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Eight-channel all-optical demultiplexer based on photonic crystal resonant cavities

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In this paper, we propose a new structure based on photonic crystals to realise a demultiplexing operation for dense wavelength division multiplexing transmission systems. To obtain high quality factor, we used arc cavities and a quality factor as high as 4860 was achieved. In the designed demultiplexer, the main cavity was responsible for selecting the wavelength. By changing the boundary rods condition of each cavity, the modes could resonate at the desired frequencies. As we wanted to see just one sharp wavelength at the output of each channel, an arc cavity was imposed in a way that by bringing other modes to the input waveguide, the wavelength selection improved (and the feedback was investigated). Based on the results, the average pass bands of channels are near to 1.5 nm and the channel spacing is approximately 1.75 nm. The proposed demultiplexer acts in a near-complete transmission efficiency and the mean value of the crosstalk was -18 dB.

Keywords: Quality factor; Demultiplexer; Photonic Crystal; Resonant cavities; Crosstalk

1 Introduction

Photonic crystals (PCs) have recently become a favourable candidate for designing all-optical devices. Among their fascinating features, PCs can be fabricated in very small sizes. They also benefit from their photonic band gap (PBG), in which the propagation of electromagnetic waves in any direction and any polarisation is prevented [1].

However, by breaking the periodicity of PCs by defects, the localisation of the electromagnetic field can be controlled [1]. Many optical devices have been designed employing this concept [2-7]. By removing a complete row of rods, an optical waveguide can be designed [8]. Removing two or more rods can result in forming a cavity [8]. The instructive and destructive interference of waves inside the cavity causes wavelength selecting.

The demand on the passband of the Internet is growing very fast. In order to send and receive high-rate data there is one choice: the wavelength division multiplexing (WDM) technique. In this technique, more than one channel is sent simultaneously through an optical fibre. In the receiver, the first step is to separate the channels from each other. Optical demultiplexers are devices that are used in the receiver to separate channels. Several methods have been proposed using PCs to separate channels, such as line defects [9], directional coupling [10], ring resonators [11], etc.

Several attempts have been made recently to design an optical demultiplexer [12-16]. One of the most important parameters of the design of a device is its expansion possibility. A multiplexer design must allow for more channels to be separated by the same scheme, if needed. In addition, the space between output channels is another important factor. Closer output channels result in better use of the fibre capacity. The power transmission efficiency of the device is another factor that must be considered.

A type of heterostructure demultiplexer using PC ring resonator has been proposed by Rakhshani et al. [12]. This device can separate three different channels from input light at the 1550 nm wavelength. The mean value of the crosstalk they reported was -24.44dB, and they could achieve power transmission

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