# Simulation of the an All Optical Switch in Linear State

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**ABSTRACT**
Switching is a principle process in digital computers and signal processing systems. The growth of optical signal processing systems, draws particular attention to design of ultra-fast optical switches. In this paper to investigate the operation of the photonic crystal switches, several methods are described. Among different methods, FDTD is a preferable method and is used. We have studied the application of photonic crystal lattices, the physics of optical switching and different types of all optical photonic crystal switches. In this paper, an all optical switch based on photonic crystal directional coupler has been simulated and analyzed by the finite difference time domain (FDTD) method. In this paper, a different structures with changes in central row rods (0.12a) in all optical directional coupler switch have been proposed then electric field intensity and the power output that are two factors to improve the switching performance and the device efficiency, have been investigated and simulated by using COMSOL software.

**KEYWORDS:** Photonic Crystals, All Optical Switches, Linear State.

## 1. INTRODUCTION

Photonic crystals are made of Nano scale structures that either allow or block individual wavelengths of light, depending on the frequency of their dielectric constants. Each wavelength of light has a unique physical size, which is what causes them to appear as different colors. In order for a wavelength to be allowed through a photonic crystal's structure, it must be compatible with the crystal's dielectric fields. Wavelengths that can pass through these structures are called modes and groups of modes are called bands. Wavelengths that cannot pass through these structures are known as photonic band gaps. While wavelengths produce pure colors in photonic crystals, they tend to blend together at the photonic band gaps [1]. This causes extreme colors to appear on the photonic crystal's surface, thereby producing strange optical phenomena. Photonic crystals have several properties that make them advantageous. For example, photonic crystals can be constructed on the centimeter scale to interact with microwave frequencies in the same way that Nano scale photonic crystals interact with optical frequencies. All optical switches have been under intensive study in recent years for example optical filters [2], resonators [3] and switching [4, 5]. Fig.1 illustrates photonic crystal, it is simulated by using COMSL software.

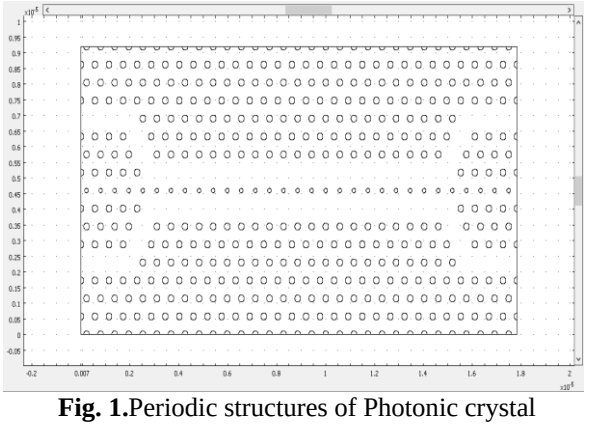

**Fig. 1.**Periodic structures of Photonic crystal

## 2. ALL OPTICAL SWITCHES

A photonic waveguide is created by removing some pillars in a photonic crystal structure. Depending on the distance between the pillars a photonic band gap is obtained. Within the photonic band gap, only waves within a specific frequency range will propagate through the outlined guide geometry. Nowadays, several technologies of switching are available and the number is being investigated [6-8]. The optical switch structure based on photonic crystal (PC) directional coupler is shown in Fig. 2 the device is made of two dimensional hexagonal PC structure. The Central rods radius in directional coupler switch is 0.12a, a is the structure lattice constant in this paper, it is considered 575nm. This switch is designed where wavelength is

1550nm the six ports of the coupler are tagged in Fig.2. The rods have radius of 0.2a [9].

