Analysis of triangular resonator integrated with zinc oxide thin film

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Abstract **- We proposed triangular resonator integrated with zinc oxide thin film. Zinc oxide thin film was placed on the part of the triangular resonator region. The propagation characteristic was analyzed using 2-D finite-difference time-domain method as a function of refractive index change of zinc oxide thin film. The wavelength of resonance was shifted about 0.002 nm when the change of refractive index of zinc oxide thin film was 0.01.**

I. INTRODUCTION

Microring resonators are very desirable for photonic applications owing to their compact features and manifold functionality [1]. Owing to very high Q-factor resonances and steep slopes, photonic microring resonators have begun to be employed in sensing devices [2]. Triangular resonators, also known as ring resonators, can provide an attractive solution for such functions [3].

Meanwhile, zinc oxide (ZnO) has unique semiconductor, photonic, and piezoelectric properties, such as wide band gap (~3.37 eV), large excitonic binding energy (~60 meV), high piezoelectric constant [4]. Most sensors based on ZnO material are operated on the basis of the modification of the electrical properties. The use of optical waveguide devices as microring resonators integrated with ZnO materials could enable to realize high sensitive optical sensors.

In this study, we proposed triangular resonator integrated with ZnO thin film and confirmed their potential application as a sensor through computational simulation using the two dimensional finite-difference time- domain (2-D FDTD) method.

II. STRUCTURE

The structure of triangular resonator integrated with a multimode-interference (MMI) coupler and total internal reflection (TIR) mirrors is shown in Fig 1. This design scheme has the good advantage of removing the direct coupling between the two access waveguides, which have some problems when they get close. ZnO thin film was placed on the part of the triangular resonator region. The parameters used here are a wavelength of 1.55 mm and the waveguide effective refractive index of 3.1267.

For the sensitivity analysis, we have calculated the variations of the transmittance and resonance shift of the triangular resonator with the refractive index change of the ZnO region.

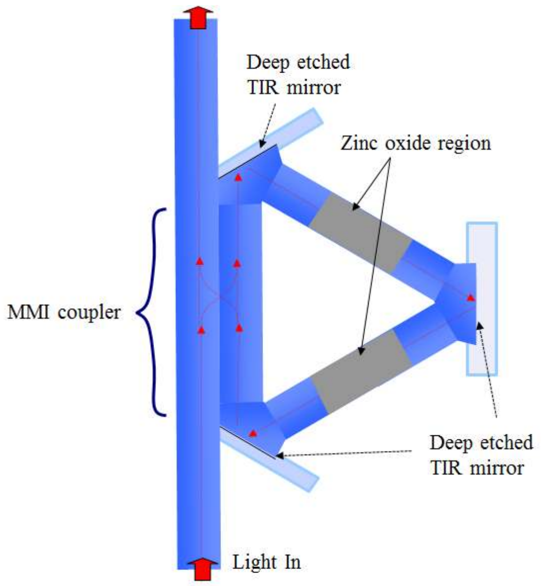

Fig 1. Schematic view of the triangular resonator with ZnO thin film.

III. RESULTS AND DISCUSSION

Beam propagation of the triangular resonator structures with different refractive indices of ZnO thin films was analyzed using the 2-D FDTD method. Here, propagation intensity profiles and resonance characteristics have been obtained.

When the refractive index of ZnO thin film is 2.0, the propagation intensity profile and resonance characteristics are shown in Fig. 2 and 3, respectively. The propagation mode shifts in the region of ZnO thin film because propagation mode is affected by refractive index of ZnO thin film.

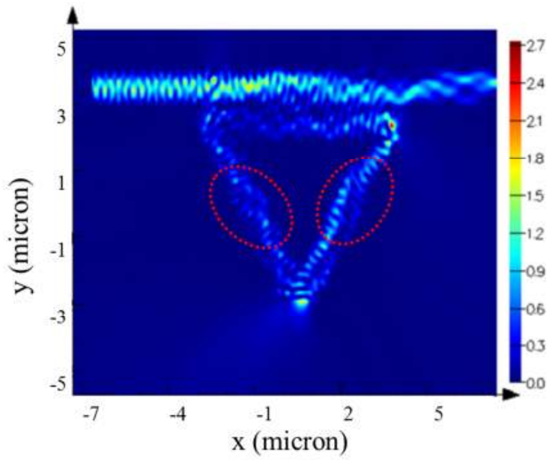

Fig 2. The propagation field intensity profiles in the triangular resonator.

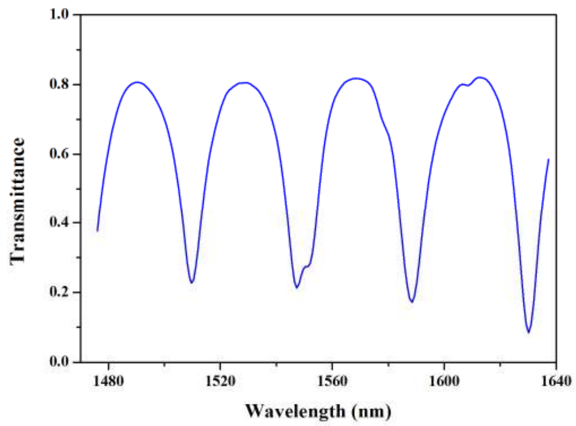

Fig 3. The resonance characteristics of the triangular resonator.

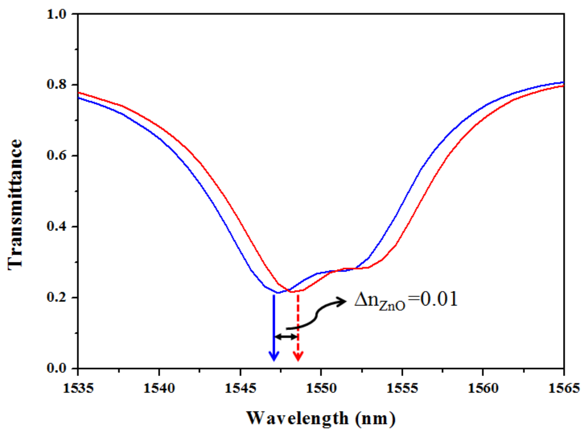

Fig 4. The shift of resonance wavelength in triangular resonators as a function of refractive indices of ZnO thin films.

Figure 4 shows the shift of resonance wavelength in the triangular resonators as a function of refractive indices of ZnO thin films. As the refractive index of ZnO thin film increase, the resonance wavelength shifts to right. The change of the resonance wavelength is 0.002 nm when the refractive index change of ZnO thin film is 0.01.

IV. CONCLUSION

A triangular resonator integrated with ZnO thin film has been designed. Then, the analysis of beam propagation in the triangular resonator structure was conducted as a function of refractive indices of ZnO thin films. The resonance shift of 0.002 nm was observed when the refractive index variation of ZnO thin film is 0.01. In conclusion, such triangular resonator can be integrated with ZnO materials and show the potential as optical sensors.

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