Optimizing the Maximum Rate of Normalized Power of Terahertz Switch Constant State Based on Photonic Crystals

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Abstract

Photonic crystals were made on the basis of structure of natural crystals. Almost, all metal elements and most of insulated elements and compound materials are found in the form of crystal at the nature. At such materials, atoms and molecules play scattering roles for electron waves. In the present paper, proposed structure of two dimensional photonic crystals having square grid and including silicone circular rods at air background at terahertz extension were studied. Also, electric and magnetic fields were estimated through finite difference method limited at time domain. [1] At this simulation, optic switching was investigated on the basis of photonic crystal structure with one waveguide and the performance of these tools is based on forming faults at photonic crystals affected by Ker nonlinearity. Also optimization was done to increase maximum rate of normalized power of constant state by two parameters including change of silicone cavities and polymer radius.

Keywords: optic switch, photonic crystal, finite difference at time domain, terahertz wave.

1. Introduction

After predicting possibility of achieving structures with full energy gap in 1891 and creating first its cases in 1990, developing observation tools and measuring small structures especially some kinds of electron microscopes revealed that natural photonic crystals are seen at the structure of most natural materials. Among these, we can mention butterfly wings, scale of such fish called rainbow of Kutubo Lake, most minerals especially certain stones called Opal, sea shells and most sea creatures like sea mouse. Below, figures of butterfly wings are indicated by optic and electron microscopes through which periodic structure is clearly seen. Photonic crystals are strongly scattering structures, that is, transfer coefficients and its reflections are strongly dependent on shined wave frequency [5].

Fig.1.natural photonic crystal available at butterfly wing- Right figure indicates optic microscope from butterfly wing and left figure shows its electron microscope and periodicity of its structure [4].

We can investigate optic switches at domains of place, wavelength and frequency. Most recent developments at the field of switching were at place domain in which optic signals are switched through waveguide input port to output port. Switching technology at domain of place can be classified by different methods. Two kinds are usually separable: one based on guided light (at fiber and waveguide) and other based on a free place optic. In the present study, we improved maximum rate of normalized power of constant state by using finite amplitude with limited difference (FDTD) [6] through changing radius of silicon cavities and polymer.

2. Kinds of Optic Switch

Optic technology that is commonly used has different kinds that include the following:

2.1. Micro-electromechanical systems

Although electromagnetic switches are classification of optic switches, these switches are separate classifications and the reason is to use it at telecommunication industry that has a different performance unlike optic switches. MEME's are at the forms of fine planes to break light. There is difference among these switches and two-dimensional or digital switches and three-dimensional or analog switches [3]. Optic MEME's are useful technologies to obtain optic switching for OXC with high capacity.

2.2. Electro-optic switches

Electro-optic switch 2*2 uses one directional coupler for coupling change rates through changing reflection index. One commonly used material is lithium Nesbit. Electro-optic switches are reliable ones but include high cost of inner losses and dependent polarization.

2.3. Thermo-optical switches

The performance of these tools is based on electro-optic effect including change at reflection index of dielectric material. there are two classes of thermo-optic switches [5, 6].

- Interferometric switches
- Digital optic switches

2.4. Digital optic switches

These switches are formed of optical tools gathered from silica on silicon. Thermo-electro-optic switches are basically small but it needs high starting power. The significant problem of this technology is the limitation of gathering and its high scattering power.

2.5. Serous crystal

The state of these switches is metal determined by more organic materials in definite time domain. At crystal-liquid phase, orientation action is done at molecule [7]. So, optical changes of material can be changed. Optic switch of serous crystal is based on state change of reflected light polarization by a serous crystal.

3. Structure

We study an ultra-fast terahertz wave switch based on T-shape photonic crystal waveguide [6]. The polymer rod is added in the junction as a point defect, the refractive index of which can be varied by adjusting the external pump laser intensity. The polymer materials have Kerr nonlinearity. The terahertz wave switch ‘on’ and ‘off’ mechanism is based on adjusting the defect mode frequency under external excitation. Structure of the schematic of the proposed terahertz wave switch is shown in Fig. 2. These lattice structures are composed of the high-resistivity silicon rods embedded in air background. The high-resistivity silicon with the refractive index of 3.42 is the material of the rods due to its transparency and low absorption in the terahertz region. Choosing the refractive index of the polymer rod changes from 1.3 to 1.5. In Ref. [9], we know that the third order nonlinear susceptibility of the polymer is in the order of 10^{-6} to 10^{-7}esu.

