Suresh Gyan Vihar University Journal of Engineering & Technology
(An International Bi-Annual Journal)
Vol . 3, Issue 2, 2017, pp 45-47
ISSN: 2395-0196

Design of A Photonic Crystal Fiber With Low Confinement Loss and Flattened Dispersion

Sandhya Sharma
Research Scholar, Dept of Electronics & Communication, Suresh Gyan Vihar University Jaipur, Rajasthan
sandhyasharma.mbm@gmail.com

Dr. O.S. Lamba
Professor, Dept of Electronics & Communication, Suresh Gyan Vihar University Jaipur, Rajasthan
onkar.lamba@mygyanvihar.com

Abstract: **In this paper a PCF is analysed by varying the air holes sizes. By controlling the diameter and pitch of air holes in 9 layers, we can achieve a low confinement loss of 0.00034 db/km and high birefringence of 0.0049 with approximately flat dispersion in single mode operation.**
Keywords: Photonic Crystal Fiber (PCF), Finite Difference Time Domain (FDTD), Confinement loss, Birefringence.

I. INTRODUCTION

Photonic crystal fiber have diverse applications in sensors, polarization sensitive devices, telecommunication, laser, medical instruments etc. Photonic crystal fiber is made of silica with hexagonal air holes which running along its length. Due to its unique structure, it generate very attractive optical properties. It is possible to design a high birefringence, flattened dispersion PCF with low confinement loss in single mode operation.[2]

Dispersion is strongly dependent on glass and air refractive index difference. By using different air filling fraction, dispersion can be controlled.PCF also have properties of low leakage loss. Light is confined in core through air holes in solid core PCF. If adequate confinement is not provided by air holes, light will move away from core. This means that it is important to design a such type of PCF by controlling air hole diameter and pitch, to obtain low confinement loss.[1]

Shishram, Ritu Sharma, Vijay Janyanietc [1]In this paper dispersion properties is analysed for hexagonal and rectangular lattice using FDTD method. **Shi Mohammad Nejad, M. Aliramejani, M. Pourmahyabadi etc[2]** In this paper a PCF with ultra flattened dispersion and low confinement loss is proposed for telecommunication band. **H.Ademgil, S. Haxha etc** [3]In this paper a PCF with zero dispersion at telecommunication bands is proposed by using Full Vector Finite Element method. **S.S.Mishra and Vinod Kumar Singh[4].** In this paper highly polarisation maintaining birefringence PCF at telecommunication band is proposed by using Full Vector Finite Element method.

II. OPTICAL PROPERTIES

Optical properties can be calculated by following formulas

Confinement loss:

$$L = 8.686 * Im\left[k_o n_{eff}\right] * 10^3$$

Birefringence:

$$B = \left| n_{eff}^{y} - n_{eff}^{x} \right|$$

The n_x and n_y are effective refractive indices of fundamental mode in x and y polarization mode.

Dispersion:

$$D = -\frac{\lambda}{C}\frac{\partial^2 n_{eff}}{\partial \lambda^2}$$

III. DESIGN & SIMULATION RESULTS

The structure of proposed PCF is shown in fig. 1. The designed PCF is solid core region with circular air holes along the length of fiber acting as cladding. The refractive index of core material and air hole is 1.45 and 1 respectively.

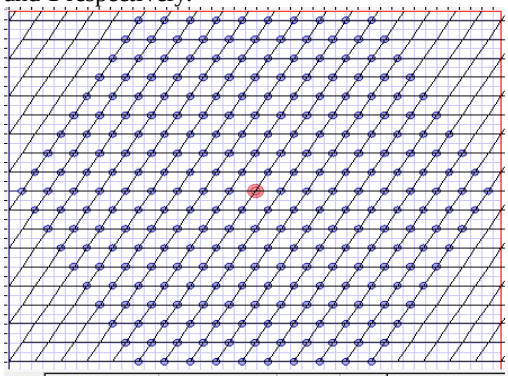

Fig 1: Layout design 1 of PCF structure with 9 rings.

