Tunable polariton condensate pattern in square-shaped perovskite crystals

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Exciton-polariton condensation is typically observed in microcavities composed of two Bragg mirrors enclosing a quantum well. However, such a vertical optical confinement is not a strict requirement. Perovskite materials, such as $CsPbBr_3$, naturally form optical resonators due to their high refractive index. This intrinsic optical confinement, together with high exciton binding energy, enables exciton-polariton condensation, even at room temperature, making the perovskite crystal a promising alternative for the exploration of polaritonic phenomena without the need for elaborate cavity fabrication [[1], [2]].

In such crystals, the geometry of the resonator plays a key role in shaping the obtained nonlinear effects. Particularly interesting are square-shaped microcrystals, because of their high symmetry.

Control of the crystal size is possible through a specially developed method of chemical synthesis. Our method allows for obtaining good-quality samples and also controlling other parameters, such as the separation of crystals from each other. The developed method is also faster and cheaper than other popular methods of manufacturing square-shaped perovskite crystals, like chemical vapour deposition.

We analysed how the crystal size affects the nature of the polariton emission. We verified that for bigger crystals, the lasing concentrates at the edges and for smaller ones, the lasing has the highest intensity at the corners. Analysis of the photoluminescence spectra showed that the observed phenomena are a consequence of polariton condensation, and the emission pattern is strongly determined by the non-Hermitian nature of the system. It opens the way for further research on nonlinear and non-Hermitian effects in polariton condensates at room temperature in confined geometry.

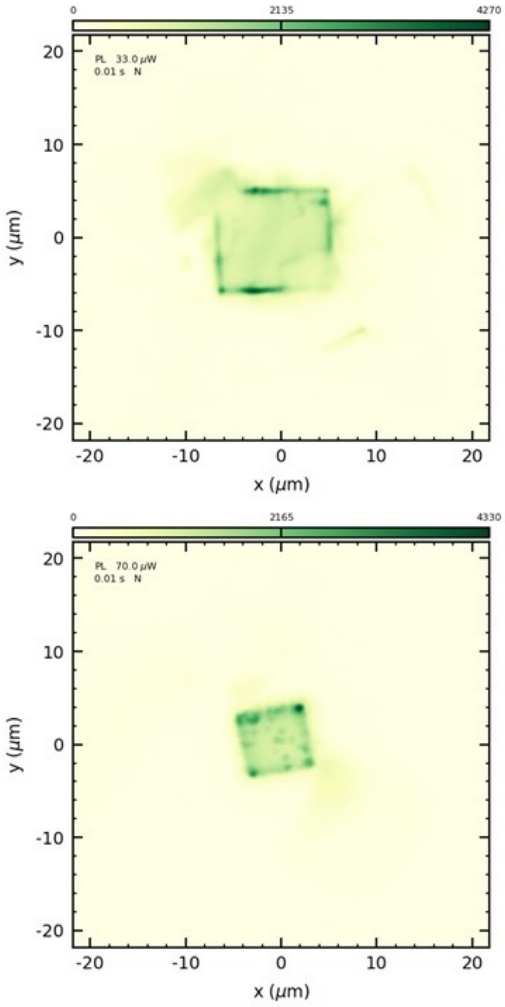

Figure 1: Polariton lasing in $CsPbBr_3$ perovskite microcrystal from the edge (top) and corners (bottom).

References

[1] M. Kędziora et al. *Nature Materials* **23**, 1515-1522 (2024).
[2] L. Polimeno et al. *Advanced Materials* **36**, 2312131 (2024).

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