Growth of Planar Semi-Polar Gallium Nitride
Tech ID: 21912 / UC Case 2005-471-0

BRIEF DESCRIPTION
A technique for the growth of planar films of semi-polar nitrides, in which a large area of (Al, In, Ga)N is grown parallel to the substrate surface.

BACKGROUND
Current nitride technology for electronic and optoelectronic devices employs nitride films grown along the polar c-direction. However, conventional c-plane quantum well structures in III-nitride based optoelectronic and electronic devices suffer from the undesirable quantum-confined Stark effect (QCSE), due to the existence of strong piezoelectric effects and spontaneous polarizations. The strong built-in electric fields along the c-direction cause spatial separation of electrons and holes that in turn give rise to restricted carrier recombination efficiency, reduced oscillator strength, and red-shifted emission. The growth of non-polar GaN remains challenging and has not yet been widely adopted in the III-nitride industry.

DESCRIPTION
Researchers at the University of California, Santa Barbara have developed a technique for the growth of planar films of semi-polar nitrides, in which a large area of (Al, In, Ga)N is grown parallel to the substrate surface. For example, samples can be grown on 10 mm x 10 mm or 2 inch diameter substrates. The advantage of semi-polar over c-plane nitride films is the reduction in polarization and the associated increase in internal quantum efficiency for certain devices.

ADVANTAGES
▶ Reduction in polarization and the associated increase in internal quantum efficiency for certain devices
▶ Easier to grow compared to non-polar nitride films

APPLICATIONS
▶ Production of planar semi-polar gallium nitride

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

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ADDITIONAL TECHNOLOGIES BY THESE INVENTORS
▶ Reduced Dislocation Density of Non-Polar GaN Grown by Hydride Vapor Phase Epitaxy
▶ Growth of Planar, Non-Polar, A-Plane GaN by Hydride Vapor Phase Epitaxy
▶ Nonpolar (Al, B, In, Ga)N Quantum Well Design
Improved Manufacturing of Semiconductor Lasers

Cleaved Facet Edge-Emitting Laser Diodes Grown on Semipolar GaN

Etching Technique for the Fabrication of Thin (Al, In, Ga)N Layers

Enhancing Growth of Semipolar (Al,In,Ga,B)N Films via MOCVD

GaN-Based Thermoelectric Device for Micro-Power Generation

Growth of High-Quality, Thick, Non-Polar M-Plane GaN Films

Method for Growing High-Quality Group III-Nitride Crystals

Defect Reduction of Non-Polar and Semi-Polar III-Nitrides

MOCVD Growth of Planar Non-Polar M-Plane Gallium Nitride

Lateral Growth Method for Defect Reduction of Semipolar Nitride Films

Low Temperature Deposition of Magnesium Doped Nitride Films

Growth of Polyhedral-Shaped Gallium Nitride Bulk Crystals

Improved Manufacturing of Solid State Lasers via Patternning of Photonic Crystals

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

Phosphor-Free White Light Source

Single or Multi-Color High Efficiency LED by Growth Over a Patterned Substrate

High Efficiency LED with Optimized Photonic Crystal Extractor

Packaging Technique for the Fabrication of Polarized Light Emitting Diodes

LED Device Structures with Minimal Light Re-Absorption

(In,Ga,AJ)N Optoelectronic Devices with Thicker Active Layers for Improved Performance

Oxynitride Phosphors for Use in White Light LEDs

II-V Nitride Device Structures on Patterned Substrates

Growth of Semipolar III-V Nitride Films with Lower Defect Density

Improved GaN Substrates Prepared with Ammonothermal Growth

Enhanced Optical Polarization of Nitride LEDs by Increased Indium Incorporation

Semipolar-Based Yellow, Green, Blue LEDs with Improved Performance

Hexagonal Wurtzite Type Epitaxial Layer with a Low Alkali-Metal Concentration

Photoelectrochemical Etching Of P-Type Semiconductor Heterostructures

Photoelectrochemical Etching for Chip Shaping Of LEDs

Highly Efficient Blue-Violet III-Nitride Semipolar Laser Diodes

Method for Manufacturing Improved III-Nitride LEDs and Laser Diodes: Monolithic Integration of Optically Pumped and Electrically Injected III-Nitride LEDs

Defect Reduction in GaN films using in-situ SiNx Nanomask

Semi-polar LED/LD Devices on Relaxed Template with Misfit Dislocation at Hetero-interface

Limiting Strain-Relaxation in III-Nitride Heterostructures by Substrate Patternning

Suppression of Defect Formation and Increase in Critical Thickness by Silicon Doping

High Efficiency Semipolar AlGaN-Cladding-Free Laser Diodes

Low-Cost Zinc Oxide for High-Power-Output, GaN-Based LEDs (UC Case 2010-183)

Low-Cost Zinc Oxide for High-Power-Output, GaN-Based LEDs (UC Case 2010-150)

Nonpolar III-Nitride LEDs With Long Wavelength Emission

Method for Growing Self-Assembled Quantum Dot Lattices

Method for Increasing GaN Substrate Area in Nitride Devices

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

Optimization of Laser Bar Orientation for Nonpolar Laser Diodes

UV Optoelectronic Devices Based on Nonpolar and Semi-polar AlInN and AlInGaN Alloys

Low-Droop LED Structure on GaN Semi-polar Substrates

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

Growth of High-Performance M-plane GaN Optical Devices

Method for Enhancing Growth of Semipolar Nitride Devices

Transparent Mirrorless (TML) LEDs

Solid Solution Phosphors for Use in Solid State White Lighting Applications

Technique for the Nitride Growth of Semipolar Thin Films, Heterostructures, and Semiconductor Devices

Planar, Nonpolar M-Plane III-Nitride Films Grown on Miscut Substrates

High-Efficiency, Mirrorless Non-Polar and Semi-Polar Light Emitting Devices

High Light Extraction Efficiency III-Nitride LED

Tunable White Light Based on Polarization-Sensitive LEDs

Method for Improved Surface of (Ga,Al,In,B)N Films on Nonpolar or Semipolar Substrates
Improved Anisotropic Strain Control in Semipolar Nitride Devices
• III-Nitride Tunnel Junction with Modified Interface
• Enhanced Light Extraction LED with a Tunnel Junction Contact Wafer Bonded to a Conductive Oxide
• Increased Light Extraction with Multistep Deposition of ZnO on GaN
• Hybrid Growth Method for Improved III-Nitride Tunnel Junction Devices
• Contact Architectures for Tunnel Junction Devices
• Internal Heating for Ammonothermal Growth of Group-III Nitride Crystals
• Methods for Fabricating III-Nitride Tunnel Junction Devices
• Multifaceted III-Nitride Surface-Emitting Laser
• Reduction in Leakage Current and Increase in Efficiency of III-Nitride MicroLEDs
• Vertical Cavity Surface-Emitting Lasers with Continuous Wave Operation
• Wafer Bonding for Embedding Active Regions with Relaxed Nanofeatures
• Heterogeneously Integrated GaN on Si Photonic Integrated Circuits
• High Speed Indium Gallium Nitride Multi-Quantum Well (InGaN MQW) Photodetector
• Distributed Feedback Laser with Transparent Conducting Oxide Grating
• Eliminating Plasma Damage for Beta-Phase Gallium Oxide Transistors
• Retaining Injection Efficiency and Optical Properties of Laser Diodes with Built-in Polarization Fields
• Laser Diode With Tunnel Junction Contact Surface Grating
• III-Nitride Tunnel Junction LED with High Wall Plug Efficiency