Liquid filled hollow core photonic bandgap fiber sensor

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Abstract: we propose a low-refractive-index-contrast hollow-core Bragg fiber sensor operating with a resonant sensing principle. Clear transmission spectrum shifts are obtained when filling the fiber with liquid analytes of different refractive indices.

OCIS codes: (060. 2370) Fiber optics sensors; (060.5295) Photonic crystal fibers

1. Introduction

We report a liquid filled fiber sensor based on our low-refractive-index-contrast hollow-core Bragg fiber [1]. This Bragg fiber features a large air core surrounded by an alternating polymethyl-methacrylate / polystyrene multilayer with refractive indices of 1.49/1.59 (see fig. 1 (a)). The large core facilitate the sample filling by significantly reducing the sample filling time, and the low index contrast of Bragg reflector is responsible for the appearance of narrow fiber transmission band which is favourable for observing spectrum shift in resonant sensing.

2. Sensing mechanism and experimental results

Filling the liquid analyte with a particular refractive index into the Bragg fiber sensor, the geometry of such a Bragg fiber provides a strong optical confinement of a guided mode in the analyte-filled core. If the real part of the analyte refractive index changes, the resonant condition for mode confinement will also change, usually leading to a strong spectral shift in fiber transmission spectrum. Therefore, the changes in the refractive index of the core material can be inferred from the variations of the fiber transmission spectra [2].

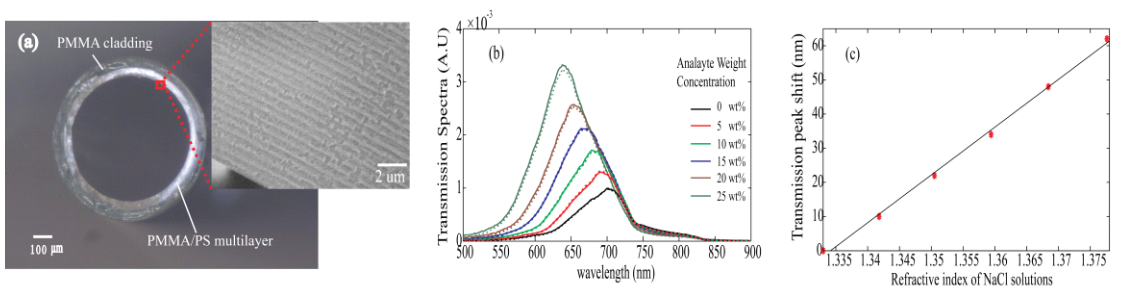

Figure 1. (a). Cross section of a Bragg fiber; the inset is the SEM graph of the PMMA/PS multilayer (b). Transmission spectra of the Bragg fiber filled with NaCl solutions. Two rounds of transmission measurements (solid and dot lines) are performed to verify the sensor repeatability. (c). spectral shifts versus refractive indices of liquid analytes filled in the fiber; the black line is the linear fitting of the spectral shifts.

We have experimentally characterized this sensor by measuring a set of NaCl solutions of the weight concentration from 0% – 25% with a 5% increment interval. From the results shown in figure 1 (b) and (c), we note that the transmission spectrum peak of liquid Bragg fiber features a linear blue-shift with an increasing concentration of NaCl solutions. Assuming 1nm spectral shift can be reliable detected, the sensitivity of this sensor is ~1400nm/RIU (refractive index unit), comparable to the highest sensitivities of previous fiber-optic sensors

3. References

[1] E. Pone, *et al*, "Drawing of the hollow all-polymer Bragg fibers," Optics Express, Vol. 14, No. 13, 5838, (2006)

[2] M. Skorobogatiy, "Microstructured and photonic bandgap fibers for applications in the resonant bio- and chemical sensors," Journal of Sensors, Vol. 2009, 524247, (2009)