NQSTI
National Quantum Science and Technology Institute

Room temperature polariton condensation from Whispering gallery modes in $CsPbBr_3$ microplatelets

Laura Polimeno[1], Annalisa Coriolano[1], Rosanna Mastria[1], Francesco Todisco[1], Milena De Giorgi[1], Antonio Fieramosca[1], Dario Ballarini[1], Daniele Sanvitto[1]

1. 1CNR Nanotec, Institute of Nanotechnology, via Monteroni, 73100, Lecce, Italy.

Abstract: Room temperature polariton condensation in $CsPbBr_3$ perovskite microstructures offers transformative potential for communication, renewable energy, and security. By optimizing capillary-bridge synthesis, we demonstrate energy tunable polariton condensate from whispering gallery modes in $CsPbBr_3$ microplatelets.

The impact of all-optical technology across various domains, including communication, data storage, renewable energy, and security, underscores the importance of advancing polariton-based devices. Room temperature (RT) polariton condensation holds the promise of revolutionizing various scientific and technological fields, spanning from communication and data storage to renewable energy and security [1].

In this study, we utilize $CsPbBr_3$, an all-inorganic perovskite semiconductor renowned for its exceptional optical and electronic properties, as a promising material for polariton-based applications.

Employing a cost-effective and versatile capillary bridge synthesis approach, we grow $CsPbBr_3$ square single crystals with smooth surfaces and well-defined lateral facets. This method enables precise control over the formation of whispering gallery modes (WGM) by confining optical modes within the perovskite crystals [2].

The unique geometry of the microplatelets induces the onset of polariton condensation at RT. By increasing the excitation power, coherent states emerge at distinct power thresholds, demonstrating the formation of polariton condensate, resulting from the strong coupling between WGMs and the perovskite exciton (Fig. 1). Our findings highlight the potential of designing high-quality microcavities without requiring additional device fabrication, paving the way for low-threshold lasing and advanced light-matter interactions.

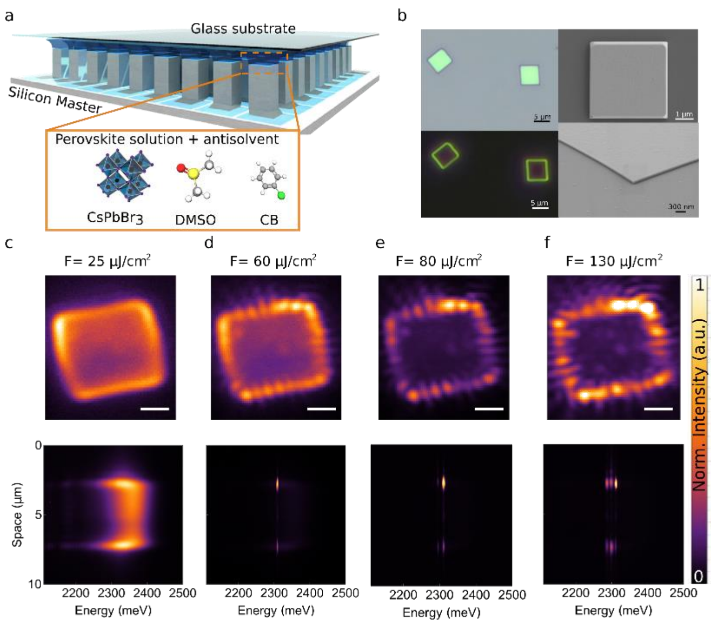

Fig. 1 (a) Sketch of the synthetic method. (b) Optical micrograph and SEM images of CsPbBr3 microplatelets. (c-d-e-f) Real space map and corresponding photoluminescence spectra for four different incident pump fluences, exciting a 150 nm-thick perovskite microplatelet. At low fluence, the emission from the microplatelet appears uniform and homogeneous in the real space map, exhibiting a single peak centered at 2330 meV, while the edge photoluminescence shows a redshift. Above the condensate threshold, the edge emission becomes significantly stronger than the emission from the center area.

References

[1] L. Polimeno, A. Fieramosca, G. Lerario, M. Cinquino, M. De Giorgi, D. Ballarini, F. Todisco, L. Dominici, V. Ardizzone, M. Pugliese, C. T. Prontera, V. Maiorano, G. Gigli, L. De Marco, D. Sanvitto, "Observation of two thresholds leading to polariton condensation in 2d hybrid perovskites," Advanced Optical Materials, vol. 8, no. 16, p. 2000176, (2020).

[2] L. Polimeno, A Coriolano, R Mastria, F Todisco, M De Giorgi, A Fieramosca, M Pugliese, C T. Prontera, A Rizzo, L De Marco, D Ballarini, G Gigli and D Sanvitto, “Room temperature polariton condensation from Whispering gallery modes in CsPbBr3 microplatelets”, Advanced Materials, vol. 36, no. 27, 2024.