16th International Conference on Mid-IR Optoelectronics: Materials and Devices MIOMD-XIV (MIOMD 2023) MIOMD1: Materials Development, Growth, and Characterization for Infrared Optoelectronics

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Halide perovskites have recently attracted significant attention as a promising material for optoelectronic applications due to their high absorption coefficient, long carrier lifetime, and low-cost processing. In particular, $CsPbBr_3$ perovskite has emerged as a promising candidate for infrared optoelectronic applications because of its narrow bandgap and high quantum efficiency. However, the synthesis and growth of high-quality $CsPbBr_3$ perovskites with controlled morphology and crystal structure remains a challenge.

Syrnatec has developed innovative technology for the growth, characterization, and development of halide perovskites. The technology is based on a two-step solution process, which involves the deposition of a precursor film followed by annealing to form the perovskite.

The precursor film was deposited using a novel spin-coating method that utilizes a mixture of $PbBr_2$ and CsBr in dimethyl sulfoxide (DMSO). The deposition was followed by annealing at a temperature of 150°C for 15 minutes to convert the precursor film to the perovskite.

The synthesized $CsPbBr_3$ perovskite was characterized using various techniques such as X-ray diffraction, scanning electron microscopy, and photoluminescence spectroscopy. The X-ray diffraction patterns of the perovskite showed sharp diffraction peaks, indicating excellent crystallinity. The scanning electron microscopy images revealed that the perovskite had a well-defined morphology with a cubic shape. The photoluminescence spectra of the perovskite showed a narrow emission peak at around 510 nm, indicating a narrow bandgap of 2.25 eV and indicative of high quantum efficiency.

The unique technology also enables the control of the crystal structure and morphology of the synthesized $CsPbBr_3$ perovskite. By adjusting the annealing temperature and time, we were able to obtain different crystal structures of the perovskite, including tetragonal and orthorhombic structures. We were also able to control the morphology of the perovskite by varying the concentration of the precursor solution.

Our experiments demonstrated that the synthesized $CsPbBr_3$ perovskite has potential applications in United States optoelectronics. The photodetector showed excellent photoresponse with 23.4% external quantum efficiency and a fast response time of 40ms.

Finally, this proposed technology will be having a potential for the large-scale production of $CsPbBr_3$ perovskite for US infrared optoelectronic applications like solar cells, photodetectors, and light-emitting diodes. The technology will provide a simple and low-cost solution-based approach for the synthesis and growth of high-quality $CsPbBr_3$ perovskite with controlled crystal structure and morphology. The potential of the technology for large-scale production of $CsPbBr_3$ perovskite which makes it a promising candidate for the commercialization of infrared optoelectronics applications in US.

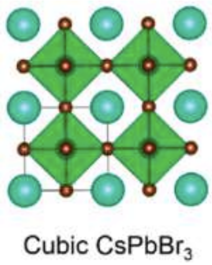


Figure 1: Structure of CsPbBr3

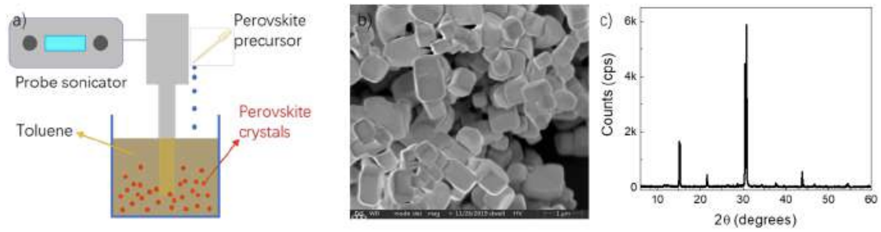


Figure 2: a. Proposed experimental set up for perovskite crystal synthesis, b. SEM image of synthesized CsPbBr3, c. XRD characterization of crystal

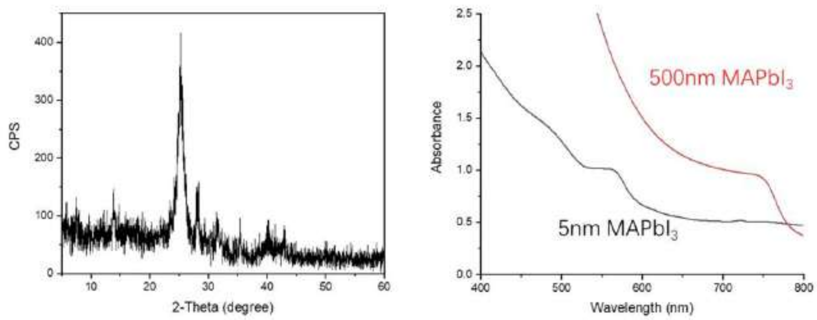


Figure 3: The XRD results. Absorbance spectra shows a significant blue shift from near IR absorption edge (750nm-800nm) to orange-red light wavelength (560nm-600nm), indicating the small size crystals exhibited the "quantum confinement," which occurs usually when crystal size goes below 5nm.

