Supporting Information

Altering Heating Area Assisted Space Confined Method for Growth of Large Scale and High Quality $MAPbBr_3$ Single Crystal Thin Film

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1. Growth of $MAPbBr_3$ SCFs with and without saturated solvent vapor

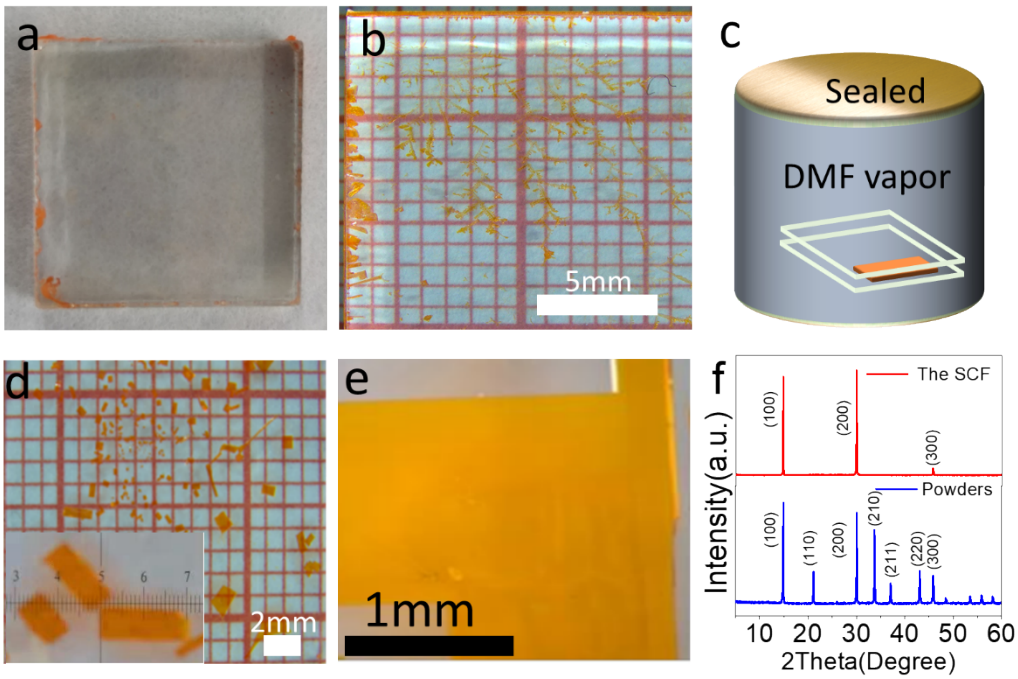

Figure S1. (a-b) Photos of SCFs grown by the space-confined method under 80 °C and continuous rising temperature from 40 °C to 80 °C; (c) Schematic diagram of saturated solvent vapor assisted method; (d-e) Photos of SCFs grown by saturated solvent vapor assisted method; (f) The XRD patterns of the SCF and powders.

Two square glass sheets with side length of 20 mm were used as substrates. The glass sheets were cleaned with deionized water, ethanol and isopropyl alcohol by ultrasonic wave successively, each cleaning time was 10 min. Then the glass sheets were dried at 60 °C. Equal molar ratio of $PbBr_2$ and MABr were dissolved in DMF to obtain 1 M transparent precursor solution. Drop precursor solution (20 ul) onto one glass sheet and cover the other glass sheet. Place the laminated glass sheets in a closed container containing DMF (5 ml). Put the closed container in an environment of 40°C, then raise the temperature by 5° per hour to 80°C, and keep the temperature at the end for 10 h. Finally, the large area of $MAPbBr_3$ SCFs can be obtained.

