Support Information

High-speed space optical communication based on metal halide perovskite single crystals

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The method to prepare big-sized Cs_4PbBr_6 Single Crystals.

CsBr (0.4 M, Macklin 99.5%) and $PbBr_2$ (0.1 M, Macklin 99.0%) were separately added to a 5mL mixed solution of ethylene glycol and DMSO in a 1:4 ratio. The mixture was heated at 130°C for 1 hour to ensure complete dissolution of the powders. After cooling the solution from 130°C to 100°C, it was then gradually cooled at a rate of one degree per hour until reaching 20°C. The resulting larger crystals were collected, and following the steps, a new supersaturated solution was prepared. This process of cooling and crystallization was repeated more than ten times to obtain large single crystals.

Synthesis of $CsPbBr_3$ Single Crystals:

Firstly, 0.638 g of CsBr (3 mmol, Macklin 99.5%) and 2.202 g of $PbBr_2$ (6 mmol, Macklin 99.0%) were individually weighed and placed into a 10 mL capacity beaker. Subsequently, 3 mL of DMSO solution was added using a pipette to the beaker, resulting in a precursor solution with a concentration of 1 mol/L (with Cs concentration at 1 mol/L). The beaker was sealed with aluminum foil and placed on a magnetic stirrer at 50°C in a water bath for 30 minutes with continuous stirring until the precursor solution turned transparent. The transparent precursor solution was then transferred to a temperature-controlled drying oven and kept at 120°C for 12 hours until several small crystals appeared at the bottom of the beaker.

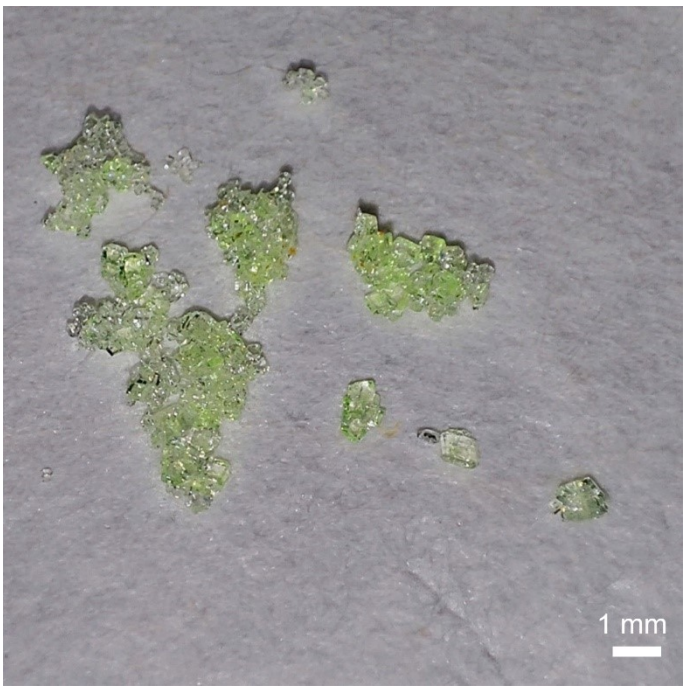


Figure S1 Images of millimeter-sized single crystals of Cs_4PbBr_6 SCs assisted by HBr under natural light conditions.

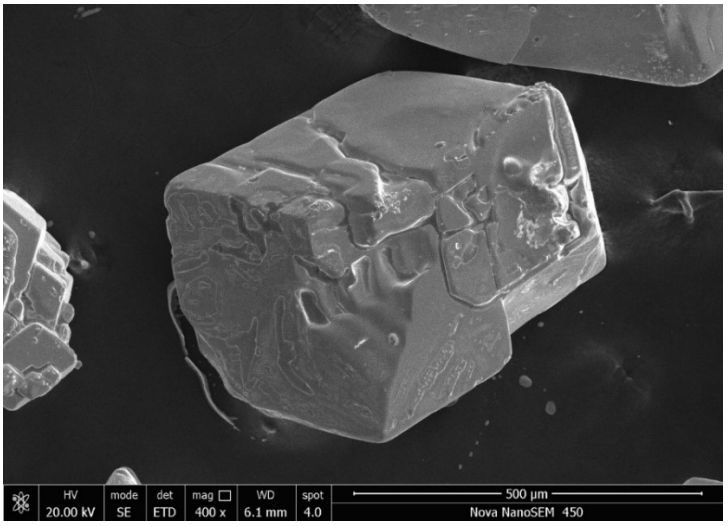


Figure S2 SEM image of millimeter-sized Cs_4PbBr_6 SCs.

