



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

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BRIEF DESCRIPTION

Sidewall lateral epitaxial overgrowth (SLEO) of non-polar a-plane and m-plane GaN that results in several device improvements such as longer lifetimes, less leakage current, more efficient doping and higher output efficiency.

BACKGROUND

It is relatively easy to grow c-plane GaN due to its large growth window (pressure, temperature and precursor flows) and its stability. However, as a result of c-plane growth, each material layer suffers from separation of electrons and holes to opposite faces of the layers. Furthermore, strain at the interfaces between adjacent layers gives rise to piezoelectric polarization, causing further charge separation. Such polarization effects decrease the likelihood of electrons and holes recombining, causing the device to perform poorly. Another reason why GaN materials perform poorly is the presence of defects due to lack of a lattice matched substrate. There is an ever-increasing effort to reduce the dislocation density in GaN films in order to improve device performance.

DESCRIPTION

Researchers at the University of California, Santa Barbara have successfully developed sidewall lateral epitaxial overgrowth (SLEO) of non-polar a-plane and m-plane GaN. By using single step lateral epitaxial overgrowth, dislocation densities can be reduced and stacking faults are localized only on the nitrogen faces. Dislocation densities can be reduced down to even lower values by eliminating defects not only in the overgrown regions but also in the window regions. Also, by favoring gallium (Ga) face growth and limiting nitrogen (N) face growth stacking fault densities can be made orders of magnitude lower. The present invention also takes advantage of the orientation of non-polar III-Nitrides to eliminate polarization fields. As a result, with the material produced by utilizing this invention, device improvements such as longer lifetimes, less leakage current, more efficient doping and higher output efficiency are possible. In addition, a thick non-polar and semi-polar nitride free-standing substrate, which is needed to solve the lattice mismatch issue, can be produced over this excellent material.

ADVANTAGES

- ▶ Reduced dislocation density in GaN films
- ▶ Reduced stacking fault density
- ▶ Eliminates polarization fields

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OTHER INFORMATION

KEYWORDS

indssl, indled, GaN, III-Nitrides,
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CATEGORIZED AS

- ▶ [Engineering](#)
- ▶ [Optics and Photonics](#)
 - ▶ [All Optics and Photonics](#)
- ▶ [Semiconductors](#)
 - ▶ [Design and Fabrication](#)

RELATED CASES

2005-565-0

- ▶ Improved performance in GaN-based devices (longer lifetimes, less leakage current, more efficient doping and higher output efficiency)

APPLICATIONS

- ▶ Non-polar and semi-polar GaN films
- ▶ GaN-based devices

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

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	7,955,983	06/07/2011	2005-565
United States Of America	Issued Patent	7,361,576	04/22/2008	2005-565

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
- ▶ 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
- ▶ Optimization of Laser Bar Orientation for Nonpolar Laser Diodes
- ▶ Method for Enhancing Growth of Semipolar Nitride Devices
- ▶ Ultraviolet Laser Diode on Nano-Porous AlGaIn template
- ▶ Improved Reliability & Enhanced Performance of III-Nitride Tunnel Junction Optoelectronic Devices
- ▶ Improved Fabrication of Nonpolar InGaIn Thin Films, Heterostructures, and Devices
- ▶ Growth of High-Quality, Thick, Non-Polar M-Plane GaN Films
- ▶ 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
- ▶ Thermally Stable, Laser-Driven White Lighting Device
- ▶ MOCVD Growth of Planar Non-Polar M-Plane Gallium Nitride
- ▶ 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
- ▶ 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
- ▶ III-V Nitride Device Structures on Patterned Substrates
- ▶ Method for Increasing GaN Substrate Area in Nitride Devices
- ▶ High-Intensity Solid State White Laser Diode
- ▶ Nitride Based Ultraviolet LED with an Ultraviolet Transparent Contact
- ▶ GaN-Based Thermoelectric Device for Micro-Power Generation
- ▶ Limiting Strain-Relaxation in III-Nitride Heterostructures by Substrate Patterning
- ▶ LED Device Structures with Minimized Light Re-Absorption
- ▶ Growth of Planar Semi-Polar Gallium Nitride
- ▶ UV Optoelectronic Devices Based on Nonpolar and Semi-polar AlInN and AlInGaN Alloys
- ▶ Enhancing Growth of Semipolar (Al,In,Ga,B)N Films via MOCVD

