Optik - International Journal for Light and Electron Optics 179 (2019) 165–172

Contents lists available at ScienceDirect

Optik

journal homepage: www.elsevier.com/locate/ijleo

Original research article

Design and analysis of single loop and double loop photonic crystal ring resonator based on hexagonal lattice structure

Harsimran Jit Kaur*, Phalguni

Chitkara University Institute of Engineering and Technology, Chitkara University, India

ARTICLE INFO

Keywords:
Hexagonal lattice
FDTD
Nano-photonics
Photonic crystal ring resonator
Photonic band gap
PWE

ABSTRACT

Photonic Crystal (PC) based optical devices have been widely explored in recent era due to their capability of miniaturization and large-scale integration of optical and opto-electronic devices. In this paper, two dimensional PC based Single Loop, Double Loop (Horizontal) and Double Loop (Vertical) Ring Resonators using hexagonal lattice structure is designed and analyzed. It reports the Discrete Fourier Transform (DFT) analysis using Finite Difference Time Domain (FDTD) method and calculates the Photonic Band Gap (PBG) using Plane Wave Expansion (PWE) method. The comparative analysis of three configurations based on Q factor reports the outperformance of double loop photonic crystal ring resonator (PCRR) with lattice constants A = 30 and C = 30 at 1550 nm with Q factor 17,000. The Q factor for double loop horizontal and single loop structure is 16,300 and 15,500 at 1550 nm.

1. Introduction

The Photonic Crystals (PCs) have gained worldwide intriguing attention in the past two decades due to the availability of photonic band gap (PBG) and the ability to influence the electromagnetic (EM) wave [1]. PCs are the periodic structures that contain high and low dielectric constant. According to periodicity in refractive index, the PCs are further classified as one dimensional PC (1DPC), two dimensional PC (2DPC) and three dimensional PC (3DPC) as presented in Fig. 1 [2].

2DPC are gaining attention from various scientific communities for designing the optical devices because of the features like better captivity of light, efficient control of spontaneous emission, efficient PBG calculation, easy fabrication, reduction in size (10–100 times) and easy integration with other devices with respect to 3DPCs [3,4]. Among the various other optical devices Photonic Crystal Ring Resonator (PCRR) is an inevitable component for integrated optics. PCRR can be designed from a bus waveguide created by introducing the line defects and a ring created the point defects as shown by Fig. 2.

This paper is divided into different subcategories as section II consists of literature review, section III consists of structural design of Photonic Crystal Ring Resonator, section IV consists of results and discussions of PCRR and conclusion is given in section V.

2. Literature review

PCRR has acquired a great interest among nano photonics since the last decade. Many researchers have done work on different optical devices composed of photonic crystals. The Spectral Index method was used for rib waveguides with rectangular cross area. The effective width principle was used to offer practical exposure into the performance of the structures by providing precise resonant

* Corresponding author.
E-mail addresses: harsimran.kaur@chitkara.edu.in (H.J. Kaur), Phalgunigoyal17@gmail.com (Phalguni).

https://doi.org/10.1016/j.ijleo.2018.10.157
Received 24 August 2018; Received in revised form 15 October 2018; Accepted 23 October 2018