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HEXAGONL PHOTONIC CRYSTAL FIBER (PCF) DESIGNING AND SIMULATION USING CHALCOGENIDE GLASS (As_2Se_3) TO MINIMIZE DISPERSION

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***ABSTRACT*-- A highly nonlinear Hexagonal photonic crystal fiber with alternate ring diameter is proposed. Chalcogenide glass of As_2Se_3 is used as the material for this photonic crystal fiber structure. Fully Vectorial Effective Index Method (FVEIM) for comparing the dispersion properties (negative and zero dispersion) and effective area in hexagonal lattice of As_2Se_3 glass PCF using different wavelength windows. It has been demonstrated that due to their negative dispersion parameter and negative dispersion slope in wavelength range 0.6 µm to 1.5 µm, lattice structures (hexagonal) of As_2Se_3 glass PCFs, with pitch (Λ=1.5 µm), can be used as dispersion compensating fibers. This Photonic Crystal Fiber structure can also be used for nonlinear applications like ultra short soliton pulse transmission, optical parametric amplification, supercontinuum generation.**

Keyword- Chalcogenide glass, Chromatic dispersion, Fully Vectorial Effective Index Method (FVEIM), Large negative dispersion, Photonic crystal fiber, Supercontinuum.

I. INTRODUCTION

Photonic crystal fibers (PCFs) are holey fibers made up of large number of air-holes in its cladding. They have been very attractive nowadays because we can easily control the dispersion, confinement loss, nonlinearity etc. by varying the structural parameters of the PCF. Controlling dispersion and achieving high nonlinearity along with low confinement loss is very crucial in PCFs. PCFs are used in applications like parametric amplification, wavelength division multiplexing, soliton transmission, gas sensing, dispersion compensation, supercontinuum generation etc. Our PCF is showing large negative dispersion so that it can be used as dispersion compensation in optical communication. We consider As_2Se_3 based chalcogenide glass as the material for our PCF. This type of glass possess very high nonlinearity with large negative dispersion. Our unique structure provides waveguide dispersion in such a manner that this waveguide dispersion will cancel some of the negative dispersion and provides a more flattened dispersion for using this PCF in the telecom wavelength of operation. Numerical simulations show that we have achieved ultrahigh nonlinearity of almost 100 times than that of silica.

II. METHODOLOGY

I done my work on OptiFDTD Software, The waveguide layout designer is used to design the PCF layout, and then this layout is coverted to a refractive index distibution file. The mode solver will load in the index distribution file and perform the mode analysis. To observe the index distribution, a point source is placed in the layout.The center wavelength is 1.3 µm with Gaussian modulated continuous wave as a time domain waveform.

Thus I proposed an Hexagonal symmetric structure having alternate ring diameter. The air-hole diameter of the rings are d= 0.5µm. The pitch (^) which is the distance between circles on adjacent rings is 1.5. The structure is shown in Fig.1.

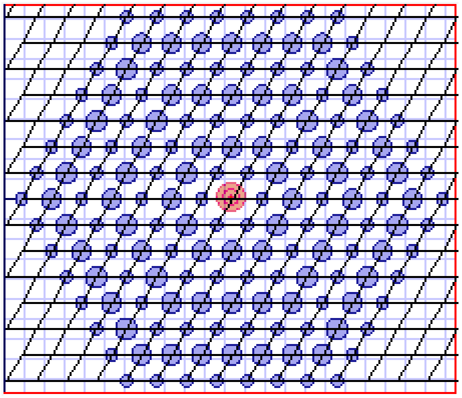


Fig.1. Proposed PCF Structure

Chromatic dispersion is the sum of material and waveguide dispersion. Material dispersion is calculated from the simpler form of Sellemeier equation, which is known as Cauchy's equation, showing the relation of material of the chalcogenide glass with the refractive index.

Cauchy's equation is given by

$$n(\lambda) = (a + b/\lambda^2 + c/\lambda^4)^{1/2} \quad (1)$$

where, $a=5.14$, $b=0.20\ \mu m^2$, $c=0.14\ \mu m^4$ and λ is the wavelength

From the wavelength dependence of refractive index, we calculate the total chromatic dispersion which includes material and waveguide dispersion as given by the equation