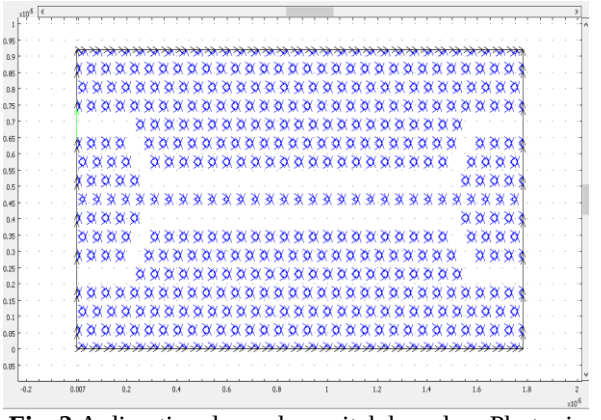

**Fig. 2.**A directional coupler switch based on Photonic crystal

The TM band gap of the structure, as depicted in Fig. 3, is in the range of $0.2735 \leq a/\lambda \leq 0.3833$, where $\lambda$ denotes the optical wavelength in free space.

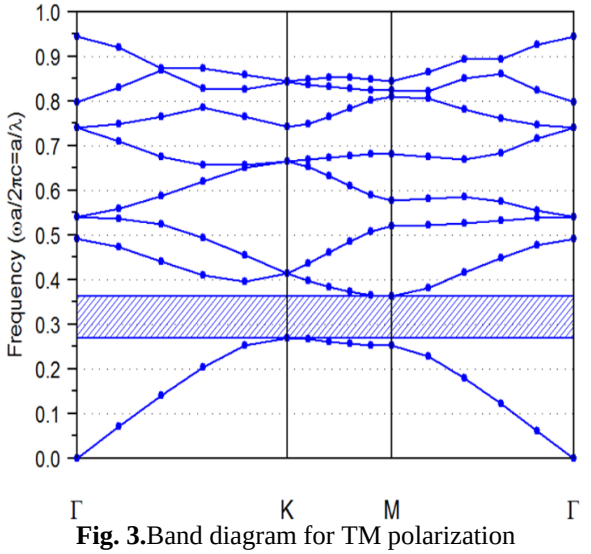


**Fig. 3.**Band diagram for TM polarization

An all optical directional coupler switch is demonstrated by Fig 4.in fact a linear switch is simulated. The refractive index of the central row is unchanged in the linear state, the coupler is operated in bar state.

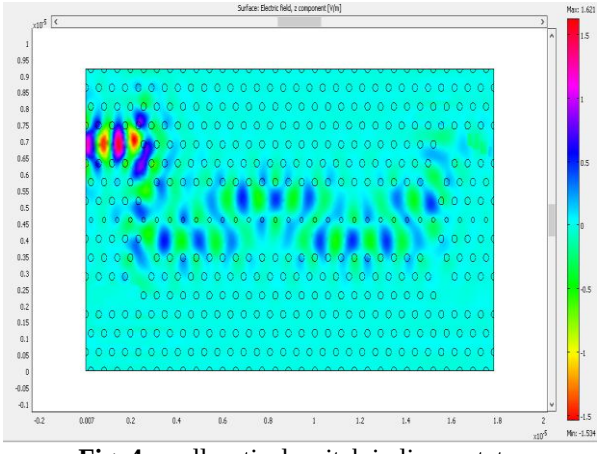

**Fig. 4.**an all-optical switch in linear state

Fig.5 shows the three-dimensional plot of wave propagating of the z component of the electric field that is simulated by using COMSOL software. It clearly shows the propagation of the wave through the guide.

