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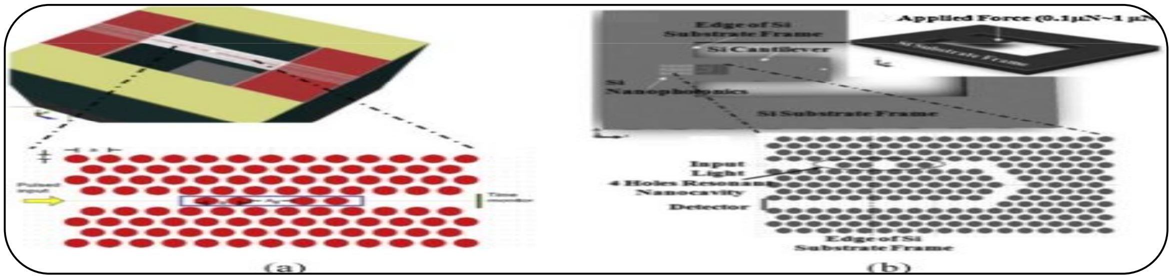

CONCEPT OF PHOTONIC CRYSTAL AND OPTICAL BASED PHOTONIC CRYSTAL

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ABSTRACT

Extensive applications in the fields of optoelectronics, optical communication, remote sensing, space engineering, etc., have led to considerable research over the past two and a half decades to design optical instruments based on photonic crystals (PCs). There are also PCs. They all attract the research community because of the variety of science and technology. The PC has the ability to integrate large amounts on the chip and to block light in specific areas of space with good control. The PC is the most promising platform for designing compact and efficient photonic devices for optical information processing.

KEY WORDS –*fields of optoelectronics, optical communication, remote sensing.*

INTRODUCTION

Photonic crystals (PCs) are artificially created materials with melded dielectric constants from time to time whose distribution follows the notification of the order of the degrees of the optical wavelength causing the electromagnetic (EM) wave propagation by creating a photonic band distance (PBG). The periodic structure produces PBGs taking into account the wavelength of light and the nature of the interference. While photos with energy in the band gap cannot propagate inside the crystal regardless of polarization and propagation direction, energy-containing structures outside the band gap can propagate through the structure. PBG semiconductors have a photonic equivalent of an electronic band gap. The frequency of the electronic potential in the semiconductors is due to the electronic arrangement of the regular atoms of the lattice which creates a forbidden energy band for the electron and similarly gives rise to the forbidden energy bands for the regularly modulated dielectric static (refractive index) photons. They are called PBG. The behaviour of light inside a PC can be best described using Maxwell's equations considering the full vector form of light.

Nowadays PCs have attracted attention due to their important applications in modern photonic engineering including optical communication and optoelectronics. Furthermore, for optical signal processing, PCs are being used as the most promising candidates for the design of compact and efficient photonic devices because of their ability to block light in specific areas of space with greater integration and better control over the chip. PCs are mainly divided into three categories namely one-dimensional (1D), two-dimensional (2D) and three-dimensional (3D) crystals, depending on whether there is recurrence in one, two or three dimensions. Where two and AB of different dielectric constants denoted by red and yellow, respectively, are formed to form the PC. The spatial duration of a PC is defined as the lattice period i.e., the size of the basic unit cell, as it is similar to the lattice stability of ordinary crystals formed by a regular arrangement of atoms. Both of these have very basic concepts, namely common crystals and PCs. One difference between them, however, is that in ordinary crystals, the static part of the lattice is in the unit of angstroms, whereas in PC it is the order of the wavelength of the incident light.

