

ORIGINAL ARTICLE

Waveguide Based 1510/1530/1550/1570 CWDM Multiplexer & Demultiplexer

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ABSTRACT

The key component of high speed network realization is the wavelength separation device. Decreasing in channel spacing has require an optical device that able to identify and split the wavelength by means Demultiplexer. Designing optical demultiplexer with wide channel spacing is complex and requires very long coupling length to separate the wavelengths. In this paper we report the design of 4 CWDM wavelength demultiplexer using Beam Propagation Method (BPM).

Key words:

Introduction

High-speed consumer connections are becoming more prevalent due to the introduction of newer services such as online video, HDTV and IPTV. This is leading to significant connectivity bottlenecks in wavelength-division-multiplexed (WDM) transmission networks. The development of low-cost small footprint optical components has become essential to solve the bottlenecks. Currently optical components are built using various different material systems. Among them, Silicon-on-Insulator (SOI), which has the highest crystal quality, compatible with mature silicon IC manufacturing, provides a very attractive platform to develop low cost photonics components (Ab-Rahman, M.S. and S. Shaari, 2001; Ab-Rahman, M.S. and S. Shaari, 2004). One of the key photonic components in a

WDM system is the wavelength demultiplexer (DeMux). Two types of silicon-based DeMux have been investigated in the SOI platform. One is the arrayed waveguide grating (AWG), and the other is the etched diffraction grating (EDG). The significant size advantage of an EDG compared to an AWG makes it more attractive to develop for a low cost DeMux chip. In this paper, we present the development of an EDG DeMux in the SOI platform. A 10 channel CWDM DeMux which has 2.5dB on-chip loss, 13nm flat-top passband and better than 22dB adjacent crosstalk is demonstrated. Moreover, the loss and crosstalk are made insensitive to the vertical angle of grating facets by placing the receiving waveguides very close to the zero degree diffraction angle of the grating.

The Art of Design – Determination of Coupling Length:

Coupling Length is defined as the active area where the signals are alternately migrate from one waveguide to another waveguide. This can be achieved by designing a fundamental of coupling waveguide architecture as shown in Figure 1. Then the coupling length will determine according to the coupling profile that is generated automatically from the BPM software used. The detail of exact coupling length selection is shown in Figure 2.

Four wavelengths of CWDM are injected to the input port. Due to the evanescent field and two very closed waveguide the signal will be migrate to another waveguide alternately. Due to different of wavelength used, propagation constant and wave number has make the signal oscillation and distance of coupling has become different and finally the signal can be separated (Figure 3). In this case wavelength of 1510 nm and 1530 nm together exit at one output port while 1550 nm and 1570 nm exit at another output port. Thus the selection point of coupling length has been determined successfully.

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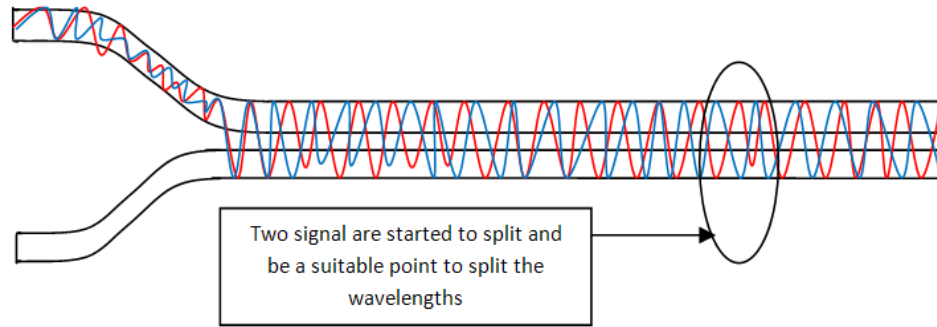


Fig. 1: Designing a fundamental of coupling waveguide architecture to determine the split point.

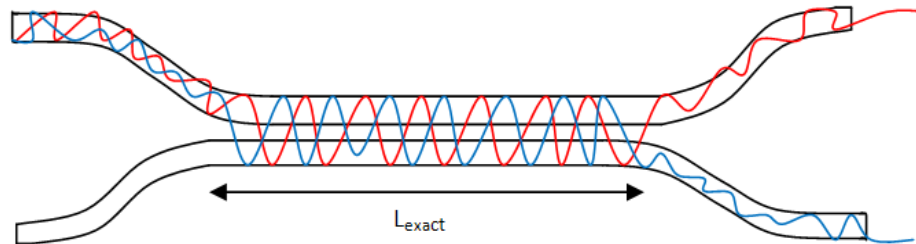


Fig. 2: Complete WDM coupler design to split two wavelengths according to different output port.

