1×4 Digital optoelectronic switch using mzi structure.

Rahul j.Thumar, prof. Rohit B. Patel

(Department of Electronics and Communication, Ganpat University, kherva.)
(Head of Department of Electronics and Communication, Ganpat University, kherva)

ABSTRACT :
The electro optic switch has wide application in optical network due to their high speed operation. In this paper, a 1×4 digital optoelectronics switch based on mach-zehnder interferometer structure on a single titanium diffuse lithium niobate substrate. The design is simulate on BPM-cad simulator for switch analysis and effect of driving electrode voltage. The study has been done on the effect of electrode voltage and performance of switching capability with reference to optical field propagation and refractive index propagation.

Keywords – **digital optical switch, mzi, electrode effect, refractive index, switching voltage optical field propagation.**

1. INTRODUCTION

A well selected switching technology play a major role in deciding the workable layout of any network and can improve accuracy, speed, scalability, reliability, if chosen and implement best possible way. The speed of optical switches is necessarily has to match with currently new generation photonic devices in which light is not only carry information but also control the switching path is much important. The electro-optic effect is a change in optical properties of a material in response to electrical field that various slowly with compared to frequency of light. Speed of this effect is less than 1 ns. Various optoelectronics materials with various structure such as mzi, y, mmi has been use to design optical switch such as LiNOb3, LiTaO3, InGaAs-AlGaInAs, photonic crystals etc. InP/InGaAsP Optical integrated MMI switches (shintaro et al., 2008) InGaAsP-InP MZI optical space switch (agrawal et. al 1995) are some examples.[1] A 2×2 electro optic switch based on mzi structure has introduce at 2008, [2]. and 4×4 banyan optical switch using optoelectronic mzi switches with low crosstalk has introduce at 2009, [3]. 1×4 Ti: LiNOb3 optical switch based on y structure has been introduce in 2009 with driving voltage 10v[4]. High performance Digital optical switch introduce for polarization independent is introduce at 2011,[5]. LiNbO3 can be doped with various dopants. Few among them dopants are titanium, iron, copper, magnesium oxide.[2] This paper propose a design of 1×4 digital optical Switch with titanium diffuse lithium niobate substrate using mzi structure with low driving voltage at electrode.

2. DESIGNING OF 1×4 MZI SWITCH.

The design switch allows switching directly in all optical domains avoiding conversion of E/O/E. This paper is oriented towards design of 1×4 integrated optical switch based on mach zehnder interferometer. The switch is created on z-cut wafer of lithium niobate and surrounded by air cladding. The switch is oriented along the y-optical axis of lithium niobate. The crystal lithium niobate has a crystal cut along z-axis and propagation direction along y-axis. Air with refractive index 1.0 is use as a dielectric material. The whole device is constructed on 65 mm long and 150 microns wide. Waveguide is formed by diffusion of titanium stripe in to lithium niobate substrate host at high temperature range from few hundred to several hundred Celsius. The lateral diffusion length Dh constant and diffusion length in depth Dv is 4.0 and 3.5 micrometer respectively. A strip thickness of titanium is 0.05µm. the waveguide has an 8.0 micrometer with Ti-diffuse profile. The has same refractive index as same as lithium niobate substrate. The 3D wafer properties include air as a cladding material with thickness of 2 micrometer and lithium niobate substrate with thickness of 10 micrometer. The device has been created using optibpm cad. A two electrode region with three electrode set is defined on the wafer structure for controlling the light propagation to different port of the switch with buffer layer. Thickness of buffer layer is 0.3µm. vertical and horizontal permittivities of buffer layer are 4.0 respectively. The thickness of electrode is 4.0 µm. electrode are defined with three region with different parameter. First region has electrode with 10 micrometers and 0v. Second electrode has 10 micrometer width and 1.3v. The gap between electrode 1 and 2 is 6 micrometer and gape between 2 and 3rd electrode is 6 micrometer. For controlling light propagation to desired port we change the center

electrode voltage of both electrode region set. The input plane is selected with mode as the starting field and 0.0 offset on z-axis. for simulation we the global data is set with refractive index modal and wavelength 1.3 micrometer. The 2D properties have set with TM polarization and 500 mesh points. We calculate 2D isotropic simulation. We varied the electron voltage of center electrode of each electrode region set.

