Defect Reduction in GaN films using in-situ SiNx Nanomask
Tech ID: 24135 / UC Case 2006-530-0

BRIEF DESCRIPTION
An efficient method to significantly reduce defects in non-polar and semi-polar group-III nitride films.

BACKGROUND
The usefulness of non-polar and semi-polar 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 there is considerable interest in the growth of nonpolar (a- and m-plane) GaN based epitaxial films. The problems associated with the growth of these nonpolar GaN based films is characterized by high defect density, reduced carrier mobility, and low reliability which all contribute to an overall lower efficiency. However, high performance devices can be achieved by eliminating these defects by improving the structural quality of the nonpolar GaN films.

DESCRIPTION
Researchers at the University of California, Santa Barbara have developed an efficient method to significantly reduce defects in non-polar and semi-polar group-III nitride films. Through the use of in-situ SiNx as a nanomask when growing GaN substrates, researchers have demonstrated reduced stacking fault density, reduced thread dislocation density, reduced surface roughness, reduced sub-micron pits, and increased luminescence. Compared to the lateral epitaxial overgrowth (LEO) technique, this invention has the advantage of being a simple process that avoids contamination characteristic of the ex-situ process used in LEO. Unlike LEO, this new process also facilitates nanometer scale lateral epitaxial overgrowth at the open pores of the film which reduces the differences between the wing and window regions of film which has adverse effects on devices if untreated. All structure improvements contribute to an overall reduction of defects uniformly across the film which significantly increases the efficiency of the material.

ADVANTAGES
▶ Uniform defect reduction across film
▶ Highly efficient process capable of being done on the nanometer scale
▶ Improved performance of semi-polar and non-polar group-III nitride based devices
▶ Highly adaptable and easily controllable process

APPLICATIONS
▶ LDs and LEDs
▶ Group-III nitride materials
▶ High powered electronic and optoelectronic devices
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**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
- 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
- Retaining Injection Efficiency and Optical Properties of Laser Diodes with Built-in Polarization Fields
- Achieving “Active P-Type Layer/Layers” In III-Nitride Epitaxial Or Device Structures Having Buried P-Type Layers
- Gallium-containing MicroLEDs for Displays
- High-Quality N-Face GaN, InN, AlN by MOCVD
- 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
- 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
- Volumetric Hole Injection with Intentional V-Defects
- Low Temperature Deposition of Magnesium Doped Nitride Films
- Transparent Mirrorless (TML) LEDs
- 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
- High Mobility Group-III Nitride Transistors with Strained Channels
- Method for Growing Self-Assembled Quantum Dot Lattices
- A Structure For Increasing Mobility In A High-Electron-Mobility Transistor
- Method for Enhancing Growth of Semipolar Nitride Devices
- III-Nitride Tunnel Junction with Modified Interface
- Fabrication of Relaxed Semiconductor Films without Crystal Defects
- Improved Fabrication of Nonpolar InGaN Thin Films, Heterostructures, and Devices
- Growth of High-Quality, Thick, Non-Polar M-Plane GaN Films
- Methods for Locally Changing the Electric Field Distribution in Electron Devices
- Increased Light Extraction with Multistep Deposition of ZnO on GaN
- Selective-Area Mesoporous Semiconductors And Devices For Optoelectronic And Photonic Applications
- High-Efficiency, Mirrorless Non-Polar and Semi-Polar Light Emitting Devices
- Fabricating III-Nitride Semipolar and Nonpolar Lasers on Scalable Foreign Substrate to Large Area
- Near-Infrared, Flip-Chip, TCO-Clad, InGaN Quantum Dot Laser Diode
- Incorporating Temperature-Sensitive Layers in III-N Devices
- Oxynitride Phosphors for Use in White Light LEDs
- Technique for the Nitride Growth of Semipolar Thin Films, Heterostructures, and Semiconductor Devices
- Enabling Epitaxial Growth On Thin Substrates
- (In,Ga,AI)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, BJ)N Device Structures
- Reduction in Leakage Current and Increase in Efficiency of III-Nitride MicroLEDs
GaN-based Vertical Metal Oxide Semiconductor and Junction Field Effect Transistors

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

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

Photoelectrochemical Etching Of P-Type Semiconductor Heterostructures

Semi-polar-Based Yellow, Green, Blue LEDs with Improved Performance

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

III-Nitride Tunnel Junction LED with High Wall Plug Efficiency

Novel Current-Blocking Layer in High-Power Current Aperture Vertical Electron Transistors (CAVETs)

In-Situ Methods Of Preventing Interfacial Impurities And Dry Etch-Induced Damage In Regrown III-Nitride Structures

Enhanced Hole Injection by P-Type Active Region and Lateral Injection in InAlGaN LEDs

Improved Manufacturing of Solid State Lasers via Patterning of Photonic Crystals

III-N Transistor With Stepped Cap Layers

Solid Solution Phosphors for Use in Solid State White Lighting Applications

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

High Light Extraction Efficiency III-Nitride LED

Photoelectrochemical Etching for Chip Shaping Of LEDs

III-V Nitride Device Structures on Patterned Substrates

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

Method for Increasing GaN Substrate Area in Nitride Devices

Burying Impurities And Defects In Regrown III-Nitride Structures

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

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

GaN-Based Thermoelectric Device for Micro-Power Generation

Fabricating Scalable, High Angle Inclination Semipolar Substrates

Polarization-Doped Field Effect Transistors with Increased Performance

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

LED Device Structures with Minimized Light Re-Absorption

Improved Light Extraction with Geometrically Tuned LED Arrays

Growth of Planar Semi-Polar Gallium Nitride

Nonpolar (A, B, In, Ga)N Quantum Well Design

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

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

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

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

Wafer Bonding for Embedding Active Regions with Relaxed Nanofeatures

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

III-N Based Material Structures and Circuit Modules Based on Strain Management