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Highly sensitive multi-coating photonic crystal fiber biosensor at near-infrared waveband

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***Abstract*—A multi-coating photonic crystal fiber with a trapezoid-shaped slot (TS-PCF) for highly refractive index (RI) sensing is proposed. TiO_2 and Indium tin oxide (ITO) are coated on the bottom of the polished-area, ITO is used as the plasmonic material. Through the full-vector finite element method (FV-FEM), the wavelength sensitivity of 5000~17000 nm/RIU in the analyte RI range of 1.31 to 1.36 is obtained. Moreover, the maximum amplitude sensitivity of 358.94 RIU^{-1} is also achieved with the relevant resolution of 2.79E-5 RIU. The proposed fiber sensor can be the suitable candidate for real time detecting in medical diagnostics and biomolecules applications.**

Keywords- Photonic crystal fiber, surface plasmon resonance (SPR), optical fiber sensors

1. Introduction

Surface plasmon resonance (SPR) fiber sensor for analyte detectin becomes a commonly and effectively method in recent years comparing with the traditional prism ones.Considering the real tim detecting applications, the outer cladding coated sensors can offer more effective solution with its larger reaction area and the mor convenient coating fabrication.

2. Structural design and numerical modeling

The proposed fiber sensor is as shown in Figure 1, the TS reaction area can efficiently provide a higher flow rate detection project. Meanwhile, the cladding structure has less confinement at the vertical axis, enhancing the surface plasmon resonance between the fiber core-guided mode and the SPPs mode.