2. Continuous feeding under constant heating area to grow $MAPbBr_3$ SCFs

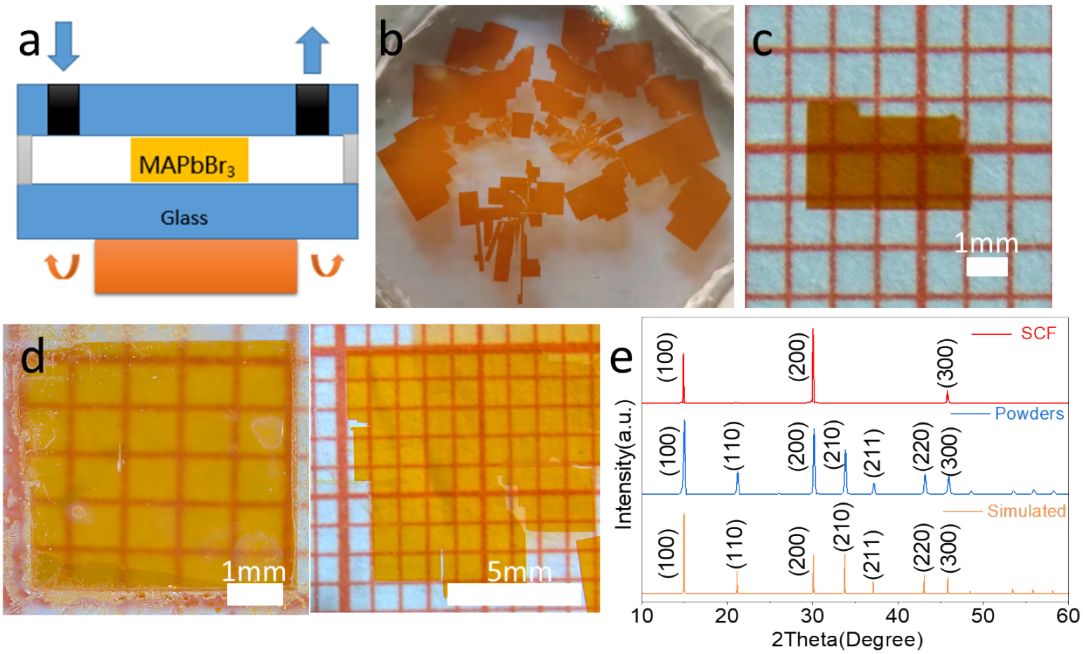

Figure S2. (a) Schematic diagram of the device for growing SCFs using spatial confinement combined with continuous feeding; (b-d)The continuous feeding impels a large number of nucleation simultaneously, and the size of wafers can reach over 3-10 mm after growing for 15 h; (e) The XRD patterns of the $MAPbBr_3$ SCF and the $MAPbBr_3$ crystal powders.

3. Subsequent growth process of $MAPbBr_3$ SCF

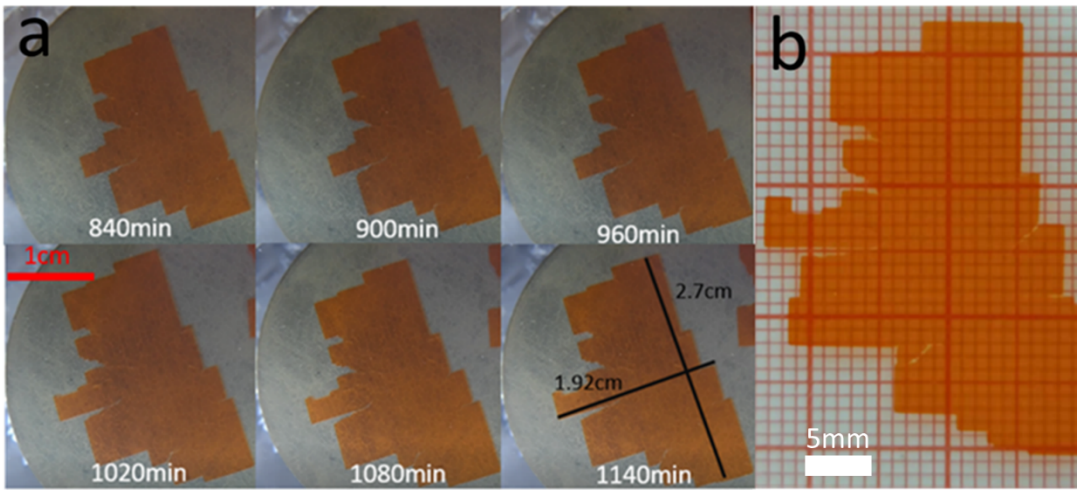

Figure S3. (a) The other glimpse pictures growing for other times; (b) The final area and depth of $MAPbBr_3$ SCF are ~4.6 cm^2 and 17.12 um.

