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Study of Zero Chromatic Dispersion in PCF using different material

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Abstract— **We have proposed a new design of Honeycomb Photonic Crystal Fiber (HPCF) and the study is carried out on dispersion characteristic of PCF. In this text book, we proposed a novel structure design of Honeycomb Photonic Crystal Fiber and investigation is carried out on the refractive index distribution of air hole rings in a Photonic band gap fiber as a function of the pitch.**

The work aims to reduce the dispersion in Photonic Crystal Fiber (PCF) using the Transparent Boundary Condition (TBC) and Scalar Effective Index Method (SEIM) the fundamental dispersion in a signal is extracted and plot of their respective negative, zero and flattened dispersion curve. Here, new hexagonal As_2Se_3 glass photonic crystal fiber is designed and proposed with seven layers.

Index Terms— **Effective refractive index (n_{eff}), photonic crystal fiber (PCF), scalar effective index method (SEIM), Transparent boundary condition (TBC), chromatic dispersion.**

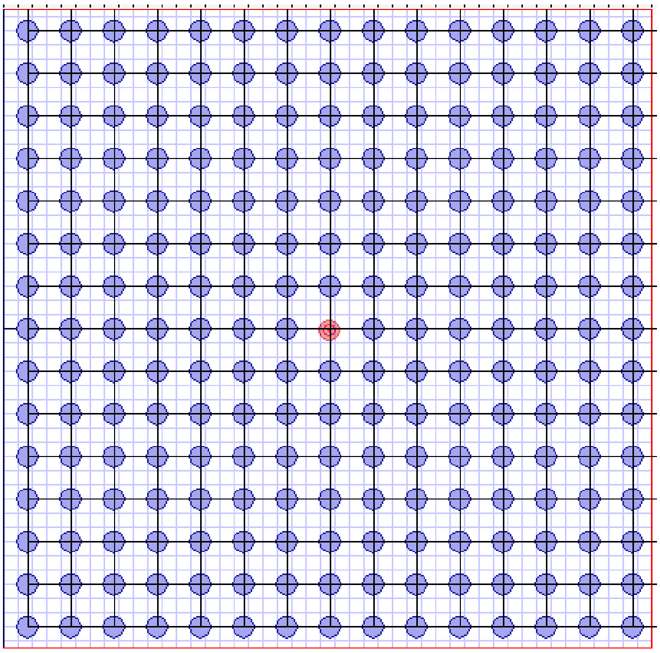
I. Introduction

Photonic crystal fibers (PCFs) [1-3] or holey fibers usually arranged in a square/ hexagonal structure of air channels running down the length of the core material (silica, As_2Se_3 glass etc.) based fiber surrounding a central solid core. In these years PCF is very attracted in the research group because of their unique properties, such as polarization and dispersion properties. The dispersion properties of large core square lattice chalcogenide As_2Se_3 glass PCF is find out using scalar effective index method (SEIM) [4-6] and also compared with the Ge- doped square core chalcogenide As_2Se_3 glass PCF. In optical communication, dispersion plays an important role as the information transmitting capacity of the fiber. Therefore it becomes attracting for study its dispersion properties. A bandgap photonic crystal fiber was made by knight et al. [7] for first time in 1998.

On the basis of these works, we designed a square lattice As_2Se_3 glass PCF with large core (figure-2) and first Ge doped ring (figure-3) and compared with conventional square lattice seven ring PCF.

2. A Square lattice conventional As_2Se_3 glass PCF

Figure 1 shows the conventional square lattice seven ring As_2Se_3 glass PCF. In this PCF we normally find one missing air hole, which make solid core of the PCF. Now we remove the four corner air holes in the first ring and doped Ge material in the remaining air holes in the first ring as shown in figure 2. In the third design we remove the first air holes ring, which makes large core As_2Se_3 glass square lattice PCF. We can control the dispersion property of PCF by varying air hole diameter ‘d’, air hole spacing ‘^’, core material and core diameter area [8].



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Design Principle and Simulation Results

Figure 2. (a) layout of seven ring hexagonal conventional As_2Se_3 glass PCF, here ‘d’ = 1.0 µm and pitch ‘^’ = 2.0 µm. (b) mode field pattern of the fundamental mode.

The design of proposed PCF is shown in figure 3. This PCF comprises seven air hole rings embedded in chalcogenide As2Se3 glass with a refractive index of 2.82. the diameter of air holes of two inner rings is 0.5 µm and other rings air hole diameter is 1.0 µm. the structure of cladding of this proposed PCF is hexagonal and the spacing ‘^’ between two air holes is 2.0 µm.

