Opt Quant Electron (2013) 45:1027–1036
DOI 10.1007/s11082-013-9713-1

Concurrent implementation of all-optical half-adder and AND & XOR logic gates based on nonlinear photonic crystal

Majid Ghadrdan · Mohammad Ali Mansouri-Birjandi

Received: 11 March 2013 / Accepted: 6 June 2013 / Published online: 15 June 2013

Abstract A new design for concurrent implementation of all-optical half-adder and AND & XOR logic gates based on nonlinear photonic crystal ring resonator has been proposed. The finite different time domain and plane wave expansion methods are used to analyze the behavior of the structure. The ring resonator has a low switching time of about 0.85 ps and low switching power equal to 277 $mW/\mu m^2$. The simulation results show that the contrast ratio is 12.78 dB for AND gate and 5.67 dB for XOR gate. Moreover, the operational wavelength of the input ports is 1.55 μm. Since the structure has a simple geometric shape with clear operating principle, it is potentially applicable for photonic integrated circuits.

Keywords Logic gate · Nonlinear Kerr effect · Photonic crystal · Ring resonator

1 Introduction

The demand for signals processing using the light has been increased dramatically with the development of telecommunication systems for high data transfer speeds and capacity. It is now accepted that digital electronics is able to respond to these demands in the future. In recent years, all-optical signal processing techniques has attracted the attention of many scientists. All-optical logic gates with high performance speed play a main role in signal processing and optical networks. Different structures have so far been presented to recognize the performance of all-optical logic gates. Initially, all optical logic gates based on semiconductor optical amplifier properties (SOA) were reported (Houbavlis et al. 1999; Soto et al. 2002; Kim et al. 2006; Miyoshi et al. 2008; Wang et al. 2008). However, some limitations such as latency time, power consumption, speed and size of these structures made it to be used less than

M. Ghadrdan · M. A. Mansouri-Birjandi (✉)
Faculty of Electrical and Computer Engineering, University of Sistan and Baluchestan,
P. O. Box 98164-161, Zahedan, Iran
e-mail: mansouri@ece.usb.ac.ir

M. Ghadrdan
e-mail: majid.ghadrdan@mail.usb.ac.ir