Electronic Supplementary Material (ESI) for Materials Chemistry Frontiers.


# Supporting Information

## Two-Dimensional $BA_2PbBr_4$ based Wafer for X-Rays Imaging Application

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## Experimental Section

*Materials Preparation*: Hydriodic bromide (HBr 55-57 wt.% solution in $H_2O$), Methylamine (MA 30 wt.% solution in $H_2O$), Butylamine (BA 98%) were purchased from Innochem corporation. lead bromide ($PbBr_2$, >99.99%) were purchased from Xi'an Polymer Light Technology corporation. We confirmed that all the reagents and chemicals were used without further purification.

*MABr Synthesis*: MABr was synthesis via reaction of HBr with MA, followed by stirring at 0℃ for more than 4 hours for a complete reaction. Then, the solution was collected and obtained initial white powder by rotary evaporation. Notably, high-quality MABr powder was obtained after alcohol dissolves and anhydrous diethyl ether recrystallization for several times. Finally, the final white powder was dried in a vacuum at 65°C for 12 h and stored in a nitrogen glovebox.

*Synthesis of 2D Perovskite Crystals*: The $BA_2MA_{n-1}Pb_nBr_{3n+1}$ is prepared by slowly cooling its aqueous solution from high temperature. The specific experimental steps are as follows: Firstly, dissolve $PbBr_2$ in 3 ml HBr (with a concentration of 1 M) at high temperature in the oil bath (100℃), stir well for 2 h, and after all is dissolved and become transparent, add 425 μl of hypophosphorous acid to the solution, denoted as A solution. Secondly, for different values of n, calculate the required molar amounts of MABr and BA based on the stoichiometric ratio. Under ice bath conditions, first dissolve MABr in 2 ml of HBr, stir thoroughly for 2 h until the solution becomes transparent, then slowly add BA to it dropwise, continue stirring for 2 h to make it fully mixed, and denoted as solution B. Thirdly, slowly add B solution dropwise to A solution, continue stirring at high temperature for 4 h to make it fully react, and then cool to room temperature at a rate of 5°C per minute, during which 2D perovskite crystals are precipitated. Fourthly, the obtained 2D perovskite crystals were repeatedly cleaned with toluene three times to remove the substances on the surface that did not participate in the reaction, the final 2D perovskite crystal was dried in a vacuum at 65°C for 12 h and stored for later use.

*Wafer Fabrication*: First, the prepared 2D perovskite crystals are added to the mechanical ball-mill tube with a ball-to-material ratio of 1 to 3, and they are fully ground into fine powder. Then, 500 mg of powder was weighed and added into the mold, which was pressed at 15 MPa for 5 min. After compression, the white 2D perovskite wafer with mirror-like surfaces were obtained.

## Characterization Section

The 2D perovskite crystal morphology and element analysis were characterized by FE-SEM (Apreo S). XRD patterns of the samples were obtained using a Bruker D2 PHASER Diffractometer with the Cu Kα line. Absorbance spectra was collected using a FLS920T. The PL spectra was measured using a PicoQuant Fluo Time 300. The source light is xenon short arc lamp. Optical images were captured by Nikon 700D digital camera. The photomicrograph of the 2D perovskite crystal was captured by a Zeiss microscope (Axioscope 5).

*X-Ray Characterization*: A miniaturized X-ray tube (Amptek) with a maximum output of 4 W and an industrial 48W X-ray tube (X160k1m-B) were employed for X-ray detection. RL were acquired with an integrating sphere (Φ=10 cm) and a fiber optical spectrometer (omni-λ300i). In the measurement of stability under X-ray irradiation, the X-ray tube voltage was kept to be 30 kV and 133 μA. Photographs of the X-ray-induced luminescence were acquired with a digital camera (Nikon D7100 with AF-SNIKKOR 18-105mm1:3.5-5.6GED). In order to extinguish the negative influence induced by direct radiation from X-ray source to camera, a triangular prism was used eliminate the penetrated X-ray photons.

