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 (EELDs), 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
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

- Optoelectronics (LEDs, VCSELs, EELDs, and Solar Cells)

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 AlGaN template
- 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
- 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