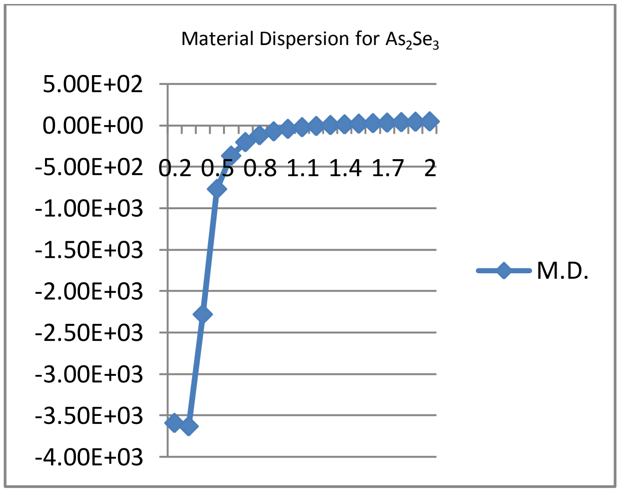
$$D = -\frac{\lambda}{c}\frac{d^2 \mathrm{Re}[n_{eff}]}{d\lambda^2} \quad \text{ps/(nm-km)} \quad (2)$$

III. SIMULATION RESULTS AND DISCUSSION

TABLE. 1

The Material dispersion of the As_2Se_3

Wavelength (W) in µm	**Material Dispersion (ps/ km-nm)**
0.2	-3.59E+03
0.3	-3.63E+03
0.4	-2.28E+03
0.5	-7.69E+02
0.6	-3.68E+02
0.7	-2.04E+02
0.8	-1.21E+02
0.9	-7.42E+01
1	-4.44E+01
1.1	-2.42E+01
1.2	-9.61E+00
1.3	1.52E+00
1.4	1.04E+01
1.5	1.80E+01
1.6	2.47E+01
1.7	3.08E+01
1.8	3.66E+01
1.9	4.15E+01
2	4.57E+01



X axis : Wevelength in µm

Y axis : Material Dispersion

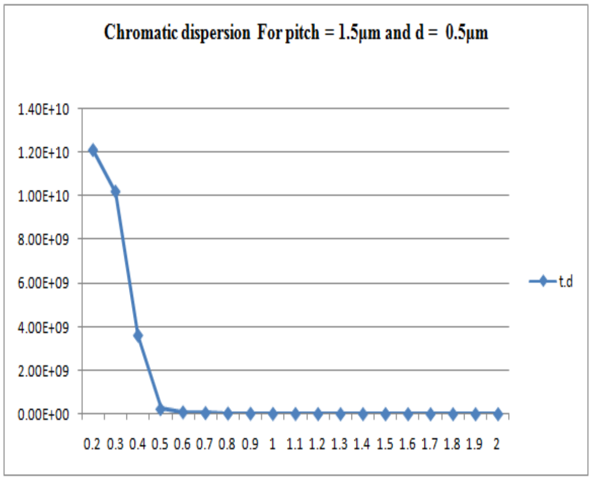
Fig. 2. Shows the Material Dispersion of Chalcagenoide Glass PCF

Chromatic Dispersion for Pitch Value(**Λ**) = 1.5 µm and Diameter(d) = 0.5 µm given in following table.

TABLE. 2

The chromatic dispersion of the proposed pcf for the air hole diameter d = 0.5 µm and pitch value = 1.5 µm

Wavelength (W) in µm	**CHROMATIC DISPERSION (ps/ km-nm)**
0.2	1.21E+10
0.3	1.02E+10
0.4	3.61E+09
0.5	2.32E+08
0.6	8.98E+07
0.7	5.17E+07
0.8	3.37E+07
0.9	2.35E+07
1	1.71E+07
1.1	1.28E+07
1.2	9.90E+06
1.3	7.80E+06
1.4	6.26E+06
1.5	5.09E+06
1.6	4.19E+06
1.7	3.49E+06
1.8	2.92E+06
1.9	2.56E+06
2	2.33E+06



X axis : Wevelength in µm

Y axis : Chromatic Dispersion

Fig 3. Chromatic dispersion for Pitch Value = 1.5 µm When diameter d= 0.5

IV.CONCLUSION

We propose Hexagonal PCF using As_2Se_3 glass. It has been demonstrated that due to their negative dispersion parameter and zero dispersion in wavelength range 0.5 µm to 1.5 µm, lattice structures (hexagonal) of As_2Se_3 glass PCFs, with pitch (Λ=1.5 µm), can be used as dispersion compensating fibers. It is also shown that As_2Se_3 glass PCF provides Zero dispersion in wavelength range 0.5 µm to 1.6 µm By this remarkable property of ultra high nonlinearity and flattened dispersion, our proposed PCF structure can be used for Supercontinuum generation.

V. FUTURE SCOPE

For future work we can consider elliptical air hole as well as missing air hole for the designing of Hexagonal structure.

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