International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 2 Issue 8, August - 2013

Design and Simulation of Litao3, Y-Branch Optical Power Splitter and Study on Variation of Transmitted Power with Wavelength in The Device

AUTHORS: Dr. C.P. Vardhani[a], S.Neelima[b]

[a]Assistant Professor, Dept. of Physics, Osmania University, Hyd-07, A.P., India.

[b]Research scholar, Photonics research lab, Dept. of Physics, Osmania University, Hyd-07.

Abstract---A low loss single mode Y-branch optical power splitter with a wide gap between the two output waveguides, is designed using Titanium diffused LiTaO3 waveguides on LiTaO3 platform such that the power splitter divides equally the input power into the two branches with minimum loss. Its performance is simulated by Beam propagation method.

This article presents the study on variation of transmitted power with various wavelengthsof the input wave.

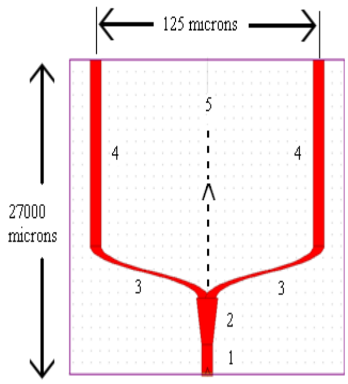
Introduction:

Photonics is a key driving technology of the 21st century and the basis of the present-day internet and long distance communications [1]. Of the various basic optical structures, signal splitting is one of the most important. As a material for integrated optics, LiTaO3 is a promising alternative to LiNbO3 because of its attractive properties such as strong electro-optic and non-linear effects similar to those of Lithium Niobate and a much higher resistance to optical damage (15kW/cm² at 0.5145 µm wavelengths [2]) and it has low loss at desired communication wavelength 1550 nm.

Design of the Y-branch Power Splitter:

This device is designed using titanium diffused lithium tantalate waveguides by RSOFT cad tool. Lithium Tantalate (LiTaO3) is an attractive host materials for various applications due to its large electro-optic and nonlinear integrated optical property which is a good alternative for Lithium Niobate Fig:1 illustrates the top view of the Y-branch optical power splitter.

This low loss single mode 1x2 Y-branch optical power splitter (fig1) is formed of a straight input waveguide (for receiving an input signal), two s-bend sin arc waveguides that meet at the linearly tapered waveguide at its leading edge, joined to the input waveguide and two straight output waveguides that are attached to the two S-bend waveguides. A sharp inner edge is formed where the two waveguide meet, forming equal branching angle for the two s-bend waveguides, which facilitates equal (50/50) splitting of the Y-branch[3]. The output waveguide are symmetrical about the propagation axis which is along the length of the device. Wide gap between the two output waveguides is desirable for the reduction of excess losses [4]. The distance between the two output waveguides is 125µm (centre-to-centre). The total length of the device is 27000 µm. The taper length is 4mm and the width of the waveguides is 6µm.



1→Straight inputwaveguide
2→ Linearly taperedwaveguide
3 → S-bend waveguide
4 → Straight output waveguide
5 → Direction of propagation

Fig1:Y-branchpowersplitter (Top view).

Simulation and its Results:

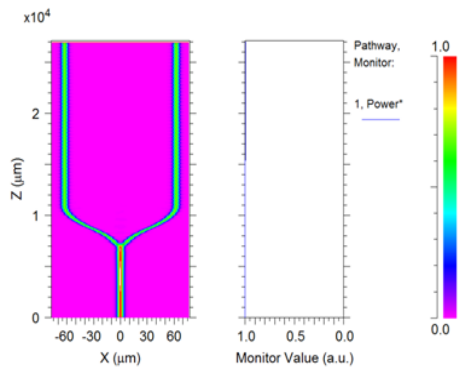


Fig2: simulation of optical signal in power splitter

Mode Profiles:

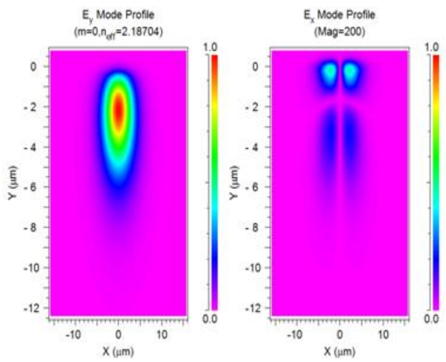


Fig3: Simulation of the Mode profile and effective refractive index across the width of the optical splitter at the wavelength 1550nm, Width 6µm.

