Desain Directional Coupler dan Optical Switch berbasis Galium Nitrida = Design of GaN-based Directional Coupler and Optical Switch

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Abstrak

ABSTRAK
Divais directional coupler dan optical switch merupakan komponen yang dibutuhkan dalam pemrosesan sinyal optik. Kemajuan teknologi wavelength division multiplexing (WDM) dan pertumbuhan lalu lintas internet yang cepat memicu banyak penelitian tentang teknologi switching optik. Galium Nitrida (GaN) merupakan material semikonduktor nitrida kelompok III yang menjadi kandidat menjanjikan untuk divais yang beroperasi pada panjang gelombang komunikasi optik.
Pada penelitian ini dilakukan desain directional coupler dan optical switch menggunakan material GaN untuk panjang gelombang telekomunikasi, yaitu 1,55 um. Desain directional coupler terdiri dari pandu gelombang S-bend dan linear sedangkan desain optical switch berbasis Mach-Zehnder Interferometer yang terdiri dari dua directional coupler yang dihubungkan dengan dua lengan persegi panjang. Optimasi desain dilakukan dengan metode finite difference beam propagation method (FD-BPM) menggunakan perangkat lunak OptiBPM. Optimasi dilakukan dengan memvariasikan parameter pandu gelombang meliputi lebar, ketebalan, width gap dan coupling gap.
Dari hasil simulasi ditunjukkan bahwa lebar dan tebal terbaik untuk memperoleh propagasi single mode masing-masing adalah 4 um. Selanjutnya, berdasarkan hasil optimasi ukuran pandu gelombang dilakukan desain directional coupler dan optical switch. Ditunjukan bahwa directional coupler dengan panjang 980 um dan lebar 15 um dengan width gap 7 um dan coupling gap 6 μm menghasilkan daya keluaran sebesar 91,71% dengan splitting ratio sebesar 48,83% : 48,03%, excess loss dan power imbalance berturut-turut sebesar 0,37 dB dan 0,07 dB.
Tahap selanjutnya, berdasarkan lebar dan tebal pandu gelombang, dilakukan optimasi desain optical switch. Dari hasil eksperimen numerik ditunjukkan bahwa desain optical switch terbaik, memiliki panjang 6380 μm dan lebar 15 um, dengan panjang elektroda sebesar 4500 μm. Optical switch mampu beroperasi sebagai switch pada = 34 V dengan insertion loss dan extinction ratio berturut-turut sebesar 1,23 dB dan 8,46 dB
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ABSTRACT
Directional coupler and optical switches are the components needed in optical signal processing. The progress of wavelength division multiplexing (WDM) technology and the rapid growth of internet traffic have triggered much research regarding optical switching technology. Gallium Nitride (GaN) is a III-nitride semiconductor becomes a promising candidate for devices which operate in wavelength optical communications.

In this research, the design of GaN-based directional coupler and optical switch design was conducted for telecommunication wavelength at 1.55 um. The design of directional coupler consists of S-bend and linear waveguide, whereas, design of optical switch based on Mach-Zehnder Interferometer consists of two directional couplers connected by two rectangular arms. Design optimization was conducted by finite difference beam propagation method (FD-BPM) using OptiBPM software. Optimization was conducted by a varying waveguide parameter such as waveguide width, waveguide thickness, width gap and coupling gap.

From the simulation results, the best of width and thickness were 4 um and 4 um, respectively, for support single-mode propagation. Next, based on the optimization result of the waveguide dimension, it was conducted a design of the directional coupler and optical switch. It was noticed that the directional coupler was 980 m long, and 15 um wide with width gap and coupling gap were 7 um and 6 μm, respectively. It generated the output power of 91.71% with the splitting ratio of 48.83 %: 48.03% while the excess loss of 0.37 dB and the power imbalances of 0.07 dB.

The next step, optimization of the optical switch design was conducted based on the width and thickness of the waveguide. From the simulation result, the best design of the optical switch was 6380 μm long and 15 um wide, with the electrode length was 4500 μm. The optical switch could operate as an optical switch at = 34V with an insertion loss of 1.23 dB and an extinction ratio of 8.46 dB.