Coupling between Guided-Mode-Resonance and Particle Plasmon Resonance in Optical Biosensors with Gold Nanoparticles

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Guided-mode-resonance (GMR) optical biosensors are promising for rapid and sensitive chemical analysis and biomedical detection [1, 2]. Enhancing the sensitivity of GMR biosensors is crucial to lower the limit-of-detection to enable sensitive detection for practical applications. In this paper, we present the use of gold nanoparticles (AuNPs) to enhance the sensitivity of GMR biosensors, and experimentally and numerically study the coupling between GMR effect and particle plasmon resonance (PPR) effect.

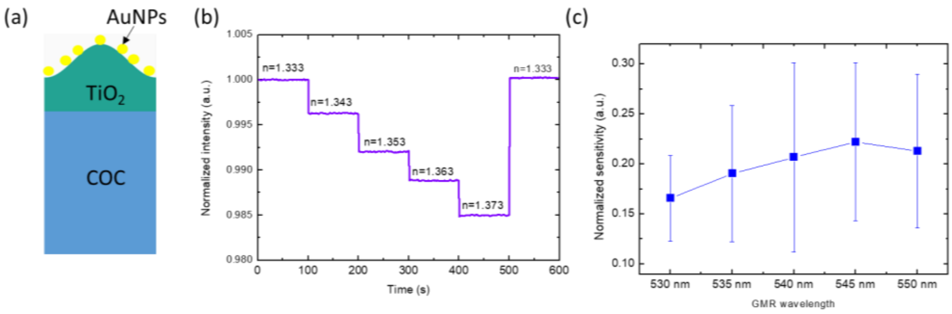

Fig. 1. (a) Schematic diagram of GMR biosensors with AuNPs. (b)Real-time response of the GMR biosensors with different RIs of the solution. (c) Normalized sensitivity at different GMR wavelengths.

The inset of Fig. 1(a) shows a schematic diagram of the GMR biosensors with AuNPs, consisting of (1) injection-molded Cyclic olefin copolymer (COC) subtract with a 1D grating structure, (2) a 100-nm thick TiO_2 waveguide layer, and (3) randomly distributed 13-nm AuNPs with a coverage of ~20%. The height and period of the grating structure are 100 nm and 417 nm, respectively. Transmission experiments are carried out using a 532 nm green LED and photodetectors to characterize the sensitivity [3]. The resonant wavelength of AuNPs is ~530 nm. To utilizing the plasmon effect to enhance the sensitivity of GMR biosensors, the biosensors are operated under oblique incident condition to couple the GMR effect and PPR effect. Real-time refractive index experiments were performed (Fig. 1(b)) tp extract the normalized sensitivity (S_n) of the GMR biosensors at different GMR wavelengths (λ_R), as shown in Fig. 1(c). S_n first increases with increasing λ_R, and then decreases when λ_R>545 nm. These results show the evidences of coupling between GMR and PPR effects for enhancing the sensitivity of GMR biosensors.

References

1. Y. F. Ku *et al.*, Optics Express 23(11), 14850 (2015).
2. H.Y. Li, *et al.* Sens. Actuators B: Chem. 206 (2015) 371–380.
3. Y. C. Lin *et al.*, Sensors and Actuators B 250 (2017) 659–666