Origins of the polarization splitting in exciton-polaritons microwires

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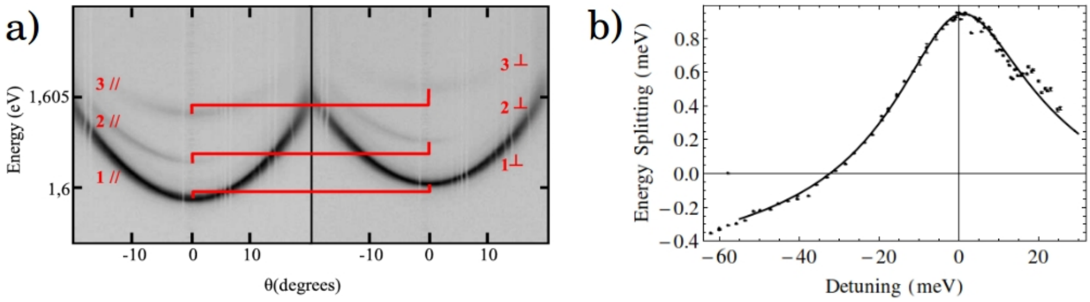
Abstract

Exciton-polaritons semi-conductor microcavities provide an interesting path to the realization of integrated devices for nonlinear optics. In particular it has been shown [1] that 1D-microcavities (planar microcavities etched in wire) allow for the realization of optical parametric oscillation (OPO) with a pump at normal incidence and balanced signal and idler intensities; a configuration particularly favorable for practical implementation. In this scheme, OPO is possible thanks to a polarization-inverting parametric scattering process and a polarization splitting between the polaritonic modes in the 1D-microcavity.

We have experimentally investigated the origins of the polarization-dependent energy splitting in the lower exciton-polariton branches of a 1D microcavity. The splitting observed can reach up to 1 meV and results from anisotropic mechanical internal constraints induced by etching. Those constraints remove the degeneracy both in the photonic (δEph) and excitonic (δEexc) components of the polariton but also in the photon-exciton coupling amplitude (δΩ). Those three contributions are for the first time simultaneously inferred from experimental data. It appears that the bare exciton-photon detuning is an efficient control of the sign, magnitude, and principal axes of the linearly polarized eigenstates splitting. Moreover, no dependence with the wire width (from 3 to 7 µm) or thermal/applied stress is observed. We propose a self-consistent mechanical model explaining the universality of those observations paving the way to the engineering of polarization eigenstates in one-dimensional exciton-polaritons.



a) Energy dispersion obtained by photoluminescence of the lower polarization branches of the 1D-confined microcavity polaritons with parallel (right) or orthogonal (left) polarization to the wire axis. Energy splitting between the two configurations is directly visible. b) Energy splitting of branch 1 between parallel and orthogonal polarization to the wire axis as a function of exciton-cavity detuning. δEph, δEexc and δΩ can be deduced thanks to a non linear fit (plain line).

[1] T. Lecomte, V. Ardizzone et al., Phys. Rev. B 87, 155302 (2013)