Dynamics of Polariton Emission in the Linear Regime

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We present a study of polariton emission from a CdTe-based microcavity. The dynamics of the emission, in the linear regime, is analyzed as a function of the exciton-cavity detuning and in-plane wave-vector. We model our results using the Hopfield coefficients to obtain the photonic and the excitonic emission rates of the polariton.

The measurements were performed at 5 K with the excitation power was kept below the stimulated scattering threshold. The signal was excited by a circularly polarized beam from a 2 ps pulsed Ti:Al_2O_3 laser and detected and time-resolved with a synchroscan streak camera with overall time resolution of 10 ps. The sample was wedged-shaped to enable changing the exciton-cavity mode detuning by moving the excitation spot across the sample. For each spot, the excitation energy was tuned 62 meV above the cavity-like polariton energy. Wave-vector resolution was achieved using a pinhole and measuring the signal at various angles with respect to the normal to the sample surface.

Analyzing the energies of the lower- (LP) and upper-polariton (UP) branches at k=0 as a function of detuning, we found a Rabi splitting of 8 meV. The dispersion curves of LP and UP were measured at various detunings and they are in good agreement with the k-dependence of the energies calculated with the Rabi splitting obtained from the detuning analysis.

We model the polariton decay rate as: $\frac{1}{\tau_d} = \frac{a_X}{\tau_X} + \frac{a_{ph}}{\tau_{ph}}$, where a_X and a_{ph} which depend both on detuning and k vector, are the calculated excitonic and photonic components of the polariton, respectively. τ_X and τ_{ph} are the excitonic and photonic decay times, which are left as model parameters, taken in first order as independent on detuning and k. The decay rate of the UP agrees with the model reasonably well. However, for negative detunings, the decay rates of the LP at k=0 are significantly smaller than the ones calculated within the aforementioned model. We attribute this discrepancy to the presence of the relaxation bottleneck, which slows down the polariton relaxation, from the high wave-vector states, to k=0. Indeed, for positive detunings, where the bottleneck effect is negligible, the calculated decay rates reproduce well the measured ones. This effect is also borne out in the k-resolved measurement: at negative detuning, where the LP has a marked photonic character, its decay rates for small k are significantly smaller than the calculated ones. However, at k corresponding to the bottleneck region the measured and calculated values coincide.