Polariton magneto-spectroscopy in GaAs/AlGaAs microcavities with modulation doped quantum wells

A. Gabbay[1], B. M. Ashkinadze[1], E. Cohen[1], E. Linder[1] and L. N. Pfeiffer[2]
[1] Solid State Institute, Technion-Israel Institute of Technology, Haifa 32000, Israel
[2] Bell Laboratories, Lucent Technologies, Murray Hill NJ 07974, USA

We report on a comparative study of the effects of a perpendicularly applied magnetic field and of microwave irradiation on the polariton spectrum in GaAs/AlGaAs microcavities (MC) with an embedded modulation-doped quantum well (MDQW) and on the electron – hole transitions of bare GaAs/AlGaAs MDQW's. In both cases, MDQW's having similar widths (250Å) were used, containing a two dimensional electron gas (2DEG) whose density was varied by optical depletion in the range of $10^{10} < n_e < 2x10^{11}$ cm^{-2} (at lattice temperatures of $T_L \sim 2K$). We measured the circularly polarized photoluminescence (PL) spectra as a function of the 2DEG density, the magnetic field strength (0<B<7T) and the modulation of these PL and polarization spectra by microwave irradiation. In the case of the bare MDQW, the lowest Landau transition polarization, shows a different B-dependence from that of the charged and neutral exciton PL lines that appear at $\nu < 1$. The microwave – modulated PL spectra show the optically detected electron cyclotron resonance. In the case of MDQW's embedded in a MC, the PL spectra show a strong dependence on the degree of optical depletion. A transformation from the weak coupling of the interband hh-2DEG transitions with the MC confined photon to the strong coupling regime is observed, as n_e decreases. Applying a magnetic field affects the degree of optical depletion that is required to induce this transformation. The dependence of the polariton spectrum circular polarization on B and its dependence on microwave irradiation are distinct from those of the bare MDQW. These differences are analyzed in terms of the charged polariton relaxation mechanisms that are different from those of the free holes and the charged excitons in the bare MDQW.