Limiting Strain-Relaxation in III-Nitride Heterostructures by Substrate Patterning
Tech ID: 24137 / UC Case 2010-804-0

BRIEF DESCRIPTION
A new method of improving performance of group-III nitride devices by limiting the strain-relaxation on crystal substrates.

BACKGROUND
The usefulness of group-III nitrides such as gallium nitride (GaN) and its alloys has been well established for its use in the fabrication of optoelectronic and high-powered electronic devices. Given recent trends in industry standards, it is desirable to produce ultra-bright LEDs and LDs in regions beyond the blue region and in the green region. The problem with producing LEDs and LDs in the green regions by epitaxy is due to the complications in producing high-quality, high-in-composition crystals. When high-in-composition crystal structures are grown on a strained substrate layer, this causes misfit dislocations which degrade device performance.

DESCRIPTION
Researchers at the University of California, Santa Barbara have developed a new method of improving performance of group-III nitride devices by limiting the strain-relaxation on crystal substrates. Limiting the strain-relaxation on group-III nitride substrates is achieved through a novel process of patterning the substrate with a specialized film which reduces the pre-existing thread dislocations before growth of the subsequent layers. By reducing these pre-existing thread dislocations, less misfit dislocation will result during layer growth and will allow for the growth of thicker/higher in composition layers of III-nitride alloy epilayers.

ADVANTAGES
▶ Reduced strain on device layers
▶ Reduced thread and misfit dislocations
▶ High thickness/composition group-III nitride stacking
▶ Reduced complications of lattice mismatch
▶ Improved device performance

APPLICATIONS
▶ UV and Green Region LEDs and LDs
▶ Group-III Nitride Materials
▶ Optoelectronics and Electronic Devices

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
- Growth of Planar Semi-Polar Gallium Nitride
- 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 Polyhedron-Shaped Gallium Nitride Bulk Crystals
- Improved Manufacturing of Solid State Lasers via Patterned 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 Minimized Light Re-Absorption
- (In,Ga,Al)N Optoelectronic Devices with Thicker Active Layers for Improved Performance
- Oxynitride Phosphors for Use in White Light LEDs
- III-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
- 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 Nanostructures

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