Highly Efficient Blue-Violet III-Nitride Semipolar Laser Diodes

Tech ID: 23858 / UC Case 2013-490-0

BRIEF DESCRIPTION

A method for making a high power blue-violet III-nitride semipolar laser diode.

BACKGROUND

Conventional solid-state lighting systems use a III-nitride light emitting diode (LED) that emits blue light to excite a phosphor that emits yellow light. Although LEDs show promise for solid state lighting applications, they nevertheless suffer from efficiency droop at high injection levels. Laser diodes are a suitable replacement for generating blue light in solid state lighting systems, since they do not experience the same droop effects.

DESCRIPTION

Researchers at the University of California, Santa Barbara have developed a method for making a high power blue-violet III-nitride semipolar laser diode. These laser diodes have output powers in excess of 1W, slope efficiencies of more than 1 W/A, external quantum efficiencies (EQEs) in excess of 35%, and show great potential for use in solid state lighting systems.

ADVANTAGES

▶ Precise control of directionality and efficiency of light extraction
▶ Higher efficiency at high operating power

APPLICATIONS

▶ Solid state lighting

PATENT STATUS

<table>
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<th>Type</th>
<th>Number</th>
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<td>United States Of America</td>
<td>Issued Patent</td>
<td>9,356,431</td>
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ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

▶ Reduced Dislocation Density of Non-Polar GaN Grown by Hydride Vapor Phase Epitaxy
▶ Growth of Planar, Non-Polar, A-Plane GaN by Hydride Vapor Phase Epitaxy
▶ Nonpolar (Al, B, In, Ga)N Quantum Well Design
▶ Improved Manufacturing of Semiconductor Lasers
▶ Cleaved Facet Edge-Emitting Laser Diodes Grown on Semipolar GaN
▶ Etching Technique for the Fabrication of Thin (Al, In, Ga)N Layers
▶ Enhancing Growth of Semipolar (AlInGa)N Films via MOCVD
▶ GaN-Based Thermoelectric Device for Micro-Power Generation
▶ Growth of High-Quality, Thick, Non-Polar M-Plane GaN Films
▶ Method for Growing High-Quality Group III-Nitride Crystals
▶ Growth of Planar Semi-Polar Gallium Nitride
▶ Defect Reduction of Non-Polar and Semi-Polar III-Nitrides
▶ MOCVD Growth of Planar Non-Polar M-Plane Gallium Nitride
▶ Lateral Growth Method for Defect Reduction of Semipolar Nitride Films
▶ Low Temperature Deposition of Magnesium Doped Nitride Films
▶ Growth of Polyhedron-Shaped Gallium Nitride Bulk Crystals
▶ Improved Manufacturing of Solid State Lasers via Patterning of Photonic Crystals
▶ Control of Photoelectrochemical (PEC) Etching by Modification of the Local Electrochemical Potential of the Semiconductor Structure
▶ Phosphor-Free White Light Source
▶ Single or Multi-Color High Efficiency LED by Growth Over a Patterned Substrate
▶ High Efficiency LED with Optimized Photonic Crystal Extractor
Packaging Technique for the Fabrication of Polarized Light Emitting Diodes

LED Device Structures with Minimized Light Re-Absorption

(in,Ga,Al)N Optoelectronic Devices with Thicker Active Layers for Improved Performance

Oxyfluoride Phosphors for Use in White Light LEDs

III-V Nitride Device Structures on Patterned Substrates

Growth of Semipolar III-V Nitride Films with Lower Defect Density

Improved GaN Substrates Prepared with Ammonothermal Growth

Enhanced Optical Polarization of Nitride LEDs by Increased Indium Incorporation

Semipolar-Based Yellow, Green, Blue LEDs with Improved Performance

Hexagonal Wurtzite Type Epitaxial Layer with a Low Alkali-Metal Concentration

Photoelectrochemical Etching Of P-Type Semiconductor Heterostructures

Photoelectrochemical Etching for Chip Shaping Of LEDs

Method for Manufacturing Improved III-Nitride LEDs and Laser Diodes: Monolithic Integration of Optically Pumped and Electrically Injected III-Nitride LEDs

