Interplay between vertical emission and guided emission in a ZnO microcavity polariton laser

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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, that can couple to the exciton transition, collect part of the emission and contribute to polariton losses. In this work we investigate a ZnO planar microcavity with mesas. 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 [1].

The spectra collected under the excitation spot and at the mesa's edge are very different, as shown on figure 1a. The vertical emission is dominated by the lower polariton branch (LPB) associated to the cavity mode whereas the edge emission forms a broad peak modulated by fringes which spacing decreases as the spot moves away from the edge. While these fringes could indicate Fabry-Perot oscillations of polaritons propagating in-plane, in analogy with radiative polaritons in GaAs microcavity wires [2], a careful analysis shows that they are the signature of beatings between 5 to 10 guided modes, without being necessary to invoke multiple reflections. These modes have a large attenuation length of 27 µm, intermediate between the propagation length of LPB polaritons (a few µm in a ZnO microcavity [3]) and the one of waveguide polaritons (100µm in a GaN microcavity [4]).

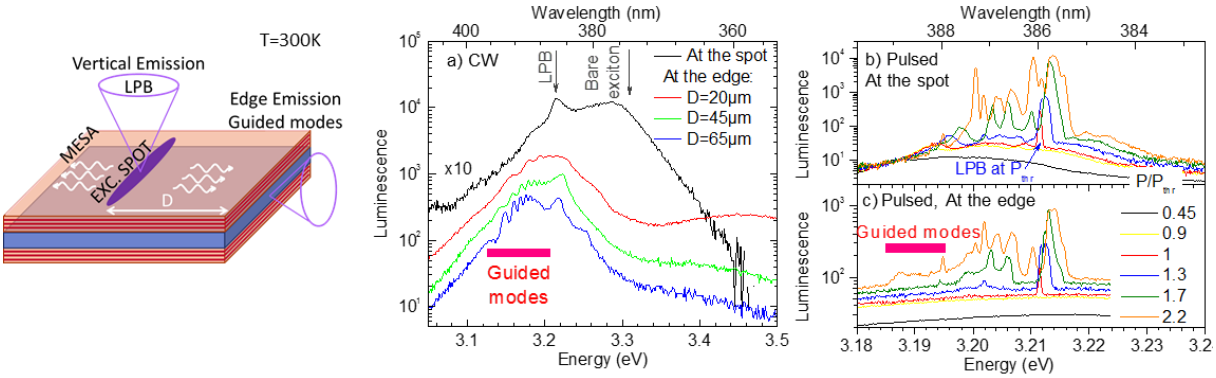

Figure 1: PL spectra under CW excitation (a), collected at the spot and at the edge as a function of the spot-edge distance D; Polariton lasing under pulsed optical excitation (T=300K), collected at the spot (b) and at the edge (c)

Under pulsed optical pumping, the guided modes are strongly excited. They form leaky modes for the excitonic reservoir, as well as for the LPB polaritons themselves. Most interestingly, when the vertical microcavity displays polariton lasing, the polariton laser emission feeds the guided modes, which then cascade in energy (Fig. 1b,c).

This work evidences therefore that the threshold of the polariton laser in conventional vertical microcavities is increased due to the existence of usually hidden guided modes, that can deplete the exciton reservoir and collect resonantly scattered light from the lasing LPB mode.

References

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