrous ethanol was dripped into the container, and the sample was left to stand for 48 hours to absorb the crystalline water (green light ^[1]). As shown in Fig. S4a, with the addition of distilled water, there is a redshift in the emission peak position, accompanied by a decrease in the relative fluorescence intensity of the

red light compared to the initial green light. Fig. S4b presents the normalized photoluminescence (PL) spectra, where an increase in distilled water content leads to a redshift in the emission peak position. In Fig. S4c, photographs depicting the change in sample luminescence color with distilled water additions of 0.01-0.06 mL are shown. Upon adding 0.05 mL of distilled water, the precipitate transitions from emitting green light to red light. This indicates the high sensitivity of $\text{Cs}_2\text{In}_{0.995}\text{Sb}_{0.005}\text{Br}_5(\text{H}_2\text{O})$ to

water. **References**

[1] Han P G, Luo C, Yang S Q, et al. All-Inorganic Lead-Free 0D Perovskites by a Doping Strategy to Achieve a PLQY Boost from <2 % to 90 % .[J]. *Angewandte Chemie-International Edition*, 2020, 59(31): 12709-12713.

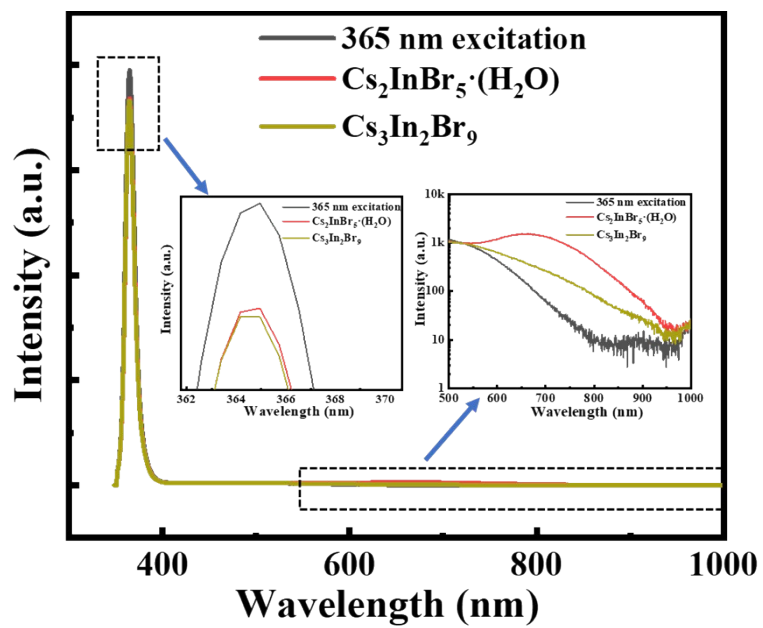


Figure S5. PLQYs testing of $\text{Cs}_2\text{InBr}_5(\text{H}_2\text{O})$: Sb^{3+} and $\text{Cs}_3\text{In}_2\text{Br}_9$

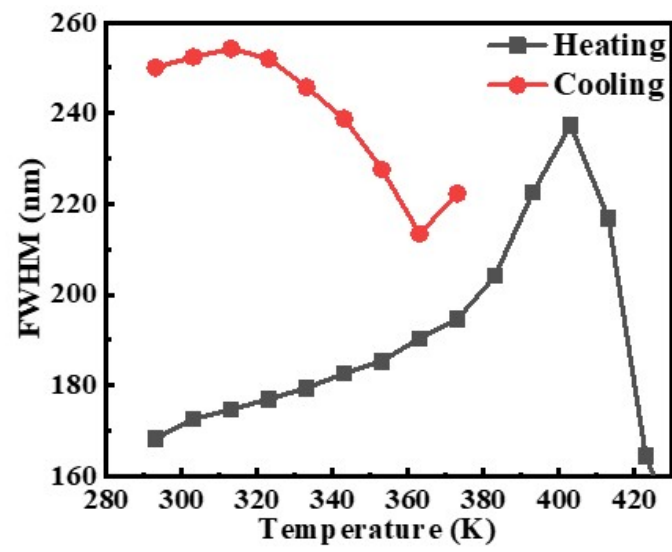


Figure S6. The variation of FWHM of heating and cooling during temperature variation process with temperature.

