Polarization-Dependent Optical Responses of Injection-Molded Guided-Mode-Resonance Biosensors

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1. Introduction

There is a strong need for low-cost, disposable, label-free biosensors to enable fast, on-site biomedical and chemical detection [1]. Among the various biosensors, guided-mode-resonance (GMR) biosensors have attracted increasing attention for practical biomedical and chemical applications because of the advantages of their simple structure, simple fabrication, and high sensitivity [2]. However, there exist challenges to fabricate sub-wavelength periodic patterns for successful GMR biosensors in a cost-efficient way. In our previous works, we have employed injection-molded technique to fabricate GMR biosensors, and demonstrated sensitivity of up to 181.9 nm/RIU [3, 4]. In this paper, we report on a study of polarization-dependent optical responses for the injection-molded GMR (IM-GMR) biosensors.

2. Experiment details of IM-GMR Biosensors

The IM-GMR biosensors used in this study were fabricated using a combination of injection-molded and sputtering technologies [3, 4]. Cyclic olefin copolymer (COC) chips with one-dimensional grating structures having a period of $\Lambda = 416$ nm and a depth of $d = 100$ nm were prepared using injection molded techniques, providing capacities of high-through and reduced production time. Subsequently, a 90-nm-thick TiO_2 layer was deposited by using a direct current magnetron. The IM-GMR biosensors were finalized by bonding the TiO_2-colated COC chips with injection-molded micro-fluidic modules with two flexible tubes acting as sample inlet and outlet. A schematic plot of the IM-GMR biosensors is shown in Fig. 1.

To evaluate the sensitivity of the IM-GMR biosensors, label-free transmission experiments were performed with analyte solutions having different refractive indices from $n = 1.333$ to $n = 1.373$. Figure 2 shows the TM- and TE-polarized transmittance spectra for the fabricated

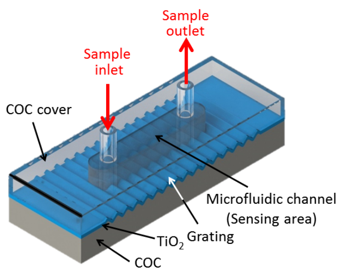

Figure 1. Schematic plot of the fabricated IM-GMR biosensors.

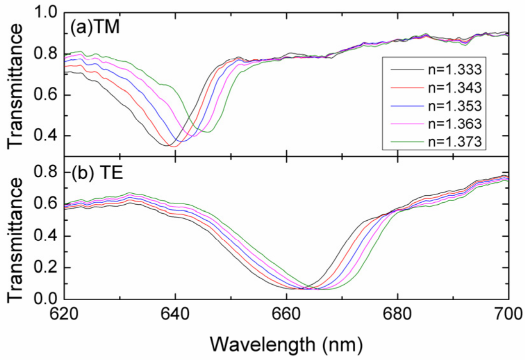

Figure 2. Measured (a) TM and (b) TE transmittance spectra.

IM-GMR biosensors under normal incident conditions. For TM-transmittance spectra, a dip was observed at 638 nm for $n = 1.333$, corresponds to the GMR wavelength (λ_R). As n is increased, the GMR wavelength continuously redshifts. The sensitivity of the IM-GMR biosensors was then determined to be $S = \Delta\lambda_R / \Delta n = 179.4$ nm / RIU. For TE modes, the GMR wavelength occurs at longer wavelengths of ~660 nm, and exhibit smaller shifts with increasing n, giving a sensitivity of $S = 147.1$ nm / RIU. The observed polarization-dependent sensitives of the IM-GMR biosensors may be useful for the simultaneous detection of multiple analytes.

3. Conclusions

We have presented a polarization-dependent study of optical response of IM-GMR biosensors. The biosensors exhibit polarization-dependent responses and a sensitivity of 147.1 (179.4) nm/RIU for TE (TM) modes is obtained.

Acknowledgements

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