3. Simulation and results.

After the input plane has been defined the global data has been set with refractive index model. Wavelength selected for simulation is 1.3 micrometer. The 2D properties have been set with TM polarization and 500 mesh point. The simulation engine is paraxial BPM solver and finite time difference is used. We did 2D isotropic simulation and observe the light propagation to desired port by changing the center electrode voltage. Figure1. Shows the wafer layout for the 1×4 optical switch based on mzi structure.. The layout is designed in optibpm cad waveguide designer.

The switching operation can be done achieved by properly biasing of 2nd electrode. So driving voltage is play an important role to in switching operation of designed switch. The switching at port 1, port 2, port 3, port 4 were obtained with proper biasing of 2nd electrode voltage. The driving voltage for stage 1 is required 6.75 voltages and for second stage is 9v.
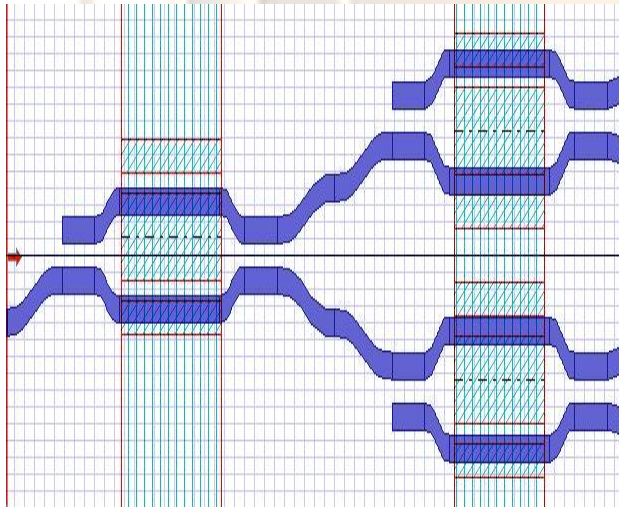

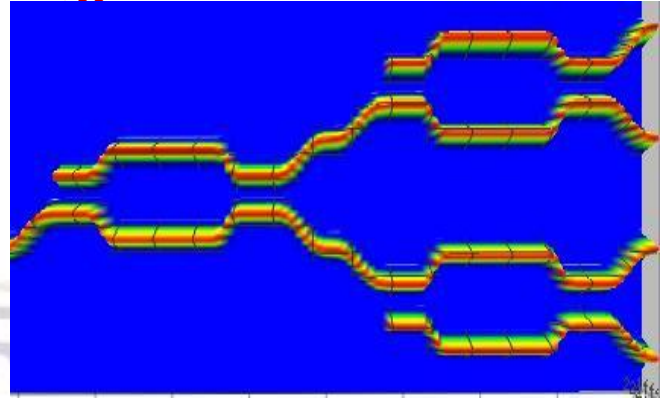Figure 1. A 1×4 optical switch using mzi structure.

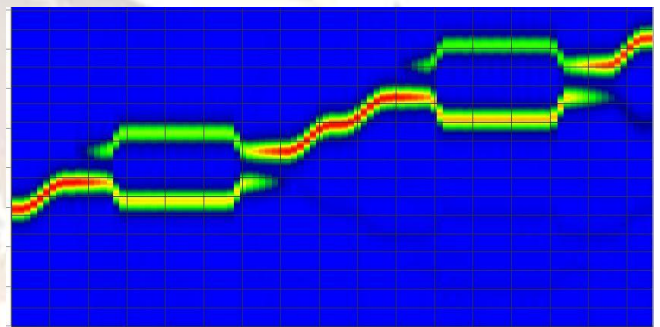Figure 2. refractive index propagation for xz slice.