The Beam propagation method is used to simulate and study the effects of variation of different parameters in this power splitter of length 27000µm.The red colour inside the straight input waveguide of the device indicates that the input power is 1 (Watt) which remains same till the branching starts in the device. As the branching starts the power splits in the two arms equally which is indicated by the green colour in the two arms. Simulation is done by varying wavelength; The index difference is maintained to be 0.002.

Simulation result gives the transmitted power which is tabulated and the insertion loss (power loss) and the attenuation coefficients are then calculated using the following formulas:

$$\mathbf{IL = 10log_{10} (P_1/P_2)} \quad \text{dB\textbackslash mm} \quad (1)$$

Where **IL** is the Insertion loss of an optical splitter and is usually measured in decibels (dB).

P_1 is the given input power (1 Watt) and

P_2 is the output transmitted power in Watts.

$$\alpha = IL/L \quad \text{dB\textbackslash mm}$$

α is the attenuation coefficient measured in decibels.

ILis the insertion loss in dB.

L is the length of the device (27000µm).

Variation of Wavelength:

The wavelength of the input wave is varied in the range 1.52 µm to 1.58 µm in the steps of 0.01 µm. The transmitted power, P_2=0.99watts for the input power P_1=1Watt is obtained at the wavelength 1550nm and above, with the other parameters kept constant i.e. branching angle 2θ=0.6degrees, width=6 µm, index difference=0.002.

Variation of transmitted power with wavelength is given below.

S.No.	Wavelength λ (µm)	Transmitted power P_2 (watts)	Power loss (dB)	Attenuation coefficient α (dB*10^{-5})
1	1.52	0.99101	0.03921	0.1452
2	1.53	0.99101	0.03921	0.1452
3	1.54	0.99034	0.04215	0.1561
4	1.55	0.99105	0.0390	0.144
5	1.56	0.99105	0.0390	0.144
6	1.57	0.99105	0.0390	0.144
7	1.58	0.99105	0.0390	0.144

Table.1

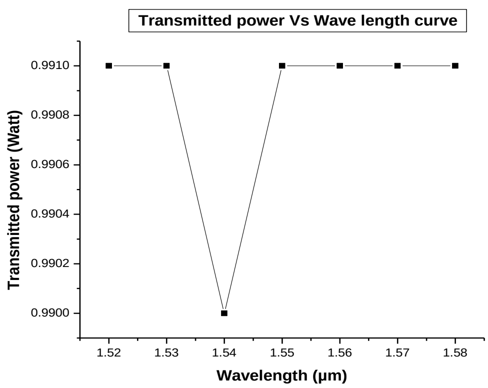


Fig4:The graph shows the Transmitted Power variation with change in Wavelength,which is almost constant .

CONCLUSION:

On the Lithium Tantalate platform the Y-branch power splitter is designed and simulated. With the help of simulation results the variation of transmitted power with different parameters is studied. The insertion loss and the attenuation coefficient is calculated using the above mentioned formulae. It is found that this optical device is giving maximum output at wavelength 1550nm, branching angle 0.6degrees, and with width of the components as 6 µm. It is found that the power loss is less than 0.1 dB. This low loss results from Lithium Tantalate waveguides. Their model characteristics, fiber optic compatibility together with the ability to modulate the refractive index in the MHz range makes them a potential candidate for high accuracy interferometer sensors and optical fiber transceiver applications. One potential application is an integrated optic gyroscope.

Acknowledgement:

We expresses thank to the members of DRDO(Delhi), CEERI (Pilani), and RCI (Hyderabad) Labs for their valuable and constructive ideas.

References:

[1]. N. R. Council, Harnessing Light: Optical Science and Engineering for the 21st Century (National Academy Press (Washington, D.C.), 1998)

[2]. Glass & Peterson 1972

[3]. United States Patent – Johannessen et al. Patent No. 6,970,625 B2, Nov. 2005

[4]. Design of a low loss Y-branch optical waveguide _By Minoru SATITO, Hideki ONO and Hiromi TAKHASHI Jpn. J.Appl. Phys. Vol.38 (1999) PP.115-116, Part 1, No.1A, January 1999

[5]. H Nishihara, M Haruna, and T Suhara, RE Fisher and W J Smith (Edi) in Optical Integrated Circuits, McGraw-Hill, USA, Optical and Electro-Optical Engineering Series, (1989).

[6] The International Journal Of Engineering And Science (IJES) ||Volume||2 ||Issue|| 7 ||Pages|| 60-77||2013|| ISSN(e): 2319 – 1813 ISSN(p): 2319 – 1805

[7]"53 nm Wavelength Tunability due to a Curvature of S-Bend in Optical Power Splitter ": July 2013 Ajay Kumar, S. K. Raghuwanshi, and Santosh Kumar