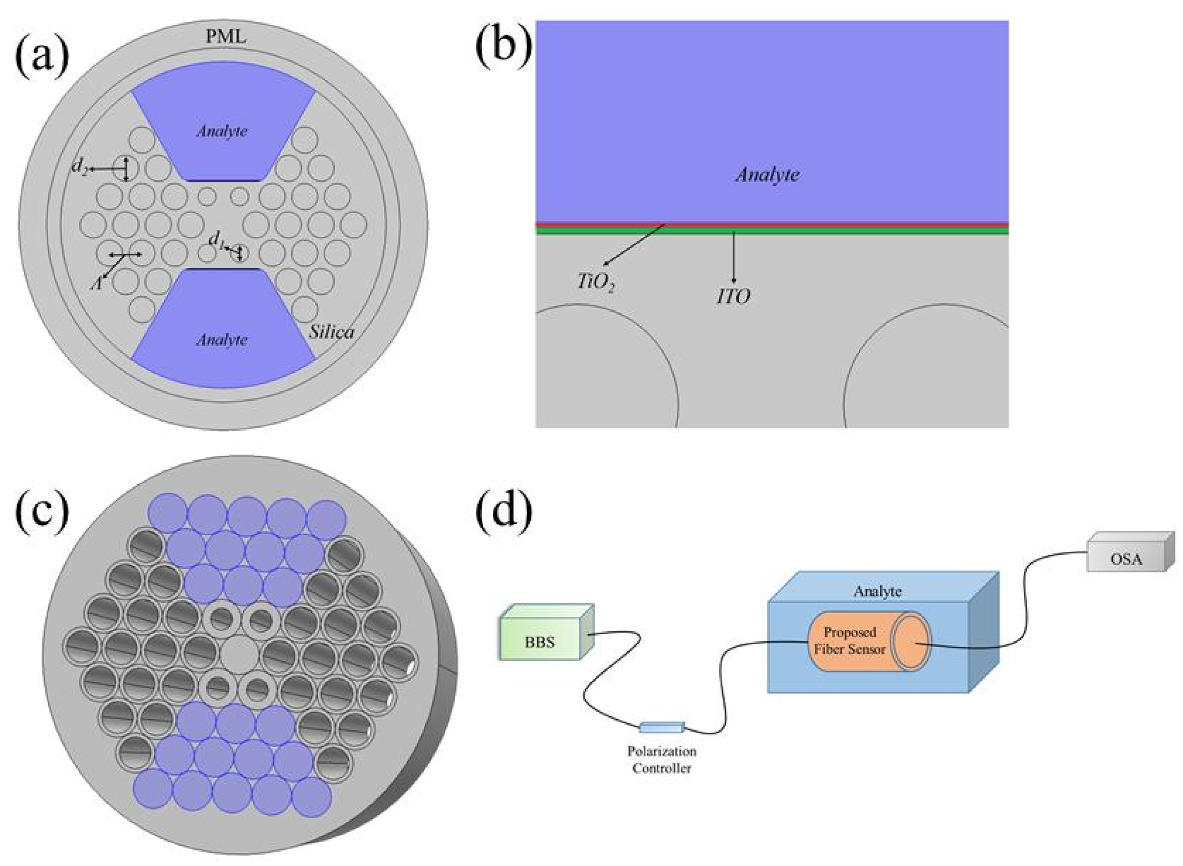


Figure 1 (a)-(c) Cross-section of the proposed fiber. (d) Schematic of the experimental set-up.

