Growth of Planar, Non-Polar, A-Plane GaN by Hydride Vapor Phase Epitaxy

Tech ID: 10268 / UC Case 2003-225-0

CONTACT
University of California, Santa Barbara Office of Technology & Industry Alliances
padilla@tia.ucsb.edu
tel: 805-893-2073.

INVENTORS
- Craven, Michael D.
- DenBaars, Steven P.
- Fini, Paul T.
- Haskell, Benjamin A.
- Matsuda, Shigemasa
- Nakamura, Shuji
- Speck, James S.

OTHER INFORMATION

KEYWORDS
indssl, indbulk, HVPE, GaN,
gallium nitride, cenIEE

CATEGORIZED AS
- Engineering
- Semiconductors
  - Design and Fabrication

RELATED CASES
2003-225-0
BRIEF DESCRIPTION

A novel method for growing high-quality thick films of a-plane GaN suitable for use as substrates in homoepitaxial device layer regrowth.

BACKGROUND

Gallium nitride (GaN) and its ternary and quaternary compounds incorporating aluminum and indium (AlGaN, InGaN, AlInGaN) have proven useful in fabricating visible and ultraviolet optoelectronic devices and high-power electronic devices. GaN and its alloys are most stable in the hexagonal wurtzite crystal structure. However, the positions of the gallium and nitrogen atoms in this structure leads to polarization of the GaN crystals along the c-axis. Virtually all GaN-based devices are grown parallel to the polar c-axis, due to the relative ease of growing planar Ga-face planes.

In addition, strain at the interfaces between adjacent dissimilar layers causes piezoelectric polarization and subsequent charge separation. These polarization effects decrease the likelihood of electron and hole interaction, which is essential for the operation of light-emitting devices. As a result, eliminating these polarization effects inherent to c-axis oriented devices could greatly enhance the efficiency of GaN light-emitting devices.

DESCRIPTION

Scientists at the University of California have developed a novel method for growing high-quality thick films of a-plane GaN suitable for use as substrates in homoepitaxial device layer regrowth. This invention can be used in conjunction with a method for growing reduced-dislocation density non-polar GaN by hydride vapor phase epitaxy (HVPE) (UC Case 2003-224).

ADVANTAGES

▶ Allows for the production of thick a-plane GaN films for use as substrates for polarization-free device growth;
▶ Produces films of superior quality that are suitable for subsequent device regrowth by a variety of growth techniques.

APPLICATIONS

▶ Fabrication of GaN by HVPE

This technology is available for a non-exclusive license. See below for a selection of the patents and patent applications related to this invention. Please inquire for full patent portfolio status.

PATENT STATUS

<table>
<thead>
<tr>
<th>Country</th>
<th>Type</th>
<th>Number</th>
<th>Dated</th>
<th>Case</th>
</tr>
</thead>
</table>


RELATED TECHNOLOGIES

▶ Reduced Dislocation Density of Non-Polar GaN Grown by Hydride Vapor Phase Epitaxy

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
▶ 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
▶ 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
▶ Group III-N Light Emitting Devices Enhanced By Stress From Post-Growth Deposited Films
▶ Thermally Stable, Laser-Driven White Lighting Device
▶ MOCVD Growth of Planar Non-Polar M-Plane Gallium Nitride
▶ Reduced Dislocation Density of Non-Polar GaN Grown by Hydride Vapor Phase Epitaxy
▶ 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