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

Tech ID: 23890 / UC Case 2014-416-0

BRIEF DESCRIPTION

A novel device structure for III-nitride devices grown on non-polar or semipolar planes.

BACKGROUND

The usefulness of III-nitrides has been well established for fabrication of visible and ultraviolet optoelectronic devices and high power electronic devices. Growing these devices on nonpolar or semipolar planes of the crystal is a popular solution for reducing the polarization effects. One of the challenges of nonpolar and semipolar growth is that when green III-nitride LEDs and LDs are grown with active regions with high indium contents, the active region can form extended defects and can easily be degraded by subsequent high temperature growth steps. This degradation is due to the growth of the p-type layers after the growth of the active region, which uses high temperatures and impedes device performance.

DESCRIPTION

A novel device structure has been developed for III-nitride devices grown on non-polar or semipolar planes that does not involve the growth of p-type layers after the active region. This configuration reduces the defects and device degradation common in III-nitride LEDs and LDs grown on semipolar planes, and has the potential for creating green III-nitride LEDs and LDs with improved performance and higher wall-plug efficiency.

ADVANTAGES

- Reduced contact resistance, absorption loss, and spreading resistance in p-GaN devices
- Decreased operating voltage of LEDs and LDs leads to increased wall-plug efficiency
- Reduced thermal losses from resistive p-GaN layers

APPLICATIONS

- Light emitting diodes (LEDs)
- Laser diodes (LDs)

PATENT STATUS

<table>
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<th>Country</th>
<th>Type</th>
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<td>United States Of America</td>
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OTHER INFORMATION

KEYWORDS

indLED, semipolar plane, light emitting diode, laser diode, III-nitride, cenIEE, indssl, indfeat

CATEGORIZED AS

- Energy
- Lighting
- Other

RELATED CASES

2014-416-0

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS
Method for Improved Surface of (Ga,Al,In,B)N Films on Nonpolar or Semipolar Substrates

Enhanced Optical Polarization of Nitride LEDs by Increased Indium Incorporation

Lateral Growth Method for Defect Reduction of Semipolar Nitride Films

Vertical Cavity Surface-Emitting Lasers with Continuous Wave Operation

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

Photonic Structures for Efficient Light Extraction and Conversion in Multi-Color LEDs

Highly Efficient Blue-Violet III-Nitride Semipolar Laser Diodes

Hybrid Growth Method for Improved III-Nitride Tunnel Junction Devices

Volumetric Hole Injection with Intentional V-Defects

Low Temperature Deposition of Magnesium Doped Nitride Films

Transparent Mirrorless (TML) LEDs

Improved GaN Substrates Prepared with Ammonothermal Growth

Optimization of Laser Bar Orientation for Nonpolar Laser Diodes

High Efficiency Semipolar AlGaN-Cladding-Free Laser Diodes

Size-Independent Forward Voltage Micro-LED with an Epitaxial Junction

Method for Enhancing Growth of Semipolar Nitride Devices

III-Nitride Tunnel Junction with Modified Interface

Growth of Polyhedron-Shaped Gallium Nitride Bulk Crystals

Nonpolar III-Nitride LEDs With Long Wavelength Emission

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

Growth of High-Quality, Thick, Non-Polar M-Plane GaN Films

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

Method for Growing High-Quality Group III-Nitride Crystals

Controlled Photoelectrochemical (PEC) Etching by Modification of Local Electrochemical Potential of Semiconductor Structure

Incorporating Temperature-Sensitive Layers in III-N Devices

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

MOCVD Growth of Planar Non-Polar M-Plane Gallium Nitride

Reduced Dislocation Density of Non-Polar GaN Grown by Hydride Vapor Phase Epitaxy

Heterogeneously Integrated GaN on Si Photonic Integrated Circuits

Methods for Fabricating III-Nitride Tunnel Junction Devices

Low-Droop LED Structure on GaN Semi-polar Substrates

Contact Architectures for Tunnel Junction Devices

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

Photoelectrochemical Etching Of P-Type Semiconductor Heterostructures

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

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

III-Nitride Tunnel Junction LED with High Wall Plug Efficiency

Improved Manufacturing of Solid State Lasers via Patterning of Photonic Crystals

Multifaceted III-Nitride Surface-Emitting Laser

Tunable White Light Based on Polarization-Sensitive LEDs

Cleaved Facet Edge-Emitting Laser Diodes Grown on Semipolar GaN

Growth of High-Performance M-plane GaN Optical Devices

Packaging Technique for the Fabrication of Polarized Light Emitting Diodes

Improved Anisotropic Strain Control in Semipolar Nitride Devices

High Light Extraction Efficiency III-Nitride LED

III-V Nitride Device Structures on Patterned Substrates

Activation of P-Type Layers of Tunnel Junctions in Micro-LEDs

Method for Increasing GaN Substrate Area in Nitride Devices

Nitride Based Ultraviolet LED with an Ultraviolet Transparent Contact

Growth of Planar, Non-Polar, A-Plane GaN by Hydride Vapor Phase Epitaxy

Single or Multi-Color High Efficiency LED by Growth Over a Patterned Substrate

GaN-Based Thermoelectric Device for Micro-Power Generation

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

Improved Manufacturing of Semiconductor Lasers

LED Device Structures with Minimized Light Re-Absorption

Growth of Planar Semi-Polar Gallium Nitride

GaN-Based Thermoelectric Device for Micro-Power Generation
UV Optoelectronic Devices Based on Nonpolar and Semi-polar AlInN and AlInGaN Alloys

III-Nitride Based VCSEL with Curved Mirror on P-Side of the Aperture

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

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

Enhancing Growth of Semipolar (Al,In,Ga,B)N Films via MOCVD