Biosensor Based on a Photonic Crystal Cavity Resonator

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Introduction

Early detection as well as identification of biomolecules is very important for many applications such as medical diagnostics, virus and bacteria detection and so on. Photonic crystal (PhC) based resonator has attracted great attention due to its strong light confinement, high quality factor and small modal volumes [1]. As compared to other types of biosensors such as multiple optical mode waveguides, Mach-Zehnder interferometers and Young interferometers, PhC based biosensors have advantages of small size, high sensitivity and CMOS compatible. The schematic of our proposed device structure is shown in Fig. 1 where (a) cavity type PhC resonator, (b) defect type PhC resonator and Fig. 2 are the SEM images of cavity type resonator.

Fabrication process

Once the geometrical parameters were defined by FDTD simulation, the proposed device was fabricated using silicon-on-insulator wafer with the SiO_2-hardmask. Patterns of waveguides and photonic crystal as well as resonators were made by electron beam lithography (EB), reactive ion etching (RIE) of hard-mask with CF_4 and inductive coupled plasma (ICP) etching of Si with Cl_2 gas. Measurements were carried out using an infrared tunable semiconductor laser (1280~1320 nm) and an InGaAs photodetector

Discussion and Conclusion

In this work, we have studied both cavity and defect type resonators for biosensing. In the cavity type, resonator confines the light and light-biomolecule interaction occurs. However, in the defect type structure only the evanescent light are in the resonator region and makes interaction with biomolecules. The sensing ability of both structures has measured using sucrose solution at different concentration. The experimental results are shown in Figs. 3 (a) and (b). The resonance wavelength has shifted linearly with changing the sucrose concentration and device has shown very high sensitivity of 2714 nm/RIU for the cavity type. This time the sensitivity measurement is more accurate than [2]. The cavity type resonator has 4 times large wavelength shift than defect type.

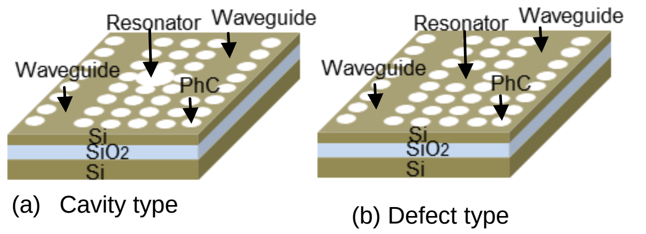

Fig. 1 Schematic of PhC based resonator (a) cavity type and (b) defect type.

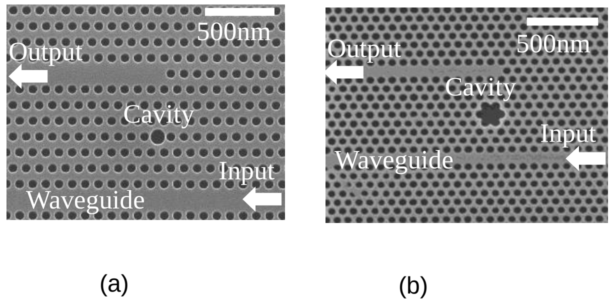

Fig. 2 SEM image of fabricated device(a) cavity type (normal) (b) cavity type (large hole diameter).

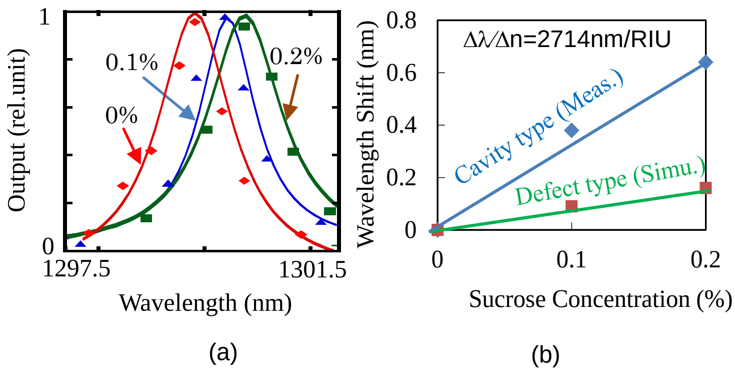

Fig. 3 Measured results of normal cavity type PhC based resonator.

References
[1] K. Li *et al.*: IEEE Photonics Journal **6** (2014) 6802509.
[2] A. K. Sana *et al.*: JSAP Spring meeting (2015) .