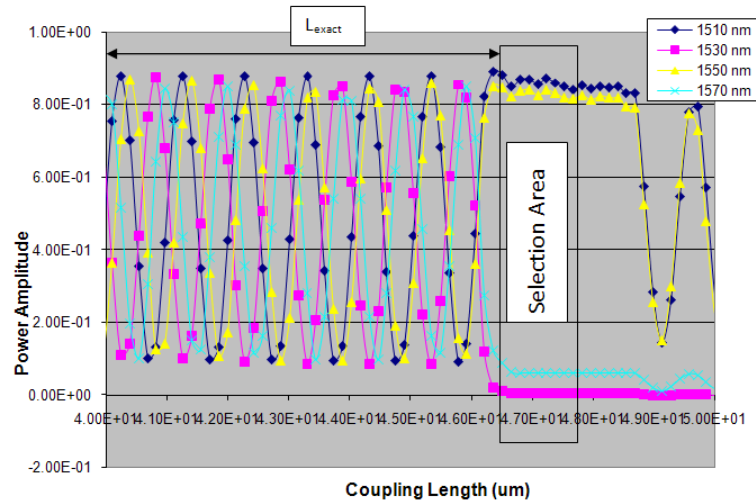


Fig. 3: Selection of exact coupling length to separate two wavelengths.

Result and Discussion

After the exact coupling lengths have been determined. They will be transfer back to the designed layout. Now the actual device is drawn again. Two separate four CWDM wavelengths may require 3 coupling lengths. First coupling length (Arm 1) is used to separate the wavelength into two groups which are 1510 nm & 1530 nm and 1550 nm & 1570 nm. The Second (Arm 2) and Third (Arm3) respectively used to separate the individual wavelengths. Figure 4 shows the coupling length for three different arms with Coupling Length of Arm 1 is 11.2 μm , Coupling Length of Arm 2 is 23.5 μm and Coupling Length of Arm 3 is 26.4 μm . Coupling Profiles for CWDM demultiplexer device are shown in Figure 5 and Figure 6 respectively.

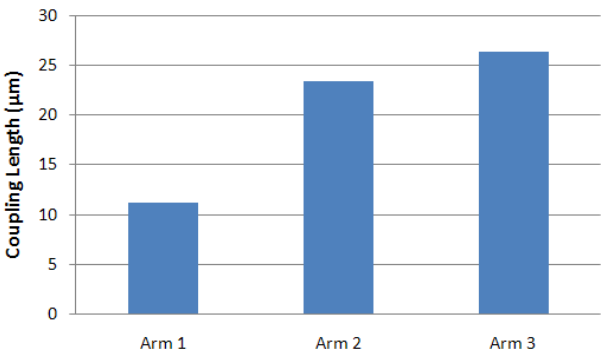


Fig. 4: Coupling length for three different arms.

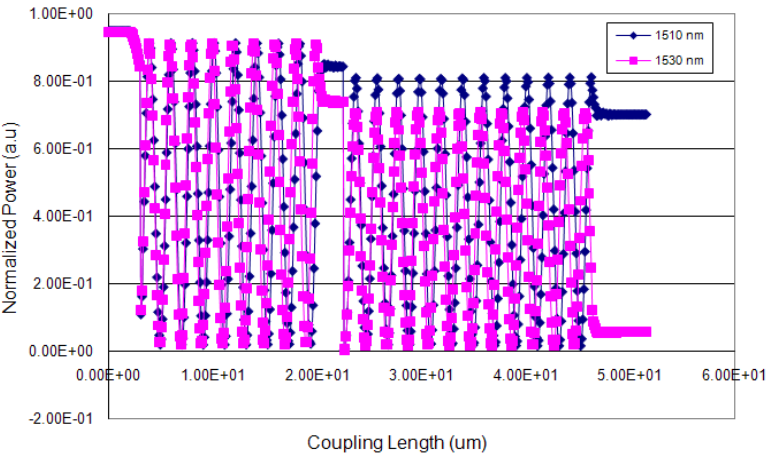


Fig. 5: Coupling profile in arm 1 two split wavelength 1510 nm and 1530 nm.

