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COMPARISION OF DIFFERENT REFRACTIVE INDEX FOR THE PHOTONIC CRYSTAL BASED WAVEGUIDE

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ABSTRACT

In this paper the power is measured of elliptic and circular unit by using two different refractive index. We use 2.94 (Silicon Carbide), 3.45 (Silicon) as a refractive index. The more power is measure in refractive index 2.94 than the refractive index 3.45. The power is measured in 2.94 is 47.3 % whereas in 3.45 refractive index the power is measured is 47%.

Keywords: Photonic Crystal (PC/PhC), Optical Switch, Relative Permittivity (r), Finite-difference time- domain (FDTD).

I. INTRODUCTION

Photonic Crystal (PhC) has become one of the most interesting element in photonics research worldwide. In 1897, E. Yablonovitch[1] and S.Jhon [2] proposed the awareness that a periodic dielectric can provide the band gap for certain region. In the frequency spectrum, similar to an electronic band gap in semiconductor materials. Photonic crystal have wide and varied applications in the field of microwave and optical technology. The one-line defect photonic crystal waveguide (in which one row of rods is missing from the regular photonic crystal structure) is one of the device that has been widely explored [3][4]. Recently, more and more studies focusing on high efficiency of transmission rate to maintain light propagation in photonic crystal structure are being done. In this paper we are present a novel irregular one- line defect photonic waveguide compare the power with an elliptical unit cell and circular with two different refractive index. One refractive index is 2.94 and other refractive index 3.45.

II. PHOTONIC CRYSTAL

Photonic crystal (PC) structures have been studied in current years, because of their micro- scale dimensions and capability to prevent the propagation light. Photonic crystals have periodically structured dielectric media [4], normally possessing photonic band gaps: ranges of frequency in which beam of light cannot propagate through the structure. This periodicity, whose measurement lengthwise scale is proportional to the wavelength of light in the band gap, is the electromagnetic analogue of a crystalline atomic lattice, where the final acts on the electron wave function to generate the familiar band gaps, exhibited in semiconductors. The introducing of defects in the crystal gives rise to generalized electromagnetic states: linear waveguides and cavities. The crystal can form a

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kind of ideal optical insulator, which can confine light lossless in the region of sharp bends, in lower-index media, and within wavelength-scale cavities, among other potential for control of electromagnetic phenomena. Examples of a photonic crystal happening naturally are the wings of some butterflies such as the blue Morpho butterfly and another example is wings of peacock.

2.1 One Dimension

Photonic crystal is an alternating stack of two different dielectric materials. When light is incident on such a stack, each interface reflects some of the field. If the thickness of each layer is chosen appropriately, the reflected fields can combine in phase, resulting in constructive interference and strong reflectance, also known as Bragg reflection

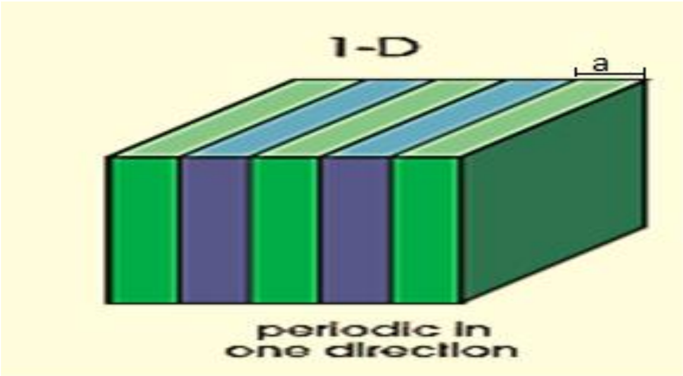

Figure 1: The multilayer film, one-dimensional photonic crystal. The term "one-dimensional" is used because the dielectric varies along one direction(z) only [6].

2.2 Two Dimension

2D Photonic crystal typically consist of an array of dielectric cylinders in a homogeneous dielectric background material.

a) 2D rod-type Photonic crystal consisting of high refractive index cylinders in a low-index background

b) 2D hole-type Photonic crystal slab consisting of low refractive index cylinders in a high-index slab

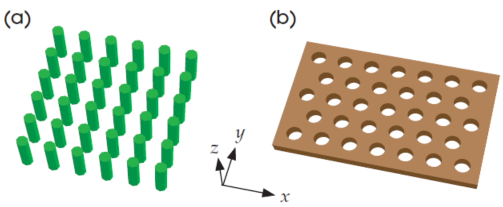

Figure 2:(a) Schematic of a 2D rod-type Photonic crystal consisting of high refractive index cylinders in a low-index background (b) Schematic of a 2D hole-type Photonic crystal slab consisting of low refractive index cylinders in a high-index slab[5]

2.3 Three Dimension

Three-dimensionally periodic photonic crystal with a full band-gap in three-dimensions. It is the complicated structure which is difficult to fabricate.

