Towards Bose-Einstein condensation of exciton polaritons at room temperature: tunable liquid crystal microcavities

J. Szczytko[1], K. Lekenta[1], M. Król[1], R. Mirek[1], R. Mazur[2], P. Morawiak[2], P. Kula[2], W. Piecek[2], M. Matuszewski[3], W. Bardyszewski[4], P. G. Lagoudakis[5], B. Piętka[1]

[1]Department, Institution, Address – all in 12pt Arial, Italic, centered.
[2]Author names in 14pt Arial, centered. Presenting author should be underlined.
Email: the email of presenting author – 12pt Arial, centered.

The possibility to observe the exciton polaritons - quasiparticles arising from a strong coupling of cavity photons and excitons in local emitters (e.g. dye molecules, transition metal dichalcogenides (TMDs) monolayers) - relies heavily on the tuning of energy difference between excitonic and photonic mode. Exciton polaritons are bosons with a small effective mass, for which nonlinear phenomena such as superfluidity, polariton lasing or Bose-Einstein condensation can be observed at room temperature.

In this communication we present a novel kind of a tunable microcavity consisting of a nematic liquid crystalline (LC) birefringent optical medium enclosed in a typical Fabry-Perot resonator [1] and filled with an emitter: organic dye or TMDs. The long-range order of elongated liquid crystals molecules results in a strong anisotropy in particular in optical properties. The liquid nature of these materials, and most of all the large freedom of molecular reorientation, allow for convenient control of these properties by relatively weak external electric fields. Significant changes in the optical properties of LC can be obtained after applying merely several volts. With the ability to manipulate the permittivity tensor and, therefore, effective refractive indices for different polarizations of light it is possible to tune the energy splitting between cavity modes which strongly influences the luminescence and lasing coming out from the microcavity (Fig. 1). Our novel device allows for the integration of Bose-Einstein condensates into the room-temperature operating devices.

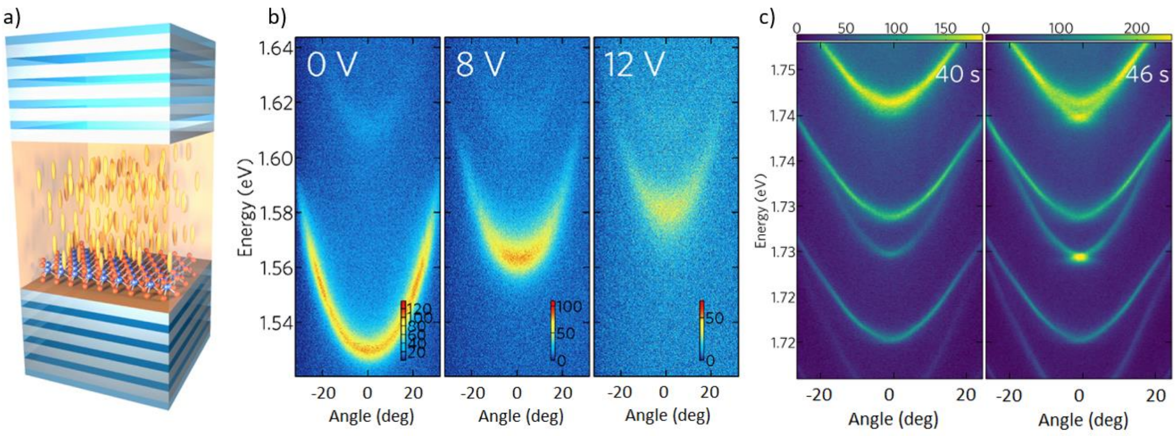

Fig. 1. a) Scheme of the tunable LC microcavity filled with MoSe2 and b) experimental results of luminescence from a single monolayer MoSe2 flake under applied voltage and c) luminescence form a LC filled with a dye.

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