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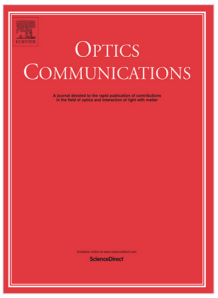

Photonic crystal filter based on defect mode and waveguide mode symmetry matching

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Photonic Crystal Filter Based on Defect Mode and Waveguide Mode Symmetry Matching

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ABSTRACT

In this paper, a new type of filter based on symmetry matching between the defect and waveguide modes in a square lattice photonic crystal for 1.31-μm wavelength is designed and evaluated. The filter consists of one elliptical defect and three wire defect waveguides with two single-mode waveguides and one dual-mode waveguide. Because the point defect state has four different resonant frequencies and four corresponding types of mode field symmetries, the proposed filter uses the match or mismatch between the defect and waveguide modes to realize two resonant frequency filtering outputs through a dual channel. To evaluate the device, the transmission characteristics of the electromagnetic waves in the device are simulated using the finite element method. The quality factor and transmission coefficient of the filter is 2,017 and 0.84 at the frequency of 0.4034 c/α (corresponding to 1.31-μm wavelength). This device can be applied to wave division multiplexing, filtering, and has the potential for applications in optical integrated chip and optical communications.

Keywords: photonic crystal; defect mode; waveguide mode; symmetry; filter

1.Introduction

Photonic crystals have attracted much attention [1,2] since they were first proposed by Yablonovitch [3] and John [4] in 1987 owing to their ability to control the flow of photons in optical fibers [5], resonators [6–9], waveguides [1,6,10], optical switches [11], filters [8,9,12–14], sensors [15], wavelength division multiplexers [16,17], and other devices. The combination of a waveguide and micro-cavity in a photonic crystal is mainly used to realize a filtering function. Two-dimensional (2D) photonic crystals play an important role in highly integrated, efficient, and stable wide-bandwidth optical communication systems because they have a flexible design, simple structure, and strong light transmission control. Multichannel photonic crystal filters at micron scale have good application potential and are receiving wide attention at present. For example, Noda et al. [18] used a combination of a waveguide and micro-cavity to implement an upload/download filter. Qiu [19] produced a filter composed of two waveguides and a dual-mode micro-cavity based on the triangular lattice photonic crystal. Takano et al. [20] designed an efficient multichannel filter based on multiple simple heterostructure filters. Feng et al. [14]