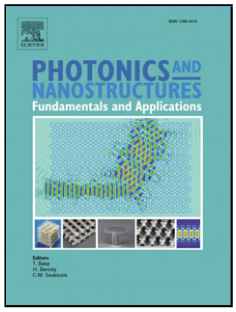

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Photonic Crystal Double-Coupled Cavity Waveguides and Their Application in Design of Slow-Light Delay Lines

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The highlights of the current manuscript are as follows:

1. The idea of photonic crystal double-coupled cavity waveguides is introduced for the first time (to the best of our knowledge).
2. Cavities created in the intersection of two photonic crystal W1 waveguides are coupled together both horizontally and vertically to create a slow-light waveguide.
3. It is shown that the coupled matrix of cavities can be used for design of ultra-compact slow-light photonic crystal optical delay lines.
4. Due to existence of two orthogonal degenerate resonance modes we were able to use each cavity twice in the path of signal.
5. The proposed structure has many potential applications, if Kerr-type nonlinear materials are employed.

Abstract

In this paper the idea of double-coupled cavity waveguides is introduced. The cavities used in this paper support two orthogonal degenerate resonance modes. These cavities are coupled together both horizontally and vertically. The obtained matrix of cavities introduces many interesting properties for design of photonic crystal devices such as phase shifters and gates. As an application, it is shown that the coupled matrix of cavities can be used for design of ultra-compact slow-light photonic crystal optical delay lines. Finite difference time domain method and plane wave expansion method are used to analyze the structures.

Keywords: Photonic crystal, Slow-light, Optical delay line, Coupled cavity waveguide, Resonator.

1. Introduction

Optical delay lines (ODLs) have a vital role for the realization of all optical switching devices. Besides that, They can be used for various applications such as: optical signal processing, optical division multiplexing, optical modulators and phased array systems [1–3]. Due to optical fiber qualities such as wide bandwidth and low propagation loss, they have traditionally been used for realization of ODLs. In order to achieve large time delays, using long length optical fibers are unavoidable. This type of delay