4. SEM image and element distributions of the $MAPbBr_3$ SCF

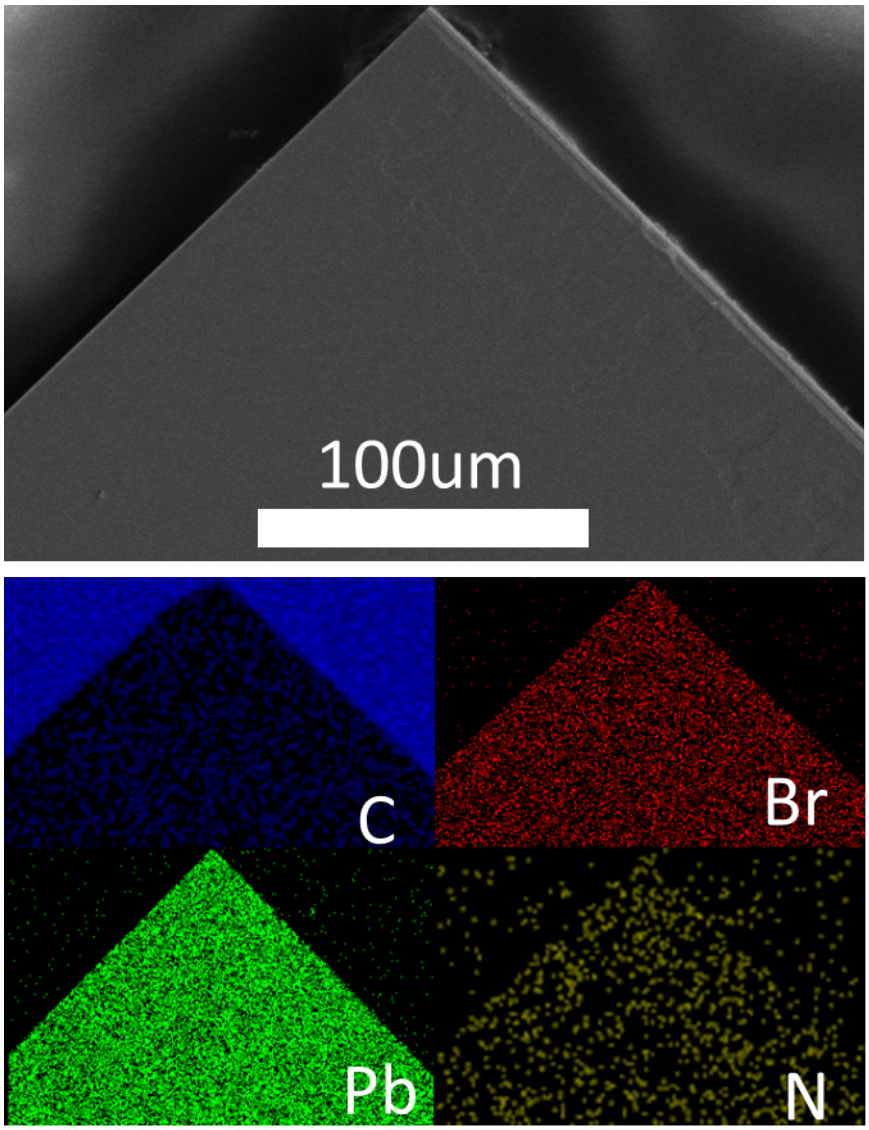

Figure S4. The SEM image and element distributions of the $MAPbBr_3$ SCF, and these exhibit the smooth surface and homogenous elemental distributions.

5. The decay times of $MAPbBr_3$ SCF and BSC

Table S1. Comparison of PL decay process of $MAPbBr_3$ SCF and BSC.

	$MAPbBr_3$ SCF	$MAPbBr_3$ BSC
τ_1 (percentage, %)	6.97 ns (53.9)	2.61 ns (36.4)
τ_2 (percentage, %)	37.4 ns (46.1)	10.6 ns (63.6)
τ_a	21.0 ns	7.7 ns

