International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-8 Issue-6, August, 2019

Design A Sensor Mach Zender Interferometer for the Detection of Chemical and Organic Substances Present In Food and Health Drinks

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Abstract: ***This Paper includes the nano cavity implementation of the biosensors in the detection of any chemical analyte and pesticide. Chemical, organic substances or any biological analytes are deemed to be present in any food or soft drink. Detection of these kinds of analytes are the potential risk. Photonic Crystals are rapid and precise to reach the sky for the next future. The photonic crystal model simulation is performed using Beam Propagation technology, with change in the refractive index in one selected arm. Therefore the designed MZI acts as a bio sensing device to detect any kind of chemical, bio analyte and organic substances that are present in different food. MZI has many advantages in photonic crystal with the use of least instrument and ready to be compatible with CMOS technology. The experimental program is observed for minute change in refractive index, in this work. Mach Zender Interferometer shall behave as sensor for small change in refractive index of pesticide value and observed power and intensity thus will be accounted. Indicates that it is highly sensitive for the changes in refractive index and in turn it can differentiate between normal food which do not contain any chemical and pesticide present in food.***

Keywords: ***Mach Zender Interferometer using beam prop; Nanocavity-coupled waveguide; photonic crystal; Rsoft.***

I. INTRODUCTION

Pests, organic chemicals and unwanted plants will be damaged by the pesticide which is basically a chemical compound. It can be used in public health to spoil different kind of disease, such as mosquitoes. For human body Pesticides are potentially toxic [1]. In soft drinks, bottled water, and food, pesticides are found. Each drink was tested for common insecticides including 16 organ chlorine pesticides, 12 organ phosphorus pesticides.

Centre of safety excellence experimented and observed high level of toxic pesticide and that causes the high level cancer and damage to lever, nervous system and making very low immune system. The drink and carbonated beverage Section Committee, FAD 14,of the Bureau of Indian Standards has been ruminated on the issues of pesticide which is present in the soft drink.

There are different kinds of sensor that can be constructed using photonic crystal to detect the pesticide but MZI which is containing some best features and easy to maintain and fabricate as sensor. Based on the MZ interferometer, MZI receives optical continuous wave and that will be splinted into two branches and each contains its phase shifter. With good sensitivity MZI is used to detect the pesticide chemicals. MZI is proposed with arms, among them one is used for sensitive purpose and other one is used for reference purpose. Therefore micro ring resonator structure may not be used in photonic crystal which is cost effective for POC (point of care) application. In order to achieve the low detection limit, the addition of high precision fabrication technique is required to obtain the high quality device. Compared to micro ring resonator sensors, MZI sensor is easy to design **[2**].MZI based sensor can be demonstrated by using different types of material such as silicon oxides. Siliconoxynitride, silicon nitride silicon-on-insulator (SOI), and even polymers.

II.THEORY

Core and cladding are the basic arrangement of Optical integrated circuits. Some features of optical integrated circuit are i) single-mode optical wave propagation **[3].** ii) Easy to control the waveguide. iii) Short interaction length and low operating voltage. iv) Optical power density is large. iv) in order to measure the phase shift between the two beams if there is a change in length of one of the path of the interferometer and that has been used among other things [**4**]. There are many applications such as aerodynamics, plasma physics and heat transfer and temperature design, this kind of designed sensor can be used. The basic feasibility is the light can be easily controlled in the reference channel without disturbing the light in the object which makes the Mach Zender configuration channel popularized in holographic interferometer. In order to form higher-index guiding layers on substrates and that is possible by deposition, thermal in diffusion, ion exchange, epitaxial growth [**5**]. For fabrication of 3-D waveguides micro fabrication techniques, including photolithography, dry or chemical etching, and lift off techniques, is required. There are different types of materials to represent a waveguide. These materials are polymer linbo3, glass, and SOI. In this paper we have proposed SOI material because it is easily available

Revised Manuscript Received on October 30, 2019.
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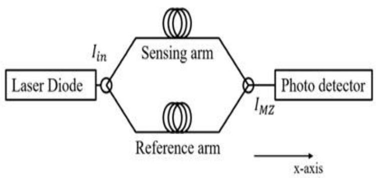

Fig. 1: Main block diagram of MZI

III WORKING PRINCIPLE

Mach- Zender interferometer (MZI) is a ultrasensitive and compact temperature sensor which is based on an in-line Analyze filled-PCF-based sensor. Some Features like electromagnetic interference, fast response; high sensitivity, compactness and robustness are present in MZI construction and that factors which bring photonic sensors into the spotlight. This MZI is integrated in lab-on-chip diagnostics and provides the facility to perform some operation for point-of-care capacity at an inexpensive cost. There are two core modes for MZI configuration. The two cores modes are LP01, LP11 modes and these two modes are usually utilized as optional arms to form inline.

