Ultra compact and low crosstalk triplexer based on photonic crystal waveguide

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***Abstract* –We propose an ultra compact and low crosstalk triplexer based on the X-type photonic crystal structure. It has been shown that the striplexer with the size as small as 36µm^2 can be designed at λ=1.55µm, λ=1.49µm, and λ=1.31µm.**

I. Introduction

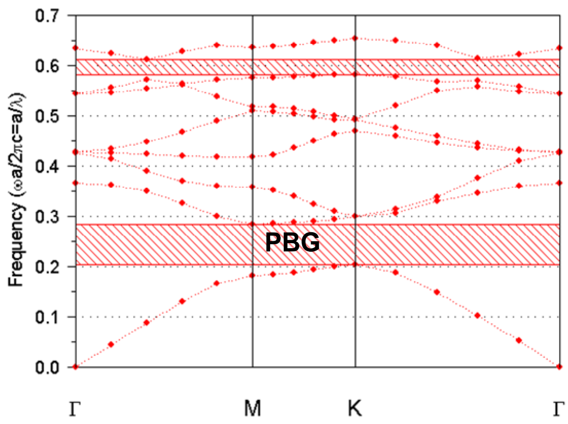
In recent years, two-dimensional (2D) photonic crystal (PC) slab waveguides are attractive for novel applications in a miniaturized photonic integrated circuit (PIC). PC can exhibit photonic band gaps (PBGs) [1], the frequency rangs in which light propagation is completely prohibited in any direction. Supporting defect modes within the PBGs, a PC waveguide can efficiently manipulate propagation of electromagnetic waves at subwavelength sizes. 2D PC waveguides are investigated extensively, because of their potential use as polarization filters, power splitters, demultiplexers, and lens [2-4].

Triplexer [5-6] is one of the most important key components for ultra-dense integrated circuits in optical communications. To construct a compact PIC on a single chip, a 2D PC waveguide intersection is an important element for optical wiring in the PIC as well as bend, branch and directional coupler. A triplexer is a (de)multiplexer for three specific wavelength, plays a very important role in a Fiber-To-The-Home (FTTH) system. According to ITU G.983 standard, the three commonly used wavelength 1310nm, 1490nm, and 1550nm.

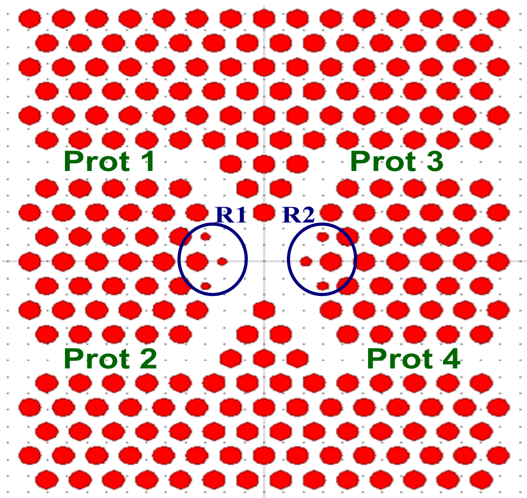
We present the numerical simulations to describe the operation principle of the three-channel demultiplexer. This concept leads the way to a practical realization of PC components for WDM.

II. Numerical Results and Analysis

We proposed a two-dimensional (2D) PC structure consists of a hexagonal array of air holes with radii of r=0.3a, where a is lattice constant. The background refractive index is chosen for silicon materials (n=3.6). It has a photonic bandgap for a TE mode (in-plane electronic field) in the normalized frequency range from 0.2 to 0.28 c/a in Fig. 1(a), where c is the velocity of the light in a vacuum. An intersection is formed by a line-defect waveguide composed of one missing row of air holes, and this device is shown in Fig. 1(b). This device has four channels in the line defect waveguide. The incident light is launched from port 1; the others are output for the three specific wavelengths. The radii of small air holes are R_1=0.12a and R_2=0.15a, respectively. Such unsymmetrical structures can effective separate wavelengths, and towards the assignation port output. The transmission performance is shown in Fig. 2. The results show two high power of wavelength can be separated in port 3, and port 4.



(a)



(b)

Fig. 1. (a) Band structure of the photonic crystal structure. (b) 2D planar four-channel photonic crystal (de)multiplexer structure.

