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Three Port Add Drop Filter based on Two Way Waveguide using Photonic Crystal

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Abstract: In This paper, optical Filter based on photonic crystal ring resonator with square lattice is proposed. The add-drop filter is designed by coupling in line quasi waveguide and resonant cavity. Photonic band gap is obtained by plane wave expansion method (PWE) and Simulation is carried out by Finite Difference Time Domain method (FDTD).This type of add-drop filter provide high transmission efficiency through drop waveguide that is 58% after numerical analysis.

Keywords: Photonic Crystal Ring Resonator, FDTD method, PWE method, Photonic Crystal, Add Drop Filter.

1. Introduction

For past many years, photonic crystal plays important role for designing an optical device using one dimensional, two dimensional, three dimensional photonic crystals. Photonic crystals are materials or inhomogeneous dielectric media with periodic variation of refractive index in some particular dimensions [1]. Photonic crystal are more popular today because it has more attractive features such as the propagation modes can be control by PC, provide accuracy in PBG calculation , easy in design and easy in fabrication capability. Photonic crystals are much better than conventional optical filter because guiding light possible through air in PC and guiding light through air provide many advantage such as, reduction of absorption losses, reduction of nonlinearity, high power transmission.

A photonic band gap is the region or range of frequencies where the light cannot propagate through the structure. Add Drop filter is the most important device to select or drop the required wavelength in optical network. Ring Add-Drop filter widely used in optical network comparison to other conventional ADFs eg. Bragg Grating Based filters Fabry Parot filters and ring resonator based filters because of its spherical mode. Photonic crystal ring resonator have one major advantage that is it does not provide any bending losses. Today's dielectric play have a effective approach in optical communication and it provide a particular path for light in waveguide, That's why today photonic crystal have innovative approach in optical communication scenario[2].

II. Designing Structure and Analysis

In this design, Add-Drop filter based on square lattice structure in two dimensional photonic crystal. This Add-Drop filter consist silicon rods in x and z directions. The number of rods in x and z direction are 21.These silicon rods have lattice constant 540 nm (distance between two air holes) and radius 0.1 µm.

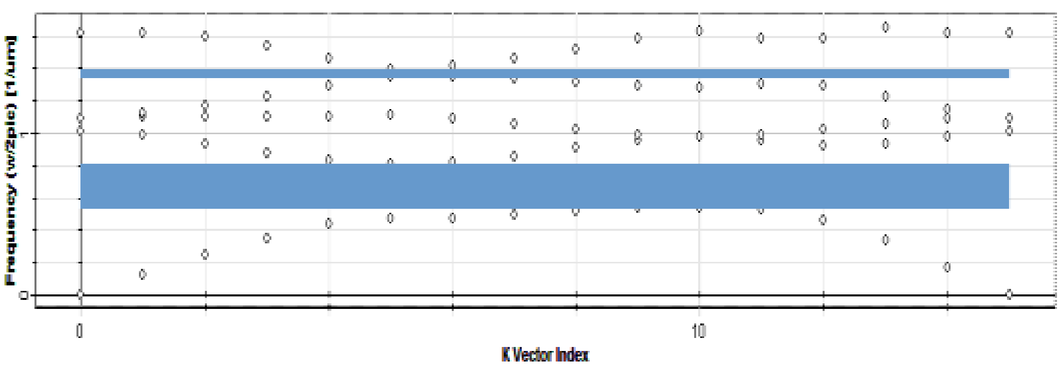

Figure 1. Band diagram of square lattice without introducing defects

The band diagram shown in figure 1. Describe the band diagram for square lattice structure without introducing defects (line defects and point defects).This PBG has Transverse electric (TE) mode only. Here, TE mode is used because whose electric field is parallel to the axis of silicon rods. This square lattice structure has two TE PBG. For first PBG ranges is from 0.295 a/λ to .435 a/λ whose respectively wavelength ranges is from 1241 nm to 1830 nm .For second PBG ranges is from 0.732 a/λ to 0.754 a/λ whose respectively wavelength range from 716 nm to 737 nm.

A ring resonator placed between two optical waveguide to transfer optical signal from one waveguide to another waveguide in Γ-X direction. Figure 2. Shows that, In Top waveguide input port marked by "A" and output port is marked by "B", that is called bus waveguide. In bottom waveguide port "C" and port "D" are called drop waveguide. These drop ports define forward dropping (Port "B" and port "C") and backward dropping (Port "D) respectively [1].