There are many processes to fabricate the 3D waveguide. The listed processes are Micro fabrication techniques, including photolithography, dry or chemical etching, and lift off techniques.

In order to design and fabricate proper waveguides, using of accurate materials and right processes is very much essential. The effective refractive index (Neff) of the waveguide mode is changed because of changing in the ambient refractive index via the passing field interaction. This phenomenon implies the working principle of interferometer.

$$\Delta Neff = \frac{\partial neff}{\partial nambient} \qquad (1)$$

$$s = \frac{2\prod L}{\lambda}\frac{\partial Neff}{\partial nc} \qquad (2)$$

$$\Delta \emptyset = \frac{2\pi L}{\lambda} N_{eff} \qquad (3)$$

$$\Delta I = \frac{1}{2}(1+\cos\Delta\emptyset) \qquad (4)$$

MZI device is constructed with the help of Silicon-on-insulator (SOI) material [6]. MZI waveguides comprising two slots wave guide such as Strip waveguide and slot wave guide. In order to achieve a high sensitivity, MZI uses slot waveguide instead of conventional sensor of a sensing path [7].MZI can have four parts. The four parts are named as coupled separated section, tapered waveguide section, input straight waveguide and isolated separated section. There is one branching section in the coupled separated section and that makes an alpha angle. This alpha angle has advantages in determining power loss at the output of strip wave guide. Strip wave guide is used as reference arm and sensing arm is slot wave guide.

IV.SENSOR DESIGN

Design description for MZI:

Table-I: Shows the measurement of MZI structure

Tool of Simulation	Beam prop
Wave length of the excitation	1.55um
Width of component	5
Index of background	1.46
Index difference	1.98
Dimension	3-dimension

Strip waveguide implies the reference arm and a slot waveguide implies the sensing arm. We have proposed and designed MZI sensor as a chemical sensor. Consider the configuration it is fragmented that light is tied into a strip waveguide and divided into two arms with a Y junction and recombine again after certain distance [**7-9**]. The intensity modulation is caused by the interference of light traveling through two arms of the interferometer of the waveguide.

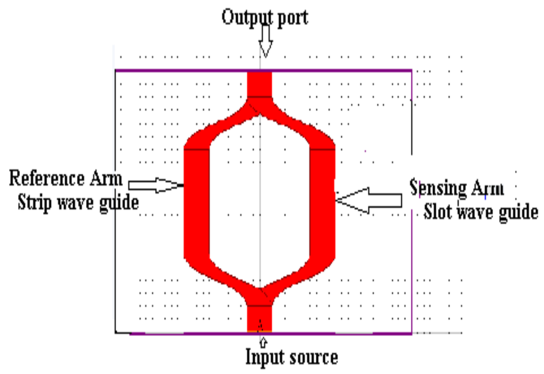

Fig. 2: Basic Structure

MZI is about 7 nm which is shown in figure 2.

By using Beam-prop technology, the sensor MZI is designed [9]. If there is change in designed value that causes the fabrication error variation in terms of width of waveguide.

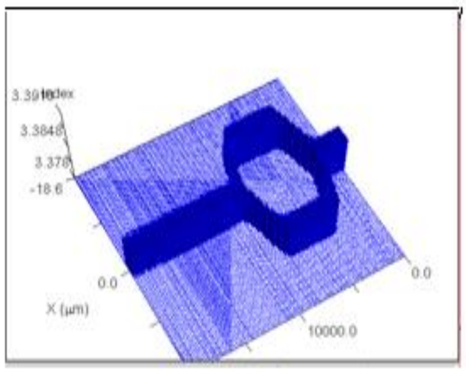

Fig. 3: Structure of MZI is designed in contour map.

