International Journal of Engineering and Technical Research (IJETR)
ISSN: 2321-0869, Volume-1, Issue-3, May 2013

Design of Flattened Dispersion of Hexagonal Chalcogenide As_2Se_3 Glass Photonic Crystal Fiber with a Huge Core

Vineet Agrawal, Ajay Kumar Bairwa, Ramesh Bharti

***Abstract*— In this paper, we will proposed a new structure of the making of a chalcogenide glass photonic crystal fiber (PCF) with increase in core diameter. As comparision with the regular PCFs in which silica glass is used as core material, the proposed PCF has following feature; at first we have used the chalcogenide As_2Se_3 glass in core material in which the first ring area contains no air holes. Then this proposed PCF has a Huge core area chalcogenide As_2Se_3 glass photonic crystal fiber. There are small chromatic dispersion in the proposed PCF comparied to regular As_2Se_3 glass PCF. The chromatic dispersion is almost flat in the range of 2.4 micrometer to 4.1 micrometer range when the air hole diameter 'd' is .75 micrometer and air hole space '^' is 2.0 micrometer**.

***Index Terms*— chalcogenide As_2Se_3 glass, chromatic dispersion, photonic crystal fiber.**

I. INTRODUCTION

Optical fibers are basically used as good transmission medium for short, medium and long distances. Now a days, research is carried out on photonic crystal fibers (PCFs) which are also called holey fibers [1,2]. The PCFs have a central region called core surrounded by periodic air holes which work as cladding. We can control the chromatic dispersion of the PCFs by changing in the core material, air hole diameter „d‟ and air hole spacing "^". When we increase the ratio of the hole diameter to the hole spacing (d/^), the zero dispersion is achieved by this [3,8. Now a days other glasses like soft glasses, chalcogenide are used in PCFs [4,9]. Chalcogenide glasses have large refractive index (2.4 – 3.0) compare to other glasses. This means non- linearity of chalcogenide glasses As2Se3 fiber is almost 10,000 times more than silica glass at 1.57 micrometer [5].

In this paper, we worked on a novel structure of PCF in very long wavelength region. In the proposed PCF, chalcogenide As2Se3 glass is used as core material and second, the center core is made larger than that of conventional As2Se3 PCFs. We have use semi- vectorial effective index method (SVEIM) for comparing dispersion properties.

Manuscript received May 20, 2013.

Vineet Agrawal, M.Tech, Scholar, Department of Electronics & Communication Engineering, Jagannath University, Jaipur.

Ajay Kumar Bairwa, Asst. Professor, Department of Electronics & Communication Engineering, RITM, Jaipur.

Ramesh Bharti, Asst. Prof., Department of Electronics & Communication Engineering, Jagannath University, Jaipur.

II. PROPOSED STRUCTURE

Figure 1 shows the proposed PCF structure. In regular As2Se3 glass PCF, we normally find that there is one missing air hole in the center of the PCF , which makes core of the PCF , and six air holes are arranged in the first and fdurther rings of hexagonal PCF. On proposed structure to make huge core total seven holes are removed from As2Se3 glass PCF, one from center of hexagonal and six holes from first ring. then total seven missing air holes in core area is called Huge core. The second ring area and all outer rings are same arranged, like regular PCFs. Semi- vectorial effective refractive index method is used for TE mode and boundary condition is used for the simulation.

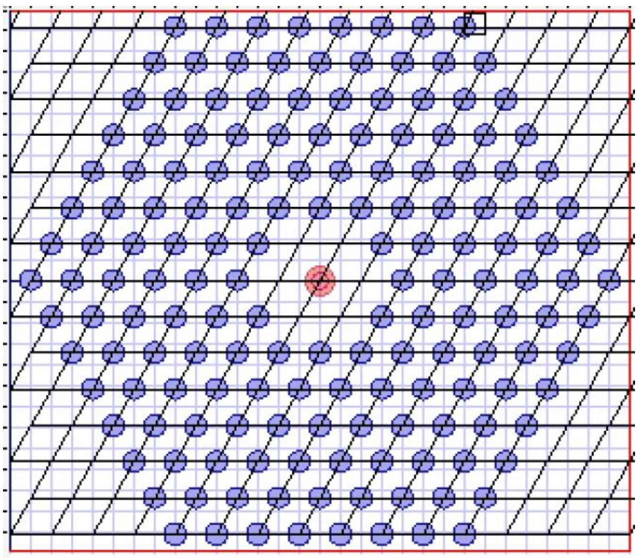

Figure 1. The structure of the proposed PCF.