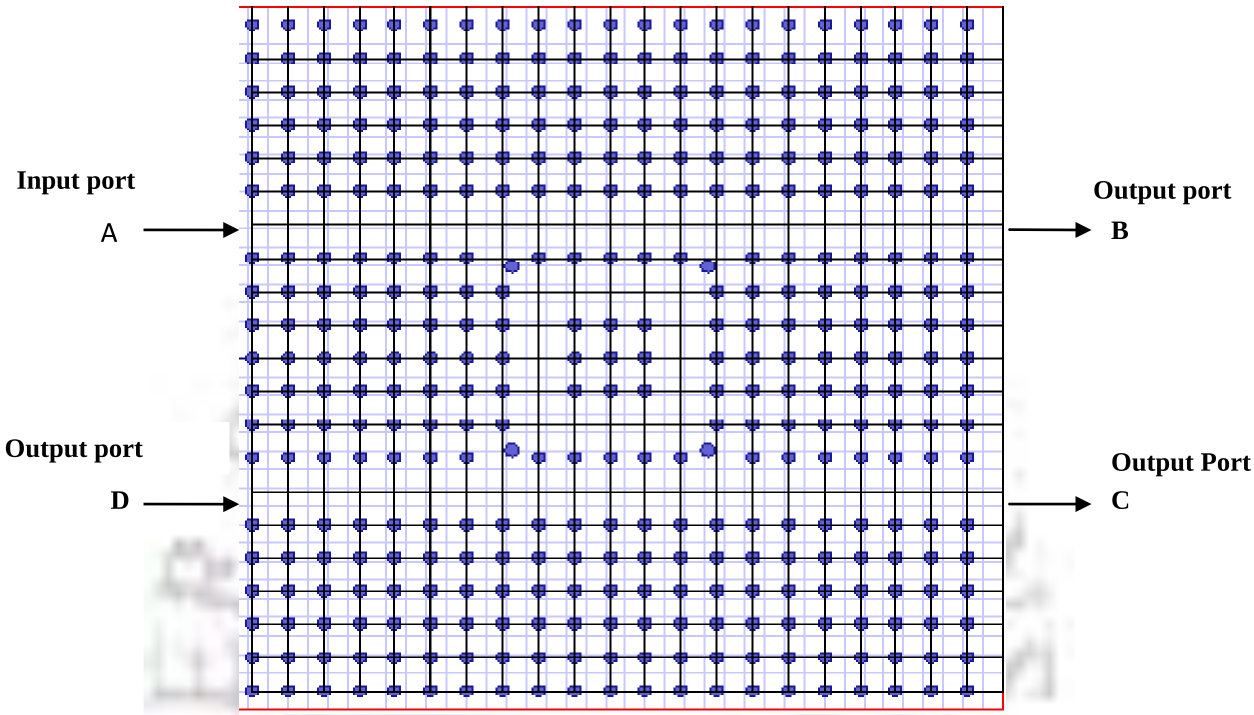

Figure 2. Schematic structure of Square lattice PCRR

Figure 2. Shows that by introducing line defect and point defect this structure are made. The rods which is positioned inside ring resonators are called inner rods and coupling rods are destined between ring resonators and waveguide. The rods which are positioned at the corner of square PCRR are called scattered rods which are used to prevent backward reflection. These scattered rods are used to enhance coupling efficiency also. These scattered rods are placed at each corner of square PCRR with half lattice constant [3].

III. Simulation and Results

A Gaussian input signal launched into input port which is marked by "A". In this design, Fast Fourier Transform(FFT) normalized transmission spectrum is obtained for port "D" and port "C", which is calculated by 2D FDTD method. Fig.3. describe normalized transmission spectrum. This Simulation shows 58% dropping and coupling efficiency for resonant wavelength of created ADF is from 1574 nm. The coupling efficiency defined as the ratio of output power at port "B" to input port "A". The dropping efficiency is defined as the ratio of output power at port "D" to input power at port "A". In this diagram by varying size of inner cavity ,coupling and dropping can be examined [4].

