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

Tech ID: 25014 / UC Case 2004-495-0

BRIEF DESCRIPTION
A method for fabricating high-quality indium-containing epitaxial layers, heterostructures, and devices based on InGaN growth on GaN substrates.

BACKGROUND
GaN and its alloys (AlGaN, InGaN, AlInGaN) have been established as effective for fabrication of visible and ultraviolet optoelectronic devices and high-power electronic devices. These devices are most often grown along the polar c-direction, using a variety of growth techniques, including molecular beam epitaxy (MBE), metalorganic chemical vapor deposition (MOCVD), or hydride vapor phase epitaxy (HVPE). Growing devices in the polar c-direction results in charge separation, spontaneous polarization, and degraded device performance. Growth of such devices along a nonpolar axis could significantly improve their performance, but InGaN-based devices have previously encountered problems with growth conditions and material quality.

DESCRIPTION
UC Santa Barbara researchers have developed a method for fabricating high-quality indium-containing epitaxial layers, heterostructures, and devices based on InGaN growth on GaN substrates. These InGaN films are grown along the nonpolar direction using a metalorganic chemical vapor deposition technique, and result in the successful creation of violet and near-ultraviolet LEDs and LDs. Previous issues related to the growth of InGaN-based devices, such as gross surface roughening, low indium incorporation, and indium desorption in InGaN heterostructures have been overcome with this technique.

ADVANTAGES
- Variability in layer thickness
- Violet and near-ultraviolet light emission
- Growth of nonpolar InGaN at a reduced temperature
- Growth of InGaN layers at or near atmospheric pressure

APPLICATIONS
- LEDs
- Laser diodes (LDs)

PATENT STATUS

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<td>United States Of America</td>
<td>Issued Patent</td>
<td>8,502,246</td>
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OTHER INFORMATION
KEYWORDS
indssl, indled, GaN, thin films

CATEGORIZED AS
- Energy
- Lighting
- Semiconductors
  - Design and Fabrication

RELATED CASES
2004-495-0

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

Etching Technique for the Fabrication of Thin (Al, In, Ga)N Layers

Lateral Growth Method for Defect Reduction of Semipolar Nitride Films

Vertical Cavity Surface-Emitting Lasers with Continuous Wave Operation

Achieving "Active P-Type Layer/Layers" In III-Nitride Epitaxial Or Device Structures Having Buried P-Type Layers

High-Quality N-Face GaN, InN, AIN by MOCVD

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

Defect Reduction in GaN films using in-situ SiNx Nanomask

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

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

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

High Efficiency Semipolar AlGaN-Cladding-Free Laser Diodes

Method for Growing Self-Assembled Quantum Dot Lattices

A Structure For Increasing Mobility In A High-Electron-Mobility Transistor

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

Fabrication of Relaxed Semiconductor Films without Crystal Defects

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

Methods for Locally Changing the Electric Field Distribution in Electron Devices

Increased Light Extraction with Multistep Deposition of ZnO on GaN

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

Selective-Area Mesoporous Semiconductors And Devices For Optoelectronic And Photonic Applications

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

Oxfluoride Phosphors for Use in White Light LEDs

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

(In,Ga,AI)N Optoelectronic Devices with Thicker Active Layers for Improved Performance

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

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

GaN-based Vertical Metal Oxide Semiconductor and Junction Field Effect Transistors

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

Novel Current-Blocking Layer in High-Power Current Aperture Vertical Electron Transistors (CAVETs)

Improved Manufacturing of Solid State Lasers via Patterning of Photonic Crystals
- III-N Transistor With Stepped Cap Layers
- Solid Solution Phosphors for Use in Solid State White Lighting Applications
- 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
- Photoelectrochemical Etching for Chip Shaping Of LEDs
- 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 Patterning
- Improved Manufacturing of Semiconductor Lasers
- LED Device Structures with Minimized Light Re-Absorption
- Growth of Planar Semi-Polar Gallium Nitride
- Nonpolar (Al, B, In, Ga)N Quantum Well Design
- UV Optoelectronic Devices Based on Nonpolar and Semi-polar AlInN and AlInGAN Alloys
- Integration And Mass Transfer Of Microleds
- Defect Reduction of Non-Polar and Semi-Polar III-Nitrides
- 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
- Wafer Bonding for Embedding Active Regions with Relaxed Nanofeatures
- Enhancing Growth of Semipolar (Al,In,Ga,B)N Films via MOCVD