Polariton lasing in 2D Perovskite Microcavities

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Exciton polaritons, with very low effective mass, are regarded as promising candidates to realize Bose–Einstein condensation in lattices for room temperature quantum simulations. Two dimensional (2D) organic–inorganic hybrid perovskites have properties that enable to sustain stable exciton polariton condensation, strong polariton–polariton interactions and long-range coherent polariton condensate flow at room temperature. The combination of huge exciton binding energies, enhanced stability, high tunability and ease of fabrication makes them ideal materials for achieving polariton condensation in optical microcavities. Here we present a fabrication of a microcavity, with layered, self-assembled perovskite $(BA)_2(MA)_2Pb_3I_{10}$ crystals as an active material sandwiched between two Bragg dielectric mirrors (DBRs). The structure of the material resembles multiple quantum wells with the perovskite layers representing the wells and the organic spacer (BA) the barriers. This natural confinement inherits perovskite excitons with huge electron-hole binding energies and makes them stable and observable even at room temperature. Initially the material is diluted as a supersaturated solution in hydrogen iodine at elevated temperature, then drop-casted on top of one DBR and lastly covered with the other DBR. The 2D crystals are formed once the sample is cooled with their width being dependent on the force acted upon the DBRs. This simple yet effective method results in the appearance of several cavity modes inside the microcavity with strong indication of anticrossing and polariton formation. At higher excitation energies, even signs of lasing can be seen from the photoluminescence measurements (Fig 1.) This microcavity fabrication method appears to be very promising for polaritonic applications and further research needs to be done for more clear and conclusive results.

a) b)

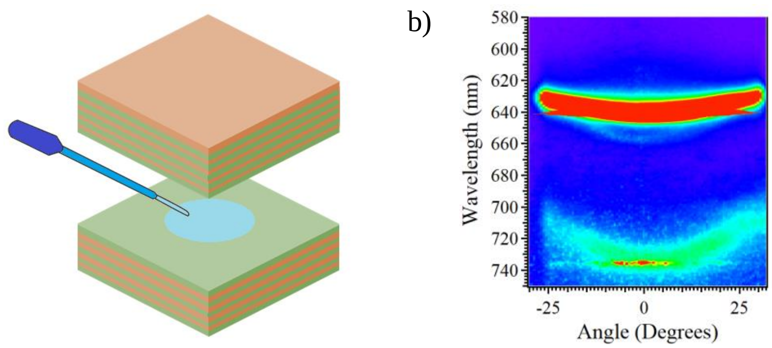

Figure 1:**a)** Fabrication of the sample with supersaturated perovskite material drop-casted between 2 DBR mirrors, **b)** Angle resolved photoluminescence measurements with indications of polariton formation and lasing

References

[1] Kasprzak, J. et al., Nature 443, 409–414 (2006).
[2] Gross, C. & Bloch., Science 357, 995–1001 (2017).
[3] Schneider, C. et al., Rep. Prog. Phys. 80, 016503 (2016).
[4] Lai, C. et al., Nature 450, 529–533 (2007).
[5] Cerda-Méndez, E. et al., Phys. Rev. Lett. 105, 116402 (2010).
[6] Jacqmin, T. et al., Phys. Rev. Lett. 112, 116402 (2014).
[7] Stoumpos, C. et al., Chemistry of Materials 2016 28 (8), 2852-2867