ABSTRACT

In this thesis the details of Titanium in-diffused Lithium Niobate (Ti:$LiNbO_3$) technology were developed in author's laboratory for fabrication of two devices: a passive polarization splitter, and a reversible optical Feynman gate. The design tool used for the purpose is effective-index based matrix method (EIMM). EIMM is used to compute propagation constants of guided modes, critical coupling length of coupled waveguides, and bending loss of waveguide bents.

Passive polarization splitter was realized at 1.55-µm wavelength using a specially designed zero-gap directional coupler (ZDC) where for an unpolarized light input in one of the input ports, transverse electric (TE) mode was available in cross-port, whereas, transverse magnetic (TM) mode was in bar-port output. The coupling length of ZDC was designed for -60 dB crosstalk for both TE and TM polarization. We have used designed low-loss S-type bent waveguides at the input and output ports of the device.

Reversible optical Feynman gate was designed by cascading four 2×2 electro-optic directional couplers. The theoretical analyses of metal electrode as well as the effect of buffer layer on top of the waveguide layout were performed. The designed optical Feynman gate is a potential candidate for the realization of low-power photonic computational circuits.

The fabrication of passive polarization splitter and optical Feynman gate were realized by using Ti:$LiNbO_3$ single mode waveguides at 1550 nm wavelength of light. One non-destructive and cost effective measurement method for loss components of these fabricated waveguides was applied. The measured fiber-waveguide coupling loss and waveguide propagation loss were ~2 dB, and ~0.5 dB/cm. Our first experiment with the fabricated passive polarization splitter yields around -10 dB crosstalk for TE and TM modes, which is useable, but higher than our designed value. The reasons for this measured high-crosstalk were identified and remedies were suggested. DC-characterization of the fabricated optical Feynman

gate was also performed. It follows the truth table for different combinations of electrical inputs and optical outputs. During fabrication of this device with Cr/Au electrodes we have not used any buffer layer. The measured total insertion loss of the device was ∼12.5 dB, and V_π of the directional couplers used were ∼1.3 Volts.

Keywords: Channel Waveguides; Coupling Length; Coupling Loss; Crosstalk; Directional Coupler; Effective index based Matrix Method (EIMM); Electro-Optic Effect; Feynman gate; Zero-gap directional coupler; Optical Logic Gate; Optical Reversible Computing; Optical Switching; Optical Waveguide; Passive Device; Polarization splitter; Polishing; Propagation Loss; Spectral Analysis; Titanium indiffused Lithium Niobate; UV-Lithography.