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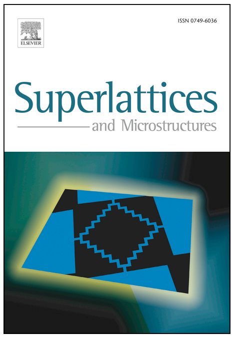

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Asymmetric Transport of Light in Arrow-Shape Photonic Crystal Waveguides

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Abstract: In this paper, we report a design of an asymmetric light propagation based on the Photonic Crystal (PC) structure. The proposed PC is constructed of an arrow-shaped structure integrating different rows of air holes which offer more than 65% transmission in one direction and less than 1% in the opposite direction. The proposed PC is based on the use of two parallel PC waveguides with different air holes in a single platform. The design, optimization and performance of the PC waveguide devices are carried out by employing in-house accurate 2D Finite Difference Time Domain (2D FDTD) computational techniques. Our preliminary numerical simulation results show that complete asymmetric transmission can be achieved in the proposed single structure which would play a significant contribution on realization of high-volume nanoscale photonic integrated circuitry.

1. Introduction

Adherence Asymmetric light propagation or nonreciprocal transmission has attracted the interest of many researchers worldwide due to their attractive properties in recent years [1]. These light propagating structures play a major role in modern optoelectronic and communication systems due to the fact that such nonreciprocal waveguide structures are considered as a potential candidate for developing a one-way road light propagation, which is a key element in future nano chip integrated circuits. The integration of discrete optical components on a single chip is witnessing an increasing demand [2]. Integration of optical devices on a common single platform offers many advantages such as device footprint and light transmission efficiency, leading to a significant reduction of the overall budget for integration of optical systems [3].
The Integration of optical asymmetric waveguide devices allows for the propagation of light in specific and desired directions whilst preventing the light to propagate in undesired directions. In other words, such waveguide devices are crucial for preventing optical reflected signals from various integrated devices and performing different functionalities, all integrated on a single platform. It is worth noting that several approaches have been proposed and reported in the literature in order to achieve optics isolations based on the use of nonlinear materials [4], time-dependent structures [5] and magneto-optic materials [6]. These approaches are based on break time-reversal inversion symmetry where the reciprocity of the Lorentz theorem doesn't hold [7]. Also, it is tremendously challenging to grow or integrate magneto-optical materials for a common substrate, therefore this is a hamper to develop and integrate compact devices on a single common platform. In comparison to the normal symmetric light propagation structures, asymmetric waveguide structures have a remarkable advantage such as one-road light transmission and in particular the circuit stability, preventing interferences of undesired signals, therefore ensuring the protection of active integrated photonic devices. When the structure exhibits a single mode, the light propagates in one direction and is blocked in the opposite one, such a structure operates like an optical isolator.