DESIGN AND SIMULATION OF SILICA-ON-SILICON PUMP/SIGNAL MULTIPLEXER FOR HYBRID PASSIVE-ACTIVE OPTICAL DEVICES

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ABSTRACT

This dissertation describes the design and simulation of silica-on-silicon pump/signal multiplexer for hybrid passive-active optical devices. Uniform symmetric directional couplers and planar Bragg gratings were utilized in this work, forming the essential building blocks in a waveguide amplifier. Several designs in relation to the multiplexers are presented in this work, with the simplest application for the directional coupler as a pump/signal multiplexer. A 980/1550 nm and an 800/1310 nm pump/signal multiplexers for erbium doped and bismuth doped waveguide amplifier, respectively were modeled. These couplers were designed and simulated in Rsoft BeamPROP environment, utilizing 3D Finite Difference Beam Propagation Method (FD-BPM) to measure light propagation in the silica waveguide. Coupler parameters including edge-to-edge spacing, and the length of the central coupling region, were optimised in order to maximise the outputs. Both couplers are 11.5 mm and 8.4 mm long respectively with channel spacing of ≥125 μm. Numerical results show that two broadly spaced wavelengths from both couplers were successfully coupled from two opposite inputs into the same output. For the purpose of broadening the amplification band for long haul optical fiber communications, a combined 800/1310 nm and 980/1550 nm pump/signal multiplexers which would be integrated into a broadband amplifier is proposed. These couplers were designed according to the silica based planar lightwave circuit fabrication tolerance and modeled using BeamPROP 3D FD-BPM. The influences of waveguide parameters such as edge-to-edge spacing, length of the central coupling region, and refractive index difference on the coupler characteristics were investigated in detail. The insertion loss for the transmission of 1310 nm and 1550 nm signal wavelengths are 0.23 dB and 0.87 dB, respectively after applying lateral offset. Furthermore, an optical chip

consists of pump/signal multiplexer and planar Bragg grating is also presented. The chip was separate designed and modeled using BeamPROP 2D FD-BPM and GratingMOD. A 360 nm broad amplification band is obtained from this configuration in order to achieve higher data capacity and bandwidth.

ABSTRAK

Disertasi ini adalah mengenai reka bentuk dan simulasi silika pada silikon pam/isyarat multiplexer untuk hibrid pasif-aktif alat-alat optik. Pengganding yang bersimetrik seragam dan jeriji Bragg adalah tumpuan dalam kerja ini dan bagaimana alat-alat itu boleh digunakan sebagai blok binaan penting dalam waveguide amplifier akan dibincangkan. Beberapa reka bentuk yang berkaitan dengan multiplexers dibentangkan. Satu aplikasi mudah untuk pengganding ini adalah seperti satu pam/isyarat multiplexer. Satu 980/1550 nm dan satu 800/1310 nm pam/isyarat multiplexers untuk erbium doped dan bismut doped waveguide amplifier, masing-masing model. Pengganding ini adalah direka dan dibuat dalam perisian bernama Rsoft BeamPROP, ia menggunakan 3D Finite Difference Beam Propagation Method (FD-BPM) untuk mengukur perambatan cahaya di waveguide silica. Parameter pengganding termasuk jarak antara dua waveguide, dan panjang yang berantau interaksi, telah disimulasikan dengan tujuan mengoptimumkan keluaran itu. Panjang kedua-dua pengganding adalah 11.5 mm dan 8.4 mm, masing-masing dengan jarak saluran yang lebih daripada 125 μm. Keputusan berangka menunjukkan yang dua panjang gelombang daripada kedua-dua pengganding telah berjaya digabungkan daripada dua input bertentangan kepada output yang sama. Untuk tujuan memperluaskan amplifikasi band yang panjang untuk menyeret komunikasi serat optik, satu gabungan 800/1310 nm dan 980/1550nm pam/isyarat multiplexers yang akan diintegrasikan ke dalam satu amplifier broadband dicadangkan. pengganding ini direka mengikut silika Planar Lightwave Circuit toleransi pembuatan dan dimodel dengan menggunakan BeamPROP 3D FD-BPM. Pengaruh-pengaruh bagi parameter waveguide seperti jarak antara dua waveguide, panjang yang berantau interaksi, dan perbezaan indeks biasan pada pengganding disiasatan. Kerugian yang sisipan untuk transmisi

panjang gelombang 1310 nm dan 1550 nm masing-masing adalah 0.23 dB dan 0.87 dB setelah menerapkan lateral offset. Tambahan pula, satu cip optik mengandungi pam/isyarat multiplexers dan jeriji Bragg dibentangkan. Cip adalah direka bentuk dan dimodelkan menggunakan BeamPROP 2D FD-BPM dan GratingMOD. Satu jalur penguatan yang luas iaitu 360 nm diperolehi dari konfigurasi ini dengan tujuan mencapai lebih tinggi data bandwidth.

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