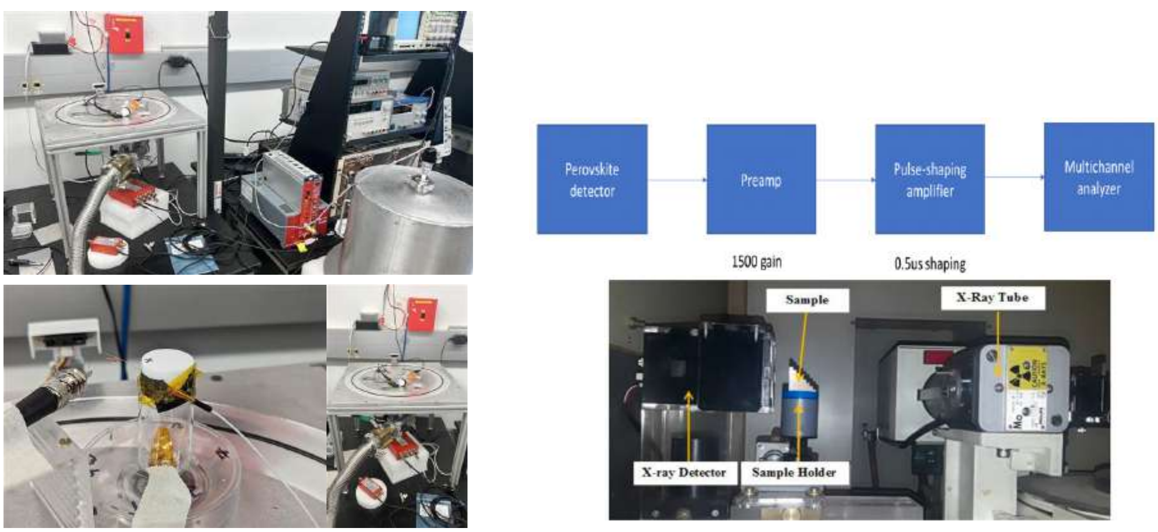
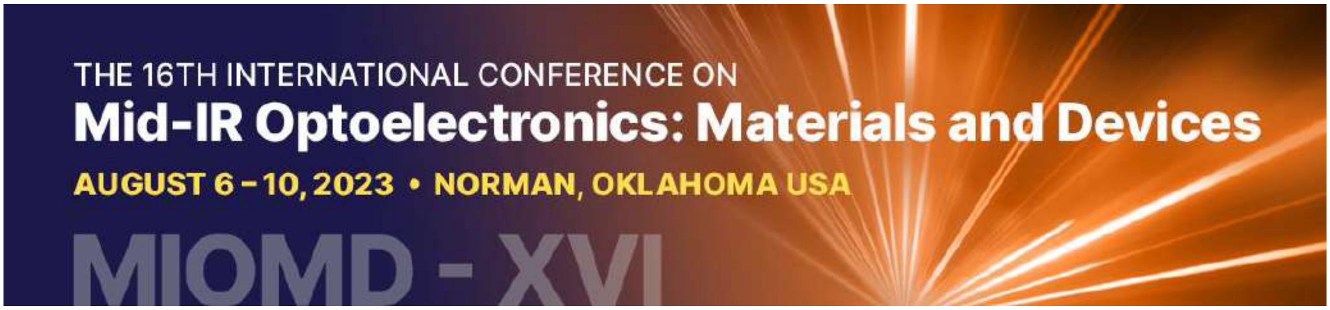


Figure 4: Proposed experimental set up

X-ray Tube Voltage (kV)	Max. X-ray Energy	X-ray Tube Current (μA)
10	10 keV	10, 20, 40, 60, 80, 100, 120, 140, 160, 180, 200
20	20 keV	10, 20, 40, 60, 80, 100, 120, 140, 160, 180, 198
30	30 keV	10, 20, 40, 60, 80, 100, 110, 120, 132
40	40 keV	10, 20, 30, 40, 50, 60, 70, 80, 90, 99
50	50 keV	5, 10, 20, 30, 40, 50, 60, 70, 79



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