Comparative Study of Dispersion between Conventional PCF and Honeycomb PCF

Sunil Sharma, Ravindra Kumar Sharma, Suman Sankhla

Abstract— **Photonic Crystal Fibers is a periodic microstructure running along the length. PCFs core and cladding might be based on different materials and various geometries. This article aims to comparative study of dispersion between two different types of Photonic crystal fibers. In the first step we compare material dispersion of both PCFs. And finally the total dispersion generated by both PCFs is compared. For this purpose we have used scalar effective index method (SEIM) and transparent boundary condition (TBC).**

Index Terms—. **Photonic crystal fiber (PCF), Scalar effective index method (SEIM), transparent boundary condition (TBC).**

I. Introduction

Photonic crystal fibers are using for various new designing application. PCFs are designed and fabricated for special-purpose applications that do not require large volume of fibers. Therefore, these special fibers are currently produced in smaller quantities compared with traditional optical fiber, which is mass produced of signal transmission. Most photonic crystal fibers have been fabricated in silica glass, but other glasses have also used to obtain particular optical properties[1]. PCF can be fabricated by the use of Photonic crystals. Photonic crystals are composed of periodic dielectric or metal-dielectric nanostructures that affect the propagation of electromagnetic waves (EM). PCF is now finding applications in fiber-optic communications, nonlinear devices, high-power transmission, fiber lasers, highly sensitive gas sensors, and other areas. PCFs generally guide light by two different guiding mechanisms, which includes index guiding (IG) or band gap guiding (BG) [2-5].

Recently, PCFs confining light by both mechanisms which is known as hybrid PCFs. In IG-PCFs, light is guided in a higher index core by modified total internal reflection from a photonic crystal cladding with low effective index while in BG-PCFs; light is confined in a low index core by trapping the light having the wavelength falling in the band gap of the photonic crystal structure[6,7]. Because of their novel guiding mechanism and diversity in design, PCFs have a number of novel properties and significant applications. For IG-PCFs, the properties include endlessly sing-mode, large-mode-area, high numerical aperture, high birefringence, high nonlinear coefficient and dispersion management [8,9].

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II. Design Principle

In this method consider the refractive index of silica is 1.458.

For hexagonal seven ring silica glass PCF

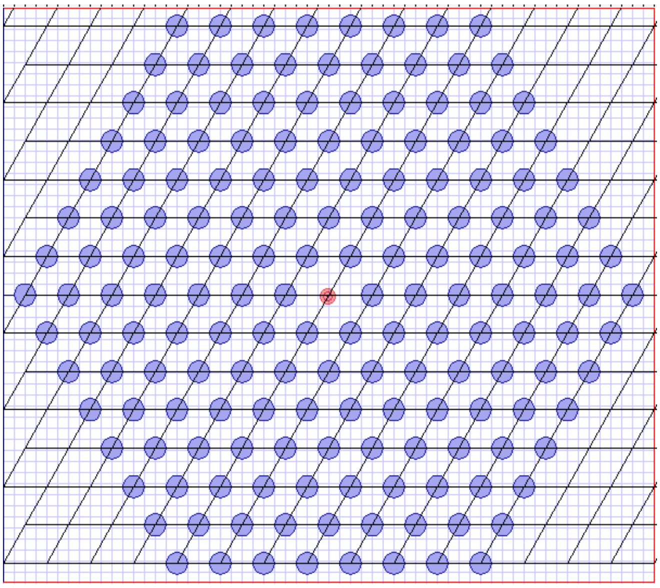

Figure 1. Seven ring Conventional PCF.

Parameter (Unit)	Value
Pitch	2.0
Holes diameter (d) (μm)	0.6
d/ Λ	0.3
Air fraction refractive index	1.0
Silica glass refractive index	1.458
Propagating wavelength (μm)	1.55
Number of rings in the cladding	3 to 7

Table 1. structure parameter of PCF for achieving flattened dispersion.

