Design and Fabrication of Tapered Polymer Microring Resonator for Single Gold Nano Particle Sensing

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1. Introduction

Detection of nanoparticles with high sensitivity is quite challenging and of paramount importance due to its wide application range in bio-medicine, environmental monitoring and public health monitoring. The optical microresonators possess high Q-factor and small mode volume which makes them an ideal platform to detect single nano particles[1]. Gold nanoparticles are inert in nature and easy to synthesis, hence they are used as label for various bio and chemical detections [2]. Thus, detecting small gold particle with high sensitivity holds a strong promise.

In this paper, we propose a conventional add-drop racetrack microring resonator with an intermediate tapered section. The tapering of microring resonator increases the strength of evanescent wave which in turn will enhance the sensitivity of the device. We have performed FDTD simulation and carried out theoretical analysis. The proposed device has been fabricated using two-photon polymerization process whose characterization is in the progress.

2. Design and simulation

Tapering of a waveguide reduces the effective refractive index of the mode propagating in the waveguide that gives rise to greater evanescent electric field outside the waveguide. This concept is integrated with microring resonator which has a high Q factor. Racetrack configuration is chosen to increase the coupling between the waveguide and microring. Bus waveguide has width of 2 µm and height of 1.5 µm, straight portion of the racetrack ring is 32 µm, the outer radius of the ring is 10 µm, and the gap between the bus waveguide and racetrack is 250 nm. One side of the ring is tapered down to 500nm which serves as a sensing region.

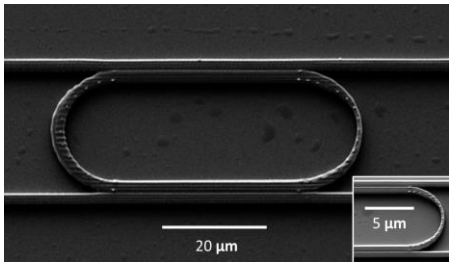

Fig. 1. SEM image of a tapered racetrack microresonator.

The structure is fabricated on silica substrate using two photon polymerization based Nanoscribe professional GT system. After writing process, the sample is cleaned in PGMEA for 10 mins and another 5 min in IPA. Fig. 1 depicts the SEM image of the fabricated structure.

Fig. 2 shows the output spectrum with and without gold nanoparticle of different radii. The presence of gold particle can be detected by the red shift in the transmission spectrum due to strong interaction with the evanescent field. In absence of gold nanoparticle, the spectrum exhibits a dip in the spectrum at ~ 1550 nm which is red-shifted in presence of gold nanoparticle (50 nm) by almost 4.5 nm. As the size of the gold nanoparticle increases, the peak shifts to left. This clearly demonstrates the size selectivity of the device. Inset shows the strong evanescent electric field in the tapered region.

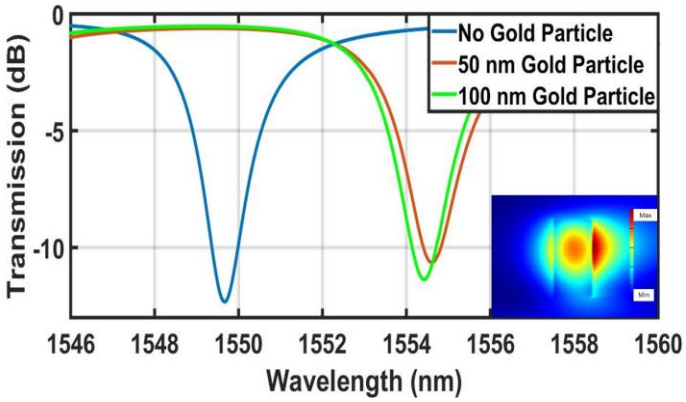

Fig. 2 Transmission spectra of a racetrack microring resonator with and without gold particle

3. Conclusions

We have fabricated a tapered racetrack microring resonator which can be used to detect single gold nanoparticles of different sizes. The proposed device could be a potential candidate for bio-sensing applications.

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References

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