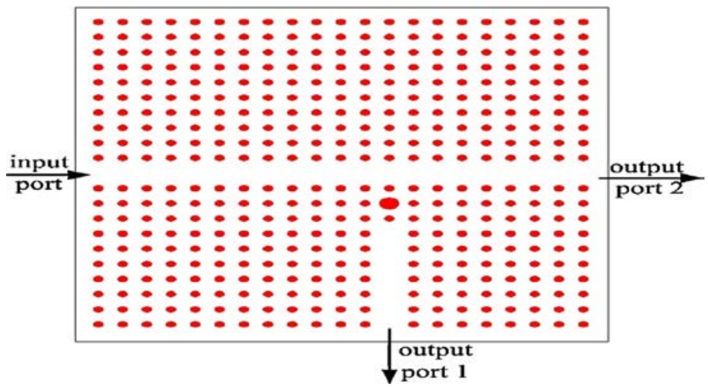


Fig. 2. Schematic of terahertz wave switch based on T-shape Photonic crystal waveguide with a point defect

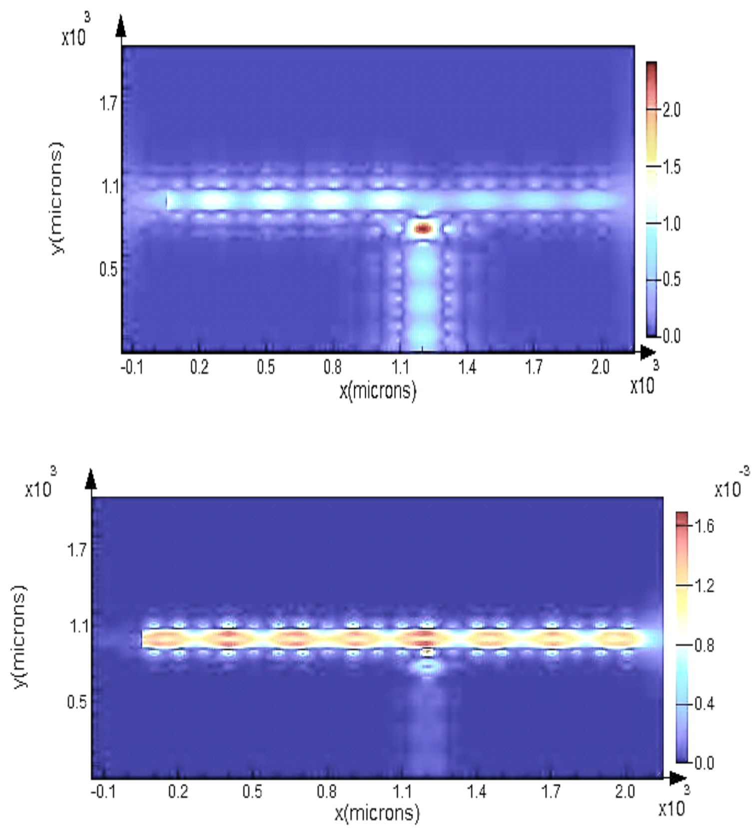
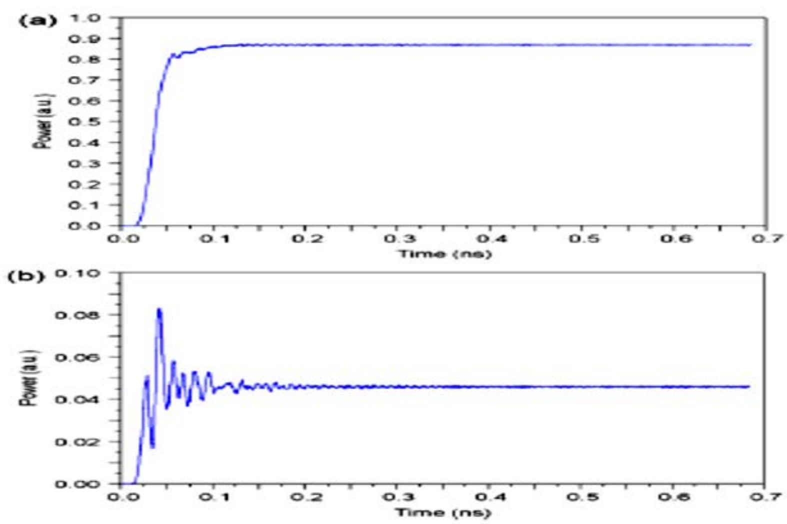


Fig. 3. Steady state electric field distribution of the terahertz wave switch (a) “on” state and (b) “off” state

4. Simulation

In fig 3, steady state electric field distribution of the terahertz wave switches: (a) “on” state and (b) “off” state. the external pump laser intensity is zero (3a), we can see that the most electromagnetic energy is converged at output port1, and only a little energy leakages to output port 2. The terahertz wave switch is at the “on” state, and the terahertz wave corresponding to the defect mode frequency can propagate along the vertical line defect. However, the defect mode frequency can be changed as the pump laser is applied. As shown in Fig. 3(b), when the external pump intensity is of 12.5 MW/cm^2, the most electromagnetic energy propagates through horizontal line defects to output port 2, while only a little energy is converged at output port 1. At this moment, it is indicated that the terahertz wave switch is at the “off” state for output port 1. Thereby, we realized a novel terahertz wave switch at output port 1.

