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Photonic Bands Predict The Behavior of Light Accurately

KEYWORDS: photonic band gap, impurity, light.

Dr.Brijesh.N.chawda

Professor , Department of Humanities and sciences, Jayaprakash Narayan college of Engg, Mahaboobnagar, Telangana, India.

ABSTRACT *In photonic band gap, light cannot enter the crystal because the gap acts as an insulator of light and the light velocity will be changed from velocity of light to zero and thus light and matter interaction is controlled.*

The existence of photonic band gap is a forbidden gap for photons in which location of light and spontaneous emission of light can be controlled by adding controlled amount of impurities and also by artificially introduced defects which in turn finds wide applications in scientific and engineering fields.

1.1.1: INTRODUCTION:

With the advent of fibre optics, data can be very easily & rapidly transmitted over long distances ranging from few meters to thousands of kilometers employing the phenomena of total internal reflection.

Modern electronic communication use radio waves and microwaves to carry information over copper wires and coaxial cables. However, the information carrying capacity of these wires is restricted.

If light is used in place of radio and micro waves, the number of signal transmission capacity can be enhanced tremendously and it possesses wide bandwidth[5].

The main problem of a fiber optic cable is its attenuation, different mechanisms are responsible for the signal attenuation within the fiber and these mechanism lead to material dispersion, material scattering, micro bending losses, etc losses also occur due to connection and splicing.

The mechanisms of attenuation of signal may be classified broadly into two types

Absorption losses 2) Scattering Losses.

The other losses include bending losses, micro bending and wave guide losses.

Also, conventional fibers possess core and cladding sections made up of either glass (or) plastic and use the principle total internal reflection for the transmission of light

The difference between refractive index is extremely small in core and cladding which is obtained by adding impurities using doping process.

Due to Raman scattering during propagation of high power of light cause the light signal to be corrupted and distorted and even the fiber may get damaged. To overcome their problems photonic crystal fiber (PCF) which is based on the properties of photonic crystals can be used.

Naturally existing photonic crystals are gemstone opal and wings of butterfly. Due to the existence of photonic crystals on the wings of butterfly beautiful colours are produced and keep butterfly wings cooler.

Photonic crystals usually consist of dielectric materials, that is, materials that serve as electrical insulators or in which an electromagnetic field can be propagated with low loss.

1.1.2: Results and Discussion to reduce the non-linear effects:

The main problem of a fiber optic cable is its attenuation and in order to overcome this problems photonic crystal fiber (PCF) which is based on the properties of photonic crystals can be used.

Photonic bands predict the behavior of light accurately. In photonic band gap, light cannot enter the crystal because the gap acts as an insulator of light and the light velocity will be changed from velocity of light to zero and thus light and matter interaction is controlled.

The basic phenomenon is based on diffraction in photonic crystals and they are fabricated by the methods used in semiconductor industry of etching and photo lithography technique.

In photonic crystals, the dielectric medium is periodically arranged such that between any two dielectric regions there exist gaps (or) separations called as band gaps similar to that of periodic potential regions in a metal. The study of motion of electron is described by kronig-penney model and Bloch theorem in periodic potential regions in a metal and the study of photonic crystals can be done by Bloch-Floquet theorem.

PC can control light freely by using 2D & 3D photonic crystals. The 2D photonic band structure possess band gap near infrared region and in 3D photonic crystal, full band gap can be obtained.

The existence of photonic band gap is a forbidden gap for photons. Light cannot enter this region as well as electrons cannot enter this region as well as electrons cannot emit photons, thus it acts as insulator of light [3].

2D Photonic crystals have close packed triangular lattice and 3D photonic crystal have FCC lattice and diamond like structure and both have band gap in TE and TM modes.

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By adding controlled amount of impurities in photonic band gaps[2] the location of light and spontaneous emission of light can be controlled and also by artificially introduced defects PC finds wide applications in scientific and engineering fields[[1].

Using PC, PCF can be fabricated such as holey fiber, photonic band gap fiber and Bragg fiber.

A two dimensional photonic crystal [4] can be imagined to have material in a square lattice of dielectric columns. The columns may be considered as tall cylinders along Z direction where the material is homogeneous and periodic along the material is homogenous and periodic along X & Y directions with lattice constant 'a'

The band structure of transverse – electric (TE) modes and transverse magnetic (TM) modes are completely different because there may exist photonic band gap for one polarization only and photonic band gap for another polarization may not exist at all.

In 2D crystal with complete band gap have spots along the Z-direction parallel to TM polarization but in 3D photonic crystal we need dielectric channels along all the three directions and try to obtain a band gap using arrays of tubes and spheres which acts as bands and atoms of certain lattice.

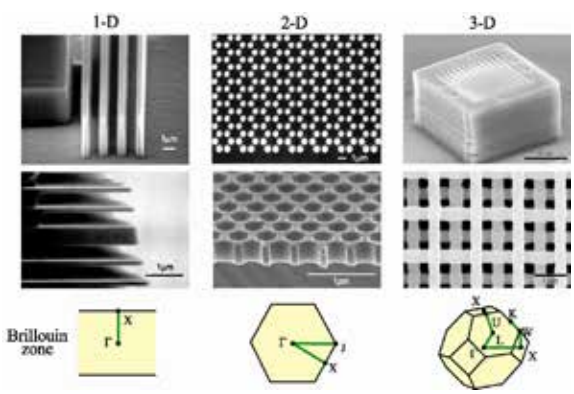

Fig. 1 Various photonic crystal structures of different dimensions and corresponding Brillouin zones.

Considering two different substances composed of higher and lower permittivity (or) dielectric constant value, the ratio of two dielectric constants value gives the dielectric contrast which in turn gives band gaps.

However, to obtain complete photons band gap is not possible even though the dielectric constant value is large. To obtain reasonable band gap the dielectric constant value must reach certain limiting value called threshold value above this threshold value the gap opens and the width gradually increases with the increase in value of dielectric constant [6].

CONCLUSIONS:

Photonic crystals have periodic repeating and alternately arranged dielectric regions of different values of dielectric constant with a band gap that forbids the propagation of certain light frequency range similar to that of periodic potential regions in a metal (or) semiconductor crystal which affects the electron motion due to the presence of allowed and unallowed zones (or) energy bands. A photonic band gap (PBG) crystal is a structure that could manipulate beams of light in the same way semiconductors control electric currents. A semiconductor cannot support electrons of energy lying in the electronic band gap. Similarly, a photonic crystal cannot support photons lying in the photonic band gap. By preventing or allowing light to propagate through a crystal, light processing can be done.

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