The effect of magnetic field on the emission from exciton polaritons in semiconductor microcavity

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Exciton – polaritons in semiconductor microcavities attracted worldwide interest due to their potential in polariton based devices, possibility to create Bose-Einstein condensate and formation of a superfluid state with zero viscosity with many spectacular properties. These half-matter half-light quasi-particles, are composed of photon confined in microcavity and exciton resonance in quantum well coupled by strong interaction. The interaction modifies the dispersion of both resonances leading to two, upper (UP) and lower (LP), polariton branches of particular shape. The occupation of polaritons along the dispersion is governed by scattering with acoustic phonons leading to the thermal distribution (in a linear regime) and the polariton-polariton interactions leading to massive occupation of ground state with zero momentum (in a non-linear regime). The excitonic reservoir that supplies polaritons to the system is directly related to the number of particles in the final state.

In this study we use external magnetic field to influence the excitonic part of polaritons. The modification of the excitonic state close to zero momentum influence directly the LP and UP branches and with high momentum is modifying significantly the excitonic reservoir. The sample consists of a GaAs lambda microcavity sandwiched between two DBR AlAs/GaAs with one 8nm thick InGaAs quantum well. The polariton population is created non-resonantly. The sample is placed in a magnetic filed up to 5T at the cold finger of a cryostat in 4.5K. We image the full dispersion of LP and UP and we trace the evolution of energy, intensity and width of the emission lines in magnetic field.

We observe a strong influence of the magnetic field on the optical response of microcavity polaritons. First, we observe a global increase of the emission intensity showing that the relaxation from the excitonic reservoir towards polariton branches is enhanced. Second, the distribution of polaritons along the dispersion gets modified leading to the magnetically induced bottleneck effect. The shift in energy and Zeeman splitting are typical for the GaAs/GaInAs system and we describe it by a theoretical model of exciton in magnetic field coupled to photonic resonance in a cavity. We take into account the diamagnetic shift of excitons, cyclotron energy and the Zeeman splitting. The comparison between our theoretical model and experimental results gives us directly the measure of exciton oscillator strength modification in magnetic field. Moreover, we observe that the width of the emission lines is modified in magnetic field. The lines become narrower or broader depending on momentum and magnetic field value. We discuss this effect in terms of motional narrowing effect and possible magnetic field influence.

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