Commercial Special Fibers for Sensing Applications

G. Latha[1], P. Nair[1]

[1]SSN College of Engineering, OMR Road, Tamil Nadu, India

Abstract

In a solid core PCF, structural parameters and the number of rings in the cladding region decide confinement losses, dispersion coefficients as well as bending losses. This paper evaluates some of commercially available solid core photonic crystal fibers. The dispersion coefficients and sensitivity of these fibers are estimated using COMSOL Multiphysics®, and compared with the theoretical values wherever available. Based on this study the best commercial solid core PCF is identified for application as a fluid sensor.

PCFs designed appropriately possess the amazing property of being endlessly single mode i.e. they act as a single mode waveguide for all wavelengths. These unusual properties of PCFs have led to an increasing interest in their applications in areas such as sensing, signal processing and optical communication systems. SCPCFs cross-section presents a periodic array of air holes surrounding a solid core, which extends invariably along the fiber length. When using a single material in the fiber manufacturing, this cross-sectional configuration leads to a lowering of the cladding's effective refractive index given that the solid core is made of the same material. The air holes close to the core boundaries act as sensing cavities when filled with the fluid under test as they effect the guidance of the optical power through the solid core. This paper evaluates seven ring PCF to identify one which gives superior performance in terms of sensitivity.

The RF module of COMSOL Multiphysics® is used to perform 2D mode analysis of all the test fibers to determine the effective index of the guided modes at wavelengths of interest. Sensitivity of the fibers is evaluated from fraction of evanescent power calculated using line integration of the electric fields. A parametric sweep over wavelengths and temperature is carried out to estimate variation in effective index and mode field diameter and the results are used to estimate temperature sensitivity of the sensor and also dispersion of these fibers.

To investigate the sensitivity of the fully infiltrated SCPCF, fluids with refractive indices between 1 to 1.43 have been chosen and calculations done using COMSOL Multiphysics®. The plot of refractive index of fluids versus sensitivity is shown in Fig (3).

Comparative study of different commercial fibers has been carried out. Sensitivity when used as a fluid sensor estimated from simulation is approximately 9.6%/K for BLAZE PCF. Chromatic dispersion for these commercial fibers is calculated using finite element analysis and verified by comparing with the values mentioned by manufacturer for the proposed fibers. The experimentally measured chromatic dispersion results using tip interferometry method are also

compared with that of the simulation results obtained using COMSOL Multiphysics®. The measured CD coefficients of fiber with seven rings were 49.9, 52.1, and 53.9 ps/nm-km at wavelengths of 1525.0, 1545.65 and 1565.0 nm, respectively. Both measured and calculated results are in good agreement within the measurement error range. Among the commercial fibers seven ring PCF is found to be superior in terms of sensitivity.

Figures used in the abstract

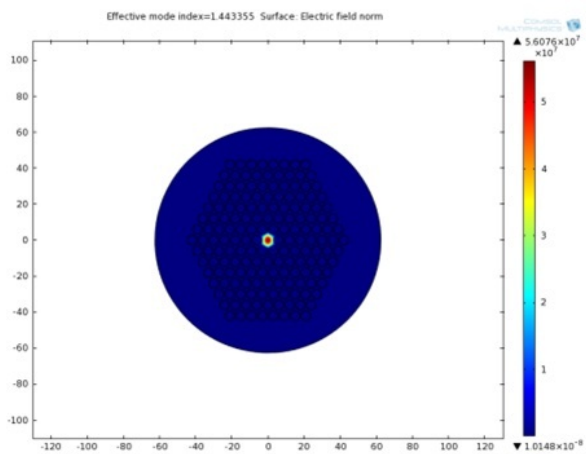

FIG (1): CONFINEMENT @1550nm FOR
7-RING WITH VARIOUS FLUIDS

Figure 1

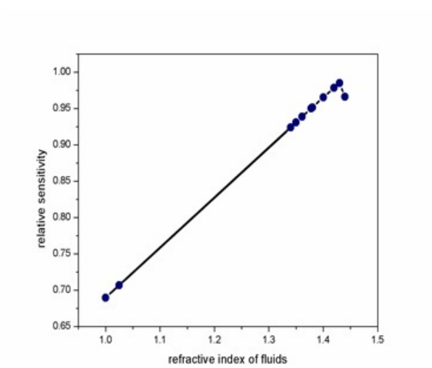

FIG (2): VARIATION OF RELATIVESENSITIVITY

Figure 2

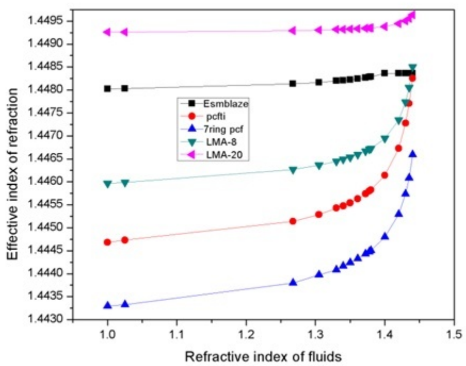

FIG (3): EFFECTIVE REFRACTIVE INDEX OF PCF FOR DIFFERENT INFILTRATED FLUIDS

Figure 3