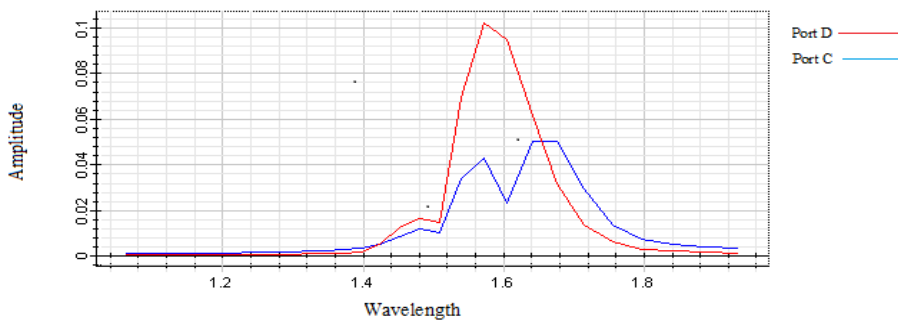

Figure 3. Normalized Transmission spectrum of square shaped PCRR

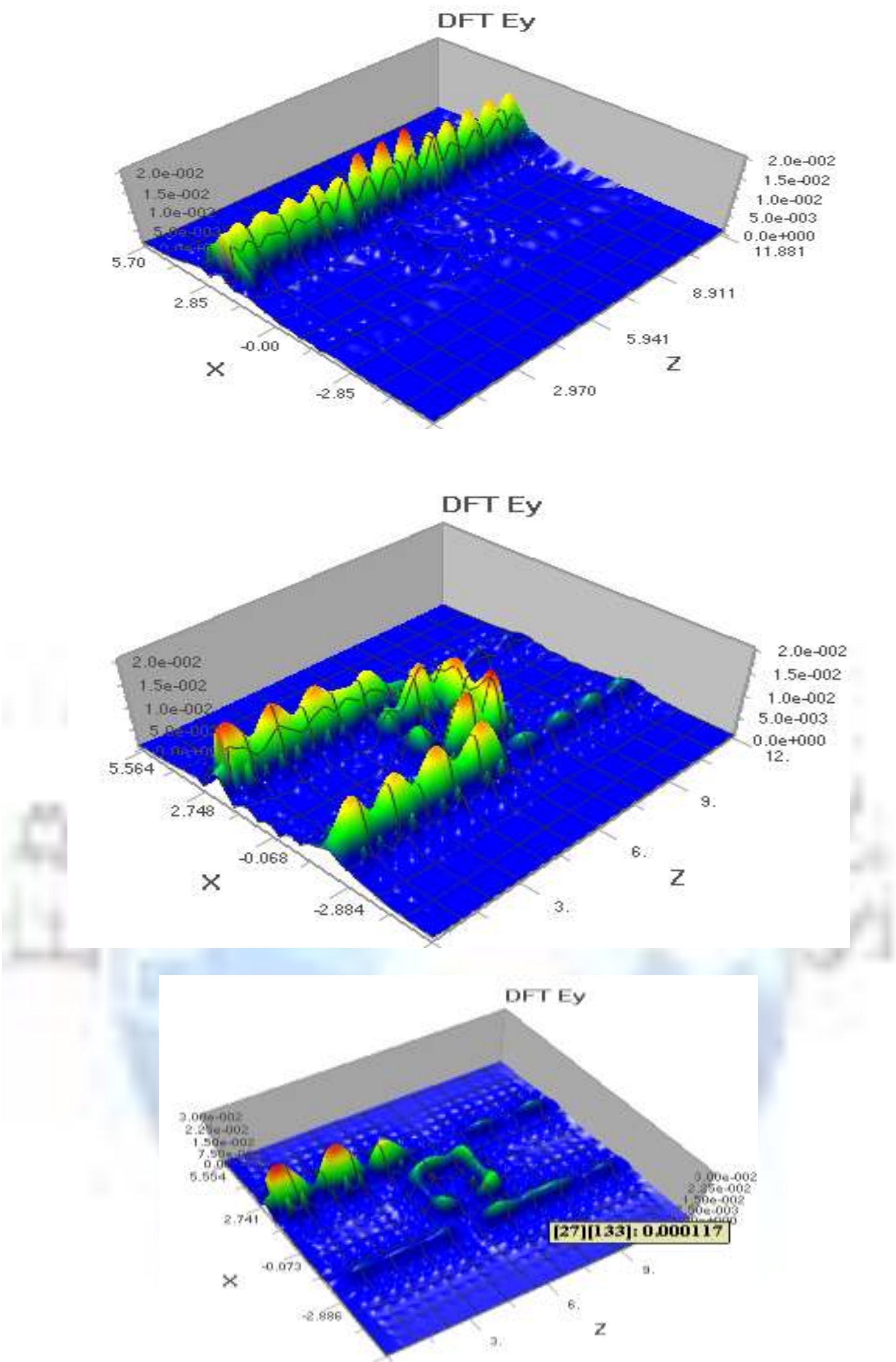

Figure 4. Electrical field pattern of square shaped PCRR. (a) 1372 nm (b) 1572 nm (c) 1678 nm

Figure 4. defines the electric field pattern of stop and pass band regions at wavelength (a) 1372 nm (b) 1572 nm (c) 1678 nm respectively. the electric field of bus waveguide is fully coupled with resonator cavity at At resonant wavelength 1572 nm. And provide backward dropping efficiency. Fig.4(a) shows the signal directly pass through bus waveguide and reach at terminal and provide forward dropping efficiency of square shaped PCRR [5].

Conclusion

In this paper, Add-Drop filter based on square lattice photonic crystal ring resonator is proposed through numerical analysis and theoretically analysis. This simulation results shows 58% coupling and dropping efficiency for proposed square shaped PCRR. The overall size of wafer dimensions is 11.2 µm x 11.4 µm. This square shaped add-drop filter would be more useful for future access.

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