For Honeycomb silica glass PCF

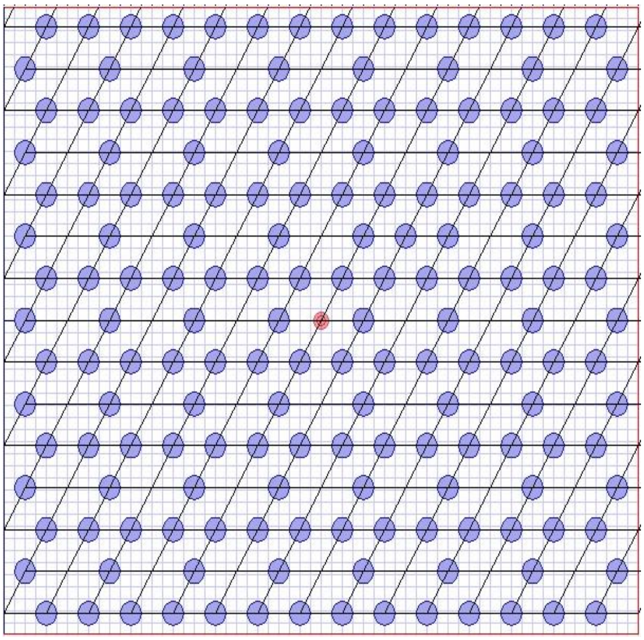

Figure 2. Structure of Honeycomb PCF

Parameter (Unit)	Value
Pitch	2.0
Holes diameter (d) (μm)	1.0
Air fraction refractive index	1
Silica glass refractive index	1.458
Propagating wavelength (μm)	1.55
Number of rings in the cladding	5 to 11

Table 2. Structure parameter of Honeycomb PCF for achieving flattened dispersion.

III. Results

The value of refractive index of silica glass can be calculated by sellemier formula[10,11].

$$n^2 - 1 = \sum_i \left(\frac{A_i \lambda^2}{\lambda^2 - \lambda_1^2} \right) \quad (1)$$

And the total dispersion, $D = D_M + D_W$. and the waveguide dispersion is defined as

$$D_W = -\left(\frac{\lambda}{c}\right) \frac{d^2}{d\lambda^2} n_{eff} \quad (2)$$

Where λ is the operating wavelength and c is the velocity of light [12-13]

For Conventional glass Hexagonal PCF

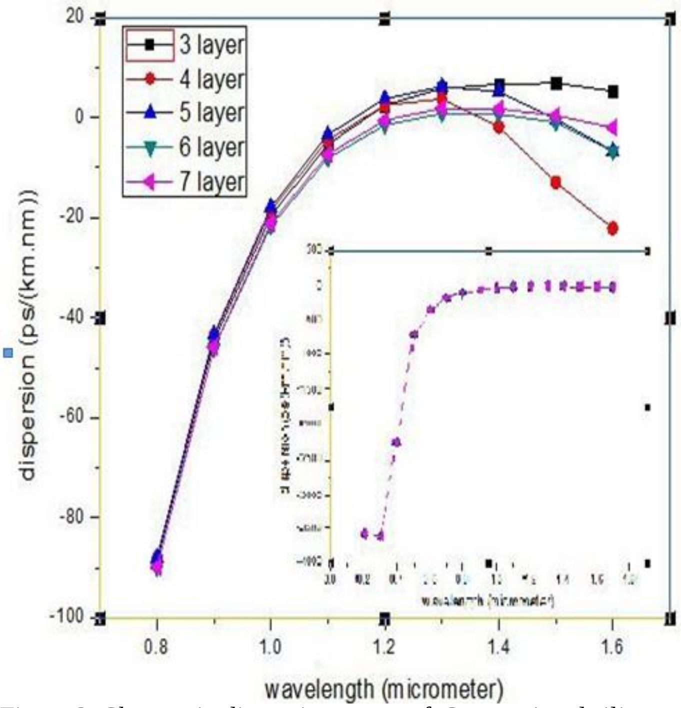

Figure 3. Chromatic dispersion curve of Conventional silica glass PCF.

