

Template-Guided Growth of Lead Halide Perovskites for Scalable Neuromorphic Computing

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Introduction

- ❑ All-inorganic lead halide perovskites (LHPs) offer exceptional excitonic transitions and tunable optical properties.
- ❑ This makes them promising materials for nanophotonic applications, including solar cells, light emitters, and photodetectors.
- ❑ In this project, we explore their potential for neuromorphic computing (NC) by developing a monolithic photonic platform integrating wide-bandgap CsPb_2Br_5 and semiconducting CsPbBr_3 .

Scheme for Neuromorphic Computing

- ❑ LHPs can support room-temperature exciton-polariton quasiparticles with strong optical nonlinearity.

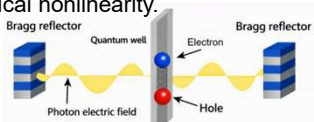


Fig. 1. Schematic of exciton-polariton quasiparticles. [LW4]

- ❑ These nonlinearities allow perovskite microstructures to function as a physical neuron whose activation resembles a rectified linear unit (ReLU).
- ❑ Our patterned structures provide a scalable material platform for such neuromorphic devices.

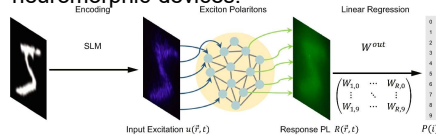


Fig. 2. The operating process of polariton neuromorphic computing on image recognition. (Gan et al., 2025)

Patterned Synthesis of LHPs

Stoichiometric Phase Control

- A 2mL precursor solution of $\text{CsBr} + \text{PbBr}_2$ is dissolved in dimethyl sulfoxide (DMSO) with controlled molar ratios. [LW1]

Surface Modification

- Polydimethylsiloxane (PDMS) is exposed to fluoroalkyl silane (FAS) vapor to create a lyophobic surface. [LW2]
- PDMS is stamped onto Si template at 50 °C.

Template-Guided Growth

- The precursor is drop-cast onto the modified microstructured template.
- The precursor is then sandwiched between the template and a glass slide
- The solvent is evaporated at 60 °C, and the confined nucleation and growth occur.

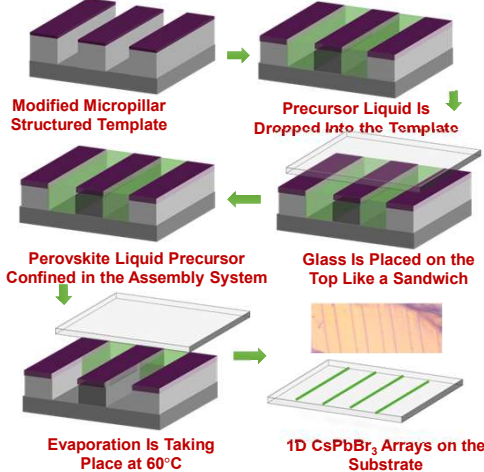


Fig. 3. Patterned synthesis and self-assembly of LHP crystals.

Phase Control During Synthesis

- ❑ CsPbBr_3 is the semiconducting phase, which exhibits excitonic emission.
- ❑ CsPb_2Br_5 is the wide-bandgap phase, which can serve as the photonic cavity to reach the light confinement required by the exciton-polariton condensation.

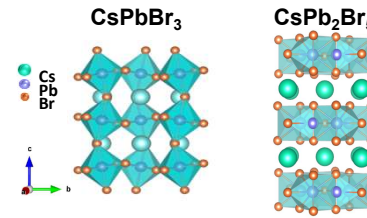


Fig. 4. Crystalline structures of CsPbBr_3 and CsPb_2Br_5 .

- ❑ We successfully produced patterned CsPbBr_3 and CsPb_2Br_5 microstructures, via stoichiometric control.
- ❑ The phases have been confirmed using optical spectroscopic measurements.

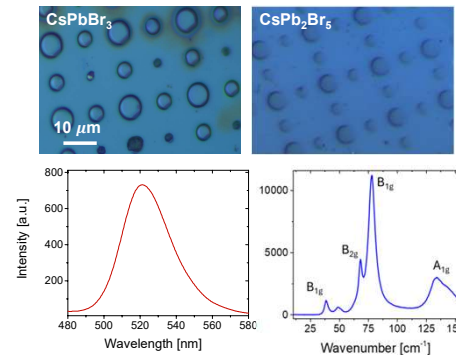


Fig. 5. Optical images and spectra of CsPbBr_3 excitonic emission and CsPb_2Br_5 Raman peaks.

Phase Conversion via Irradiation

- ❑ Controllable and localized CsPb_2Br_5 to CsPbBr_3 phase conversion has also been demonstrated under laser irradiation.

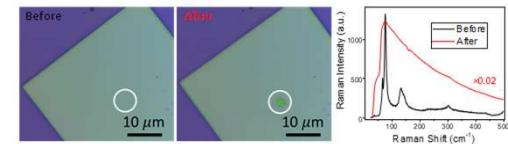


Fig. 6. Optical images and spectra of a CsPb_2Br_5 crystal before and after laser irradiation.

Conclusions and Future Work

- ❑ By integrating stoichiometric phase control, surface modification, and templated substrates, we demonstrate a soft-lithographic route for the patterned growth of CsPbBr_3 and CsPb_2Br_5 .
- ❑ The ability to convert CsPb_2Br_5 into CsPbBr_3 enables scalable fabrication of perovskite-based cavity-emitter coupled systems suitable for neuromorphic photonic hardware.
- ❑ These results highlight a materials-level pathway toward room-temperature polariton devices and integrated photonics.

Acknowledgements

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Slide 1

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LW2 Please define the abbreviation before using it

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LW3 If this is from a paper, please add the reference or replace it with the schematic from the proposal

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LW4 Please add a figure here

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LW5 Please double-check the size requirement for the poster. I saw 40X30 in Brenda's email

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JR5 0 It is 40X30 but the templates go in 48"x36" and 36"x24" and one of the requirements is a UNL branded template so I went for the 36"x24"

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