Spin-controlled parametric polariton scattering in quasi-one-dimensional cavities

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In semiconductor microcavities strongly coupled exciton-photon polaritons can undergo parametric scattering processes [1]. The characteristics of such conversion processes are mainly determined by the polariton mode spectrum. However the spin properties of cavity polaritons in the non-linear regime exhibit a complex phenomenology and depend largely on the excitation conditions [2]. Previous studies concentrate on planar microcavities, where the polariton eigenstates are circularly polarized. It has been demonstrated, however, that parametric polariton oscillation can as well be achieved in low dimensional cavities [3]. By adjusting the lateral cavity extensions, the parametric processes can be tailored: besides controlling the mode spectrum, the polarization of the polaritons is also modified. In quasi one-dimensional systems the polariton eigenstates are linearly polarized. We present studies on such wire-shaped cavities, where the photon field quantization gives rise to a multiplet of polariton modes. We concentrate on states with zero wave vector. The anisotropy in the cavity plane gives rise to a splitting between the two linearly polarized eigenstates for each of these modes. The prerequisites for parametric conversion is the conservation of energy or in other word the equidistance between three modes. This can be achieved between the three lowest polariton sub-branches. Due to the polarization splitting, the mode spacing depends on the relative polarization of the three states involved. We demonstrate, how this can be utilized to control the polarization selection rules of the process. For this purpose one polarization component of the first excited polariton mode is resonantly excited with a cw-laser. Our studies show that polarization of the signal state can be adjusted by changing the cavity detuning or the sample temperature.

[1] P.G. Savvidis et al., Phys. Rev. Lett. 84, 1547 (2000);
[2] A. Kavokin et al., Phys. Rev. B 67, 195321 (2003);
[3] G. Dasbach et al., Phys. Rev. B 66, 210210 (2002).