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>
<th>Number</th>
<th>Dated</th>
<th>Case</th>
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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
- High Efficiency LED with Optimized Photonic Crystal Extractor
- Enhanced Optical Polarization of Nitride LEDs by Increased Indium Incorporation
- Edge-Emitting Laser Diode with Via-Activated Tunnel Junction Contact
- Lateral Growth Method for Defect Reduction of Semipolar Nitride Films
- Flexible Arrays of MicroLEDs using the Photoelectrochemical (PEC) Lift-off Technique
- Vertical Cavity Surface-Emitting Lasers with Continuous Wave Operation
- Low-Cost Zinc Oxide for High-Power-Output, GaN-Based LEDs (UC Case 2010-183)
- Internal Heating for Ammonothermal Growth of Group-III Nitride Crystals
- 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
- Phosphor-Free White Light Source
- Volumetric Hole Injection with Intentional V-Defects
- Control of Photoelectrochemical (PEC) Etching by Modification of the Local Electrochemical Potential of the Semiconductor Structure
- Low Temperature Deposition of Magnesium Doped Nitride Films
- Transparent Mirrorless (TML) LEDs
- Improved GaN Substrates Prepared with Ammonothermal Growth
- Laser Diode With Tunnel Junction Contact Surface Grating
- Optimization of Laser Bar Orientation for Nonpolar Laser Diodes
- Wavelength-Selective Phosphor Coating for Laser Lighting Devices
- High Efficiency Semipolar AlGaN-Cladding-Free Laser Diodes
- 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
- Near-Infrared, Flip-Chip, TCO-Clad, InGaN Quantum Dot Laser Diode
- 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
- (Al, In,Ga, B)N Device Structures
- Methods for Fabricating III-Nitride Tunnel Junction Devices
- 3D Hole Injectors for InAlGaN Light-Emitting Diodes
- 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
- Enhanced Hole Injection by P-Type Active Region and Lateral Injection in InAlGaN LEDs
- 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
- III-Nitride VCSEL with a High Indium Content Active Region
- 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
Hexagonal Wurtzite Type Epitaxial Layer with a Low Alkali-Metal Concentration
Method for Increasing GaN Substrate Area in Nitride Devices
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 Patternning
Improved Manufacturing of Semiconductor Lasers
LED Device Structures with Minimized Light Re-Absorption
Growth of Planar Semi-Polar Gallium Nitride
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