Retrieval Number F9226088619/2019©BEIESP
DOI: 10.35940/ijeat.F9226.088619
Journal Website: www.ijeat.org

Published By:
Blue Eyes Intelligence Engineering
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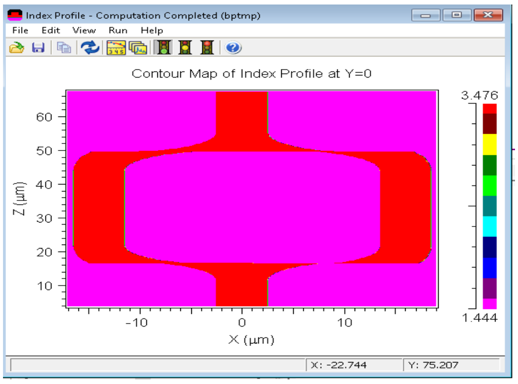


Fig. 4: MZI structure with index profile

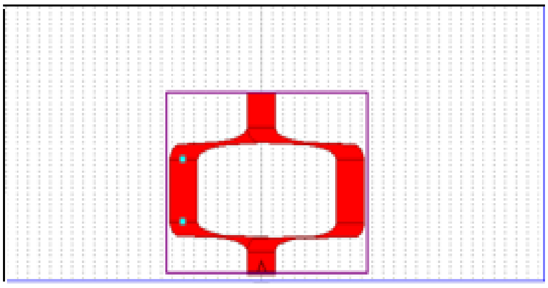


Fig. 5: Designed in 3D structure Using Beam prop

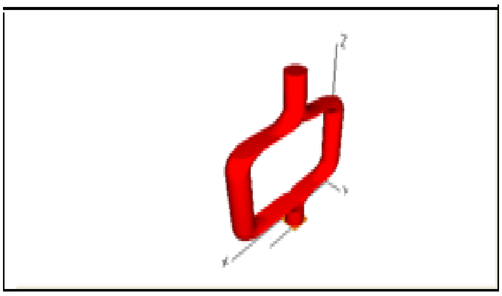


Fig. 6: Designed in 3D structure Using Beam prop

V. RESULTS AND DISCUSSION

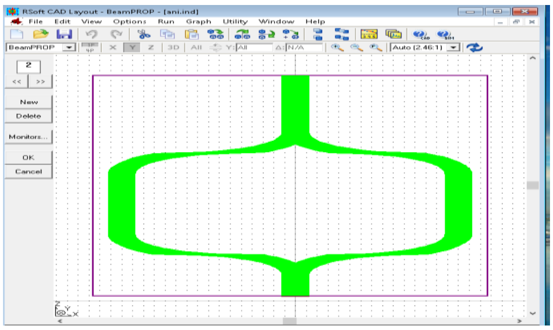
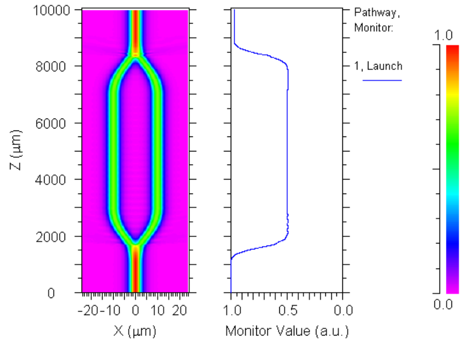
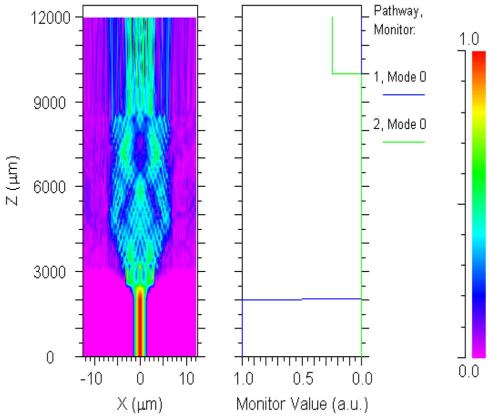


Fig. 7: Selected path for light propagation through input and output



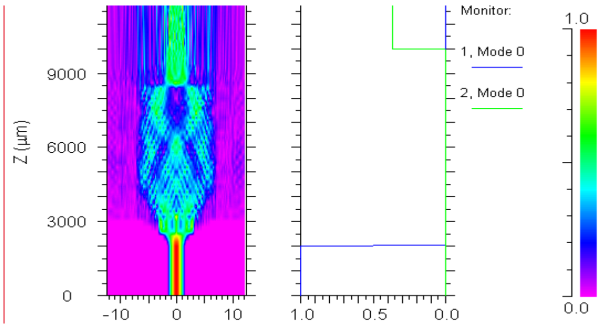
Graph 1: Propagation of the light through the sensor and observed Power without coating (absence of R.I value) for both the Arm.

