# Numerical Analysis of Perforated Microring Resonator Based Refractive Index Sensor

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**Introduction**: In this work perforated microring resonator based refractive index sensor is presented. Numerical analysis of the microring using COMSOL Multiphysics was performed. From transmission spectra sensitivity and quality factor of our proposed structure were evaluated. It was shown that perforated microring resonator exhibits higher sensitivity than ordinary microring resonator while also maintaining high quality factor.

Two different geometries were analyzed: one with all holes having equal radii, second – one of the holes (defect hole) having smaller radius.

Geometrical parameters of the structure:

| | |
|---|---|
| *Ring outer radius* | 2.150 μm |
| *Ring width* | 0.350 μm |
| *Waveguide width* | 0.250 μm |
| *Hole radius* | 0.070 μm |
| *Defect hole radius* | 0.047 μm |

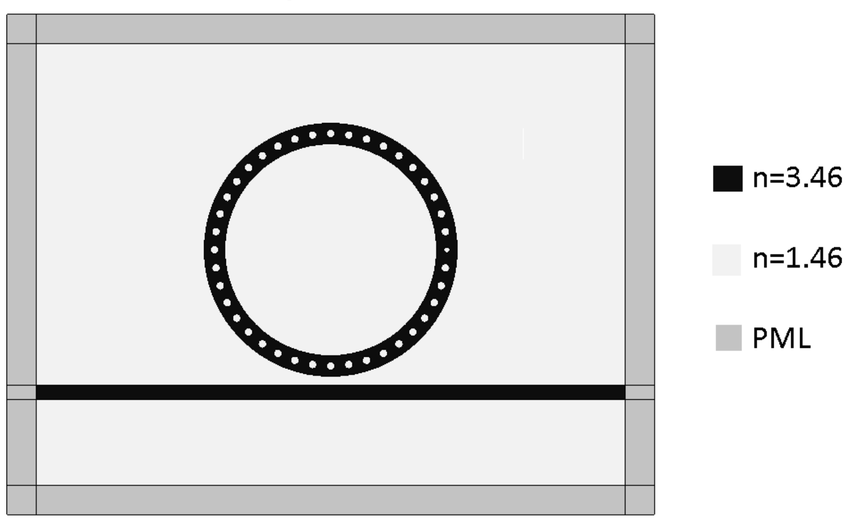


**Figure 1**. Geometry of the analyzed microring resonator

**Computational Methods**: COMSOL was used to solve Helmholtz equation for transverse magnetic field in 2D spatial domain for the structure shown in figure 1. Excitation source having spatial distribution of fundamental waveguide mode was set at left side of the waveguide. Transmitted power was monitored at the right side of the waveguide. To get a transmission spectra, parametric sweep for different wavelengths was performed. To suppress any reflection from boundaries of computation window, perfectly matched layers were used (figure 1).

$$\nabla \times \left( \left( \varepsilon_r - \frac{j\sigma}{\omega_0 \varepsilon_0} \right) \nabla \times \vec{H} \right) - \mu_r k_0^2 \vec{H} = 0$$