The value of refractive index of As_2Se_3 glass calculated by sellemier formula [6].

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

Where c is the velocity of light and λ is the wavelength of light.

III. SIMULATION RESULTS

Figure 2 (a) and (b) shows the simulated modes field at ^ =2.0 μm and air hole diameter d = .75 μm at 2.4 μm wavelengths of conventional PCFs and proposed PCFs respectively.

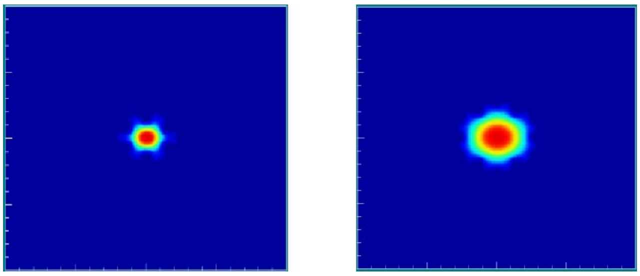

Figure 2 simulated mode field of the (a) normal PCF (b) proposed PCF with ∧ = 2.0 µm and d = 1.0 µm at 2.4 µm.

In figure 3 plot of the refractive index of conventional PCF and proposed PCF are shown. The refractive index of proposed PCF is much higher than the conventional PCF. The refractive index difference is increased between the regular PCF and proposed PCF with the increasing wavelength, and the refractive index difference is 0.0336 at 2.4 µm wavelength.

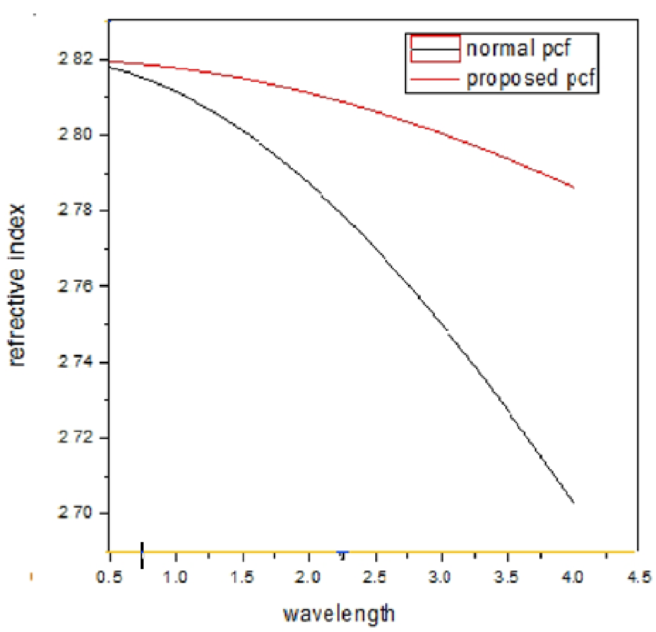

Figure 3. Notable difference of refractive index between conventional PCF and proposed PCF.

For good explanation first we have plotted material dispersion of chalcogenide As_2Se PCF as shown in figure 4. The total dispersion $D = D_M + D_W$. Waveguide dispersion D_W is defined as-

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

Here refractive index n for core material is calculated by sellemier formula. Material dispersion is always independent on pitch and diameter of air holes “d”.

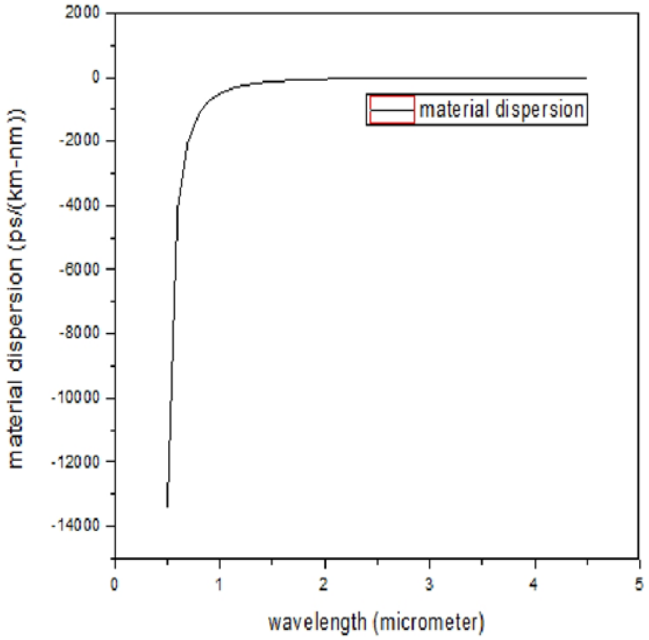

Figure 4. Material dispersion curve of As2Se3 glass PCF.