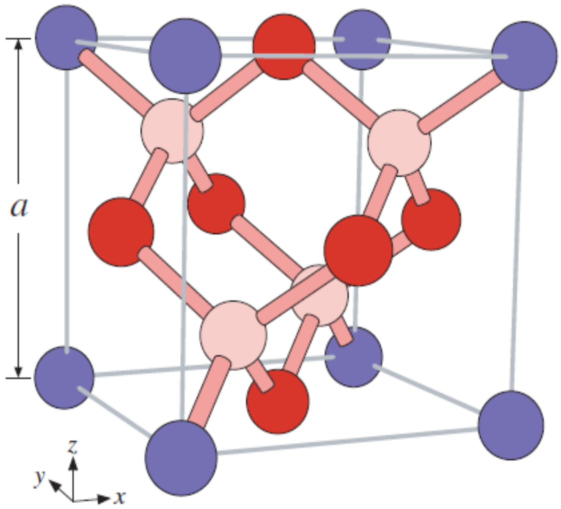

Figure 3: Structure of Three-Dimensional Photonic Crystal [6]

III. DESIGN

To design the Photonic crystal waveguide we use two refractive index is used 2.94 (silicon Carbide) and 3.45 (silicon). We conclude that 2.94 has a large band gap compare with others refractive index (3.45) band gap. Large band has many applications. So we use refractive index 2.94 for remaining work.

2D photonic crystal structure with one waveguide single row of air holes with the circular unit cell and elliptical is shown in a fig 1(a). The photonic waveguide is fabricated by etching the air holes in the substrate. Since a photonic crystal waveguide is a line defect in crystalline structure, it represent a dielectric slab of a certain width sandwiched between two semi- infinite photonic crystals. In the present design, the air holes (refractive index n=1) of the photonic structure have a radius r=0.2 and a=0.43μm, where lattice constant, and the relative permittivity of the background material is r=11.9 (corresponding to silicon material).

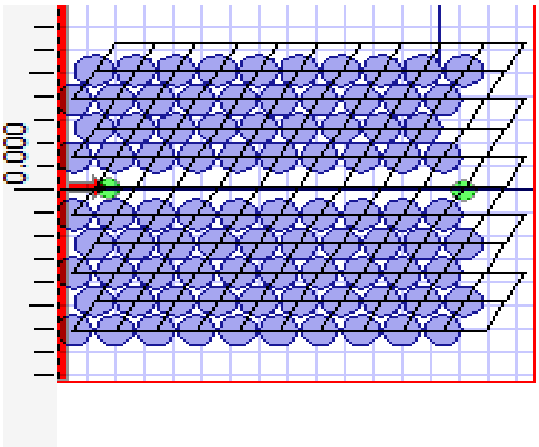

Fig 4(a) Waveguide bounded by circular unit cell with refractive index-2.94.

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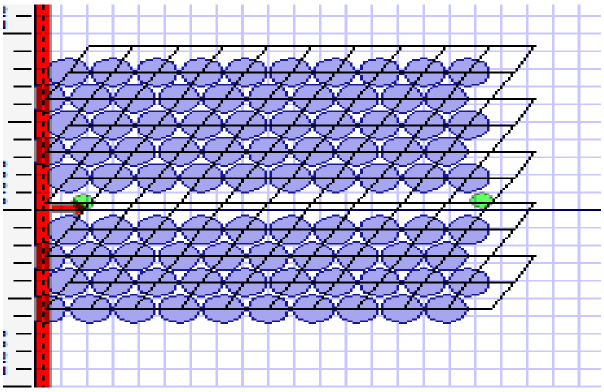

Fig-5(a) Waveguide bounded by circular unit cell with refractive index-3.45.