Defect Reduction in GaN films using in-situ SiNx Nanomask

Semi-polar LED/LD Devices on Relaxed Template with Misfit Dislocation at Hetero-interface

Limiting Strain-Relaxation in III-Nitride Heterostructures by Substrate Patterning

Suppression of Defect Formation and Increase in Critical Thickness by Silicon Doping

High Efficiency Semipolar AlGaAs-Cladding-Free Laser Diodes

Low-Cost Zinc Oxide for High-Power-Output, GaN-Based LEDs (UC Case 2010-183)

Low-Cost Zinc Oxide for High-Power-Output, GaN-Based LEDs (UC Case 2010-150)

Nonpolar III-Nitride LEDs With Long Wavelength Emission

Method for Growing Self-Assembled Quantum Dot Lattices

Method for Increasing GaN Substrate Area in Nitride Devices

Flexible Arrays of MicroLEDs using the Photoelectrochemical (PEC) Lift-off Technique

Optimization of Laser Bar Orientation for Nonpolar Laser Diodes

UV Optoelectronic Devices Based on Nonpolar and Semi-polar AlInN and AlInGaAlN Alloys

Low-Drop LED Structure on GaN Semi-polar Substrates

Improved Fabrication of Nonpolar InGaN Thin Films, Heterostructures, and Devices

Growth of High-Performance M-plane GaN Optical Devices

Method for Enhancing Growth of Semipolar Nitride Devices

Transparent Mirrorless (TML) LEDs

Solid Solution Phosphors for Use in Solid State White Lighting Applications

Technique for the Nitride Growth of Semipolar Thin Films, Heterostructures, and Semiconductor Devices

Planar, Nonpolar M-Plane III-Nitride Films Grown on Miscut Substrates

High-Efficiency, Mirrorless Non-Polar and Semi-Polar Light Emitting Devices

High Light Extraction Efficiency III-Nitride LED

Tunable White Light Based on Polarization-Sensitive LEDs

Method for Improved Surface of (Ga,Al,In)N Films on Nonpolar or Semipolar Substrates

Improved Anisotropic Strain Control in Semipolar Nitride Devices

III-Nitride Tunnel Junction with Modified Interface

Enhanced Light Extraction LED with a Tunnel Junction Contact Wafer Bonded to a Conductive Oxide

Increased Light Extraction with Multistep Deposition of ZnO on GaN

Hybrid Growth Method for Improved III-Nitride Tunnel Junction Devices

Contact Architectures for Tunnel Junction Devices

Internal Heating for Ammonothermal Growth of Group-III Nitride Crystals

Methods for Fabricating III-Nitride Tunnel Junction Devices

Multifaceted III-Nitride Surface-Emitting Laser

Reduction in Leakage Current and Increase in Efficiency of III-Nitride MicroLEDs

Vertical Cavity Surface-Emitting Lasers with Continuous Wave Operation

Continuous Fluidic Printing Of MicroLEDs

Creating and Releasing Nanoscale Light Emitting Devices from Their Growth Substrates

Colloidal Lithography-Enabled Creation of Metasurface-Integrated MicroLEDs and Devices

Efficient Implementation of a Tunnel Junction Contact on a Nitride-Based Edge-Emitting Laser Diode

Unidirectional Phospholinesence with GaN/InGaN Quantum Well Metersurfaces

Wafer Bonding for Embedding Active Regions with Relaxed Nanostructures

Contact to III-Nitride Tunnel Junction Devices Using Narrow Current Spreading Layer and Current Blocking Layer

Heterogeneously Integrated GaN on Si Photonic Integrated Circuits

Enhancement of Semi-Polar Gallium Nitride Surface Morphology in Photo-Electrochemical Undercut Etching

Transparent Vertical Cavity Surface Emitting Laser for Augmented and Mixed Reality Displays

Control Of Photoelectrochemical Etch Parameters For Minimization of Interfacial Roughness of Light Emitting Device Structures

High Speed Indium Gallium Nitride Multi-Quantum Well (InGaN MQW) Photodetector

Distributed Feedback Laser with Transparent Conducting Oxide Grating