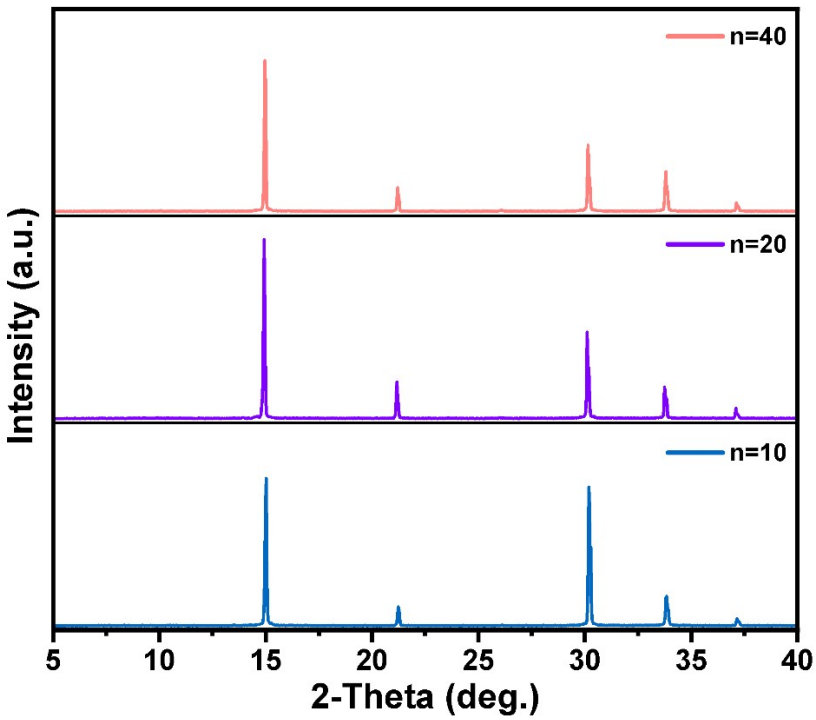


**Figure S1.** High n-values (n=10/20/40) 2D perovskite XRD

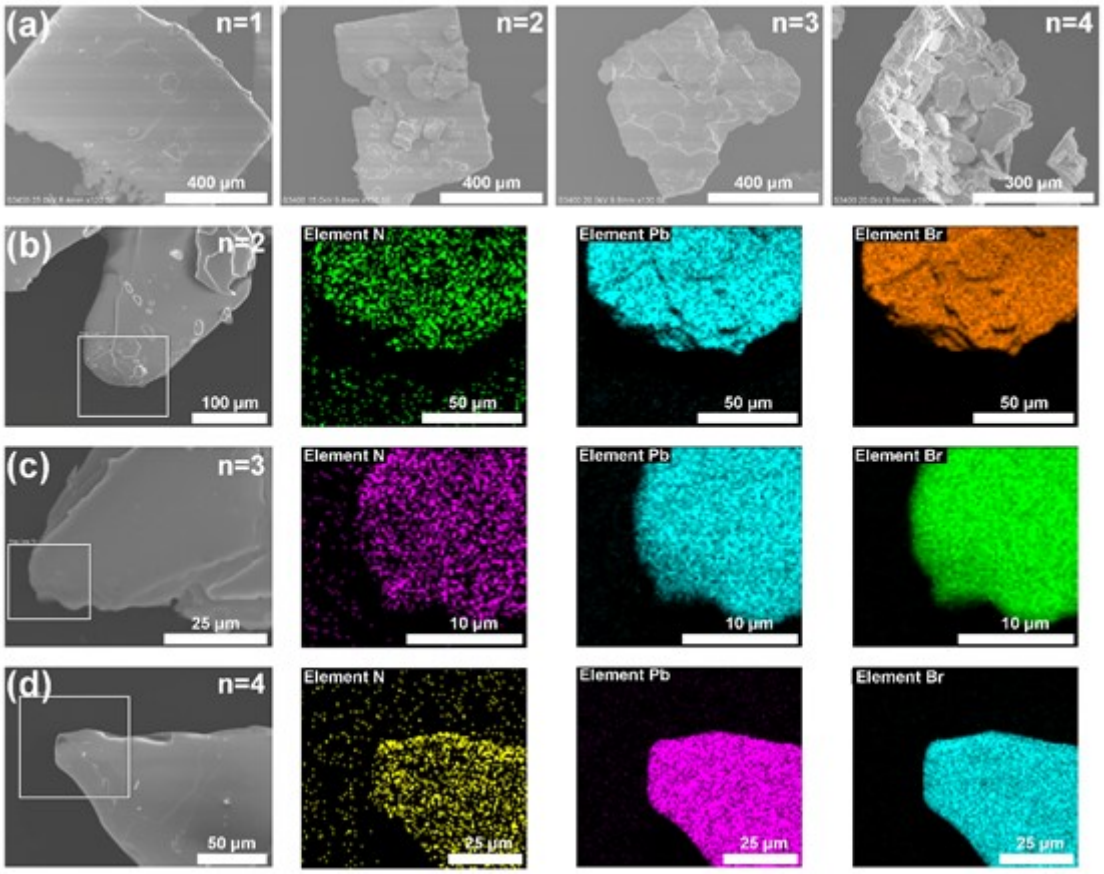


**Figure S2. Morphology Characterization and Element Analysis of $BA_2MA_{n-1}Pb_nBr_{3n+1}$:** (a) SEM of 2D perovskite crystal with different n values; Elemental analysis of 2D perovskite crystals with (b) n=2, (c) n=3 and (d) n=4.

