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

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OTHER INFORMATION

KEYWORDS

indssl, indbulk, GaN, nitride, transistor

CATEGORIZED AS

- **Energy**
  - Lighting
- **Semiconductors**
  - Design and Fabrication

RELATED CASES

2007-675-0

APPLICATIONS

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

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	8,729,671	05/20/2014	2007-675
United States Of America	Issued Patent	8,080,469	12/20/2011	2007-675

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- 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
- Eliminating Misfit Dislocations with In-Situ Compliant Substrate Formation
- III-Nitride-Based Vertical Cavity Surface Emitting Laser (VCSEL) with a Dielectric P-Side Lens
- Aluminum-cladding-free Nonpolar III-Nitride LEDs and LDs
- Low-Cost Zinc Oxide for High-Power-Output, GaN-Based LEDs (UC Case 2010-183)
- 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
- Low Temperature Deposition of Magnesium Doped Nitride Films
- Transparent Mirrorless (TML) LEDs
- Improved GaN Substrates Prepared with Ammonothermal Growth
- Optimization of Laser Bar Orientation for Nonpolar Laser Diodes
- Method for Enhancing Growth of Semipolar Nitride Devices
- Ultraviolet Laser Diode on Nano-Porous AlGaN template
- Improved Reliability & Enhanced Performance of III-Nitride Tunnel Junction Optoelectronic Devices
- 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 Growing High-Quality Group III-Nitride Crystals
- Controlled Photoelectrochemical (PEC) Etching by Modification of Local Electrochemical Potential of Semiconductor Structure
- Oxyfluoride Phosphors for Use in White Light LEDs
- Technique for the Nitride Growth of Semipolar Thin Films, Heterostructures, and Semiconductor Devices
- (In,Ga,Al)N Optoelectronic Devices with Thicker Active Layers for Improved Performance
- Thermally Stable, Laser-Driven White Lighting Device
- MOCVD Growth of Planar Non-Polar M-Plane Gallium Nitride
- 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
- 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
- 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
- Novel Multilayer Structure for High-Efficiency UV and Far-UV Light-Emitting Devices
- III-V Nitride Device Structures on Patterned Substrates
- High-Intensity Solid State White Laser Diode
- Nitride Based Ultraviolet LED with an Ultraviolet Transparent Contact
- 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
- High-Efficiency and High-Power III-Nitride Devices Grown on or Above a Strain Relaxed Template
- 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
- Enhancing Growth of Semipolar (Al,In,Ga,B)N Films via MOCVD

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