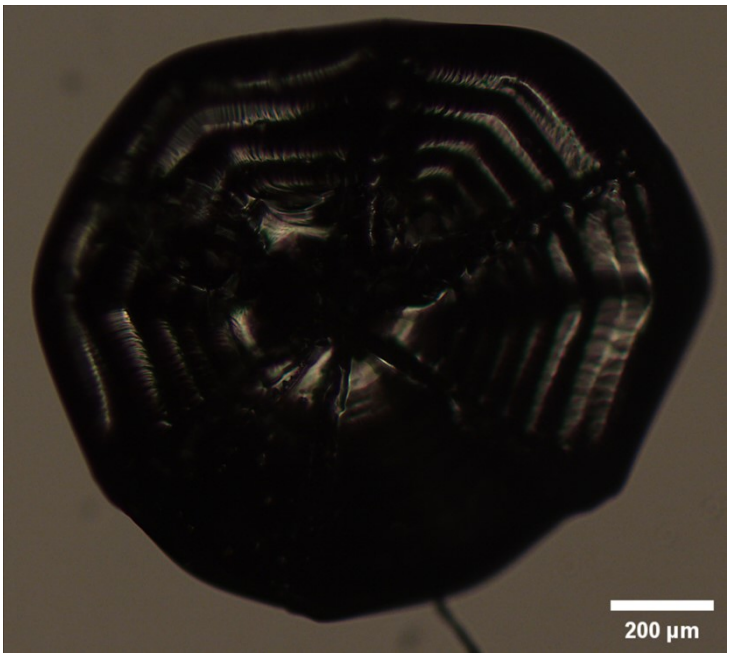


Figure S3 Image of millimeter-sized Cs_4PbBr_6 SCs under 5X objective lens.

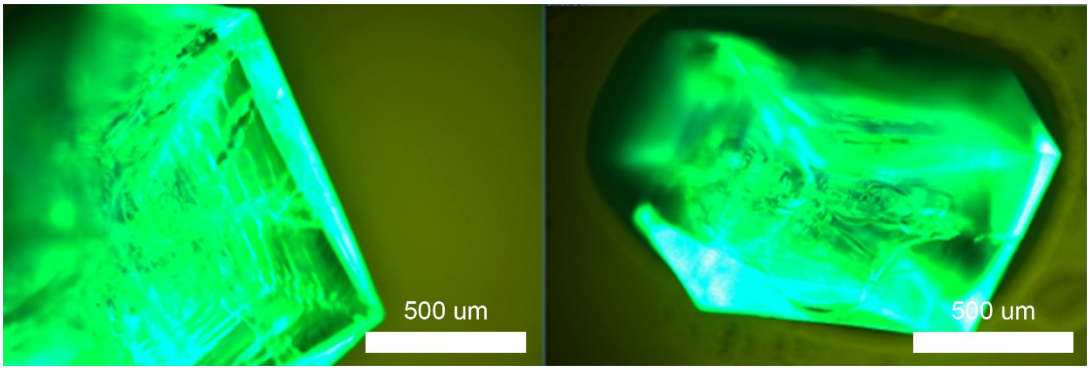
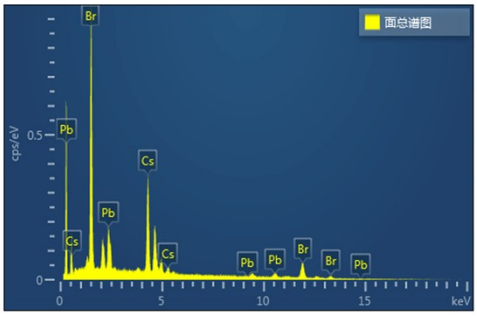


Figure S4 Images of millimeter-sized Cs_4PbBr_6 SCs under 365 nm ultraviolet light.



