Label Free Biosensor Based on Photonic Crystal Resonator

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Introduction

There have been interests in developing of label free based optic biosensors [1]. Among the different types of biosensor photonic crystal based biosensor opens new possibilities due to their photonic bandgap. Silicon 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 (c) SEM images of cavity type resonator [2].

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 infra-red tunable semiconductor laser (1280~1320 nm) and an InGaAs photodetector.

Discussion

In this work, we have studied both cavity and defect type resonators with different center hole diameter. The experimental results of cavity type shows larger wavelength shift than defect type. Moreover, larger cavity offers more resonance wavelength shift than small cavity type device. The experimental results are shown in Figs. 2 (a) and (b). Figure 2 (a) is the measured results at center hole 400 nm. In Fig. 2 (b), for the large center hole, the resonance wavelength shift is not linear possibly due to bubbles generated inside the cavity. The small cavity i.e. center hole 400 nm and 430 nm, the resonance wavelength shift linearly changed with sucrose concentration. In our measured results the abnormal(center hole is connected to surrounding holes) cavity (450 nm) has about 1.7 times large wavelength shift than small cavity (cavity size 430 nm) at 0.1 % sucrose concentration and we confirmed that 2.3 times large wavelength shift of large cavity type structure than defect type structure at 0.1 % sucrose concentration [2].

Conclusion

We found that the cavity type PhC resonator has large sensitivity than that of the defect type device due to large sensing area.

References

[1] B. Liedberg *et al.*: Sensors. Actuator. B **11** (1993) p.63.

[2] A. K. Sana *et al.*: Extended Abstracts of the 2015 International Conference on Solid State Devices and Materials, Sapporo, 2015, p.380

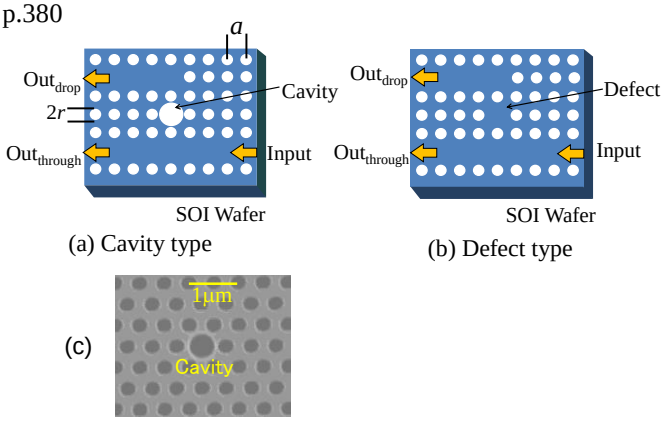

Fig. 1 Schematic of proposed devices (a) cavity type and (b) defect type and (c) SEM image of cavity type device.

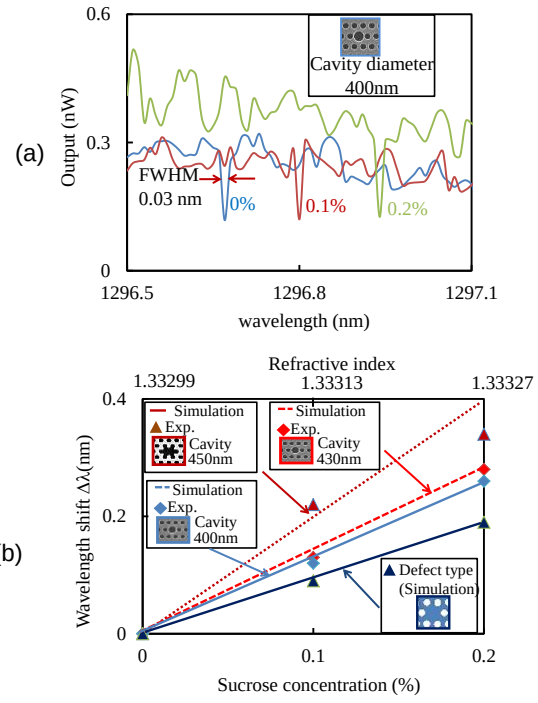

Fig. 2 (a) measured results of normal cavity type PhC based resonator (b) resonance wavelength shifts with respect to sucrose concentration variation for various sensors.