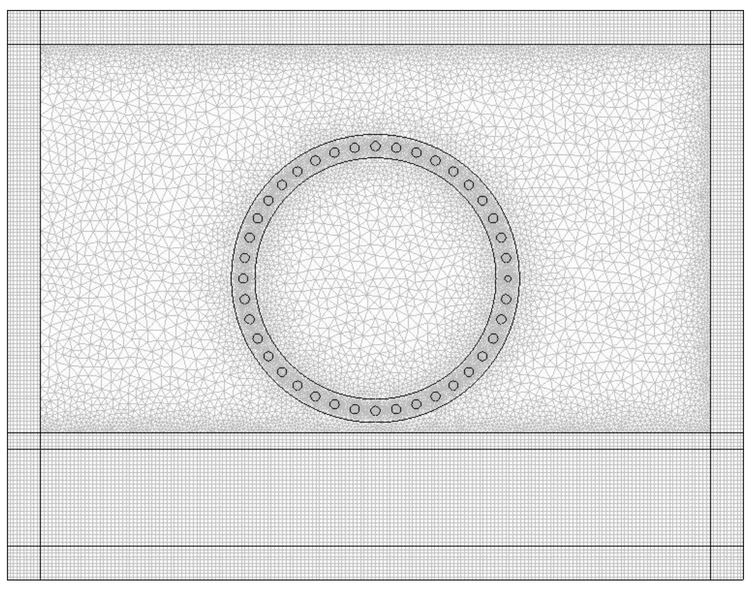

**Figure 2**. Mesh used in simulations

**Results**: Quality factor of different modes is between 1800 and 3150. Bulk sensitivity 260 nm/RIU. Transmission spectra and magnetic field distributions at different resonance wavelengths are shown in figures bellow:

