Photonic crystal slab cavities with embedded quantum wells for single-photon nonlinear optics

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We study theoretically the realization of zero-dimensional confined eigenstates of mixed material and electromagnetic excitations in photonic crystal slab cavities, namely, *photonic crystal cavity polaritons*. Such quasi-particles arise from the strong coupling of quantum well (QW) excitons and high-Q photonic crystal (PC) cavity modes [1]. The structure is assumed to be a PhC membrane with a QW grown in the middle of the PC slab. The presence of air holes may be detrimental for the QW exciton line broadening, due to possible non-radiative recombination or surface states absorption induced by the presence of many semiconductor/air interfaces. We introduce a simplified theoretical model to show that the formation of cavity polaritons acts as a confining potential to the excitonic part of the polariton states. This allows for a self-protection mechanism against the presence of the holes, thus reducing unwanted broadening of the polariton lines.

Cavity designs with reduced field overlap with semiconductor/air interfaces are crucial to this end. Theoretical modelling as well as experimental results on modified H1 cavities (one-missing hole in a triangular lattice) are presented [2].
Our results pave the way to the observation of non-linear optical effects at the single-photon level induced by the polariton-blockade of multi-photon injection through the cavity region [3]. PhC slab cavities play a crucial role in view of the realization of this proposal, owing of their increasing degree of tunability and fabrication accuracy [4].

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