



# III-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

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	11,164,997	11/02/2021	2017-131

## 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](#)

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## INVENTORS

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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

## 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 AlGaIn 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 InGaIn 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 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
- ▶ 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

- ▶ 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