元素	wt%	原子百分比
Br	42.60	58.08
Cs	39.95	32.74
Pb	17.45	9.18
总量:	100.00	100.00

Figure S5 EDS spectrum and atomic composition

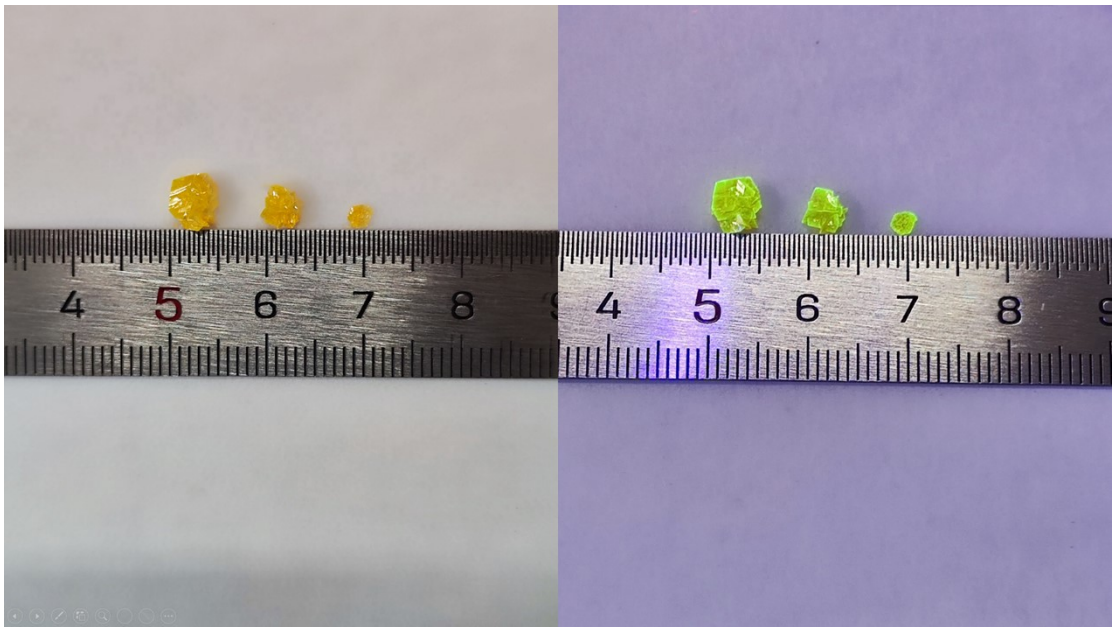


Figure S6 Cs_4PbBr_6 SCs SCs of different size under natural light and UV lamp.