Figure 5 shows the simulated chromatic dispersion of the proposed PCF for various values of air hole diameter d. the chromatic dispersion is almost flattened in range of 2.4 µm to 4.6 µm, when pitch is 2.0 µm. decreasing the air hole diameter the chromatic dispersion is also decreased.

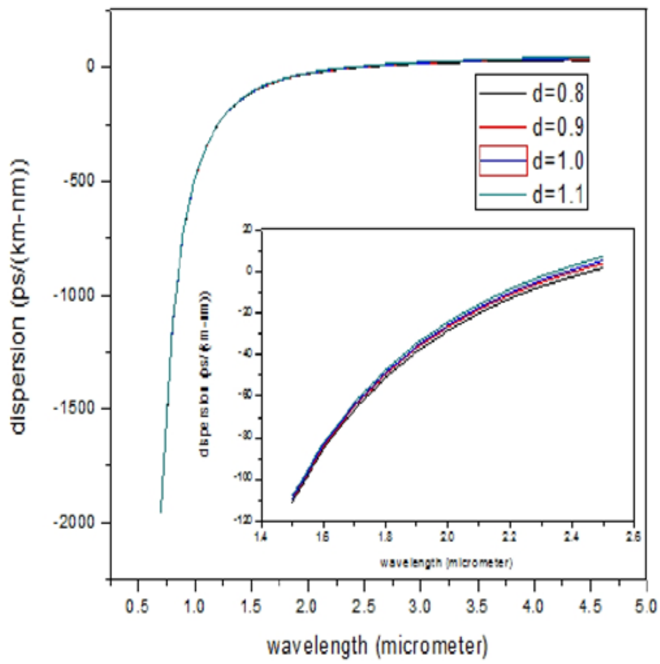

Figure 5 chromatic dispersion of the proposed PCF for different values of the air hole diameter d when air hole spacing ∧ = 2.0 µm.

of the proposed PCF (Huge center core) makes the chromatic dispersion flat in long wavelength range.

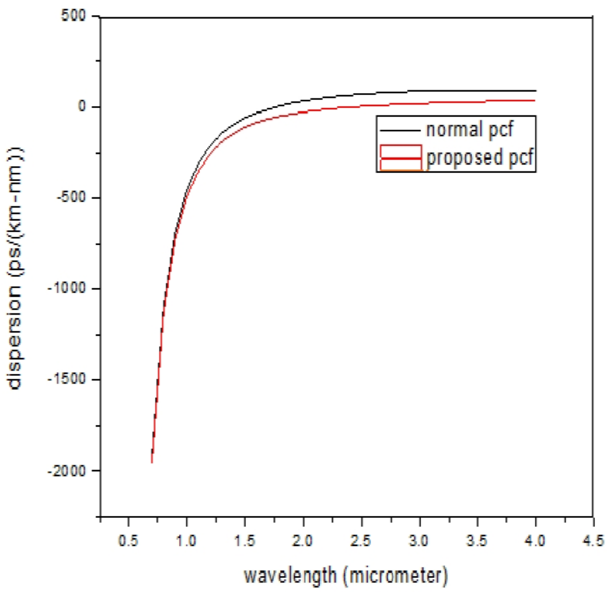

Figure 6 shows the simulated chromatic dispersion of the proposed PCF when ∧ = 2.0 µm and d = .75 µm.

IV. Conclusion

In this paper we have proposed a new structure of flattened and small dispersion compare to regular PCF structure. The features of the proposed PCF is that the center core is larger than that of conventional As_2Se_3 glass PCFs means seven air holes are missing in core. The core material is used As_2Se_3 glass in both PCF. The large core structure makes the flat and near to nil chromatic dispersion compare to conventional PCF.

V. Future work

This design can be done by changing the air hole diameter and also changing the layers of air hole rings. The further analysis can be done by removing Some inner holes layer and changing circular air holes to elliptical.

Acknowledgment

The authors thanks to co- author Mr. Ajay Kumar Bairwa, Head of depart ment, Rajdhani institute of technology & management, jaipur, Mr. Ramesh Bharti. Head of Dept. of Electronics & Communication Engineering, Jagannath University & and for valuable efforts in preparation of the manuscript.

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