Tecnológico de Monterrey
Paper Review Form*

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Materia: *Métodos de investigación e innovación* Clave: *GI*5000.1

Artículo: *Nano – electric field sensor based on Two Dimensional Photonic Crystal resonator*
(Rajasekar & Robinson, 2018)

Instructions

Read the paper, complete a copy of this form and return it, as already indicated, to the module lecturer. You ought to complete each section, otherwise you will not be given full credit.

1 Content of Research

What kind of contribution did the paper attempt to make? Various possible kinds of contribution are listed below. Tick each of those that applies and justify your assessment. Use the comments section for extended discussion.

- ☑ 1. Describes a new technique.
- ☐ 2. Extends or improves an existing technique.
- ☐ 3. Establishes properties of a technique or relations between two or more techniques either empirically or theoretically.
- ☐ 4. Describes a new application of a technique.
- ☐ 5. Tests the psychological validity of a technique.
- ☐ 6. Combines several techniques into a system.
- ☐ 7. Identifies and motivates a new problem.
- ☐ 8. Serves a tutorial role, *e.g.* a survey.
- ☐ 9. Other (please specify).

Comments:

☐

2 Correctness and Completeness of Paper

Assess the correctness and completeness of the paper by ticking which of the following apply. Justify your answers in the comments section.

*Format shamelessly stolen from Alan Bundy.

☐ 1. The methodology employed by the authors is not sensible.
☐ 2. There are major technical errors in the paper.
☐ 3. There are major omissions in the paper.
☐ 4. The reported research is not in a completed state.
☐ 5. Related research is not adequately compared.
☐ 6. The paper is deficient in some other way (please specify).

Comments:

☐

3 Significance of Research

Assess the significance of the reported research by answering the following questions. Justify your answers.

1. What hypotheses are tested by the reported research?

   ☐

2. What are the outcomes of this hypothesis testing?

   ☐

3. Assess the importance of the reported research on a scale of 1 (trivial) to 5 (major breakthrough).

   ☐

4 Precis

Describe the message of the paper in your own words. Use 100-200 words.

☐

References

Rajasekar, R., & Robinson, S. (2018). Nano-electric field sensor based on Two Dimensional Photonic Crystal resonator. *Optical Materials*, *85*, 474–482. doi:10.1016/J.OPTMAT.2018.09.016

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Nano-electric field sensor based on Two Dimensional Photonic Crystal resonator

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ABSTRACT

In this paper, hybrid Silicon-Barium Titanate (Si-BTO) based Two Dimensional Photonic Crystal (2DPC) platform is proposed for electric field sensing based on the effective refractive index modulation of electro-optic material. The nano-sensing platform is composed of the PC based resonator and inline quasi-waveguides in a 2D triangular lattice with circular rods that are arranged in the air medium. The BTO based nano-cavity resonator is playing a very important role in sensing the different electric field over a wide wavelength range. The operating wavelength range of the proposed sensor is investigated via Photonic Band Gap (PBG) which is obtained by the Plane Wave Expansion (PWE) method. The transmission efficiency, quality factor, electric field sensitivity and change in refractive index are analyzed by using Finite Difference Time Domain method (FDTD). The simulation results reveal that the resonant wavelength of the electric field sensor is linearly shifted to the higher wavelength region while increasing the electric field from 0 kV/mm to 25 kV/mm. The proposed sensing platform provides high transmission efficiency and very high refractive index sensitivity with an ultra-compact size. Hence, it is highly suitable for nano-chip based sensing applications.

1. Introduction

In recent years, ultra-compact photonic sensors are extremely attractive and excellent candidates for the optical community, and also it can meet the current demands such as lightweight, low power, ultra-compact size, high-precision and fast response for on-demand real-time applications [1]. The ultra-small electric field sensor is very important for voltage balancing, microwave detection, shielding of electromagnetic radiation, electromagnetic interference prevention, electric industry, detection of charges, radio-frequency reception, and so on [2,3]. Also, electric field sensors are attracted much attention due to their numerous advantages such as safety and remote measurement, intrinsically resistant to electromagnetic interference and rapid response speed [4]. In the literature, high sensitive, low power, highly accurate and ultra-compact photonic sensing platform has developed to detect the electric field for a wide range of application [5]. However, the optical losses are increased while reducing the size of the devices [6]. Alternatively, Photonic Crystals (PC) based devices are effectively utilized to reduce the device size to a nanoscale range with the ultra-low optical loss, and it provides strong photon confinement within the resonator [6].

PC is a kind of artificial nanostructure which is created by periodically arranging the two different materials with different refractive index in a single substrate. The peculiar property of PC is Photonic Band Gap (PBG), which make it suitable for controlling and guiding the light signal at the scale of optical frequency [7]. The light signal in the PBG range is forbidden from propagating inside the structure. However, it can be allowed only by introducing the defects in the periodic PC structure. Fundamentally, the 2DPC platform is an excellent candidate for the optical device due to the simple structure, small size, perfect PBG calculation, strong light confinement and easy to integrate with optical integrated circuits [7]. Over the last two decade, 2DPC platform utilizes to design the various photonic devices such as logic gates [8], filters [9], demultiplexers [10], sensors [11–27] etc.

During the last decade, Si-based PC is a most promising platform for optical sensing applications. However, Si is insensitive to the external electric field and not suitable for electric field sensing because it has very low linear electro-optic coefficients due to their centrosymmetric crystalline structure [28]. Therefore, non-centrosymmetric crystalline structure based high-performance electro-optic material is integrated with Si to enhance the electro field sensitivity. Recent years, hybrid Si-$LiNbO_3$ based PC material is widely used for electric field sensor [29]. However, the $LiNbO_3$ electro-optic coefficients value (r_{33} = 30 pm/V) only 20 times larger than Si and its integration very difficult with Si

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