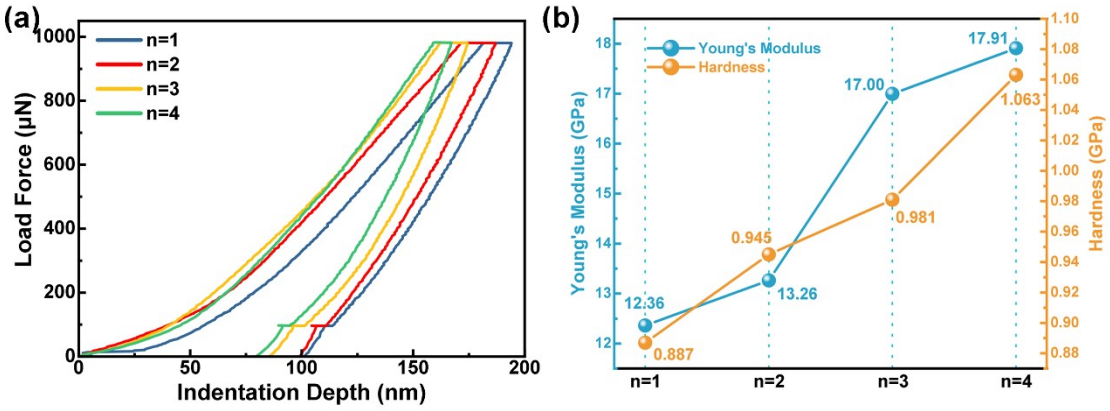


**Figure S3. Characterization of mechanical properties of 2D perovskites:** (a) Load-force-dependent indentation depth curve of different n values 2D perovskite wafer; (b) Yang's modulus and Hardness comparison of the different n values 2D perovskite wafer

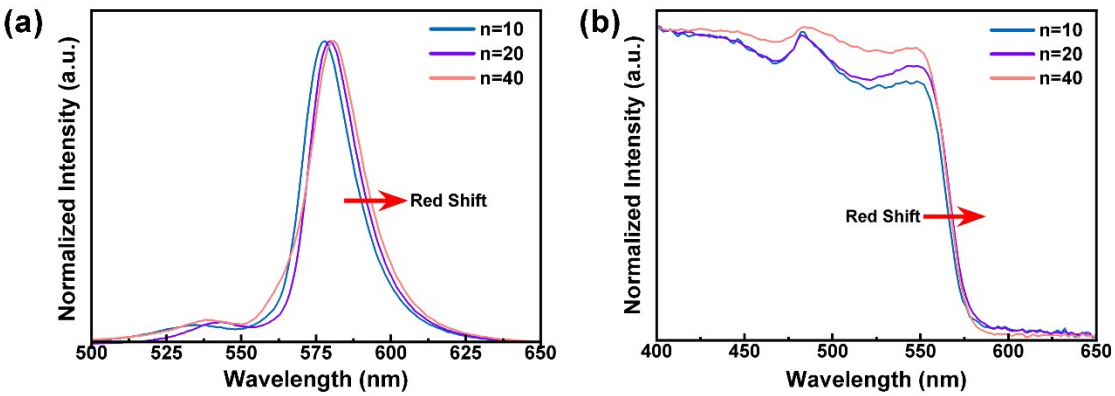


**Figure S4. $BA_2MA_{n-1}Pb_nBr_{3n+1}$ Luminescence Performance Characterization:** (a) Photoluminescence spectrum (PL); (b) UV-Vis absorption spectrum (UV-Vis)

**Table S1. Key parameters of TRPL of the $BA_2PbBr_4$ (extracted from Figure 3e)**

| | $\tau_1$ (ns) | A1 | $\tau_2$ (ns) | A2 | $\tau_3$ (ns) | A3 | $\tau_{ave}$ (ns) |
|---|---|---|---|---|---|---|---|
| **$BA_2PbBr_4$** | 1.45 | 0.72 | 5.64 | 0.34 | 33.37 | 0.009 | 6.82 |