The Distributed Bragg Reflector (DBR) is a common example of 1D PC and is used in most cases as a mirror, especially in the emission laser (VCSEL) on the surface of the vertical cavity. This creates alternating layers of lower and higher refractive index material layers. 2D PC with two axes e.g. The material is homogeneous with the X and Y, Z axes. Pillar arrays and hole arrays are examples of 2D PCs. Although 3D PCs may have better control over the propagation of light waves in all directions regardless of polarization, their forging is still a challenging task. For the opto-electronics industry, for example, the operating frequency is typically 1.5 inches (in infrared) and the mesh duration of the PC must be in units of 0.5 µm. Edge microlithography methods, i.e. X-ray lithography and electron beam lithography are required for the construction of these complex structures.

PHOTONIC BANDGAPS CONCEPT:

The behaviour of the EM wave passing through the photonic crystal can be easily understood if the movement of the hole and the carrying electron are compared by the semiconductor (SC). C crystal, where the alignment of atoms occurs in a diamond-lattice fashion and this mesh represents the regular period on the electrons passing through it; Such as an interaction between a C nuclei and an electron by electrostatic force. Such interactions create permissible and restricted energy levels. Flawless silicon crystals do not have electrons in a forbidden energy gap or so-called band gap. Conversely, the electronic band gap may contain energy if the mesh period deteriorates due to the absence of C atoms or the presence of doping at the C site, or if the SC itself has interstitial impurities.

Photons take the example of such a situation as they pass through a slab of transparent homogeneous dielectric material with a large number of air holes in the form of a mesh. Rotating photos will find parts with a high index of refractive index of dielectric distance with sections with a low index of air permeability. Photons represent this type of inequality in the analogy of a potentially reflective index traveling through an electronic competitor C crystal. Of course, the large difference in the refractive index between the two segments will limit most segments to both in light of the event. The restriction results in the creation of permitted energy zones separated by so-called band gaps.

PHOTO CRYSTALS AND BRAGG DIFFERENCES:

Bragg diffraction is the basic mechanism by which interference determines the properties of photonic crystals. The Bragg reflection of electromagnetic radiation was first studied by the diffraction of X-rays through atomic crystals and then for optical waves in stratified media and gratings. Fulfilling the Bragg position mas as $m\lambda = 2a\ Sin\Theta$, (where ‘A’ is the distance between the mesh planes), the set of crystal planes acts like a mirror. Here the structural interference tends to be reflected, if the difference in path length between the reflections of the progressive layers is equal to the prime multiple of the 2a Sinϴ wavelength. Adequately ordered photonic crystals can provide 100% Bragg reflection efficiency after constructive intervention from the plane reflections of most mesh. It is forbidden that light can be diffused at the time of Bragg's variation. Hence, the Bragg variant comes with a stop gap: a restricted frequency window in relation to the spread.

PHOTONIC CRYSTAL APPLICATIONS:

Optical communications and optoelectronics have been the subject of extensive research by scholars to pave the way for the publication of modern optical technologies and to make the most of these technologies. For example, exciting applications of PCs rely on the existence of PBG in materials such as light wave, laser, low loss waveguides, splitter, photonic crystal fibre, antennas and ultrafast optical switches restricting spontaneous emission localization. Mirror photonic equipment is widely used; commonly used in solar energy storage, imaging as well as laser cavities. Metallic and multi-layered dielectrics are the two basic types of mirrors. Metal mirrors are inexpensive and reflect many types of frequency phenomena from arbitrary angles. However, absorption at infrared and optical frequencies appears to reduce the incidence by a few present. Hence the metal mirrors show reflective limits. Conversely, multi-layered dielectric mirrors can cause extremely little damage and can therefore be highly reflective for a specific frequency range. As such, they can act as "accurate mirrors" in any direction and with any polarization in a specific frequency range. In recent years, these "perfect mirrors" have been studying interest and have been faked using 1D PCs. The PC must reflect the EM waves of any polarization, thus digging through the angle; the concept of mirror everywhere is realized. PC-based ubiquitous mirrors have minimal damage compared to metal mirrors, especially in infrared, optical or lower wavelengths. Such mirrors have exciting applications in optical fibre, fabricator resonator, planar microcircuit correction, and so on.

