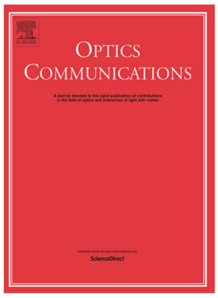

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PII: S0030-4018(18)30813-7
DOI: https://doi.org/10.1016/j.optcom.2018.09.032
Reference: OPTICS 23471

To appear in: *Optics Communications*

Received date : 24 April 2018
Revised date : 12 September 2018
Accepted date : 14 September 2018

Wide-Band Low Cross-talk Photonic Crystal Waveguide Intersections Using Self-Collimation Phenomenon

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Abstract

In this paper, wide-bandwidth low cross-talk W1 photonic crystal waveguide intersections are proposed based on self-collimation effect. The waveguides are realized using a 2D square lattice of GaAs rods in an air background. A second photonic crystal lattice is inserted in the intersection region which provides the self-collimation effect and eliminates the cross-talk. The region between the two lattices is optimized in this paper to produce the highest transmittance and widest bandwidth. Consequently, several waveguide intersections are designed based on the proposed method. Each has a different bandwidth and central wavelength. Due to their unique features such as the wide bandwidth, the low cross-talk value and having high transmittances, such structures have a variety of applications in highly integrated optical circuits which are realized based on photonic crystals. Plane wave expansion and finite difference time domain methods are used to analyze the structures. Simulation results show that a bandwidth of 124 nm and a maximum transmission value of 99% can be obtained using the proposed method.

Keywords: Photonic crystal, Cross-talk, Self-collimation, Intersection, Waveguide.

1. Introduction

Unique features of photonic crystals (PhC) make them prominent candidates for realization of photonic integrated circuits (PIC) [1]. Having a small footprint is the main feature of PhCs. Many optical elements have already been realized using PhCs. They include filters [2,3], resonators [4], couplers [5,6], splitters [7–9], modulators [10,11], switches [12–14], sensors [15,16], logic gates [17–19], phase comparators [20], electric-field sensors [21], mode convertors [22], optical delay lines [23,24], memory cells [25] etc.

Although PhCs owing to their relatively small footprint area can be used for realization of compact PICs but these structures have some disadvantages. One of these disadvantages is their relatively higher propagation loss compared to the conventional dielectric photonic waveguides. Albeit, for designing optical devices, PhCs provide a variety of privileges which diminish the problem of their higher propagation loss. The propagation loss in a PhC waveguide depends on the dielectric material used for