Diagram 1 shows the corresponding time domain steady state intensity response, and it is as short as around 0.3 ns. The switching rate is related to not only the response time of polymer material, but also the system response time. As we know, the response time of polymer material is supposed to be about tens of fem to seconds which is smaller than the system response time. As a result, the switching rate of the proposed terahertz wave switch is of 0.3 ns.



Diagrams. 1. Time domain steady state intensity response of (a) “on” state and (b) “off”

5. Description and Results

This optimization was analyzed to improve maximum rate of normalized power of constant state indicated at figure 1. So, two kinds of simulation were carried out to increase maximum rate of normalized power of constant state with two parameters of changing silicon cavity radius and polymer radius. We should note two points about finding maximum rate of normalized power of constant state. The first point is applying start time of power calculation. Calculation starts when output reaches constant state. So, start time of power calculation is taken into consideration as 300 ps.

In order to improve figure 1 of ‘On’ state and also to find constant state, we used time monitoring and calculator script of constant state maximum. This script uses settings of time monitoring as follows:

```
x_span = %x span%;

add time;

Set ("name", "output");

set ("simulation type","2D Z-normal");

set ("monitor type ","Linear X");

set ("start time",300e-12);

set ("down sample X",100);

set ("output power",1);

set ("output Ex",0);

set ("output Ey",0);

set ("output Ez",0);

set ("output Hx",0);

set ("output Hy",0);

set ("output Hz",0);

set ("min sampling per cycle",50);

set ("x",0);

set ("y",0);

set ("z",0);

set ("x span",x_span);
```

Also, maximum calculator script is as follows. This code places maximum rate of output normalized power at MAX variable.

```
Pout = get data ("output", "power");
MAX = max (Pout);
```

The achievement of R lattice sweep 2 parameters of silicon radios and polymers will change at some time to result the fig of potential of maximum normalization. 2D fig. below shows the changes of these two parameters and color spectrum of maximum normalized potential.

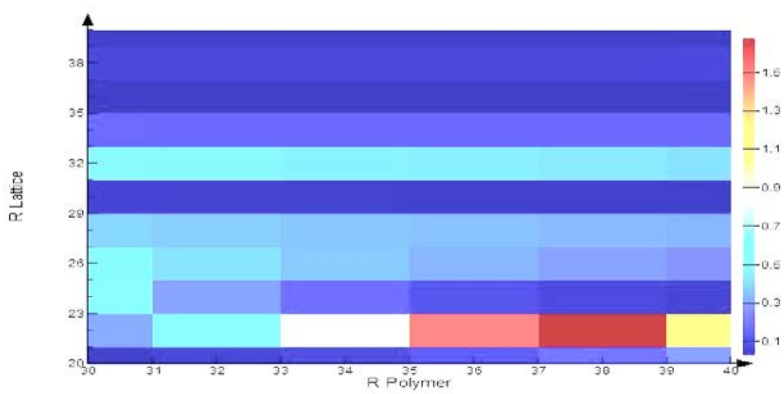


Diagram.2. The maximum color spectrum power normalized (on)

As it is shown in Diagram for Radius of 37 to 39 micrometer of polymer and Radius of 21 to 23 of silicon cavity, we have potential increase and this increase is about 1/8 and it shows the improvement of system. For validating this increase we have drawn a linear fig. for change of polymer Radius at Radius 22 micrometers.