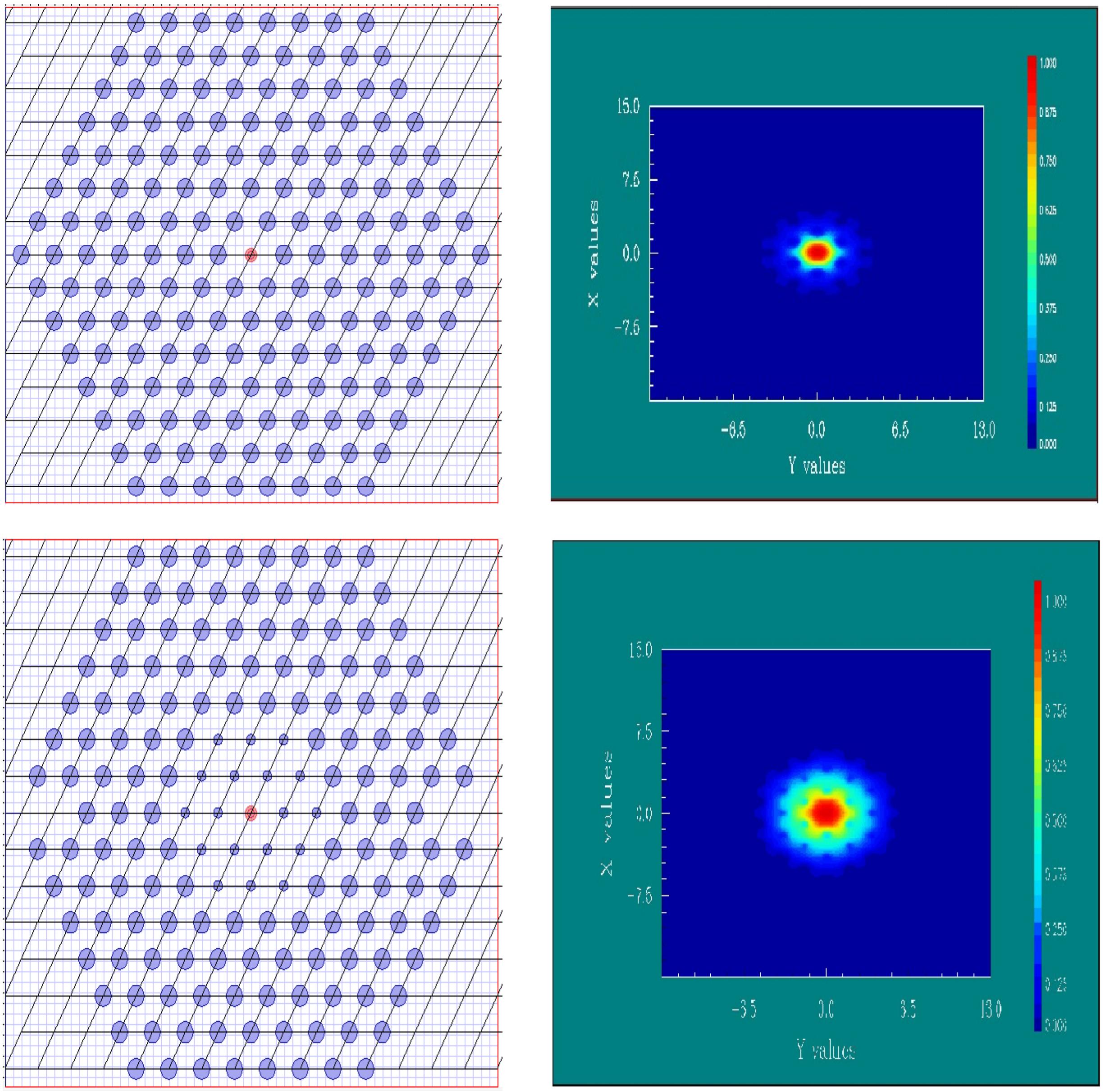

Figure 3. (a) The cross section of proposed As_2Se_3 glass PCF, here d_1 = 0.5 μm, d_2 = 1.0 μm and ^ = 2.0 μm. (b) Mode field pattern of proposed As_2Se_3 glass PCF.

III CHROMATIC DISPERSION

For good explanation first we have plotted material dispersion of chalcogenide As_2Se_3 PCF as shown in figure 4. The total dispersion $D = D_M + D_W$. Waveguide dispersion D_W is defined as-

$$D_M = -\left(\frac{\lambda}{c}\right)\frac{d^2}{d\lambda^2}n_{eff} \quad (4)$$

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).