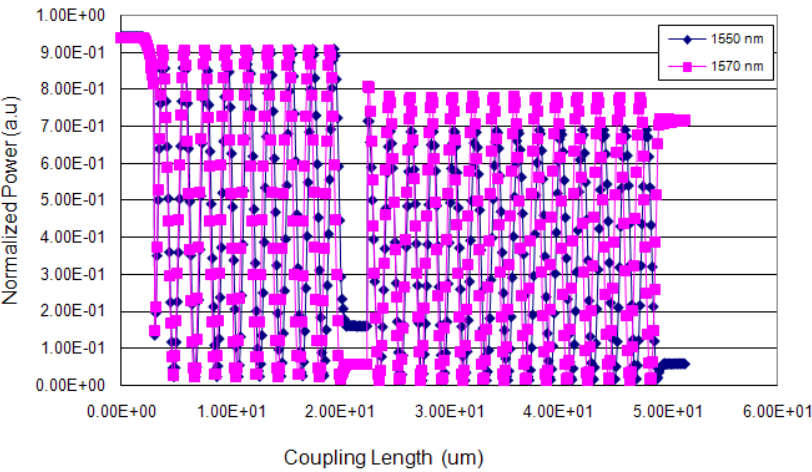


Fig. 6: Coupling profile in arm 1 two split wavelength 1550 nm and 1570 nm.

The simulation results are shown in Figure 7 until Figure10. Although the wavelength is separated completely however the leakages are still generated at every output port.

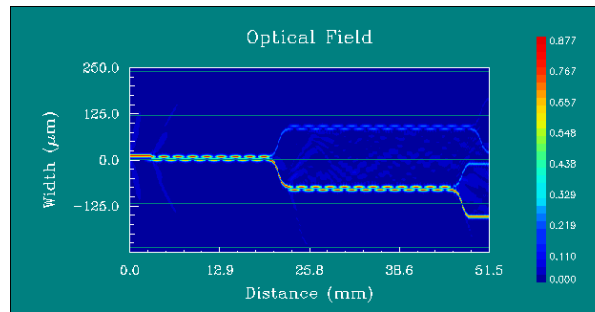


Fig. 7: Propagation profile when wavelength 1510 nm is dropped.

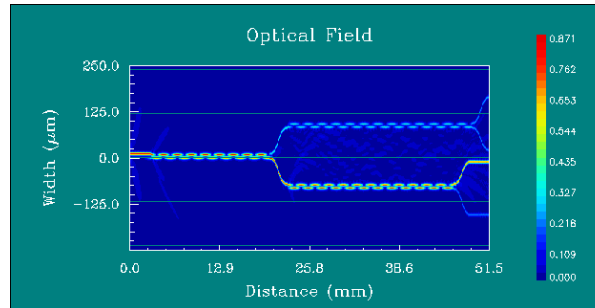


Fig. 8: Propagation profile when wavelength 1530 nm is dropped.

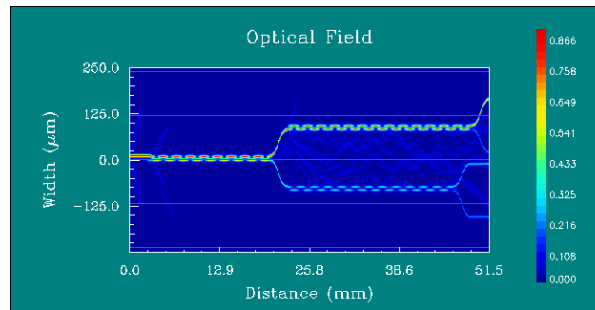


Fig. 9: Propagation profile when wavelength 1550 nm is dropped.

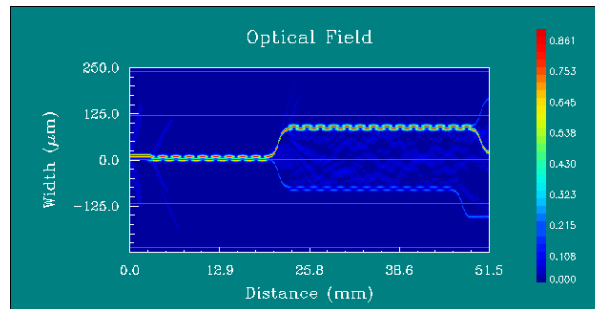


Fig. 10: Propagation profile when wavelength 1570 nm is dropped.

Conclusion:

We have designed 4 channel CWDM demultiplexers based on coupled mode theory and beam propagation method as the simulation tool. The devices use singlemode output waveguides to produce flat-top transmission spectra. The total device length is 51.5 mm and . The fabricated devices have very large and have the potential

to provide a low cost demultiplexer solution. But if the modification imposed to the device (such as thickness and interruption) may reduce the device length as reported in our previous publication.

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