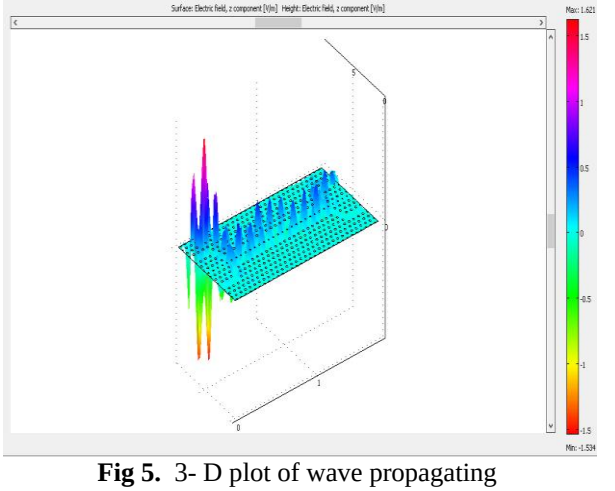

**Fig 5.** 3- D plot of wave propagating

## 3. RESULTS OF SIMULATION

Simulation and analysis of photonic crystal is done by using COMSOL software. By removing some of the AlGaAs pillars in the crystal structure a guide can be create for the frequencies within the band gap. Light can then propagate along the outlined guide geometry. So electric field can illustrate the propagation of the wave through the guide. Normalized electric field for our proposed structures is shown by Figure 6.

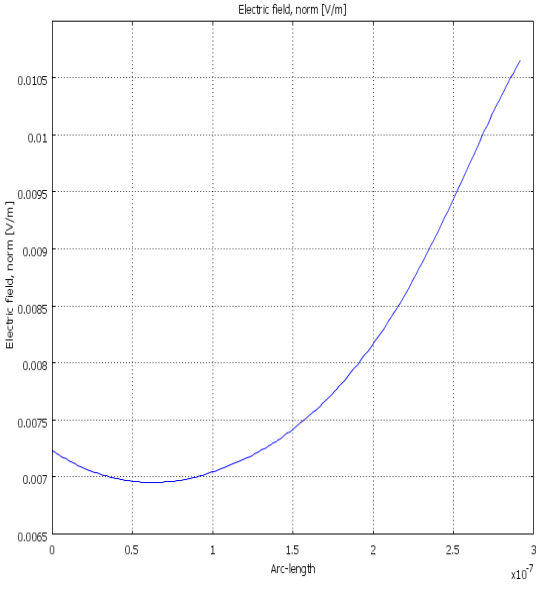


**Fig. 6.**normalized electric field for our proposed structures

Some factors improve performance of devices, power output can evaluate Photonic crystal efficiency. Figure 7 contains a plot of normalized power flow where the highest and lowest power for the proposed structure in state linear are illustrated. One of the most important factors in designing and analyzing is output power and numerous applications are found by super flexible in power output.

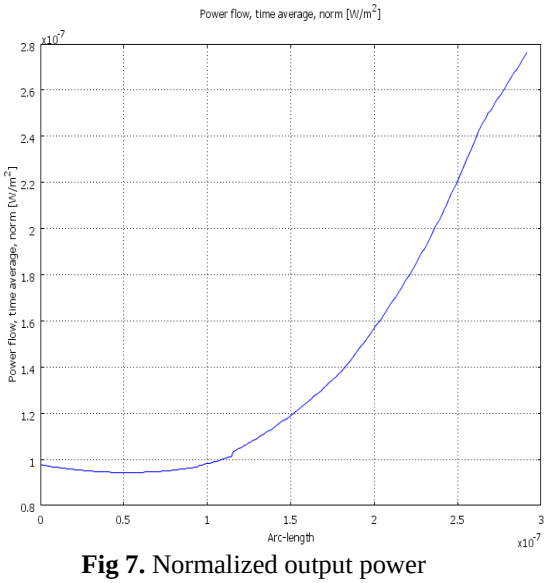


**Fig 7.** Normalized output power

## 4. CONCLUSION

The photonic crystal optical switch is one of the important applications of photonic crystals in telecommunication networks. Switching is a principle process in digital computers and signal processing systems. In this paper an all optical directional coupler in linear state has been simulated. Central rods radius in directional coupler switch is defined 0.12a.This switch has been analyzed by FDTD method.in order to simulation of considered optical switch COMSOL software has been utilized.

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