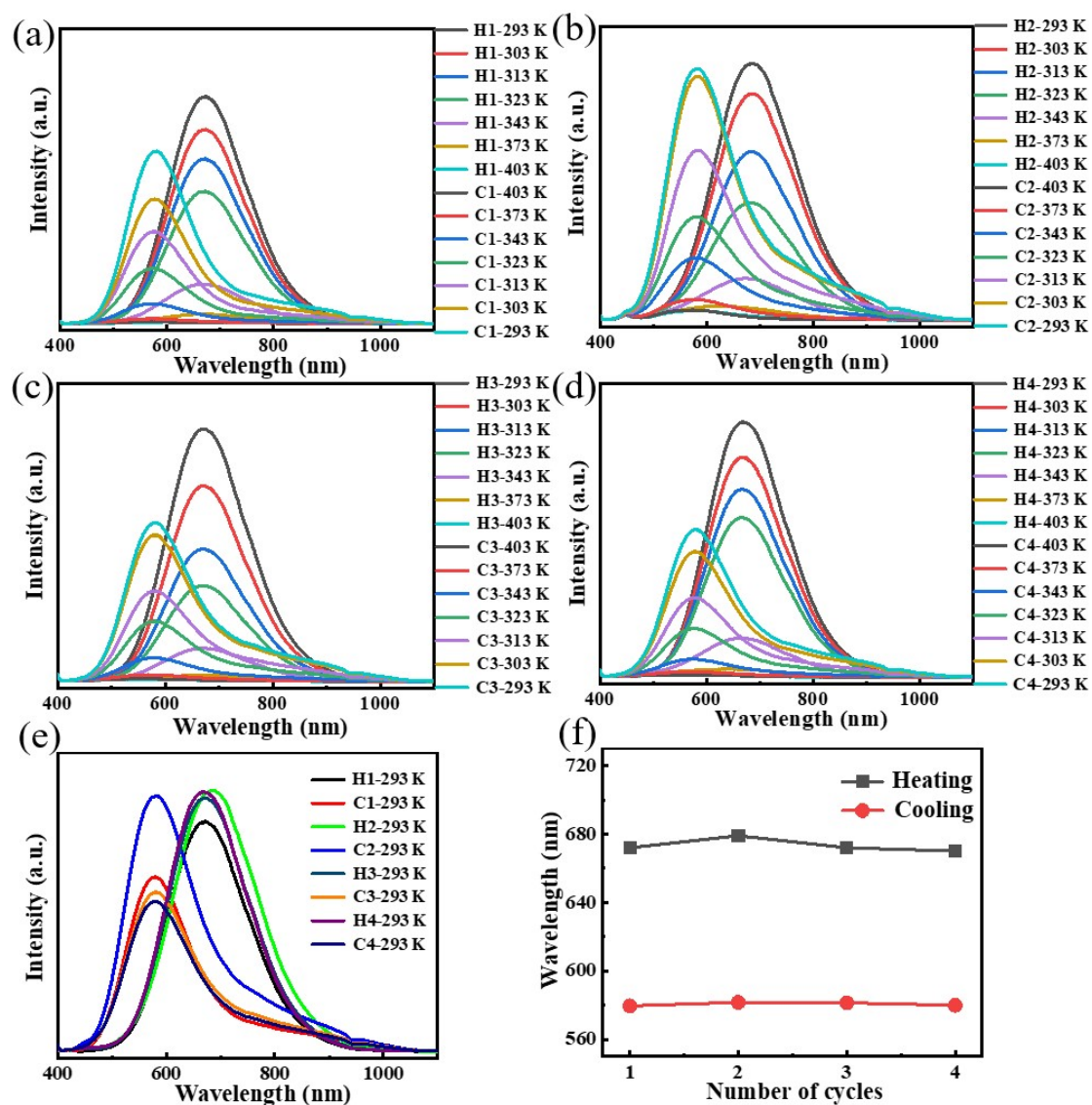


Figure S7 Temperature dependent spectrogram during four cycles of heating and cooling. (a) First cycle; (b) Second cycle; (c) Third cycle; (d) Fourth cycle; (e) The fluorescence intensity at the starting and ending points of each cycle; (f) The position of the emission peak at the starting point of each cycle.