SUMMARY OF Ph.D. DISSERTATION

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Title

A Study on an Ultra-Compact Arrayed-Waveguide Grating for Optical Communications

Abstract

Small-sized and functional optical waveguide devices are necessary to realize high-speed and large-capacity photonic networks. In particular, the size reduction of the wavelength de/multiplexer is required for a dense wavelength division multiplexing (WDM) system. The purposes of this study are; miniaturizing a silica bend waveguide, optimizing the small-sized design and the fabrication processes of the arrayed-waveguide grating (AWG) for a dense WDM system, and developing the PLC type dispersion compensator using a high-resolution AWG.

In chapter 1, the role of various optical devices in optical network systems is described. The basic properties, structures and applications of the planar lightwave circuits (PLCs) are also described.

In chapter 2, a V-bend optical waveguide which has a monolithically integrated waveguide metal mirror is proposed to reduce the chip size of the PLC. The optimization of the V-bend waveguide design with given silica parameter is achieved. The size of the V-bend waveguide is 1/180 of the conventional curved waveguide with the same waveguide parameters. The bending loss of less than 2 dB is obtained by reducing the misalignment and the tilt of the mirror under 1 μm and 1 degree, respectively.

In chapter 3, an ultra-compact arrowhead AWG is proposed. It has V-bend waveguides in each array waveguide and the size is about 1/7 of the conventional AWGs with the same performances. An 8ch, 25 GHz-spacing, 4.2 mm × 22.8 mm sized, arrowhead AWG was fabricated. The insertion loss and the adjacent crosstalk were 5.24 dB and -20.9 dB, respectively.

In chapter 4, the high-resolution AWGs with multiple-arrowhead structures are proposed. The high-resolution AWG with a channel spacing of less than 10 GHz is fabricated. The phase error compensation method by filling a trench in the waveguide with the index-controlled polymer is proposed.

In chapter 5, a dispersion compensator which consists of the arrowhead AWG and a dispersion compensating mirror is proposed. The constant dispersion compensator with a dispersion of 123 ps/nm was fabricated. The dispersion compensation experiments for 40 Gbit/s, NRZ (Non-Return-to-Zero) and RZ (Return-to-Zero) signal have been successfully demonstrated. A tunable dispersion compensator with a dispersion-adjusting structure which is located in front of the dispersion compensating mirror is proposed. Dispersion compensators with dispersions of 1103 ps/nm and 234 ps/nm were fabricated by using resin with refractive indices of 1.405 and 1.510, respectively.

Chapter 6 concludes the results of the study.