We use SiC over Si as it has following advantages[7]:

- Reduces cooling costs and complexity
- Heat is conducted away much more effectively
- Greatly reduces complexity of cooling systems
- Significant reduction in cost and size
- SiC has a higher energy band gap than silicon.
- More robust (hardened) against disturbances such as heat, radiation or intense electromagnetic fields
- Very useful in sensor and military applications

IV. RESULT

The propagation of light in photonic crystal waveguide is simulated by 2D finite difference time domain (FDTD) method using opti-FDTD.

After simulation, power is measured at both end of waveguide with structure shown in figure 6(a) 6(b) 6(c) and fig 6(b), and the level of power transmission determine as 16% and 14% respectively.

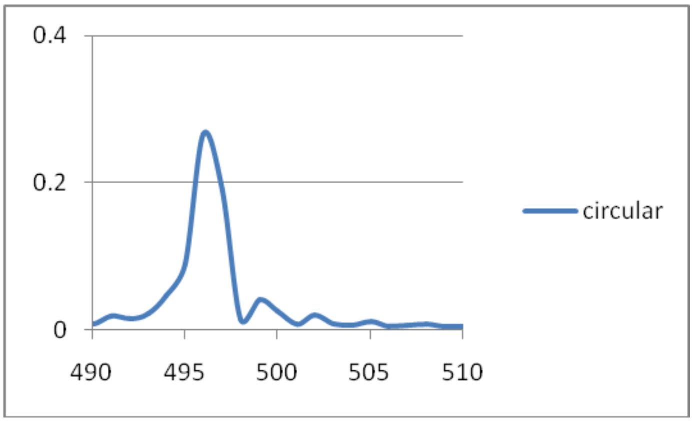

Fig 6.(a) Power measured at output of waveguide(refractive index-2.94).

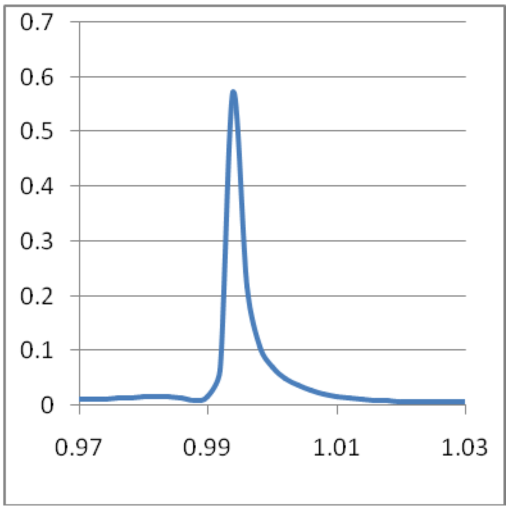

Fig 6.(b) power measured at input of waveguide(refractive index-2.94)

After simulation Power measured for circular unit cell at output is 0.27 and at input is 0.57. Power percentage is 47.3%.

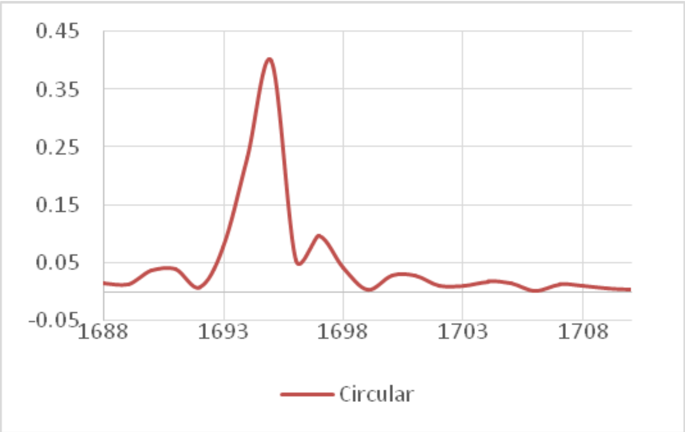

Fig 6.(c) Power measured at output of waveguide (refractive index-3.45)

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Fig 6. (d) Power measured at input of waveguide(refractive index-3.45).

After simulation Power measured for circular unit cell at output is 0.4 and at input is 0.85 Power percentage is 47%.

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V. CONCLUSIONS

Two refractive index 2.94 (silicon Carbide) and 3.45(silicon) were used to make the photonic crystal to make the photonic crystal waveguide and we observed that 2.94 based photonic crystal waveguide gave 47.3% and 3.45 based photonic waveguide gave 47%.

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