MZI based Silicon photonic circuits for arbitrary power splitting application

Shamsul Hassan[1], Devendra Chack [2]

[1, 2] Department of Electronics Engineering, Indian Institute of Technology (ISM) Dhanbad
E-mail : shamsulhassan786@gmail.com

1. Introduction

In recent years, Silicon photonics [1] has played vital role in the field of optical communication, optical sensor applications and On-chip optical interconnects. Silicon on insulator (SOI) is a nice platform for the integration of photonics and electronics device on the same chip. Optical power splitter is a fundamental component for Photonic integrated circuits (PICs). So, it is necessary to have adjustable optical power splitter [2-3].

In this paper, Mach Zehnder Interferometer (MZI) based photonic circuit is designed using optical components such as Y branch splitter [4], silicon strip waveguides and 2 x 2 adiabatic coupler [5]. The MZI has two arms having different path length to impose phase difference between them. So, we have designed the circuit to obtain arbitrary splitting of power at the output port by adjusting the path difference.

2. Modelling and simulation

In the circuit, imbalance MZI is used for adjustable power splitting application. It constitutes of Y branch at input to split the signal into two paths and adiabatic coupler to obtain the output at two different port 3 and 4. The silicon strip waveguides (w=0.5 µm and h=0.22 µm) is used to guide the propagation of light. The simulated mode profile of the waveguide is shown in Fig. 1.

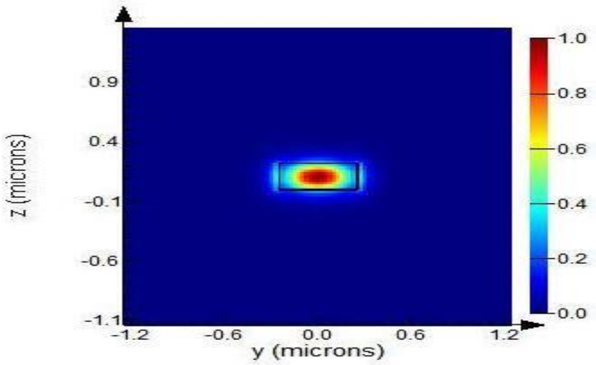

Fig. 1. Mode profile of strip waveguide

In the above figure, we can observe that the optical power confinement is highly in silicon core region. The length of one arm of MZI is 20.0 µm and the other arm is varied according to power splitting ratio. The optical transfer function of imbalance MZI is expressed as:

$$\frac{I_0}{I_i} = \frac{1}{2}\left[1+\cos\left(\beta_1 L_1 - \beta_2 L_2\right)\right]$$

The circuit simulation is done for TE polarization using Lumerical (Interconnect) design tools. The transmission spectrum of the circuit is shown in Fig. 2. over the 100 nm wavelength range. For the different value of ΔL, the output power is shown in Table I.

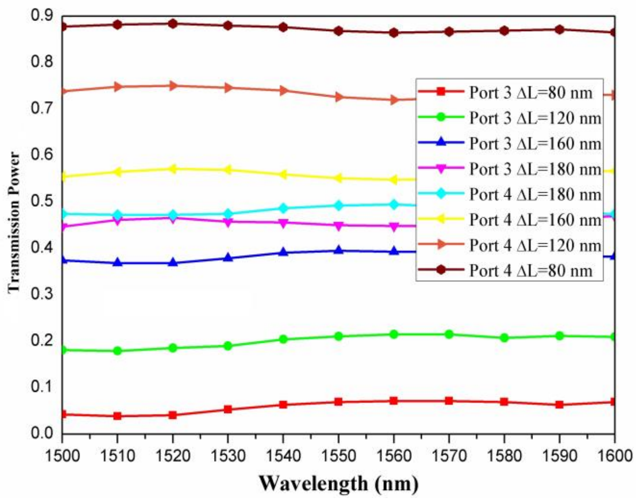

Fig. 2. Transmission spectrum for different ΔL

Table I Arbitrary Optical output Power

ΔL (nm)	Power (Port 4)	Power (Port 3)
80	0.86	0.09
120	0.73	0.23
160	0.55	0.40
180	0.5	0.46

3. Conclusions

From the above results, we observe that the power splitting ratio is depend on path difference and it is changing for very small change in length. The circuit has power splitting ratio nearly 3:1 and 1:1 for path difference 120 nm and 180 nm respectively. Moreover, the circuit is compact, wavelength insensitive over C-band and having low losses. The circuit can be used in PICs and Passive optical networks.

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