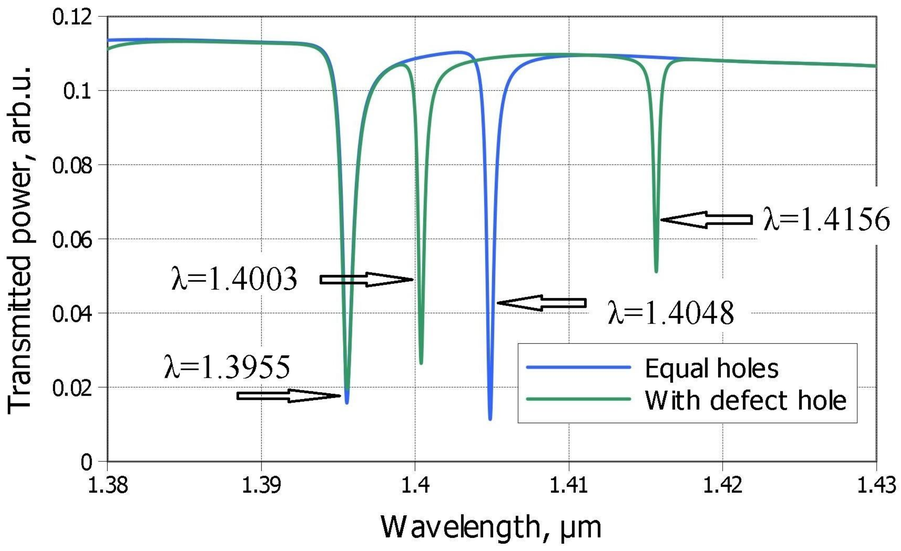


**Figure 3**. Transmission spectra of perforated microring resonators.

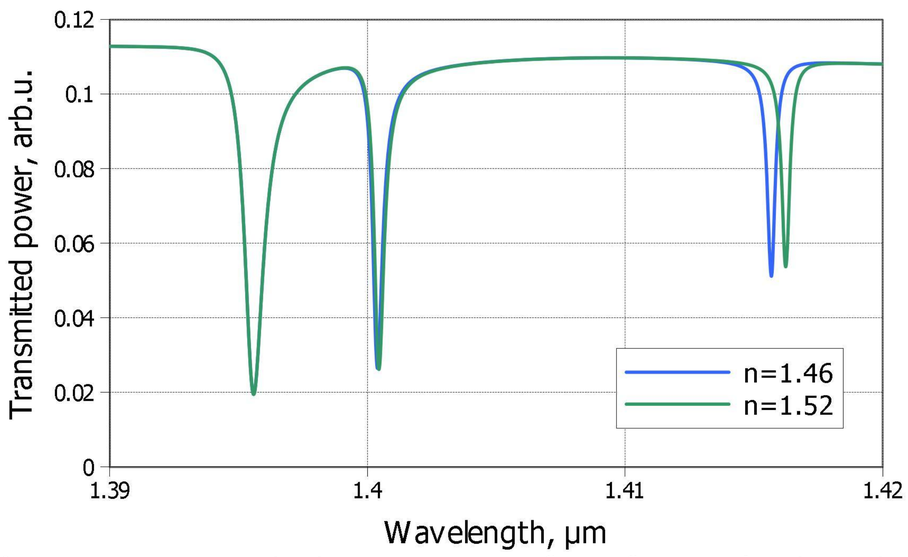


**Figure 4**. Transmission spectra of perforated microring with defect hole having higher refractive index.

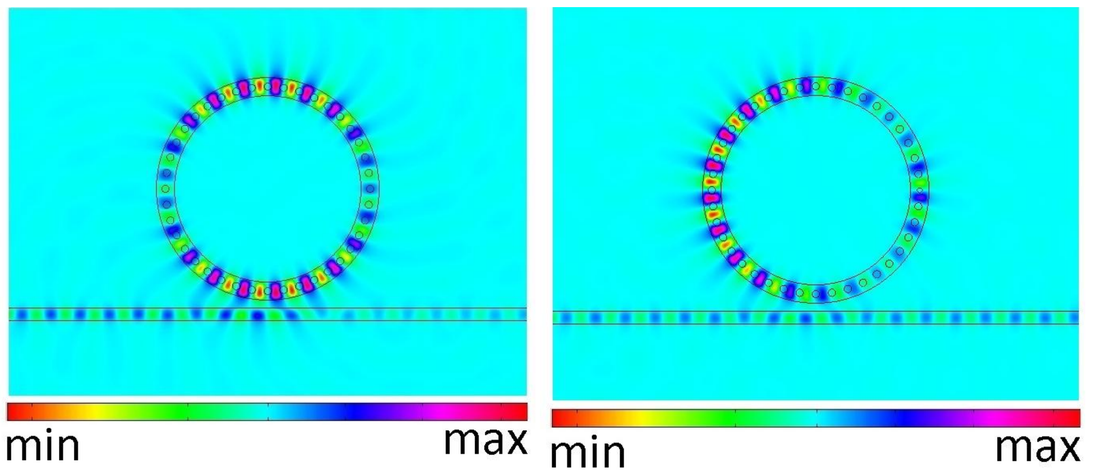


**Figure 5.** λ=1.3955 μm **Figure 6.** λ=1.4048 μm

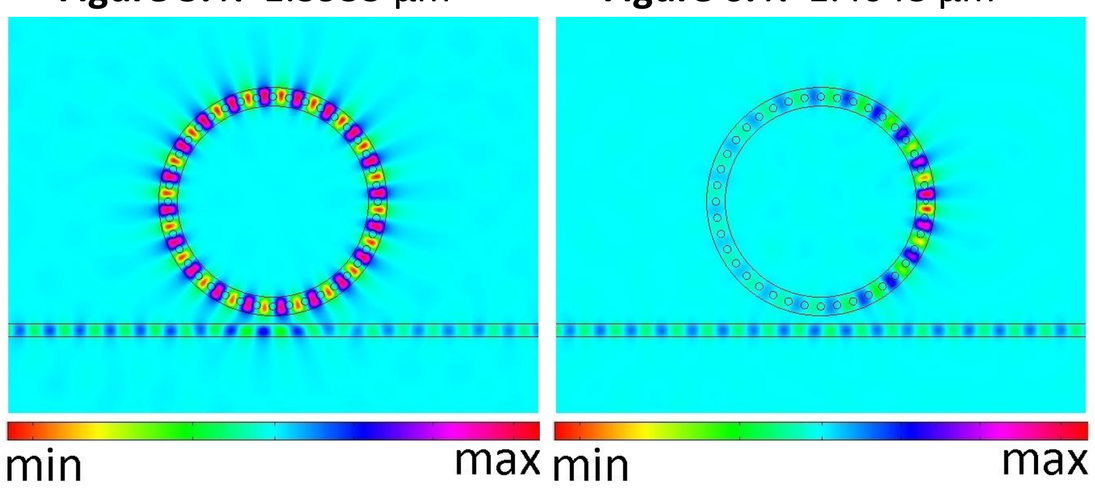


**Figure 7.** λ=1.4003 μm **Figure 8.** λ=1.4156 μm

**Conclusions**: Presented perforated microring resonator has higher bulk sensitivity than ordinary microring resonator while also maintaining relatively high quality factor.

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