Karakterisasi dan desain semikonduktor galium nitrit untuk aplikasi pemanduan gelombang = Characterization and design of gallium nitride semiconductors for waveguiding application

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Abstrak

ABSTRACT
A good justification for gallium nitride on silicon is a potential for optoelectronic integrated circuits, and its low cost has stimulated the growth of GaN on large size wafers. The application interest for GaN/Si is power electronics. This current work focuses on characterization optical, electro-optical, and microstructural and simulation design of GaN/Si channel waveguide. For the characterization of GaN microstructure, we use SEM, TEM, AFM, and XRD to observe layer thickness, material structure, material roughness, and crystalline quality of materials. Using the guided wave prism coupling technique, we have fully established the index dispersion and, thickness of GaN at room temperature, as well as its surface roughness based on AFM characterization. Futhermore, the thermal dependence of GaN at ordinary and extraordinary refractive indices are determined to be at 1.227 10-5/ K and 1.77 10-5/ K, respectively. The thermal dependence of GaN shows better value than GaAs at the wavelength range of 0.4 - 1.5 m. It has a slightly low-temperature dependence. Results demonstrate that excellent waveguide properties of GaN on silicon with an optical propagation loss of GaN/Si at 633 nm is 2.58 dB/cm, which is higher than the propagation loss of GaN/sapphire at around 1.34 dB/cm. The roughness of GaN/Sapphire and GaN/Si samples have been identified at the range 1.6 - 5.2 nm and 9.6 - 13 nm, respectively. The birefringence of GaN/Si is negative within the range of -0.16 x10-2 to -6.06x10-2. This negative value means that the polarization of the wave is parallel to the optical axis. Electrooptic constants r13 = 1.01 pm/V and r33 = 1.67 pm/V are higher than those obtained for III-V GaAs semiconductors. We compared the results on Si with those on sapphire. Based on a numerical simulation using OptiBPM, the design result has single mode output with 1 m thickness layer of SiO2 at the planar waveguide design, while the channel waveguide design has 1 m thickness layer of GaN. The simulated result that the maximum power output approximately 50- 58 at the plannar and rib waveguide design.
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