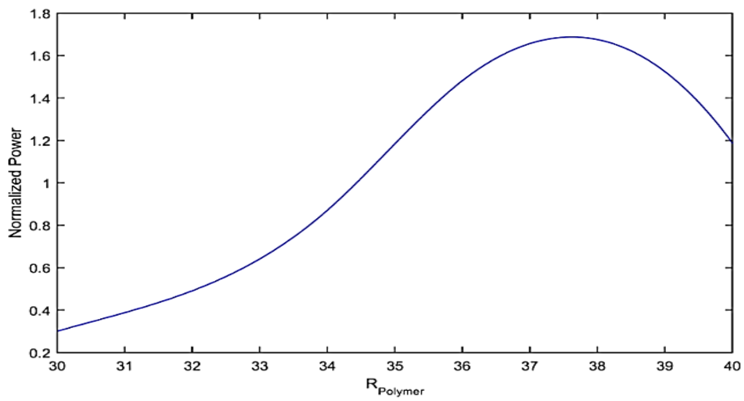


Diagram.3. Linear power output depending on the radius changes (on)

As it is presented at the fig., the maximum resulted potential will reach to 1/8 at radius of 38 micrometer for polymer and 22 micrometers for silicon cavity and the system will have improved performance and it is reported that maximum potential at fig. will be 1a- 0/85 through achievement of R Lattice sweep for fig-2b. 2 parameters of silicon and polymer radius will change following fig. shows color spectrum and rate of maximum normalized potential.

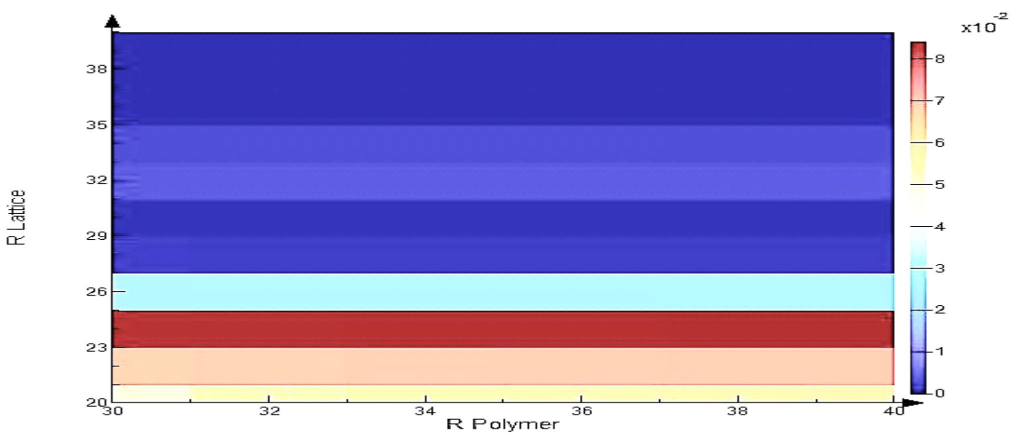


Diagram.4. The maximum color spectrum power normalized (off)

As it is shown in Diagram we have increased the radius of 30-40 micrometer for polymer and radius of 23-25 for silicon cavities. This increase is about 0/08 and it validates the improvement on performance of system. For validating this potential increase the liner fig of exiting power due to changes on radius of polymer with 24 micrometers is drawn.

As it is shown at Diagram with radius of 40 micrometers for polymer and 24 micrometers for silicon cavity the maximum potential will reach to 0/08 and system will have a better performance and the maximum reveals at fig. 1b is 0/045.

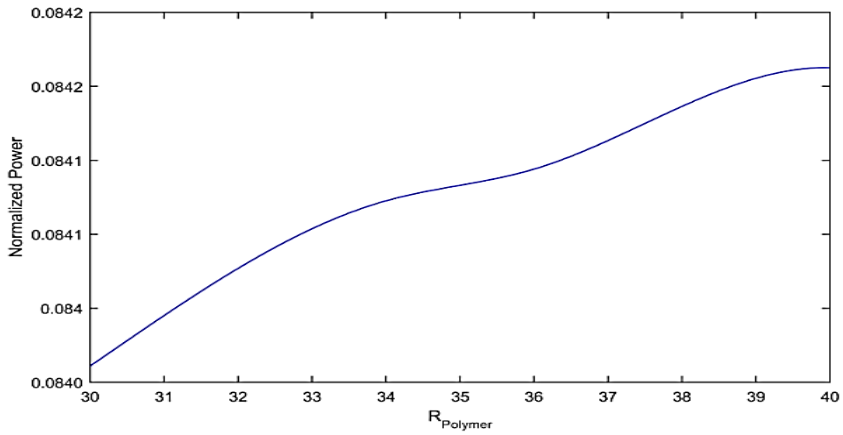


Diagram.5. Linear power output depending on the radius changes (off)

6. Conclusion

Working on simulating with soft wear of numerical for reaching to transmission spectrum of normalized from port1and extending, the electrical environment of constant condition from Terahertz and time of switch and for improvement of maximum normalized potential for stable condition, 2 figs. of 2a and 2b were analyzed. And 2 simulations were achieved to increase the reach for stable condition.

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