Chromatic Dispersion of chalcogenide glass-based Photonic Crystal Fiber with Ultra-high numerical aperture

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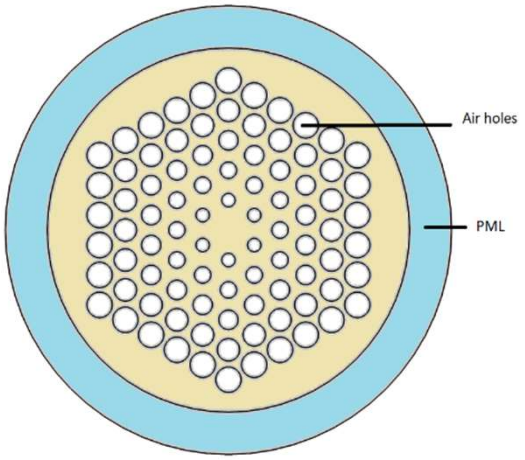
ABSTRACT

We report a chalcogenide glass (As2Se3) based photonic crystal fiber having a solid core. The proposed PCF has ultra-high numerical aperture value reaching upto 1.82 for the explored wavelength range of 1.8-10 µm in Mid-Infrared region. With this the PCF has high light gathering capacity. With negative dispersion reaching upto approx -2000 ps/km-nm at 4.8 micrometers, the fiber acts as a dispersion compensating fiber, with confinement loss being close to zero for higher values of wavelength. The value of dispersion is significantly less due to the regular variation in the size of the holes in the transverse direction, as compared to the design when there is no gradation. The value of numerical aperture increases as the pitch increase from 0.92 to 0.96 to 1 micrometer, at a particular value of wavelength. The design has been optimized with appropriate value of the perfectly matched layer to get the best results.

DESIGN OF PCF



The structure has five rings of air-holes arranged hexagonally. The diameter of air holes is ∧*0.35, ∧*0.55, ∧*0.75, ∧*0.95, ∧*1.15, of the respective layers starting from the innermost layer.

The base used for designing the PCF is As_2Se_3, a chalcogenide glass material. The Refractive Index of As_2Se_3 is calculated following the Sellmeier Equation [1] ,

FORMULA USED

$$\text{Dispersion } (D(\lambda)) = -\frac{\lambda}{c}\frac{d^2 n_{eff}(\lambda)}{d\lambda^2}$$

$$\text{Numerical Aperture } (NA) = \sqrt{{n_c}^2 - {n_{eff}}^2}$$

RESULTS

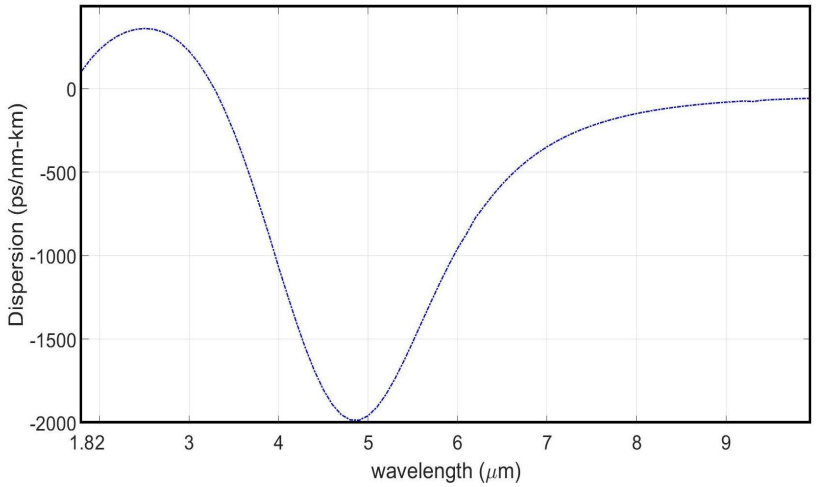


Fig.1: Dispersion Variation of Proposed PCF structure

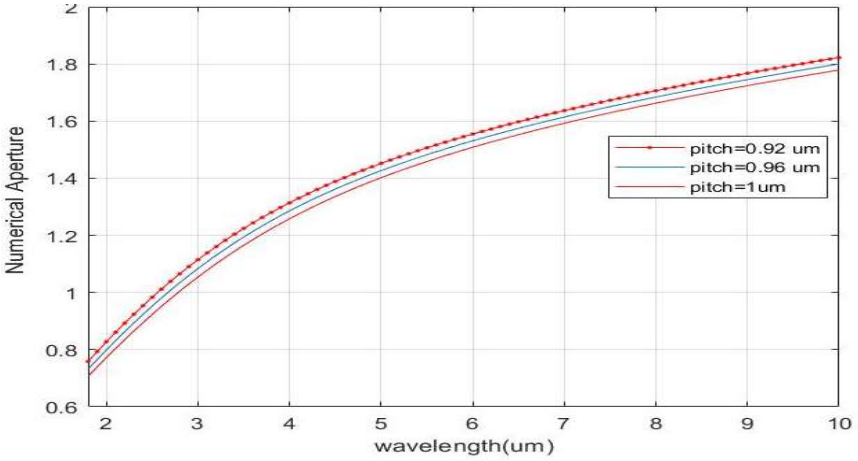


Fig.2: Numerical Aperture variation of Proposed PCF with varying pitch

CONCLUSION

For our designed PCF, we are getting ultra-high numerical aperture value greater than 0.75 for wavelength 1.8-10 µm in Mid-IR range [2]. This makes the proposed fiber a good one for gathering a good amount of light in the core region. A high value of numerical aperture implies that the modes are strongly guided in the PCF. The value of NA is greater for the higher value of pitch. Also the negative value of the dispersion can be further decreased by varying the pitch and the size of the air-holes in the mid-infrared regime.

REFERENCES

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