Ill-Nitride Tunnel Junction LED with High Wall Plug Efficiency
Tech ID: 31762 / UC Case 2017-131-0

BACKGROUND
Commercially-available III-nitride light-emitting diodes (LEDs) 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 the University of California, Santa Barbara have introduced an n-GaN layer that produces less loss than a traditional transparent conducting oxide. The favorable current spreading of the n-GaN layer also helps to reduce the droop observed in previous iterations of III-Nitride LEDs. The combined benefits of this novel current spreading layer materialize into a device with over 70% wall plug efficiency.

ADVANTAGES
▶ Improved light extraction
▶ Improved energy efficiency (over 70%)
▶ No requirement for TCOs or mirrors

APPLICATIONS
▶ III-Nitride LEDs

PATENT STATUS
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<tr>
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<td>United States Of America</td>
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OTHER INFORMATION
KEYWORDS
LED, tunnel junction, GaN, III-nitride LED

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

RELATED CASES
2017-131-0

RELATED TECHNOLOGIES
▶ Contact Architectures for Tunnel Junction Devices
▶ Methods for Fabricating III-Nitride Tunnel Junction Devices
▶ Enhanced Light Extraction LED with a Tunnel Junction Contact Wafer Bonded to a Conductive Oxide
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
▶ 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 Ill-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
▶ 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
▶ 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
▶ Group Ill-N Light Emitting Devices Enhanced By Stress From Post-Growth Deposited Films
▶ Thermally Stable, Laser-Driven White Lighting Device
▶ MOCVD Growth of Planar Non-Polar M-Plane Gallium Nitride
▶ Reduced Dislocation Density of Non-Polar GaN Grown by Hydride Vapor Phase Epitaxy
▶ Methods for Fabricating Ill-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
▶ 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
Growth of Planar, Non-Polar, A-Plane GaN by Hydride Vapor Phase Epitaxy
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
Nonpolar (Al, 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
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