6. Electronic structure of $MAPbBr_3$ SCF

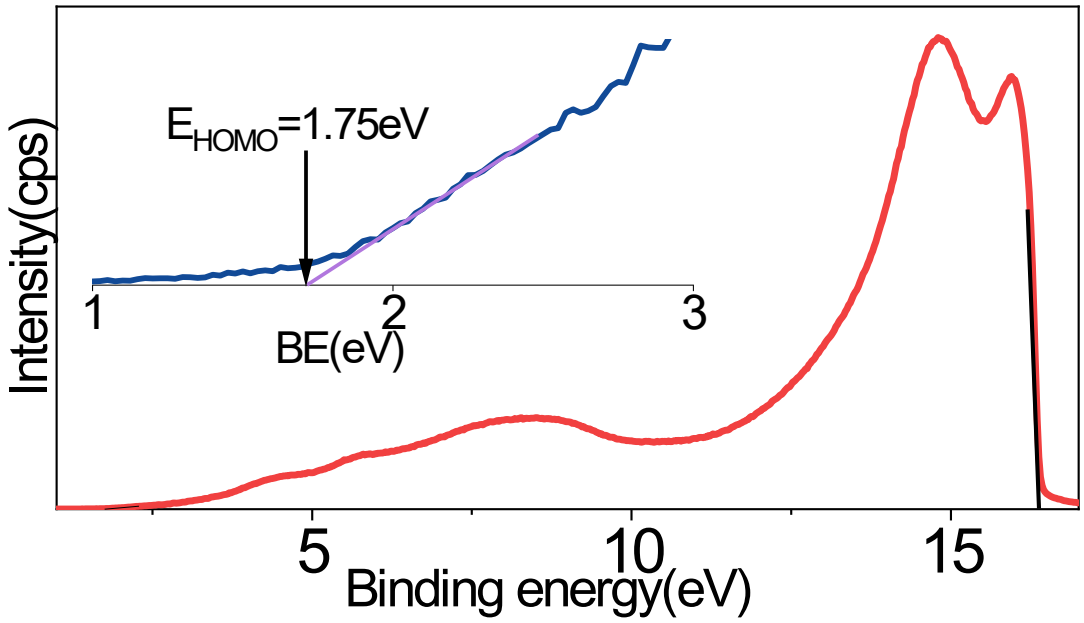

Figure S5. UPS spectra of $MAPbBr_3$ SCF.

7. Comparison of dark currents of $MAPbBr_3$ SCF and BSC photo-detectors

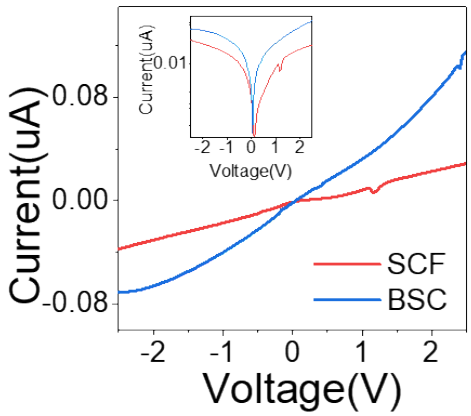

Figure S6. The dark currents for $MAPbBr_3$ SCF and BSC photo-detectors.

8. Synthesis of MABr

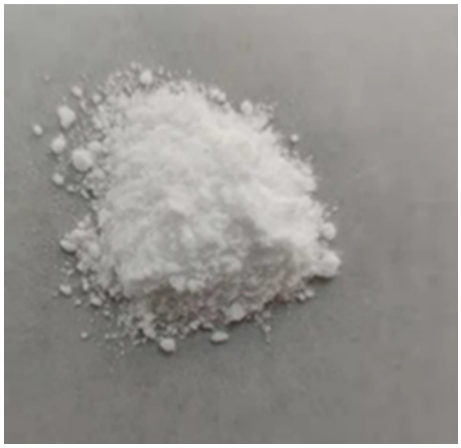

Figure S7. Picture of as synthesis of MABr powder.

A slightly excess molar stoichiometric proportion of CH_3NH_2 was mixed in HBr solution under an ice bath in an ambient atmosphere under stirring for over 6 h. The mixed solution was sealed and heated at 60 °C for 24 hours. With the progress of the reaction, the excess solvent volatilized to obtain white CH_3NH_3Br (MABr).

9. Growth of $MAPbBr_3$ BSCs

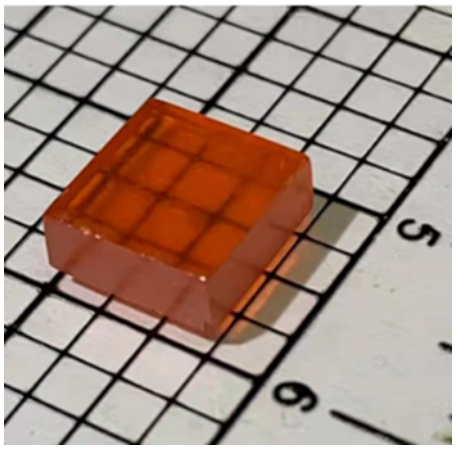

Figure S8. Picture of $MAPbBr_3$ BSC.

The precursor solution (1M with equal molar MABr and $PbBr_2$ in DMF) was placed in a constant temperature environment of 80 °C and $MAPbBr_3$ BSC was obtained after 24 h.