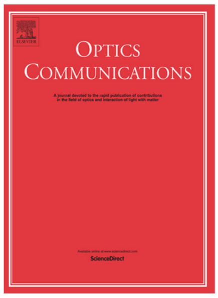

All-optical photonic crystal memory cells based on cavities with a dual-argument hysteresis feature

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All-Optical Photonic Crystal Memory Cells Based on Cavities with a Dual-Argument Hysteresis Feature

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Abstract— In this paper, the idea of an all-optical photonic crystal memory cell based on a cavity with a hysteresis feature as a function of two independent variables is introduced. A two-dimensional square lattice of Si rods in a SiO_2 background is used for this purpose. Plane wave expansion and finite difference time domain methods are used to simulate the structures. A novel cavity topology with Kerr-type nonlinearity is used for designing the memory cells. The cavity which supports two degenerate orthogonal modes is designed at the intersection of two W1 waveguides and exhibits a fairly wide hysteresis loop. It is shown that such topologies can be used to design fast all-optical memory cells. Two different topologies for the realization of all-optical memories are thereby proposed. Based on the simulation results, for the final structure proposed in this paper, a 2ps-wide Gaussian-shaped trigger pulse can be used to change the state stored in the memory cell. It takes nearly 5ps for the memory to change its state.

Index Terms—Optical Memories, Microresonators, Bistable circuits, Optical Kerr effect, Optical logic devices, Optical switches.

1. Introduction

Conventional electronic technology is expected to face serious problems with issues such as increasing the speed and reducing power dissipation in the near future. Soon, they may not be able to satisfy the vast demand for higher computational speeds. Photonic integrated circuits (PICs) are among the candidates to replace electronic integrated circuits. Photonic crystals (PhCs) due to their small size and routine fabrication process are attractive candidates for miniaturization of PICs[1]. In the past decade, many elements have been designed and fabricated using PhCs. They include: splitters[2], resonators [3], modulators [4], couplers [5], interferometers [6], switches [7], logic gates[8,9], adders[10–13], subtractors [14], encoders [15], decoders [16,17], flip-flops [18], sensors [19–21], analog-to-digital converters [22,23], multiplexers and demultiplexers [24,25]. Being able to design fast PhC optical memories paves the way for much more complex PICs.

In this paper, all-optical switching mechanism is used to design photonic crystal memory cells. Based on the knowledge of the authors, the concept of PhC all-optical switching was first presented in[26]. PhCs with third-order nonlinearity are among the most favorite choices for the realization of all-optical