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Study the Effect of Some Photonic Crystal Arrangements on the Dispersion and Effective Refractive Index of Photonic Crystal Fiber

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Abstract: *The recent optical fibers are the microstructure optical fibers (MOFs). They are consistingof a hexagonal arrangement of air holes along the length of a silica fiber surrounding a central core of solid silica. They can guide light through the total internal reflection mechanism and photonic band gap effect. PCFs contain axially air channels which provide alargedegreeffreedomindesigneto achieveavarietyof peculiar properties,numerous PCF-based sensors have been proposed, developedand demonstrated fora broad range of sensing applications.PCF is dependo on different parameters such as the diameter of air hole, number of holes, and the distance between the air holes. This paper presents the results of the customizing of a photonic crystal fiber. This customizing is essential to know the actual parameters of the PCF for its use in the application.*

1. Introduction

Fibers made of photonic crystal (PCs) are fibers having internal periodic structure made of fine tubes[1] filled with air, laid to form a hexagonal lattice. To confine the propagating light in a narrow region the photonic structure is used in the graphene layer for the sake of enhancing light–matter interaction[2]. They much attention have been paid in recent years to PCFs due to these flexible structure, easy on-chip integration, outstanding light confinement capability, and compact size [3]. There exist several parameters to manipulate lattice pitch, air hole shape and diameter, refractive index of the glass, and type of lattice[4]. Freedom of design allows one to obtain endlessly single mode fibers, which are single mode in all optical range and a cut-off wavelength does not exist[5].Moreover, there are two guiding mechanisms in PCF, there are index guiding mechanism (similar to the one in classical optical fibers) and the photonic bandgap mechanism. The holey Fiber (also called the index guided fiber) light is guided in the solid core made of pure silica by modified total internal reflection mechanism [6-8].light guidance in solid-core PCF can still be well explained with the total internal refraction of light on the interface between the core which has refractive index of silica and the cladding which has lowered effective refractive index due to air holes [9], this type shown in figure (1a).

While Photonic Band-Gap Fibers follows Photonic Band Gap Mechanism and here the light is guided in air holes. When replacing central part of the array of air holeswith a bigger hole of much larger diameter in comparison to the surrounding holes, so obtained fiber is called the Photonic band-gap fiber. The structure periodicity of is broken, sodefect introduced causes a change in its optical properties[11-12].Figure (1b) illustrates the Photonic Band Gap Fiber.

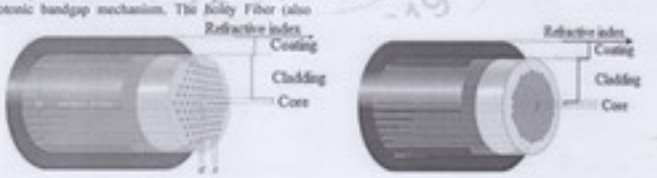

Figure 1: PCF microstructured cladding (a) solid core and (b)hollow core PCF [10]

2. Theory

The nonlinear Schrödinger equation (NLSE) is approximately describes the propagation of an optical signal, through a fiber[13], by neglecting, third and fourth order dispersion coefficient of the medium so the equation appeared in the form (1):

$$\frac{\partial A}{\partial z} = -\frac{\alpha}{2}A(z,t) - \frac{1}{2}\beta_2\frac{\partial^2 A}{\partial t^2} + i\gamma|A|^2 A \quad \ldots (1)$$

Where theapproximation slowly-varying envelope is used with assumptiveinstantaneous nonlinear response. A(z, t) is the electric field amplitude complex envelope of the optical signal at a retarded time (a temporal frame of reference moving with the group velocity of the pulse), t, and after propagating a distance, z, and α, β_2, and γ arethe medium parameters of in which the pulse is propagating.$\beta_2$is the second-order dispersion coefficient, while α is the loss parameter, and γ isthe nonlinear coefficient.