3. Results and discussion

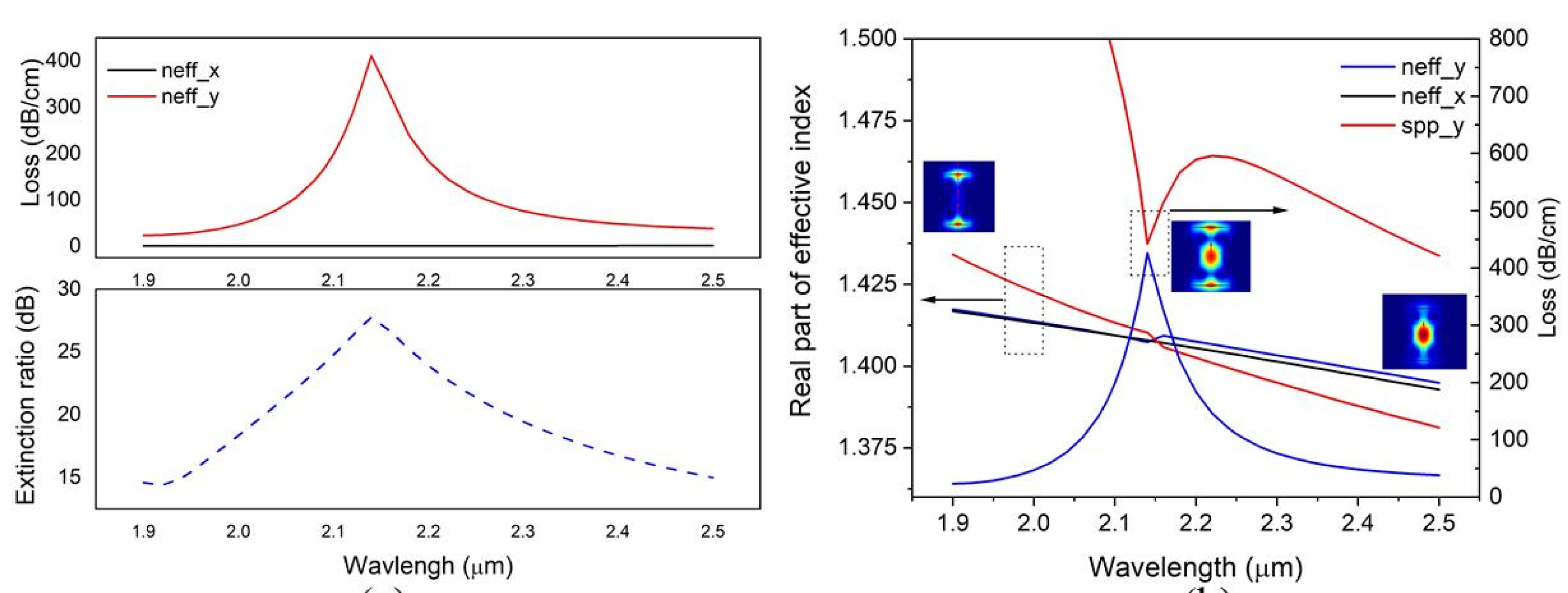
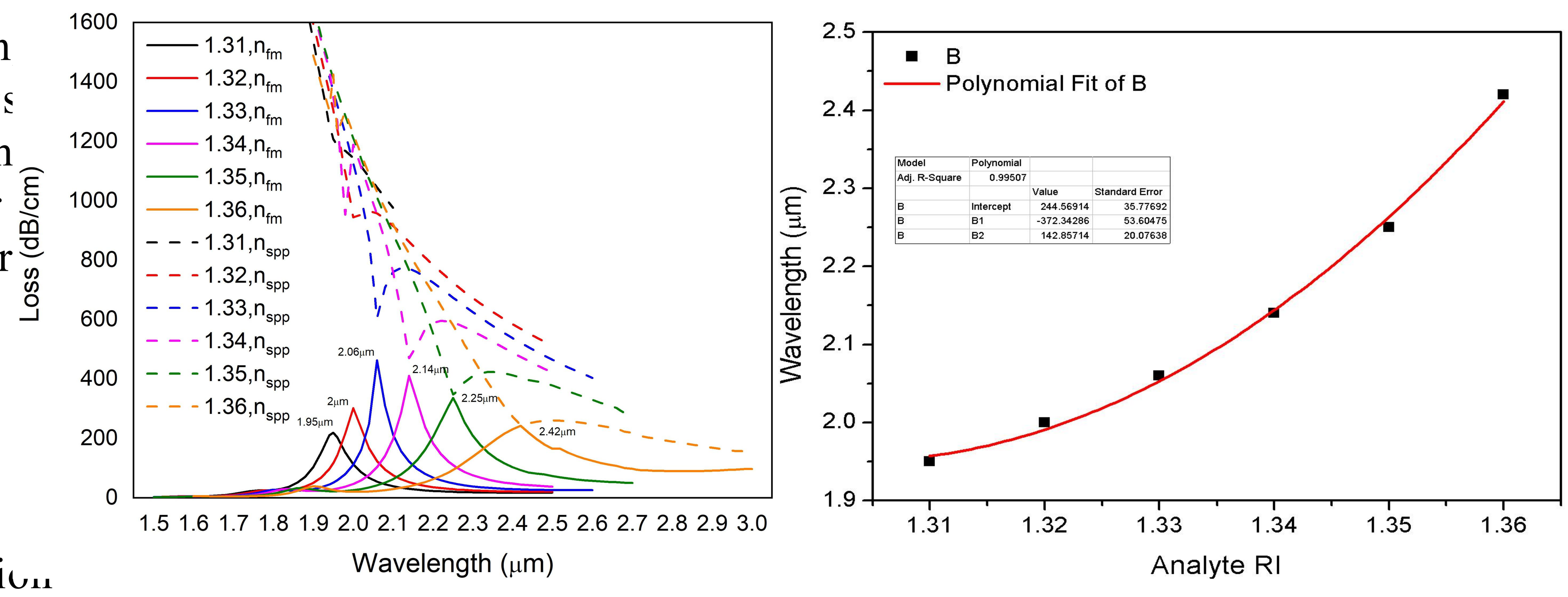
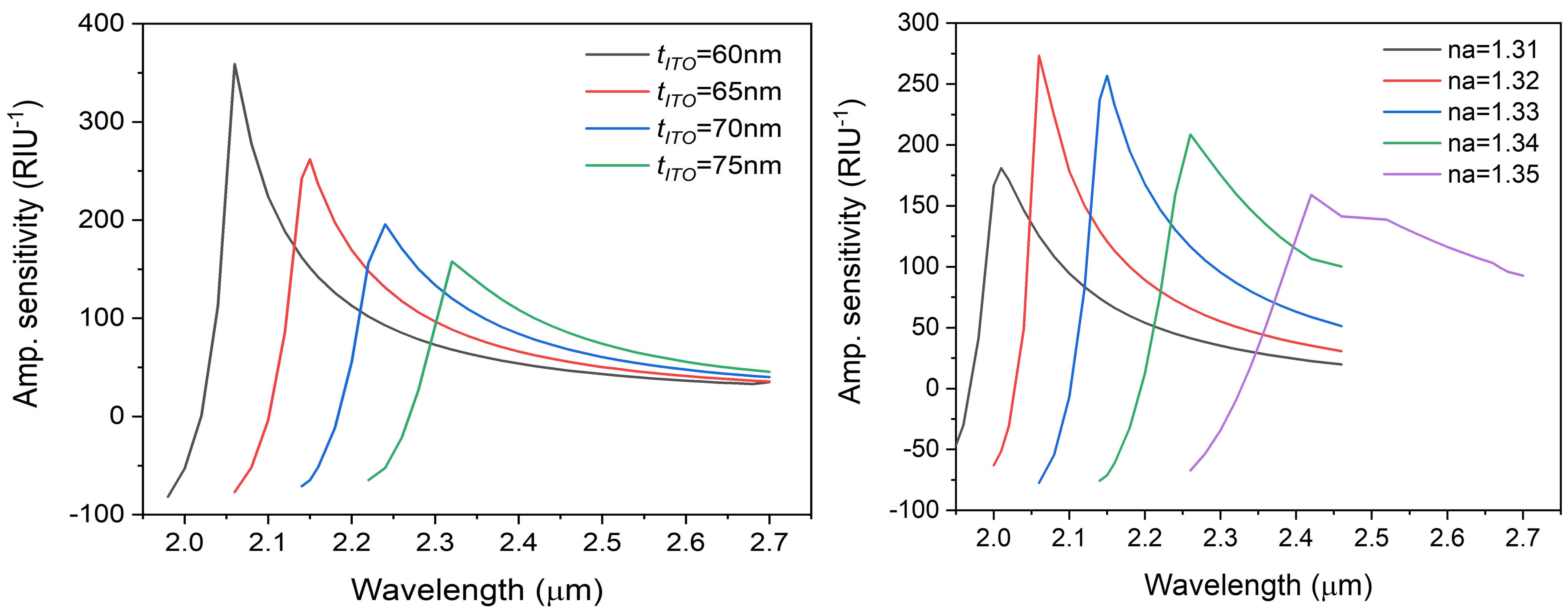


