Abstract

In summary, the resonance frequencies and the field distributions of 2D-PC were investigated. PC hybrid waveguides with quasi-flat and Lorentzian transmission spectrum were analyzed and modeled by using FDTD and CMT methods. The theoretical results derived by CMT were in good agreement with FDTD simulation results. It was shown that when the phase-shift of the electromagnetic waves traveling between two adjacent PC coupled cavities (φ), is close to $(k+1/2)\pi$, the transmission spectrum of the hybrid waveguide is quasi-flat. A modified HW3 with extra rods in both ends of the CCW and Lorentzian transmission spectrum was proposed, which can be used in implementation of WDM filters. It was shown that in this case φ is close to zero. Transmission of ultra-short pulses through the hybrid waveguide was also investigated. In this thesis, a low cross-talk and wideband waveguide intersection design based on two orthogonal hybrid waveguides in crossbar configuration was proposed and modeled by using the FDTD and CMT methods. Also, it has been shown that when the phase-shift of the electromagnetic waves traveling between two adjacent PC coupled cavities is approximately equal to $(k+1/2)\pi$, i.e. quasi-flat condition, optimum performance results for the intersection can be achieved. In addition, it has been clearly proved that simultaneous crossing of ultra-short pulses through the intersection is possible with negligible interference. The proposed solution can be easily generalized to other 2D square as well as 3D cubic PCs. Furthermore we presented a highly efficient three-port CDF with a coupled cavity based wavelength reflection feedback. A modified HW2 with extra rods in both ends of the CCW and Lorentzian transmission spectrum was proposed, which can be used as the key element in implementation of WDM filters. It was shown that the phase-shift of the EM waves traveling between the modified HW2 cavities is close to zero. According to the theoretical theory using CMT in time, the performance of the proposed CDF was investigated and the conditions which lead to 100% drop efficiency were extracted. The performance of the designed filter was calculated using the 2D-FDTD method. The simulation results show that the designed CDF has a line-width of $0.78nm$ at the center wavelength $1550nm$, and also a multi-channel CDF with channel spacing around $10nm$ $(1nm)$ with inter-channel crosstalk below $-30dB$ $(-15dB)$ is possible. These characteristics make the proposed CDF suitable for use in WDM optical communication systems.

Keywords: **Photonic Crystals, Photonic integrated devices, Hybrid waveguides, Photonic crystal intersections, Channel add/drop filters.**

Iran University of Science and Technology
Electrical Engineering Department

Design and Modeling of WDM Photonic Crystal Integrated Devices Based on the Interaction of Cavity and Waveguide

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By:
Kiazand Fasihi

Supervisor:
Dr. Shahram Mohammadnejad

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