Polariton condensation phase diagrams in GaN and ZnO planar microcavities

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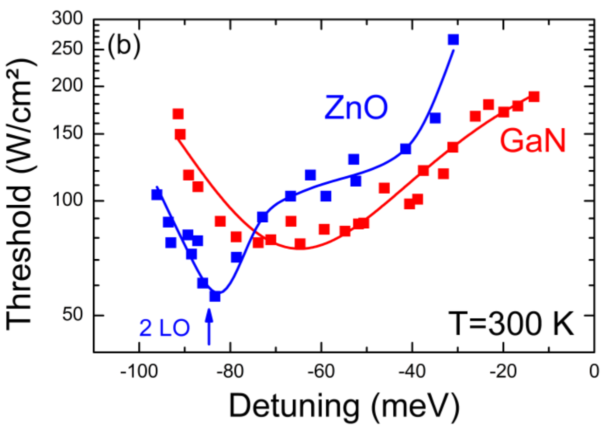
Cavity polaritons, quasiparticles that share both matter and light properties, have been intensively investigated since two decades from fundamental and experimental points of view. Thanks to their bosonic nature, phenomena such as the Bose-Einstein condensation or the superfluidity have been evidenced. Possible applications in the field of optical or electro-optical components can be foreseen: low threshold polariton lasers, optical switches, and optical transistors, for example. However, the weak binding energy of excitons in semiconductors such as GaAs prevents the use of these materials for room temperature applications (kT=26 meV). GaN and ZnO wide bandgap semiconductors appear to be a solution for the achievement of polaritonic components operating at room-temperature, since the binding energies of their excitons are respectively 26 meV and 60 meV.

The polariton laser effect in these two material systems has been investigated through optical pumping as a function of temperature in order to analyze the relaxation processes enabling a macroscopic occupation of the ground state[1]. The cavity detuning, which corresponds to the energy difference between exciton and photonic mode, has also been investigated as it allows to tune the energy difference between the excitonic reservoir and the bottom of the LPB. The studied microcavities, with similar optical properties (given that they share the same bottom DBR), have been elaborated on silicon mesas, which allow to relax the strain energy stored by the lower distributed Bragg mirror. The phase diagram, which reports the laser threshold as a function of the cavity detuning has been recorded between 10K and 300K (see figure). Simulations developed within the semi-classical Boltzmann equations account for the experimental data in a satisfactory way and highlight the efficiency of phonon-assisted relaxation in these wide-bandgap polar materials.



Measurements beyond room temperature - typically 350K and 400K - evidence the complexity of the lasing effect in GaN microcavities, which can occur within the strong or weak coupling regimes while displaying very similar features; this last fact renders, in some cases, very difficult to assess the lasing regime. To give further insight into such situations, the experimental observations will be discussed in terms of possible gain mechanisms involving polaritons, excitons or an electron/hole plasma.

1. Jamadi O. *et al*, Physical Review B **93**, 115205 (2016)