Figure 2 (a) Confinement loss at two directions and the restrain ratio. (b) Dispersion relations of the fundamental mode and SPP mode with the relevant confinement loss of the fundamental mode.



(a) (b)

Figure 3 Fundamental and SPP loss spectrums with the variation of analyte RI from 1.31 to 1.36. (b) Polynomial Fit of the SPR wavelength on the analyte of RI variation.



(a) (b)

Figure 4 Variations of analyte RI (a) and ITO thickness (b) on the sensor sensitivity.

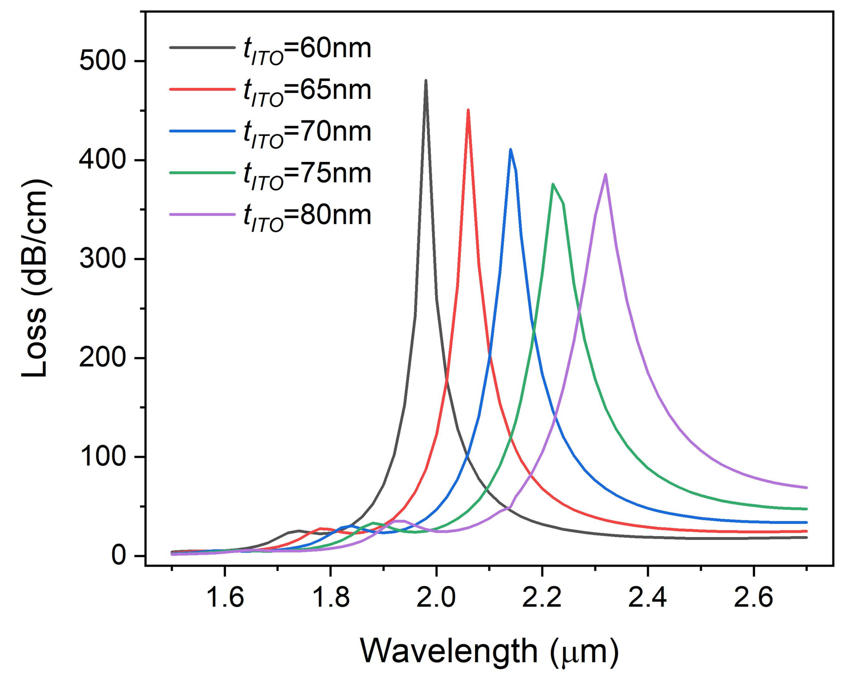


Figure 5 Variations of ITO thickness on the fundamental mode confinement loss.

4. Conclusions

Based on the trapezoid-shaped slot and dual-coating layers, the TS-PCF sensor can be utilized for theconvenient real-time detecting application at the near-infrared band.