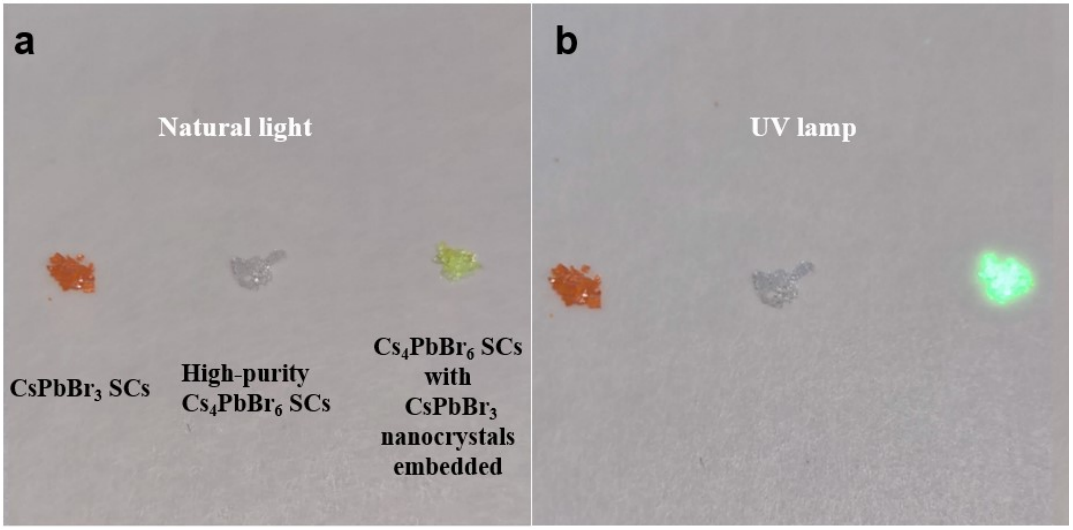


Figure S7 Photos of $CsPbBr_3$ SCs, high-purity Cs_4PbBr_6 SCs and Cs_4PbBr_6 SCs under nature light and UV lamp.

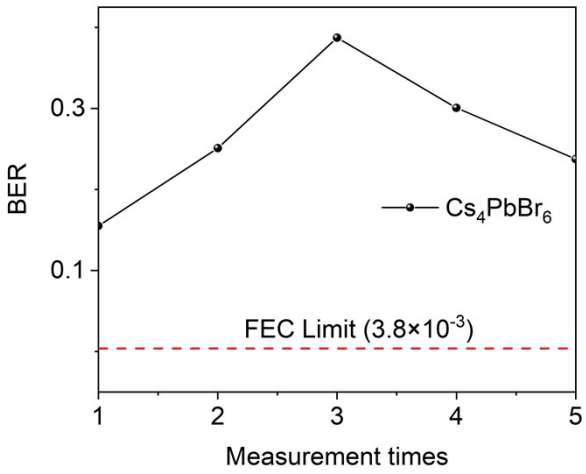


Figure S8 The BER of high-purity Cs_4PbBr_6 SCs at a data rate of 10Mbps (measured 5 times).

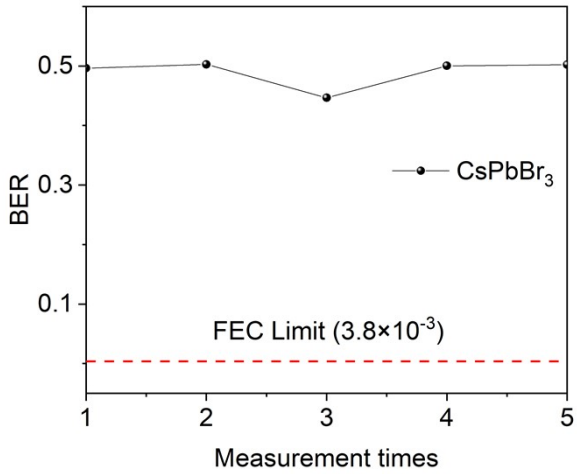


Figure S9 The BER of $CsPbBr_3$ SCs at a data rate of 10Mbps (measured 5 times).

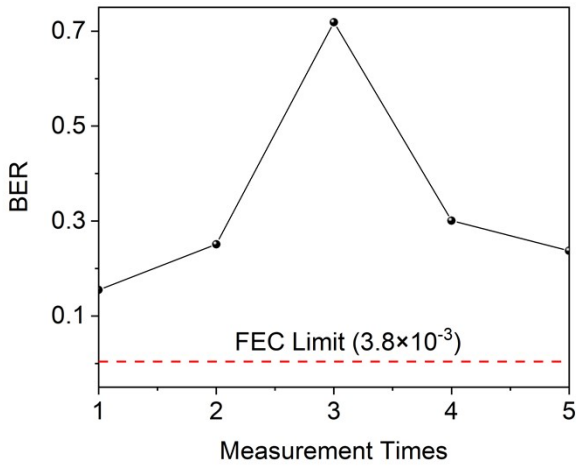


Figure S10 The BER of the biggest Cs_4PbBr_6 SCs we obtained (~0.5 cm) at a data rate of 10Mbps (measured 5 times)