**Improved GaN Substrates Prepared with Ammonothermal Growth**

Tech ID: 23650 / UC Case 2006-666-0

**BRIEF DESCRIPTION**

A method for growing m-plane GaN using an ammonothermal growth technique.

**BACKGROUND**

The usefulness of gallium nitride (GaN) and its alloys has been well established for its use in the fabrication of optoelectronic and high-powered electronic devices. Most commercially available GaN-based devices are grown on conventional c-plane surfaces. The use of c-plane surfaces has disadvantages, which limit the performance of resulting devices. Recent studies have pointed out several benefits and advantages of growing m-plane devices. Despite these benefits, current technology is limited due to poor smoothness of m-plane surfaces.

**DESCRIPTION**

Researchers at the University of California, Santa Barbara have developed a method for growing m-plane GaN using an ammonothermal growth technique. Using this method, m-plane growth results in smoother surfaces than c-plane growth. M-plane growth has associated benefits such as p-type doping and inverted polarization charge. High p-type conductivity improves device efficiency, while transistors grown on m-plane GaN overcome high gate leakage problems of traditional GaN transistors. M-plane optical devices also experience higher emission efficiency due to the absence of a polarization field, and their optically active layer usually has higher Indium incorporation, allowing for longer wavelength emission. This novel method also reduces processing steps because flip-chip bonding and de-bonding steps are no longer needed to expose the m-plane of the growth.

**ADVANTAGES**

- Smoother substrate surface
- Improved device efficiency

**APPLICATIONS**

- LEDs and Laser Diodes
- High Electron Mobility Transistors (HEMTs)
- Power switching devices

**PATENT STATUS**

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<th>Country</th>
<th>Type</th>
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<td>United States Of America</td>
<td>Issued Patent</td>
<td>8,263,424</td>
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**OTHER INFORMATION**

**KEYWORDS**
indssl, indammono,
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indfeat

**CATEGORIZED AS**

- Engineering
- Energy
- Lighting
- Optics and Photonics
- All Optics and Photonics
- Semiconductors
- Design and Fabrication

**RELATED CASES**

2006-666-0
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
- Eliminating Misfit Dislocations with In-Situ Compliant Substrate Formation
- III-Nitride-Based Devices Grown With Relaxed Active Region
- Low-Cost Zinc Oxide for High-Power-Output, GaN-Based LEDs (UC Case 2010-183)
- Highly Efficient Blue-Violet III-Nitride Semipolar Laser Diodes
- Hybrid Growth Method for Improved III-Nitride Tunnel Junction Devices
- Low Temperature Deposition of Magnesium Doped Nitride Films
- Transparent Mirrorless (TML) LEDs
- Optimization of Laser Bar Orientation for Nonpolar 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
- Method for Manufacturing Improved III-Nitride LEDs and Laser Diodes: Monolithic Integration of Optically Pumped and Electrically Injected III-Nitride LEDs
- 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
- 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
- Highly Compact, High-Index Dielectric Nanostructures for Deep-Ultraviolet Devices
- Growth of Group III-Nitride Crystals using Supercritical Ammonia and Nitrogen
- 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
- III-Nitride-Based Devices Grown On Thin Template On Thermally Decomposed Material
- Growth of Semipolar III-V Nitride Films with Lower Defect Density
- III-Nitride Tunnel Junction LED with High Wall Plug Efficiency
- High Efficiency III-Nitride Devices with Smooth Relaxed InGaN Buffer and Strain Compliant Template
- 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
- GaN-Based Thermoelectric Device for Micro-Power Generation
- Limiting Strain-Relaxation in III-Nitride Heterostructures by Substrate Patterning
- 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

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