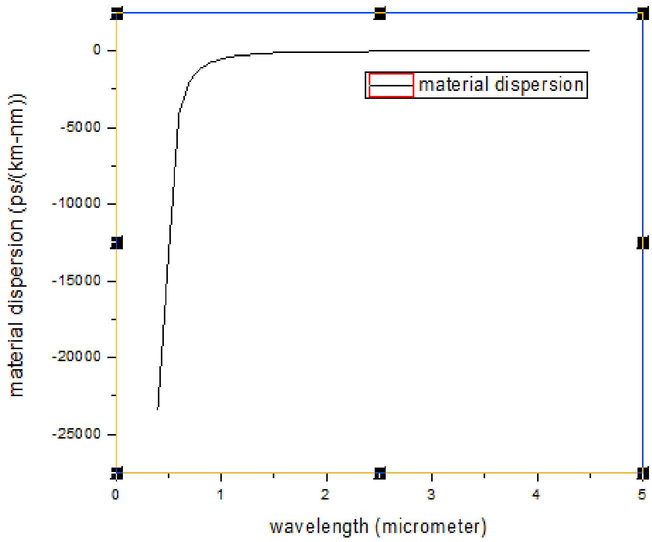

Figure 4. material dispersion curve of As_2Se_3 glass PCF.

Figure 5 shows the simulated chromatic dispersion of the proposed PCF for different values of air hole diameter d. the chromatic dispersion is almost flattened in range of 2.4 µm to 4.5 µm, when pitch ᴧ is 2.0 µm. decreasing the air hole diameter the chromatic dispersion is also decreased.

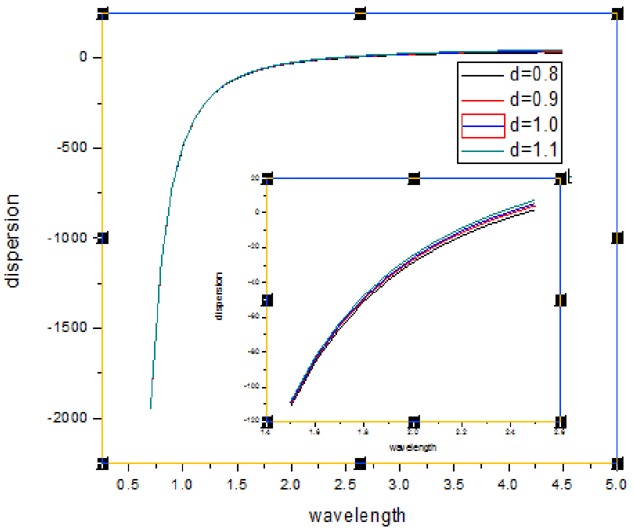

Figure 5 chromatic dispersion of the proposed PCF for different values of the air hole diameter d when air hole spacing ᴧ = 2.0 µm.

The structure of the proposed PCF (large center core) makes the chromatic dispersion flat in long wavelength region.

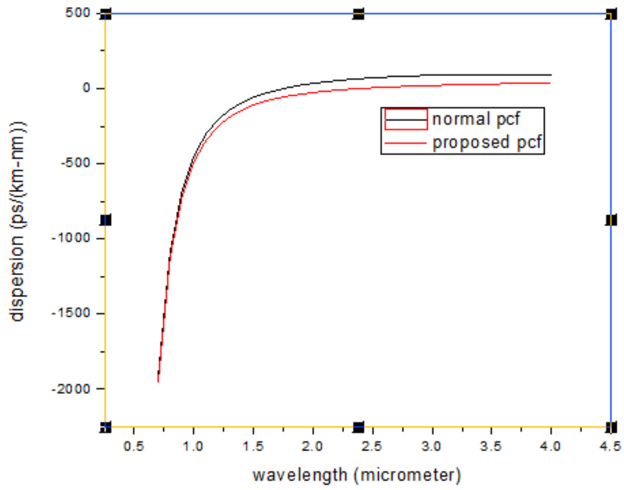

Figure 6 shows the simulated chromatic dispersion of the proposed PCF when ᴧ = 2.0 µm and d = 1.0 µm.

We analyzed the chromatic dispersion of a PCF where Ge doped ring has introduced and also compare with the large core As_2Se_3 glass PCF. The results suggest that the dispersion of Ge doped As_2Se_3 glass PCF is lower then conventional As_2Se_3 glass PCF but higher then large core PCF. Therefore that the proposed large core As_2Se_3 glass PCF can be used as low and flattened dispersion fibers.

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