Guided polaritons in a ZnO vertical microcavity

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The polariton emission in a microcavity is usually measured from the surface, and little is known about the actual role of guided modes below the light cone in air; these can couple to the exciton transition and give rise to additional polaritons branches, creating thereby a polaritons leak channel, and can further collect part of the "vertical" polaritons emission. Overall, for a vertical microcavity they can be considered as a source of polariton losses. On the other hand, the physics of guided polaritons in waveguides has recently attracted some interest as a new class of fluids of light supporting bright temporal solitons, as well as a new type of polariton lasers [1-3].

In this work we investigate the propagation and relaxation properties of guided polaritons in vertical microcavities based on ZnO active layers and we evidence their role in the dynamics of the polariton laser.

Figure 1 illustrates the scheme of the study of the guided modes in a ZnO vertical microcavity with mesas, in the strong coupling regime. The excitonic reservoir is pumped non-resonantly under a focused spot, and feeds both the polaritons near k=0 and the guided polaritonic modes. The emission of the guided modes is observed at the mesa's edge, together with the vertical emission. The microcavity operates as a polariton laser under pulsed optical pumping [4]. The guided modes are observed at energies below the minimum of the lower polariton branch. Interestingly, their spectrum presents fringes that are the signature of beatings between multiple guided modes, which are coherently pumped under the excitation spot. This observation, for distances up to 65µm, demonstrate the long ballistic propagation of the guided polaritons, and their efficient feeding by the excitonic reservoir. This last process competes with the relaxation towards the LPB.

Under strong pulse excitation, the guided polaritonic modes influence the operation of the polariton laser. In the absence of cracks in the mesas, the polariton laser operates near k=0 and the corresponding peaks appear in the spectrum of the guided modes, indicating an efficient feeding of those modes beyond threshold. If cracks are present in the mesa, then an intricate dynamics can be observed, resulting from a competition between vertical (out-of-plane) and horizontal (in-plane) polariton lasing.

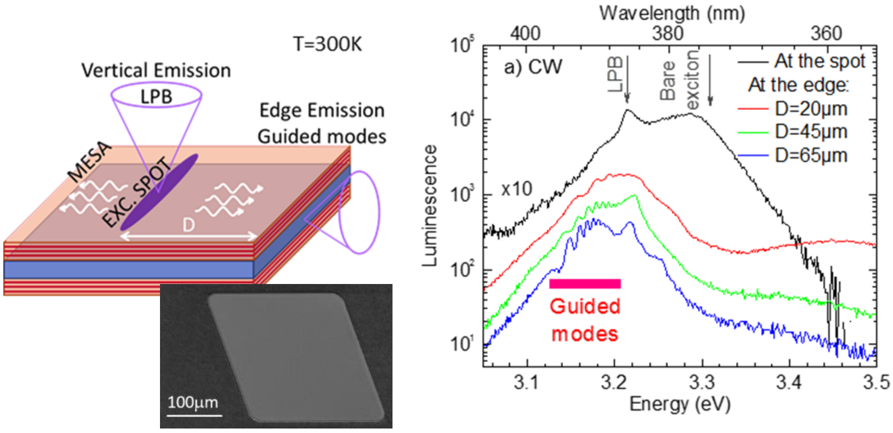

Figure 1: (left) Scheme of the optical configuration employed to study guided polaritons in a ZnO vertical microcavity; SEM image of a cavity mesa. (right) PL spectra under CW excitation, collected at the spot (black) and at the edge (color) of a mesa as a function of the spot-edge distance D.

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