PHOTONIC CRYSTAL FIBRES:

Photonic Crystal fibre (PCF), first introduced in 1996-1996, has a cladding layer that has an intermittent period in the transverse plane of the fibre, or can be said to be perpendicular to the flow. If the frequency of the light passing through the fibre core is in the selected PBG of the two-dimensional PC, the penetration of light into the cladding layer will not be possible if the fabrication was made by periodic cladding in the earlier period; and therefore, it must be directed through the core by the photonic band gap effect. In such a special case, light steering is possible in an air or vacuum core which means that the core can be designed in such a way that its index does not exceed the index of the cladding. The light that runs in the vacuum core of the optical fibre medium will definitely have limitations such as absorbent losses and non-linear effects with a significant reduction compared to having a solid core in the fibre, making it useful in high power light control applications. Further, in this case other limitations, such as content dissemination, will come to an even less important stage, leading to a completely new path of dispersal management. In addition, detecting light navigation with linear defects does not suggest the use of a 3D period structure or total PBG. Such fibres are almost insensitive to bending even in the smallest bending radius. Photonic crystal fibres can be endlessly single-modelled, meaning that only one mode is supported, regardless of the optical wavelength.

OPTICAL FIBRE:

Optical filters can be defined as devices that have the characteristics of routing and switching in optical signals, on specific wavelength channels that take the optical data into the optical fibre with the least possible distortion. There are many types of technologies available for making optical filters, such as fibre brag gratings (FBG), diffraction gratings, aerated waveguide gratings (AWG), dielectric thin-film filters, and more. To handle the critical calculation of adequately separated wavelength channels using conventional channel add-drop filters, the size of the device should be in the order of cm, which would be beyond the reach of integrated photonic elements, accepting this challenge, PC-based optical filters thanks to its elegant skills of managing and manipulating light propagation in low design sizes. Furthermore, PC-based optical filters are widely used in WDM-based optical networks and / or for separating near-distance wavelength channels. If we add a defect layer in 1D PC we may notice a narrow band transmission filter. Such structures have an intense transmission peak located in the PBG region that can be used for the selection of the desired wavelength channel. The stacking of different PCs can be used for the construction of photonic quantum well (PQW) structures that use the multichannel filtering phenomenon due to the photonic limiting states. Another way to know a multichannel filter based on a 1D superconductor dielectric PC, without any flaws in getting a comb like resonance peaks. Such filters differ fundamentally from PCs with PQW as a defect layer. There are other designs proposed for designing Thu-Morse multilayers optical filters. All of the above filters are based on 1D PC. In addition, PC-based tunable optical filters have attracted their attention due to their useful and important contributions to optical communication and ultra-fast optical processing.

ONE DIMENSIONAL PHOTONIC CRYSTALS:

One-dimensional photonic crystal (1D PC) is the simplest case of PC. A1D PC consists of alternating layers of high and low refractive index dielectric materials with refraction N1 and N2 indices. Dielectric material layers with thicknesses of D1 and D2 are arranged in X direction with mesh period $A = d_1 + d_2$ from time to time respectively. The structure is homogeneous between the y and z axes. Let n be the total number of periods. A1, B1; C1, D1; A2 and B2 represent the phenomena and reflect the electric field amplitude in the first, second and third layers, respectively. NA and NS can be refractive indices of incidence and substrate media.

CONCLUSION:

Concepts and principles behind PCs and optical devices based on PCs. Important milestones in the history of the PC are underlined. As discussed earlier, Bragg differentiation and interference are two basic mechanisms that determine the optical properties of a PC. The first study of the diffraction of EM radiation called Bragg reflection was carried out for X-rays by atomic crystals. This was followed by the discovery of reflections of optical waves in multilayer media and gratings. In this introductory chapter, a brief history of PCs is explained along with the number of potential applications such as photonic band gap content, their development and classification. We have used the standard transfer matrix method (TMM) to study the optical properties of photonic structures.

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