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

Tech ID: 10268 / UC Case 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.

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OTHER INFORMATION

KEYWORDS

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

CATEGORIZED AS

▶ Engineering
▶ Semiconductors
▶ Design and Fabrication

RELATED CASES

2003-225-0

PATENT STATUS

<table>
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<th>Country</th>
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RELATED TECHNOLOGIES
▶ Reduced Dislocation Density of Non-Polar GaN Grown by Hydride Vapor Phase Epitaxy

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,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
▶ 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