Enhanced polariton relaxation by electron - polariton collisions

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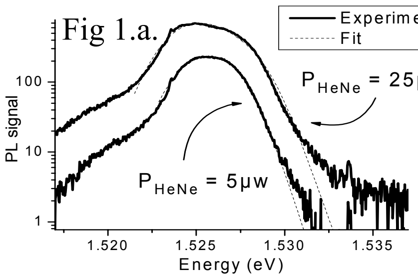
The injection of a low density electron gas (2DEG) in a microcavity in the strong coupling regime has recently been proposed to break the relaxation bottleneck and achieve a better thermalization of polaritons [1].

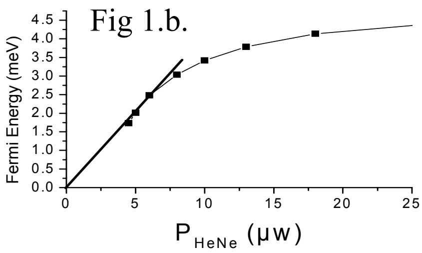
In this work, we study a structure containing three GaAs quantum wells (QWs) inside the microcavity: a wide one surrounded by two narrow ones. This active layer enables to continuously tune the electron density [2]. Electrons optically generated in the narrow QW by a high energy laser (He:Ne) transfer to the wider one. Excitons created in the wider QW by a lower energy laser are in the strong coupling regime with the cavity mode.

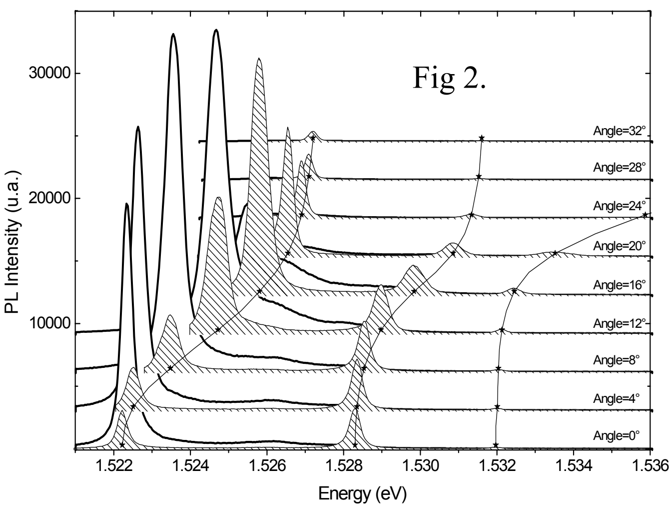
We first study the emission of the active layer after having removed the cavity top mirror. At high He:Ne excitation power, the photoluminescence lineshape becomes asymmetric and can be very well fitted considering electron-hole recombination up to the electron Fermi level (see fig. 1a). Thus we deduce the electron density at high power (fig. 1.b.) and extrapolate it to the low density regime (the linear increase of the electron density at low power has been checked experimentally).

We then study the polariton relaxation in the presence of the electron gas. Fig. 2 presents photoluminescence spectra measured at different angles with (thick black line) and without (hatched spectra) the electron gas (density = 10^9 cm^{-2}). A clear redistribution of the polariton population is observed and the relaxation bottleneck is considerably reduced. We observe a strong increase (x 7) of the population in k=0, together with a clear decrease of the population at high k states. This shows that, as predicted, electrons help polariton relaxation toward k=0.

The role of the temperature as well as a comparison between polariton-polariton and electron-polariton scattering efficiency will be addressed.







[1] G.Malpuech *et al.*, Phys Rev B **65**, 153310 (2002)
[2] G.Ramon *et al.*, Phys Rev B **65**, 085323 (2002)