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High Purcell Factor Photonic Crystal Cavities for Single Photon Sources

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ABSTRACT
Enhancement of spontaneous emission is of crucial importance in the design of high efficiency single photon sources [1]. This can be achieved by creating defect cavities with both high Q and small effective mode volume, which results in a high Purcell factor[1-4]. Photonic Crystal (PhC) microcavities are very promising candidates in this area and this work is using 3D Finite Difference Time Domain modelling to investigate these devices. We have extensive experience in modelling and measuring more conventional pillar microcavities [5,6] and thus are ideally placed to assess PhC based structures.

Figure 1 shows the structure under consideration, this is the case for a one missing hole cavity. The figure also shows the strongly confined x directed Electric field. Figure 2 shows the simulated Q factor calculated from observing the ring down of the cavity mode and the use of Fourier transforms.

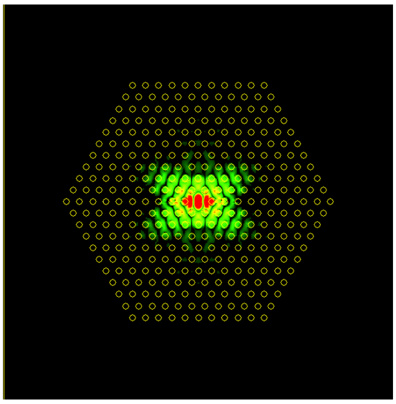

Figure 1. One missing hole PhC microcavity showing Abs(E_x) field (x-horizontal, z-vertical), Lattice constant, a = 0.254 nm, r/a = 0.3, slab thickness = 0.65a, n_{slab} = 3.6.

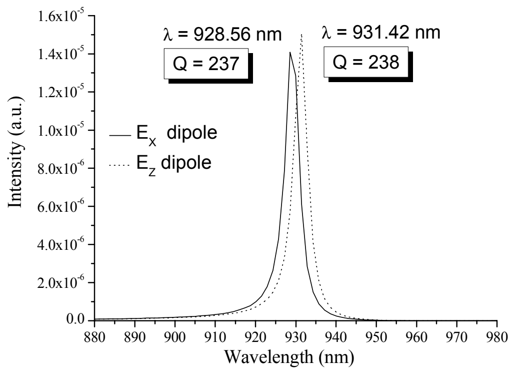

Figure 2. Q factor calculated from time domain response of cavity for case of two different dipole directions.

As expected for this simple case very small Q factors are obtained. This work will go on to investigate different cavity configurations and calculate effective mode volumes in order to evaluate the Purcell factor in more advanced designs.

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