Performance of an Integrated Structure of Photonic Crystal-Microdisk in a Functional Nano-Particles Sensor

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Abstract

In this paper, the design and simulation of a functional nano-particles nano-sensor is presented by combining the structure of an optical microdisk resonator and photonic crystal in the form of an array of cubic air-holes along the circular path near microdisk's periphery. The use of optical microdisk resonator will result in the manipulation and concentration of the whisperings gallery modes, plus etching cubic air-holes on a circular pathway of intensified whisperings gallery modes that is more effective to control modes. Finally, the design of slots with a depth of about a fraction of the thickness of the disk, which links the neighboring air-holes in the same circular path, helps to create special conditions for making the nano-particles sensor device. In this combined structure, small modal volume with very high quality factor modes is provided to confine optical modes for sensing. We report values as $0.075(\lambda/n)^3$ for the modal volume in the centralized slot area for modes with a quality factor larger than 10 million, using finite element method simulation. Sensing properties of the structure are analyzed using variation of wavelength of the modes for different disk geometries, photonic crystal array, and the dimensions of the linked slots, and access to an acceptable sensitivity 109 nm/RIU (nm/refractive index unit) is possible.

Keywords: Nano-Particle, Nano-Structure, Nano-Sensor, Photonic Microdisk, Tapered Cavity properties

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