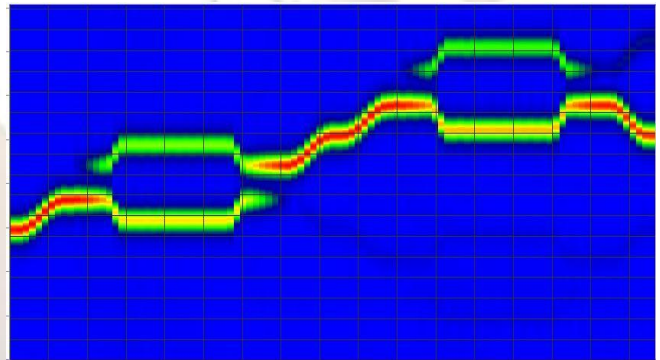Figure 3. Light propagation for port 1.

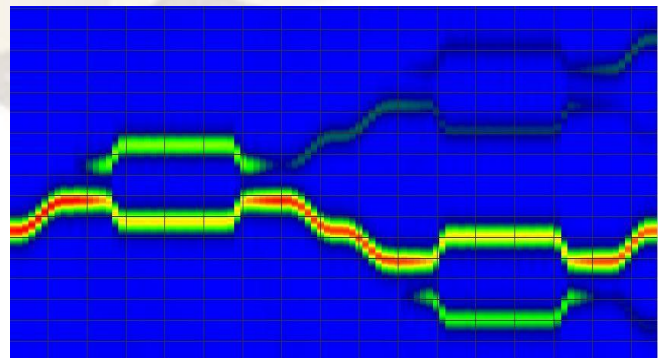Figure 4. Light propagation for port 2.

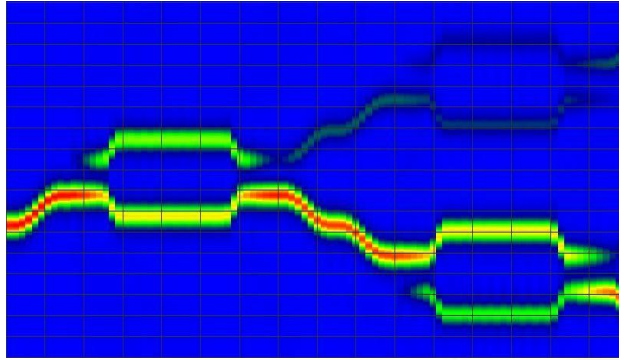Figure 5. Light propagation for port 3

.

Figure 6. Light propagation for port 4.

Above Fig. 3 to 6 shows the light propagation for port 1, port 2, port 3 and port 4.
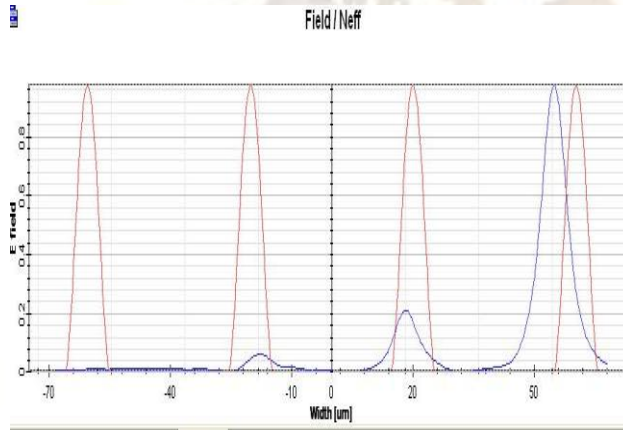

Figure 7. Optical field propagation for port 1.
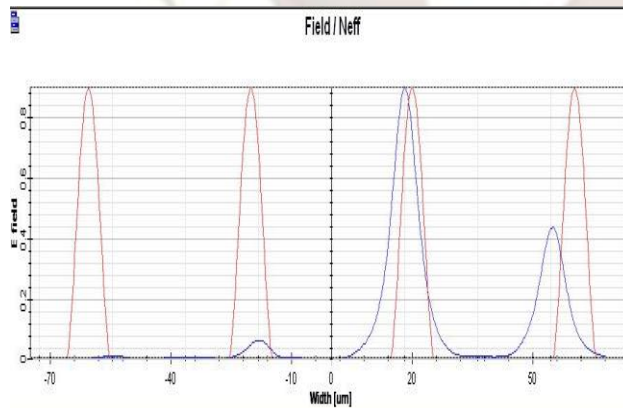

