Non-linear effects in the ultrafast emission from semiconductor microcavities

L. Viña[1], A. Kavokin[2] and R. André[3]

[1]*Universidad Autónoma de Madrid, Campus de Cantoblanco, E28049 Madrid, Spain*
[2]*LASMEA, UMR 6602 CNRS, Univ. Blaise-Pascal, 24, av des Landais, 63177, Aubière, France*
[3]*Lab. Spectrométrie Physique (CNRS UMR5588), Université J. Fourier - Grenoble 1 - BP 87 F-38402 Saint Martin d'Hères, France*

We present a time-resolved study of the light emission of a CdTe-based microcavity. In the non-linear regime, under high excitation conditions, in the strong coupling regime, we observe pronounced beats of the intensity of the photoluminescence arising from the bottleneck region of the exciton-polariton band. These beats are very sensitive to the excitation density and vanish under weak pumping conditions. We attribute the beats to a new non-linear coupling mechanism of optically active and dark crystal states, related to polariton.-polariton scattering, which leads to mixing between bright and dark states.

Our sample is a $Cd_{0.40}Mg_{0.60}Te$ microcavity of thickness λ, sandwiched between distributed Bragg reflectors (DBRs). Two pairs of 90-Å thick CdTe quantum wells are placed at the antinodes of the cavity, leading to a Rabi splitting of ~ 14 meV. A slight wedge in the cavity thickness allows tuning the cavity and the exciton into resonance by moving the excitation spot across the wafer.

The microcavity is mounted in an immersion cryostat and is optically excited with 1.5 ps pulses at the first minimum above the stop-band of the DBRs. The emission, angle-resolved using a small pinhole, is time- and spectrally-resolved using a streak camera with an overall time resolution of ~ 10 ps. For polarisation-resolved measurements, two $\lambda/4$ plates are included in the experiment: the excitation light is σ^+-polarised and the PL emission is analysed into its σ^+- and σ^--polarized components. The experiments presented here are performed at a negative detuning of -13 meV with power densities below 50 W cm^{-2}, which ensure that the strong-coupling regime is maintained. Only the heavy hole excitons were optically excited, the light-hole exciton resonance is not seen in the spectra as it lies at higher energies and is not coupled to the cavity mode.

We also report on the existence of excitonic states not-coupled to cavity modes, which under high excitation present a non-linear behaviour and possible lasing.