Prostate Specific Antigen Detection Using Photonic Crystal Nanocavity Resonator

[o]Amrita Kumar Sana[1], Yoshiteru Amemiya[1], Takeshi Ikeda[2], Akio Kuroda[2], and Shin Yokoyama[1]
[1]Research Institute for Nanodevice and Bio Systems, Hiroshima University
[2]Department of Molecular Biotechnology, Hiroshima University
E-mail: amrita-sana@hiroshima-u.ac.jp

Introduction

Rapid and sensitive detection of proteins, antibodies in biological samples has broad applications including immune response for infectious diseases, cancer, and cardiovascular disease [1]. For instance, cancer biomarker and cancer cells detection have shown great promise in early detection of colon, prostate, and leukemia cancers [2]. The sensing mechanism of the photonic crystal (PhC) is that the effective refractive index of the sensing area is changed by the activation of target biomaterials. Proposed biosensors have been used to detect prostate specific antigen (PSA) that is responsible for prostate cancer. The schematic of proposed device is shown in Fig. 1.

Fabrication process

The device were fabricated onto silicon on insulator (SOI) wafer [3].The SOI substrate has a top silicon layer of thickness 300 nm on a 1.1 μm buried oxide layer. A 110 nm thick oxide layer was thermally grown as an intermediate layer of pattern transfer. An electron beam (EB) sensitive photoresist, ZEP-520A was spin coated onto the oxide layer. An electron beam lithography system was used to define high resolution patterns on the resist. The patterns were then developed by xylene and iso propyl alcohol. In order to transfer this pattern into the Si layer we used reactive-ion etching (RIE) and inductively coupled plasma (ICP) using CF_4 and Cl_2 gas respectively. In a final step, wet etching by diluted hydrofluoric acid was used to remove SiO_2 mask. SEM image of the fabricated device is shown in Fig. 2.

Discussion and Conclusion

Prostate cancer is the 6th most common cause of cancer death overall in the world [4]. In this work, we have developed a double nanocavity type PhC based resonator to defect the PSA marker. We have used the rapid functionalization method of PhC nanocavity resonator with antibodies using Si-tagged protein G. The measured result is shown in Fig. 3(a) and Langmuir's fitting curve with measured results is shown in Fig. 3(b). Since various kinds of antibody can be used as receptors for bio sensing, this method promises to realize the integrated biosensors for high-throughput analyte detection without labeling. This PhC-based sensing platform has shown a great promise in detecting PSA at the early stage of prostate infection with high sensitivity (0.5 ng/ml). At this stage our device promises good agreement to detect PSA marker but it needs further measurements to make sure the device performance.

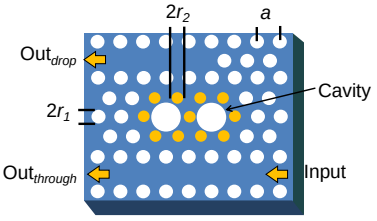


Fig. 1 Schematic of photonic crystal based double nanocavity resonator.

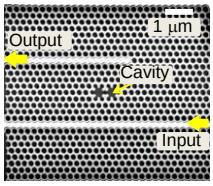
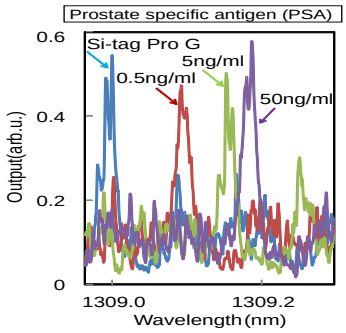


Fig. 2 SEM image of fabricated device.

(a)



(b)

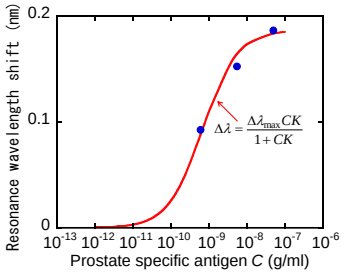


Fig. 3. (a) Measured results at different PSA concentration and (b) Concentration of PSA versus resonance wavelength shift and Langmuir's fitting curve.

References

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