III-Nitride Tunnel Junction with Modified Interface
Tech ID: 25740 / UC Case 2016-245-0

BACKGROUND
A commonly explored limitation of p-GaN is that it is a poor current spreading layer and that traditional p-contacts will increase operating voltages in III-nitride devices. The introduction of tunnel junctions solves these issues and expands the opportunities for new device designs. This technology seizes the opportunity for higher tunneling currents.

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

ADVANTAGES
▶ Reduced operating voltage
▶ Current spreading with GaN
▶ No requirement for a TCO or silver mirrors
▶ Simple fabrication
▶ 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>Type</th>
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<td>United States Of America</td>
<td>Issued Patent</td>
<td>10,685,835</td>
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RELATED TECHNOLOGIES
▶ Laser Diode With Tunnel Junction Contact Surface Grating
▶ Contact Architectures for Tunnel Junction Devices
▶ III-Nitride Tunnel Junction LED with High Wall Plug Efficiency
▶ Methods for Fabricating III-Nitride Tunnel Junction Devices
▶ Enhanced Light Extraction LED with a Tunnel Junction Contact Wafer Bonded to a Conductive Oxide
▶ Hybrid Growth Method for Improved III-Nitride Tunnel Junction Devices

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

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OTHER INFORMATION
KEYWORDS
indled, indssl, LED, solar cells, edge emitting laser diodes, III-nitride, p-GaN, indfeat, indmicroelec

CATEGORIZED AS
▶ Energy
▶ Lighting
▶ Other
▶ Engineering
▶ Engineering
▶ Semiconductors
▶ Design and Fabrication

RELATED CASES
2016-245-0
Enhanced Optical Polarization of Nitride LEDs by Increased Indium Incorporation
Enhancing 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
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
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
Highly Efficient Blue-Violet III-Nitride Semipolar Laser Diodes
Hybrid Growth Method for Improved Ill-Nitride Tunnel Junction Devices
Phosphor-Free White Light Source
Volumetric Hole Injection with Intentional V-Defects
Low Temperature Deposition of Magnesium Doped Nitride Films
Transparent Mirrorless (TML) LEDs
Improved GaN Substrates Prepared with Ammonothermal Growth
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
Method for Growing Self-Assembled Quantum Dot Lattices
Size-Independent Forward Voltage Micro-LED with an Epitaxial Junction
Method for Enhancing Growth of Semipolar Nitride 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
Increased Light Extraction with Multistep Deposition of ZnO on GaN
Method for Manufacturing Improved Ill-Nitride LEDs and Laser Diodes: Monolithic Integration of Optically Pumped and Electrically Injected Ill-Nitride LEDs
Selective-Area Mesoporous Semiconductors And Devices For Optoelectronic And Photonic Applications
High-Efficiency, Mirrorless Non-Polar and Semi-Polar Light Emitting Devices
Method for Growing High-Quality Group Ill-Nitride Crystals
Controlled Photoelectrochemical (PEC) Etching by Modification of Local Electrochemical Potential of Semiconductor Structure
Incorporating Temperature-Sensitive Layers in Ill-N Devices
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
Colorimetric Sensing Of Amines.
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
Reduction in Leakage Current and Increase in Efficiency of Ill-Nitride MicroLEDs
Methods for Fabricating Ill-Nitride Tunnel Junction Devices
Low-Droop LED Structure on GaN Semi-polar Substrates
Contact Architectures for Tunnel Junction Devices
GaN Interverlayer Design to Fully Eliminate V-Pits from InGaN Pseudo-Substrates
Semi-polar LED/LD Devices on Relaxed Template with Misfit Dislocation at Hetero-interface
Photoelectrochemical Etching Of P-Type Semiconductor Heterostructures
Semipolar-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
Improved Manufacturing of Solid State Lasers via Patternning of Photonic Crystals
Solid Solution Phosphors for Use in Solid State White Lighting Applications
Multifaceted III-Nitride Surface-Emitting Laser
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

Activation of P-Type Layers of Tunnel Junctions in Micro-LEDs

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

Method for Increasing GaN Substrate Area in Nitride Devices

Nitride Based Ultraviolet LED with an Ultraviolet Transparent Contact

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

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

Improved Manufacturing of Semiconductor Lasers

LED Device Structures with Minimized Light Re-Absorption

Growth of Planar Semi-Polar Gallium Nitride

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

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

Integration And Mass Transfer Of Microleds

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

III-Nitride Based VCSEL with Curved Mirror on P-Side of the Aperture

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