Method for Increasing GaN Substrate Area in Nitride Devices
Tech ID: 24795 / UC Case 2007-675-0

BRIEF DESCRIPTION
A technique for producing large-area, high-quality freestanding non-polar and semi-polar nitride substrates via multiple slicing and growth steps.

BACKGROUND
Gallium nitride (GaN) and its compounds that incorporate aluminum and indium have been well established for fabrication of optoelectronic devices and high-power electronic devices. Typically, these devices are grown epitaxially using growth techniques such as molecular beam epitaxy, metalorganic chemical vapor deposition, and hydride vapor phase epitaxy. These methods in current nitride technology employ nitride films that are grown along the polar c-direction, where multiple basal plane axes of GaN and its alloys are aligned perpendicular to the c-axis. However, these devices suffer from the quantum-confined Stark effect (QCSE), which causes spontaneous polarizations.

One possibility for eliminating spontaneous polarization in GaN optoelectronic devices is to grow them on non-polar planes of the crystal. Subsequent non-polar layers are equivalent to the top plane, assuring the bulk crystal will not be polarized along the growth direction.

DESCRIPTION
Researchers at the University of California, Santa Barbara have developed a technique for producing large-area, high-quality freestanding non-polar and semi-polar nitride substrates via multiple slicing and growth steps. The available surface area is increased geometrically by changing the growth direction of thick-film growth steps. Multiple growth steps with different growth directions that are not orthogonal to the prior substrate surface are utilized, which enlarges the surface area of the final crystal plane. The number of process repeats (growth/slice/polish) and the angles of the slice steps depend on the final crystal plane. This invention is pertinent to all nitrides, and results in reduced defect densities.

ADVANTAGES
· Total polarization is eliminated (non-polar) or reduced greatly (semi-polar)
· Improved device performance
· Applicable to all nitride-based optoelectronic devices

APPLICATIONS
· Optoelectronic devices (LEDs, LDs)
· High-power electronic devices (transistors)

PATENT STATUS

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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
- 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) Lift-off Technique
- Vertical Cavity Surface-Emitting Lasers with Continuous Wave Operation
- Gallium-containing MicroLEDs for Displays
- High Speed Indium Gallium Nitride Multi-Quantum Well (InGaN MQW) Photodetector
- 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
- 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
- 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
- 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
- Near-Infrared, Flip-Chip, TCO-Clad, InGaN Quantum Dot Laser Diode
- Incorporating Temperature-Sensitive Layers in III-N Devices
- Oxyfluoride 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
- (Al, In,Ga, B)N Device Structures
- Reduction in Leakage Current and Increase in Efficiency of III-Nitride MicroLEDs
- Methods for Fabricating III-Nitride Tunnel Junction Devices
- 3D Hole Injectors for InAlGaN Light-Emitting Diodes
- Formation of Transparent Integrated MicroLED Displays
- 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