Control of the generation and propagation of polariton condensates at 300K in ZnO microcavities

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Abstract-The spatial dynamics of the formation of a polariton condensate under a tightly focused excitation is imaged through 2D near-field and far-field 2D tomography in a ZnO microcavity, up to room temperature. The modelling exhibits the role of the outwards polariton flux caused by the reservoir repulsion, that leads to a 3 to 10 fold increase of the condensation threshold and is imprinted in the shape of the polariton condensate.

ZnO is a wide bandgap semiconductor with strong excitonic properties, in particular a large oscillator strength and a large exciton binding energy. Together with GaN, CuBr and some organic semiconductors, it raises a strong interest for the generation and control of polariton condensates up to room temperature. Such condensates were achieved over a wide range of exciton-photon composition and from cryogenic to room temperature in a hybrid microcavity consisting of a bulk ZnO active layer and two dielectric Bragg mirrors [1].

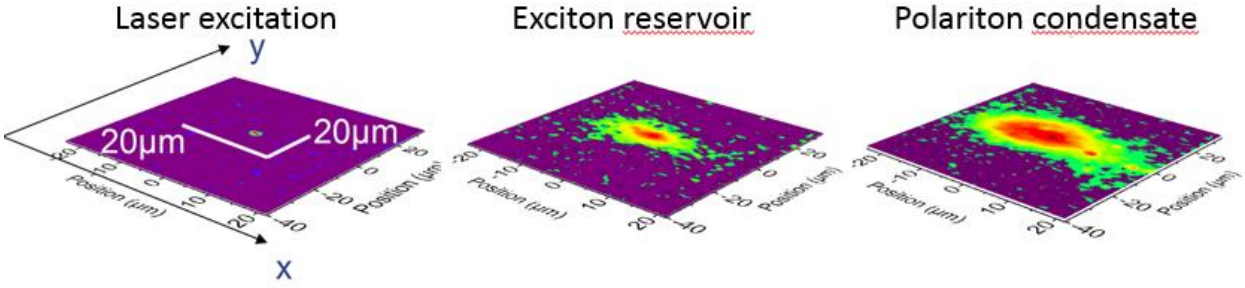

Figure 1: Formation and propagation of a polariton condensate in a ZnO microcavity at T=80K and a positive detuning comparable to the Rabi splitting. False color real space images under pulsed excitation (4.66 eV/266 nm, 400 ps, 1nJ/pulse).

The present work is devoted to the spatial dynamics of the condensate formation under the so-called "tightly focused excitation regime" [2] that is commonly used when optically pumping a polariton laser. The non-resonant laser excitation is focused over a few microns, and generates an exciton reservoir which feeds the polariton condensate, as shown by the experiment presented in figure 1. Using the terms of the laser physics, the threshold of the polariton laser is reached when the stimulated scattering from the reservoir to the condensate balances not only the polariton losses (related to the photon lifetime), but also the outwards polariton flux since

polaritons are repelled by the reservoir through the Coulomb interaction. The interplay between the condensate ballistic propagation and the tighly focused excitation is investigated as a function of the detuning, and its dependence on the polariton lifetime and the polariton effective mass is modelled through a resolution of the Gross-Pitaevskii in the cylindrical geometry [3]. This analysis shows that the threshold exciton density for condensation is 3 to 10 times larger for a 4 µm spot than for a large spot in the 2D limit, as also reported recently [4]. We show that the polariton current has a major influence on the spatial profile of the polariton condensate. The prospects concerning the optical control of the shape of the polariton condensate will be discussed.

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