It is analyzed by Full Vector Finite Element Method (FV-FEM).We designed four types of PCF by varying the diameter and pitch.

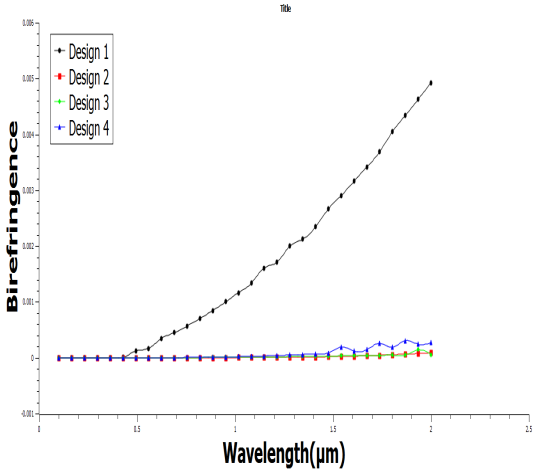

Fig. 2: Birefringence Vs wavelength for PCFs of different d/ʌ.

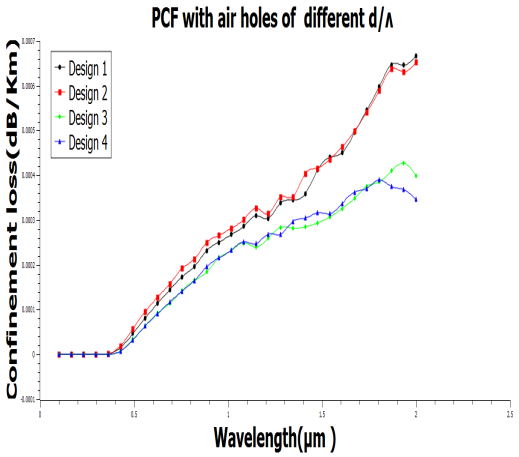

Fig.3 : Confinement loss Vs wavelength for PCFs of different d/ʌ.

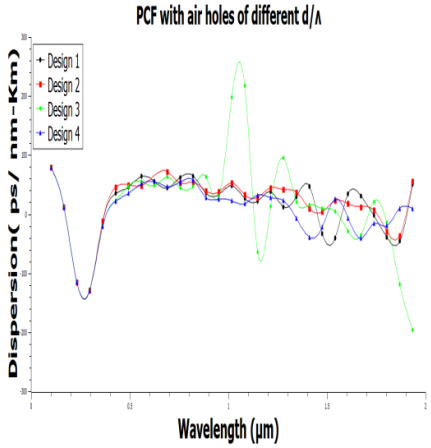

Fig.4:Dispersion Vs Wavelength for PCFs of different d/ʌ.

Table 1: Design Parameters ofsimulation

Parameter	Design 1	Design 2	Design 3	Design 4
Diameter of air holesµm	0.70	0.76	0.75	0.6
Pitch µm	2.3	2.3	2.4	2.4
d/ʌ	0.30	0.33	0.31	0.25
No. Of Rings	9	9	9	9

It is shown in fig 2 that we can achieve high birefringence of 0.0049 in design 1 but as we reduces the value of d/ʌ, birefringence can not be increased.It is shown in fig 3 that by reducing the value of d/ʌ, confinement loss can be reduced at 0.00034 dB/Km at operating frequency of 1.55 µm.It is also shown in fig. 4 that we can obtained the approximately flattened dispersion for all value ofd/ʌ of PCF.

IV CONCLUSION

In this paper PCFs of varying d/ʌ is proposed. By reducing the value of d/ʌ, high birefringence of 0.0049, low confinement of 0.00034 dB/ Km and approximately flattened dispersion can be achieved. This types of fiber can be used for telecommunication band and lasers.

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