



## Improved Reliability & Enhanced Performance of III-Nitride Tunnel Junction Optoelectronic Devices

Tech ID: 29876 / UC Case 2018-260-0

### BRIEF DESCRIPTION

A structure for improving the performance and reliability of III-nitride based tunnel junction optoelectronic devices.

### BACKGROUND

Tunnel junctions are a breakthrough alternative to traditional transparent or metallic contacts but have typically required a regrowth by Molecular Beam Epitaxy (MBE). Metal organic chemical vapor (MOCVD) tools are more commonly used in semiconductor processing related to optoelectronic devices such as light-emitting diodes (LEDs), vertical-cavity surface emitting lasers (VCSELs), edge-emitting laser diodes (ELEDs), and solar cells. However, tunnel junctions grown by MOCVD are difficult to achieve. The heavy n-type doping required leads to a dislocation incline, resulting in a buildup of tensile stress that can lead to morphological degradation and reduced carriers tunneling efficiency. Improving the n+GaN layer at the tunnel junction interface could improve the efficiency, reliability, and overall quality of III-nitride optoelectronic devices that use a tunnel junction.

### DESCRIPTION

Researchers at the University of California, Santa Barbara have developed a structure for improving the performance and reliability of III-nitride based tunnel junction optoelectronic devices. The proposed structure allows for improved surface morphology, leading to a uniform field across the tunnel junction interface. Additionally, both the barrier for interband tunneling distance and the forward voltage in the devices can be significantly reduced. A smoother surface of the n-type material is realized and a higher carrier concentration in the n-type material is observed. Since MOCVD tools are already commonly used in semiconductor processing this technology can be readily and easily applied to the current market.

### ADVANTAGES

- ▶ Enhanced performance
- ▶ Improved reliability
- ▶ Can be easily commercialized
- ▶ Smoother surface & higher carrier concentration in the n-type material

### APPLICATIONS

### CONTACT

Pasquale S. Ferrari  
[ferrari@tia.ucsb.edu](mailto:ferrari@tia.ucsb.edu)  
tel: .

### INVENTORS

- ▶ Alhassan, Abdullah
- ▶ DenBaars, Steven P.

### OTHER INFORMATION

#### KEYWORDS

optoelectronics, LED, VCSELs, indfeat, Solar cells, Tunnel junction

#### CATEGORIZED AS

- ▶ **Optics and Photonics**
  - ▶ All Optics and Photonics
- ▶ **Energy**
  - ▶ Lighting
- ▶ **Engineering**
  - ▶ Engineering

#### RELATED CASES

2018-260-0

## PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	11,158,760	10/26/2021	2018-260
United States Of America	Published Application	22-0029049	01/27/2022	2018-260

## ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- ▶ Vertical Cavity Surface-Emitting Lasers with Continuous Wave Operation
- ▶ Eliminating Misfit Dislocations with In-Situ Compliant Substrate Formation
- ▶ 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
- ▶ 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 Fabrication of Nonpolar InGaIn Thin Films, Heterostructures, and Devices
- ▶ Growth of High-Quality, Thick, Non-Polar M-Plane GaN Films
- ▶ 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
- ▶ 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
- ▶ 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
- ▶ UV Optoelectronic Devices Based on Nonpolar and Semi-polar AlInN and AlInGaN Alloys
- ▶ Defect Reduction of Non-Polar and Semi-Polar III-Nitrides
- ▶ 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



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