Technique for the Nitride Growth of Semipolar Thin Films, Heterostructures, and Semiconductor Devices
Tech ID: 25247 / UC Case 2005-668-0

BRIEF DESCRIPTION
A method to grow semipolar (Ga, Al, In, B)N thin films, heterostructures, and devices on suitable substrates or planar templates in which a large area of the semipolar film is parallel to the substrate surface.

BACKGROUND
The usefulness of gallium nitride (GaN) and its ternary and quaternary compounds incorporating aluminum and indium has been well established for fabrication of visible and ultraviolet optoelectronic devices. Current nitride technology for these devices uses nitride films grown along the polar c-direction; however, quantum-well active regions in devices suffer from the quantum-confined Stark effect (QCSE). One way to combat the issue is to grow films on semipolar planes of GaN in order to improve device performance by reduce polarization effects and increasing the efficiency of optical transitions.

DESCRIPTION
Researchers at UC Santa Barbara have developed a method to grow semipolar (Ga, Al, In, B)N thin films, heterostructures, and devices on suitable substrates or planar templates in which a large area of the semipolar film is parallel to the substrate surface. The method uses vapor phase epitaxy, such as metalorganic chemical vapor deposition (MOCVD), in order to grow the semipolar structures. Additionally, this technique alters the crystal growth orientation in order to reduce polarization effects in nitride thin films. This method is stable, energy efficient and cost-effective.

ADVANTAGES
▶ Reduces the negative impact of polarization
▶ Improved device efficiency
▶ Improved crystal growth orientation

APPLICATIONS
▶ LEDs and Laser Diodes (LDs)
▶ Semiconductors

PATENT STATUS

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<td>United States Of America</td>
<td>Issued Patent</td>
<td>10,529,892</td>
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OTHER INFORMATION
KEYWORDS
indssl, indled, MOCVD, thin films

CATEGORIZED AS
▶ Optics and Photonics
▶ All Optics and Photonics
▶ Energy
▶ Lighting
▶ Semiconductors
▶ Design and Fabrication

RELATED CASES
2005-668-0

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
Flexible Arrays of MicroLEDs using the Photoelectrochemical (PEC) Liftoff Technique

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

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

Low Temperature Deposition of Magnesium Doped Nitride Films

Device Structures Utilizing Barrier Enhancement Conductive Materials on N-polar III-N

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

High Mobility Group-III Nitride Transistors with Strained Channels

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

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

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

Incorporating Temperature-Sensitive Layers in III-N Devices

Controlling Linearity in N-Polar GaN MISHEMTs

Oxyfluoride Phosphors for Use in White Light LEDs

Enabling Epitaxial Growth On Thin Substrates

(In,Ga,Al)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

N-polar III-N Semiconductor Device Structures Enabled by Wet Chemistry

Heterogeneously Integrated GaN on Si Photonic Integrated Circuits

(AI, In,Ga, B)N Device Structures

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

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

Semi-polar-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)
- In-Situ Methods Of Preventing Interfacial Impurities And Dry Etch-Induced Damage In Regrown Ⅲ-Nitride Structures
- Enhanced Hole Injection by P-Type Active Region and Lateral Injection in InAlGaN LEDs
- Improved Manufacturing of Solid State Lasers via Patterned 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
- Burying Impurities And Defects In Regrown Ⅲ-Nitride Structures
- 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
- Polarization-Doped Field Effect Transistors with Increased Performance
- 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
- 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,Ga,B)N Films via MOCVD
- Ⅲ-N Based Material Structures and Circuit Modules Based on Strain Management