The numerical results show high transmission performance in port 3 and port 4. However, the crosstalk was obvious may cause larger losses for each port.

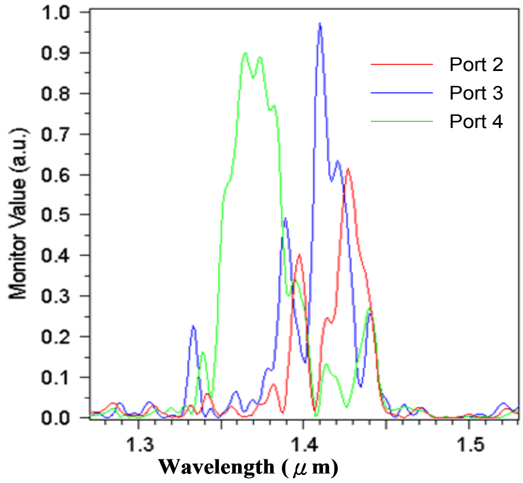


Fig. 2. The transmission spectrum with R_1=0.12a and R_2=0.15a.

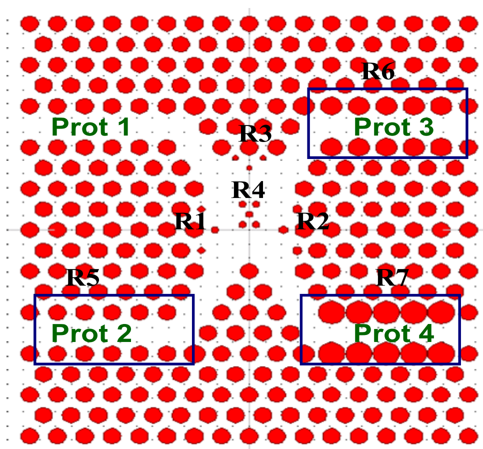
III. Simulation results

In order to reduce crosstalk between each port, we further modify original structure, as shown in Fig. 3(a). For the proposed structure, the R_3 and R_4 are 0.096a and 0.128a, respectively. By property changing the waveguide width of R_5, R_6, and R_7, the crosstalk is effective decreased to achieve a good filtering performance. We define R_5=0.326a, R_6=0.384a, and R_7=0.48a, and the transmission performance is shown in Fig. 3(b). The numerical results show that the crosstalk of every channel can be decreased. And we can detect low crosstalk of every channel. The low crosstalk for this structure was showed in Tab. 1.

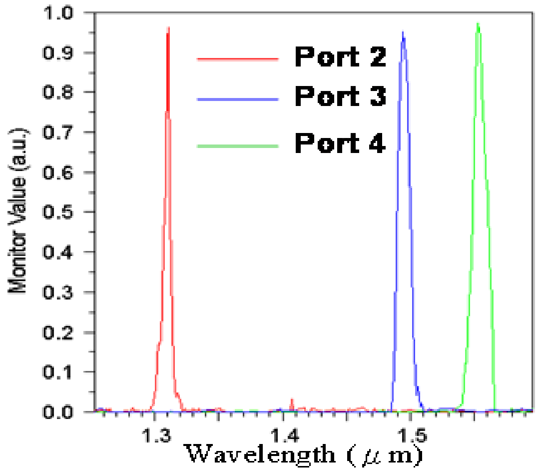
Tab. 1 The crosstalk of three outputs in novel triplexer.

	Ch1	Ch2	Ch3
Ch1		-34.26	-29.79
Ch2	-19.79		-28.56
Ch3	-37.12	-38.96	

Unit: dB



(a)



(b)

Fig. 3(a) The modified 2D triplexer based on the X-type photonic crystal structure. (b) The transmission spectrum.

IV. Conclusion

A novel triplexer by using X structure based on a two-dimensional photonic crystal with a hexagonal lattice of air holes in a dielectric substrate was proposed. This device has four channel of one input, and three outputs in line defect waveguide. This device can separate three wavelengths of 1.31µm, 1.49µm, and 1.55µm, respectively. According to FTTH systems of ITU G.983 standard, this device has advantages of the high-transmission, ultra compact, and low-crosstalk.

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