On-chip photonic crystal cavity designs for nanoparticle characterization

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Planar Photonic Crystal (PhC) cavities are unique optical resonators that can confine modes in a sub-wavelength volume V and have a high-quality factor Q. Decreasing V enhances light-matter interaction in the mode volume, whereas increasing Q improves the detection limit of any frequency shift induced by a perturbation of the cavity mode. As a result, such cavities are promising refractive index sensors to detect biomolecules as small as proteins [1].

Such cavities are defined by introducing a lattice defect in a two-dimensional periodic array of low-index holes that are etched in thin planar waveguides of high-index material. Being integrated photonic structures, they can benefit from a complete on-chip signal processing.

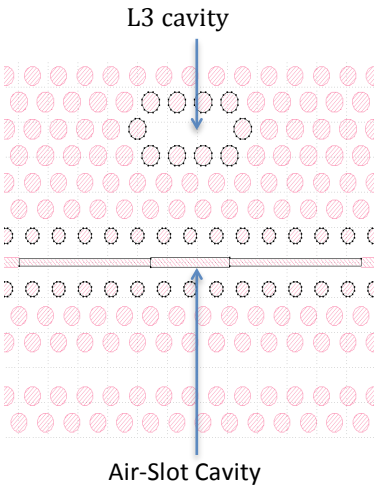

Fig.1: Mask design of PhC cavities

We investigate here new designs to probe with a high-detection limit the frequency shifts induced by a nanoparticle in the core of a hollow core PhC cavity. As shown in Fig.1, the hollow-core PhC cavity that allows nanoparticles to interact with the maximum of the cavity field is created from a slight modulation of the width of a low-index slot that replaces a line of holes in the PhC pattern [2]. A second cavity formed by three in-line missing holes, commonly called L3 cavity, is used to probe the frequency fluctuations of the hollow-core cavity. Various adaptations of such a design are being processed on Silicon-on-Insulator (SOI) substrate using deep ultraviolet (UV) lithography by the ePIXfab platform.

We will present the design methodology that was based on guided-mode expansion method [3] and demonstrate the high performance of the proposed concept to extract information about the size and the shape of different nanoparticles.

References:

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