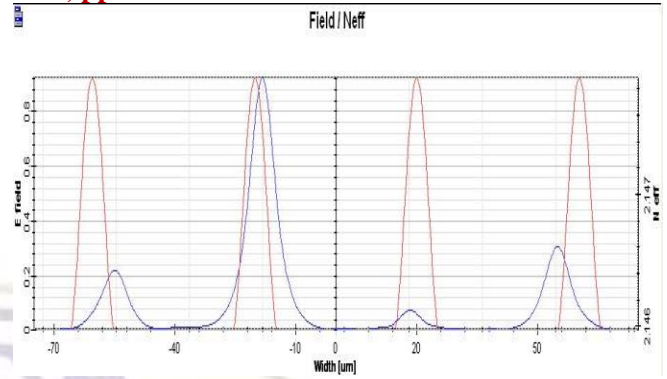Figure 8. Optical field propagation for port 2.

Figure 9. Optical field propagation for port 3.
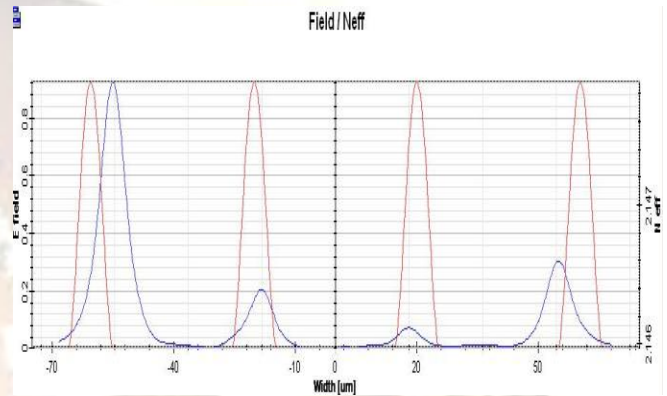

Figure 10. Optical field propagation for port 4.

Fig. 7 to 10 shows optical field propagation for port 1 ,port 2, port 3, port 4, respectively.

4. CONCLUSION.

The 1×4 optoelectronics switch using mach zehnder structure has been designed and simulated for light switching to desired port with low electrode voltage 6.75 for stage 1 and 9v for stage 2 means required less driving voltage for wavelength 1300 μm. compared y structure switch.   The future proposes work is to design a switch with less driving voltage or with same driving voltage for both stage by physical parameter change.

REFERENCES:-

[1]   G.Singh, R.P.Yadav, V. Janyani, Ti:indiffused lithium niobate mach-zehnder interferometer all optical switches. *A review new advance technology,* 311-320

[1]   [2] Ghanshayam shingh, R.P. Yadav, Vijay Jaynyani, and Aranab. Design of 2 × 2 Optoelectronics switch based on mzi and studies the effect of electrode switching voltage *World Academy of science, Engineering and Technology 39* 2008,401-407.

[3]   Vandana Sachdeva, Rajeev Ratan, J.S. Mahanwal, Design of 4×4 banyan optical switch using optoelectronic mzi switches with low crosstalk, *Indian journal of science and technology,vol.2 No. 10(oct* 2009) *ISSN:0974-6846,*48-51

[4]   Shurti Karla, Ghanshayam Singh, Vijay Jaynyani, R.P. Yadav. 1×4 Ti: LiNbO3 digital optical switch: design and performance analysis for THz operations, *International conference on optics and photonics Chandigarh, India ICOP-*2009,30oct-1Nov2009

[5]   S. Gupta, P. Jain, S. Bothara , V. Janyani , R.P.Yadav, G.singh ,High performance Digital optical   switch, *photonicslettersofpoland,vol.3(1),*2011,38-40

[6]   Mohammad Syuhaimi , Ab.Rahman , Khaled Mohamed Shaktur, Rahman Mohammad, an electro optic 3×3 switch based on integrated Mach-Zehnder Interferometer, *Proc.*8th *WSEAS international conference on applied electromagnetic, wireless and optical communication, ISBN* 978-960-474-167-0,ISSN:1790-2769,11-14