

Commercial Solid Core Photonic Crystal Fibers for Sensing Applications

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Introduction: The dispersion coefficient and sensitivity of some commercial solid core photonic crystal fibers is estimated using COMSOL, and compared with the theoretical values wherever available. Based on this study the best solid core PCF is identified for application as a fluid sensor.

Computational Methods: RF module of COMSOL is used to perform 2D mode analysis of the test fibers to determine the effective index of the guided modes at wavelengths of interest. From the variation of effective index with wavelength dispersion characteristics of the PCF is calculated. Sensitivity of the fibers is evaluated from fraction of evanescent power calculated using line integration of the electric fields. The numerical calculation for sensitivity is given by

$$r_f = f\left(\frac{n_r}{n_c}\right) \quad \text{where}$$

$$f = \frac{\int_{holes} (E_x H_y - H_x E_y)}{\int_{Total} (E_x H_y - H_x E_y)}$$

n_r is refractive index of the fluid, n_c is core refractive index.

Results: ESM-Blaze, SCPCF, 7-Ring fiber and PCFTI fibers are analyzed. As a sample, the measured chromatic dispersion in tip interferometry method [1] for PCFTI is compared with that calculated using Comsol Multiphysics in table(1).

Conclusions: Chromatic dispersion for commercial fibers is calculated using finite element analysis and verified against manufacturer's data.

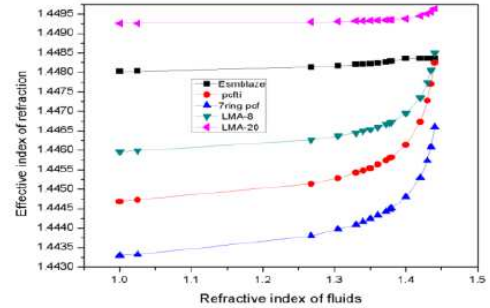


Figure 1. Effective refractive index versus refractive index of liquids

CD Coefficient from literature ps/nm-km	CD Coefficient from simulation ps/nm-km	Wavelength in nm
49.927	40.2	1525
52.169	51.5	1545
53.954	42.9	1565

Table 1. Variation in dispersion coefficient for PCFTI fiber

The sensitivity variation with infiltrated fluids with RI ranging from 1.0 to 1.44 is highest for PCFTI fiber. These fibers can be used as fluid sensors and also used in interferometers for dispersion measurements.

References:

- Ran Gao, et. al "Novel Method for the Measurement of Chromatic Dispersion of Photonic Crystal Fibers" IEEE Photonics Technology Letters, Vol. 25, NO. 2, January 15, 2013
- E.K.Akawah, et. al "Design and analysis of photonic crystal fibers for broad band applications" 978-1-4673-4789-1/12/\$31.00 c 2012 IEEE.