We have achieved Best Result for conventional glass PCF is when pitch is 2.0 micrometer and ring is 7 of PCF

For Honeycomb Silica glass PCF

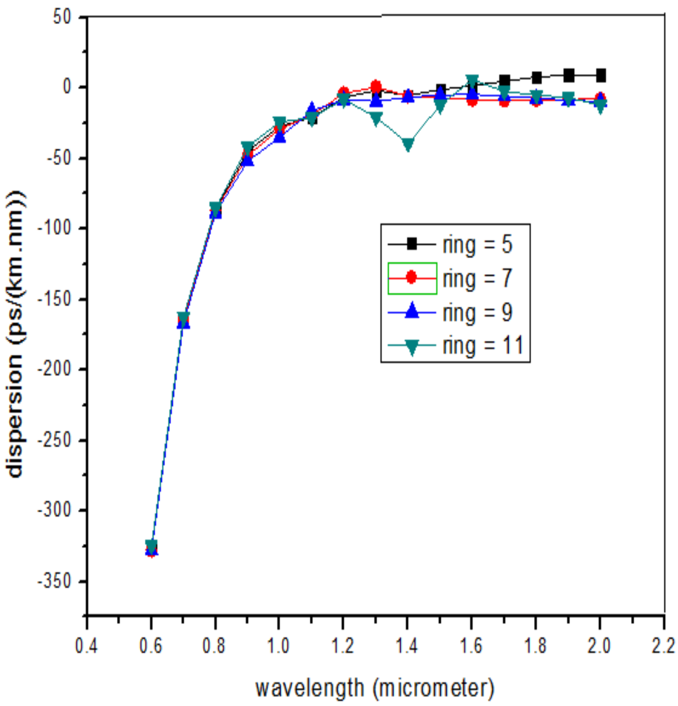

Figure 4. Shows the comparison of chromatic dispersion of Honeycomb PCF when pitch is 2.0 μm and air hole diameter (d) is 1.0μm.

We have achieved Best Result for Hexagonal silica glass PCF is when pitch is 2.0 micrometer and ring is 7 of PCF.

Comparison between conventional and honeycomb PCF

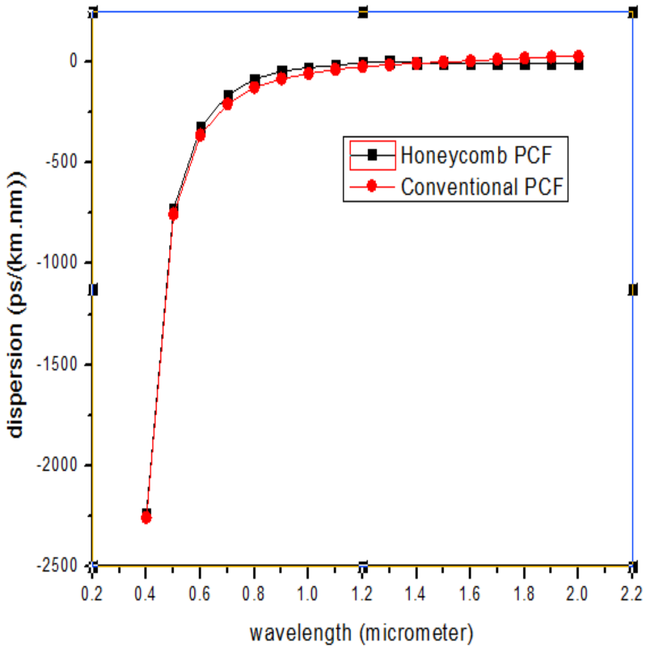

Figure 5. Comparison of dispersion between both PCFs.

IV. Conclusion

The result, so obtained, gives that the dispersion calculated for Honeycomb photonic crystal fiber using the Scalar index method gives best result in comparison of Conventional PCF structure. Here we have calculated the chromatic dispersion for various data but we find out that when we consider Pitch 2.0 µm and air hole diameter (d) 1.0 µm and select the 7 layers then it gives best result.

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