Low-Droop LED Structure on GaN Semi-polar Substrates

Tech ID: 24988 / UC Case 2011-832-0

BRIEF DESCRIPTION

An LED structure of GaN thin films grown by metal organic chemical vapor deposition (MOCVD) on (20-2-1) semi-polar GaN substrates that demonstrate low efficiency droop.

BACKGROUND

When III-nitride-based LEDs are grown on nonpolar and semi-polar planes, unbalanced in-plane biaxial strain causes the curvature of the highest valence band to increase. The result is an increase in symmetry between the valence band and conduction band curvatures. For wide bandgap materials, symmetric conduction and valence bands may suppress Auger recombination, which is the mechanism widely accepted as being responsible for efficiency droop. Particularly in high indium composition layers, it has been observed that quantum wells grown on certain semi-polar planes may have superior alloy uniformity to devices grown on c-plane; this difference should lead to reduced alloy scattering and the devices should demonstrate reduced efficiency droop in general.

DESCRIPTION

Researchers at UC Santa Barbara have developed an LED structure of GaN thin films grown by metal organic chemical vapor deposition (MOCVD) on (20-2-1) semi-polar GaN substrates that demonstrate low efficiency droop. These devices provide a pathway to nitride-based devices that are free from the droop effect. The structure incorporates n-type superlattice layers located below the quantum wells (QW), a QW active region of at least three periods, and p-type superlattice layers above the QWs. Devices grown on the (20-2-1) plane have shown that they have superior alloy uniformity, reduced alloy scattering, and thus diminished efficiency droop.

ADVANTAGES

- Superior alloy uniformity
- Greatly reduced alloy scattering
- Reduced efficiency droop

APPLICATIONS

- Solid state lighting systems

CONTACT

Pasquale S. Ferrari
ferrari@tia.ucsb.edu
tel: .

INVENTORS

- DenBaars, Steven P.
- Feezell, Daniel F.
- Nakamura, Shuji
- Pan, Chih Chien
- Tanaka, Shinichi
- Zhao, Yuji

OTHER INFORMATION

KEYWORDS

indssl, indled, MOCVD, indfeat

CATEGORIZED AS

- **Energy**
  - Lighting

RELATED CASES

2011-832-0

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	8,686,397	04/01/2014	2011-832

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- 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
- III-Nitride-Based Vertical Cavity Surface Emitting Laser (VCSEL) with a Dielectric P-Side Lens
- 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
- Improved GaN Substrates Prepared with Ammonothermal Growth
- Optimization of Laser Bar Orientation for Nonpolar Laser Diodes
- Method for Enhancing Growth of Semipolar Nitride Devices
- Ultraviolet Laser Diode on Nano-Porous AlGaN template
- Improved Reliability & Enhanced Performance of III-Nitride Tunnel Junction Optoelectronic Devices
- 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
- Method for Growing High-Quality Group III-Nitride Crystals
- Controlled Photoelectrochemical (PEC) Etching by Modification of Local Electrochemical Potential of Semiconductor Structure
- 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
- 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
- Novel Multilayer Structure for High-Efficiency UV and Far-UV Light-Emitting 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
- High-Efficiency and High-Power III-Nitride Devices Grown on or Above a Strain Relaxed Template
- UV Optoelectronic Devices Based on Nonpolar and Semi-polar AlInN and AlInGaN Alloys
- Defect Reduction of Non-Polar and Semi-Polar III-Nitrides
- III-Nitride Based VCSEL with Curved Mirror on P-Side of the Aperture
- Enhancing Growth of Semipolar (Al,In,Ga,B)N Films via MOCVD

University of California, Santa Barbara
Office of Technology & Industry Alliances
342 Lagoon Road, ,Santa Barbara,CA 93106-2055 |
www.tia.ucsb.edu
Tel: 805-893-2073 | Fax: 805.893.5236 | padilla@tia.ucsb.edu