Tunable liquid crystal microcavity

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In the rapidly growing field of polaritonics, an issue of major interest is the interaction of light with matter, both in the linear and non-linear regime. 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 or Bose-Einstein condensation can be observed in room temperature.

In this communication we present a novel kind of a tunable microcavity consisting of a nematic liquid crystalline (LC) optical medium enclosed in a typical planar Fabry-Perot resonator constructed of two distributed Bragg reflectors (DBR). In such resonators localized electric field, resulting in emergence of a photonic mode, is able to couple strongly to an emitter placed within the cavity. By use of a nematic liquid crystal, a material composed of ordered elongated molecules (therefore exhibiting significant anisotropy of the refractive index) that can be reoriented with external electric field, it is possible to effectively tune the optical path length between the DBRs and, in consequence, the cavity mode energy (Fig. 1) in the range of several tens of meV. Furthermore, the birefringent nature of the used LC allows for experiments with split orthogonal linearly polarized modes (e.g. vertically (V) and horizontally (H)), with the rate of splitting controlled by the same electric field, applied through electrodes attached on the outside of the DBRs.

The device we report on enables room-temperature experiments with tunable photonic mode, as well as the V-H splitting varying over a wide range of values simultaneously in the entire cavity area. Thus, we have the ability to adapt to the resonance with the excitonic mode. Described features make our microcavity suitable for use with TMD-based and other local emitters.

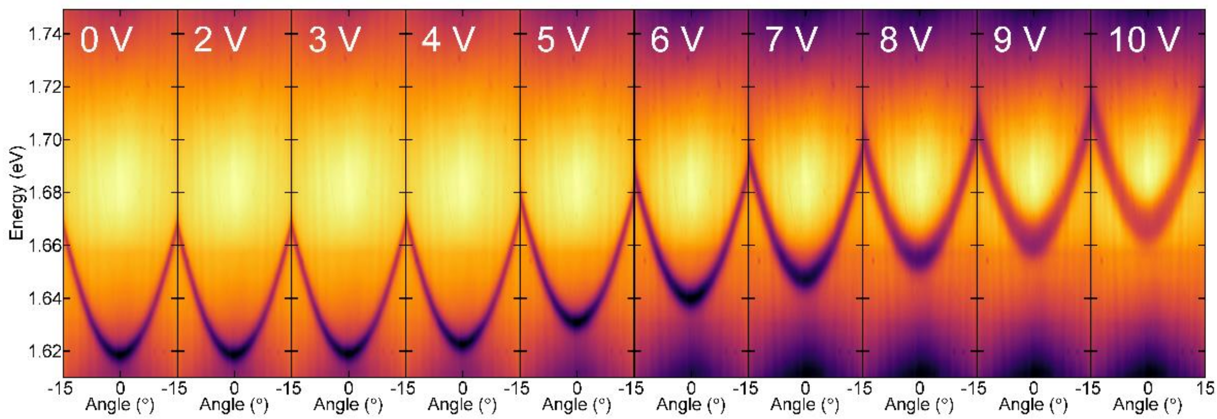

Fig. 1 Angle-resolved reflectance spectra for different voltage (0 V – 10 V) applied to the liquid crystal microcavity in horizontal polarization.

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