Ill-Nitride Tunnel Junction with Modified Interface

Tech ID: 25740 / UC Case 2016-245-0

BRIEF DESCRIPTION
A method for improving the performance of semipolar III-nitride light-emitting devices.

BACKGROUND
Current commercially available III-nitride light-emitting diodes (LEDs) and edge-emitting laser diodes use an active region in a biased p-n junction to allow for electron and hole injection. The p-GaN is difficult to contact electrically and has low hole concentration and mobility. This means that p-GaN cannot be used as a current spreading layer and that traditional p-contacts will add significant voltage to devices. Despite these inherent problems, all commercial light-emitting devices utilize a p-contact and a material other than p-GaN for current spreading, typically transparent conducting oxides (TCO).

DESCRIPTION
Researchers at UC Santa Barbara have developed a method for improving the performance of semipolar III-nitride light-emitting devices. This method involves modification of the very highly doped (n+/p+) interface to reduce the energy barrier associated with tunneling and increase the tunneling current. The modification involves introducing extra charge carriers, such as dopant atoms, or impurities that results in electronic trap states that enhance tunneling.

ADVANTAGES
- Improved device performance due to decreased operating voltage of devices
- Elimination of a need for a TCO or silver mirror
- Simpler manufacturing process due to fewer processing steps
- Ability to incorporate multiple active regions into a single device

APPLICATIONS
- LEDs
- Edge emitting laser diodes
- Vertical cavity surface emitting lasers (VCSELs)
- Solar cells

PATENT STATUS

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<th>Country</th>
<th>Type</th>
<th>Number</th>
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<td>United States Of America</td>
<td>Published Application</td>
<td>18-0374699</td>
<td>12/27/2018</td>
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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, 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 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 Minimized Light Re-Absorption

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

Oxyfluoride 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

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

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

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) Lift-off Technique

Optimization of Laser Bar Orientation for Nonpolar Laser Diodes

UV Optoelectronic Devices Based on Nonpolar and Semipolar AlInN and AlInGaAlN Alloys

Low-Drop 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

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

Colorimetric Sensing Of Amines

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

Continuous Fluidic Printing Of MicroLEDs

Creating and Releasing Nanoscale Light Emitting Devices from Their Growth Substrates

Colloidal Lithography-Enabled Creation of Metasurface-Integrated MicroLEDs and Devices

Efficient Implementation of a Tunnel Junction Contact on a Nitride-Based Edge-Emitting Laser Diode

Wafer Bonding for Embedding Active Regions with Relaxed Nanostructures

Contact to III-Nitride Tunnel Junction Devices Using Narrow Current Spreading Layer and Current Blocking Layer

Heterogeneously Integrated GaN on Si Photonic Integrated Circuits

Enhancement of Semi-Polar Gallium Nitride Surface Morphology in Photo-Electrochemical Undercut Etching

Transparent Vertical Cavity Surface Emitting Laser for Augmented and Mixed Reality Displays

Control Of Photoelectrochemical Etch Parameters For Minimization of Interfacial Roughness of Light Emitting Device Structures

High Speed Indium Gallium Nitride Multi-Quantum Well (InGaN MQW) Photodetector

Distributed Feedback Laser with Transparent Conducting Oxide Grating