After applying the RI value choldrane, there is power change in the Mach Zender chip.



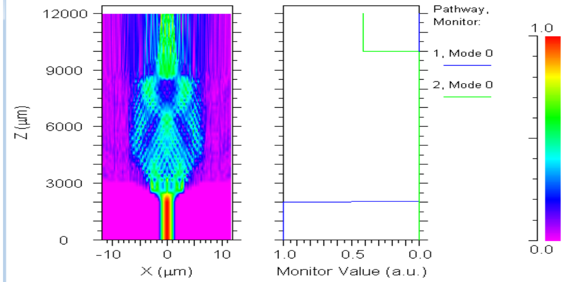
Graph 2: Power observed and reduced to 22 %

Applied ri value ddt to the sensing arm



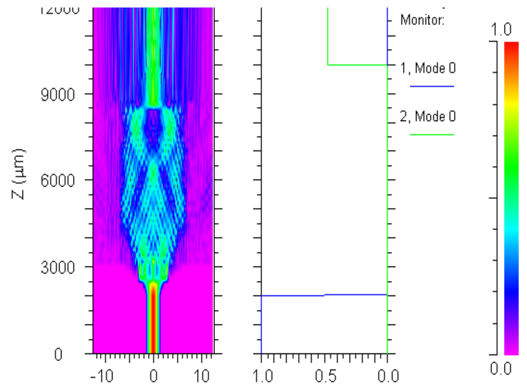
Graph 3: Power observed and reduced to 38%

Applied ri value of phorate to the sensing arm



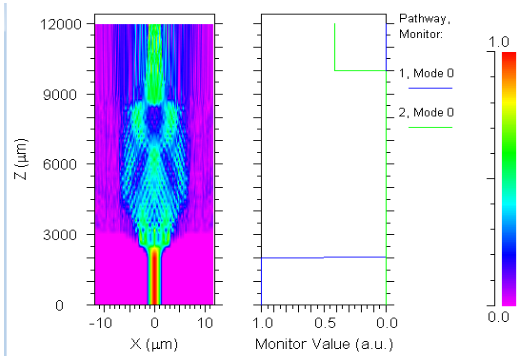
Graph 4: Power observed and reduced to 48%

Applied ri value of malathion to the sensing arm



Graph 5: Power observed and reduced to 50%

Applied ri value of hch to the sensing arm



Graph 6: Power observed and reduced to 42%

Table-II: Observed Power for different RI value of Chemical Substances Using Designed Sensor

Different Chemical Substance of RI value	**Observed power**
Choldrane,	22 %
DDT	38%
Phorate	48%
Malathion	50%
HCH	42%

From table –II, it is been observed that different RI value is applied to the sensor and there is changes in the power observation which means by observing the power, different chemical substances is detected through designed sensor. Intensity analysis is also done by varying the R.I value of chemical substances.

Table-III: Based on different RI value of pesticide present in soft drinks power, intensity is observed by using Δø and ΔN_{eff} value.

Name of the Sample	Δø in radians	ΔN_{eff}	Power	Intensity (ΔI)
Choldrane	66.4238	3.443426	22%	0.2192
DDT	66.2707	3.443698	45%	0.3932
Phorate	66.3727	3.443717	48%	0.4697
Malathion	66.3216	3.443707	50%	0.6158
Hch	66.526	3.443744	42%	0.2999

VI CONCLUSION

In this paper we have proposed a sensor which is able to detect the chemical, pesticide or organic substances that are present in fruit drinks, soft drinks and food. Band gap engineering', that is varying the band gap appropriately in a device and the 'intensity engineering', varying the phase difference appropriately in a device. Both can easily be achieved by adjusting the composition of semiconductors, that is, by using silicon material. We have demonstrated an optical sensor consisting of silicon on insulator Mach–Zender interferometer. By changing the RI value of analyte of the waveguide sensing arm, thereby changing the refractive index of the sensing arm to modulate the intensity of output light. To observe the intensity by use of N effective value from the design, we proposed silicon based photonic device which is known as MZI. In this paper we have observed the transmitted output power when we used different RI value of chemicals. By observing the intensity and output power at the sensing arm of the sensor, the chemical substance is detected. This proposed sensor will be very much useful in examining the chemical, pesticide or organic substances level which is present in fruit drink, soft drinks or food.

ACKNOWLEDGEMENT

We thank CMRIT for providing us the opportunity to carry out this work.

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