Methods for Fabricating III-Nitride Tunnel Junction Devices

Tech ID: 28865 / UC Case 2017-130-0

CONTACT

Pasquale S. Ferrari
ferrari@tia.ucsb.edu
tel: .

INVENTORS

- DenBaars, Steven P.
- Hwang, David
- Mughal, Asad J.
- Nakamura, Shuji
- Speck, James S.
- Yonkee, Benjamin P.
- Young, Erin C.

OTHER INFORMATION

KEYWORDS

III-nitride devices, tunnel junction, tunel junction devices, indled, edge-emitting laser diodes, laser diodes, MOCVD, indfeat

CATEGORIZED AS

- **Energy**
  - Lighting
- **Engineering**
  - Engineering

RELATED CASES

2017-130-0

BRIEF DESCRIPTION

Methods of physical vapor deposition for III-nitride tunnel junction devices.

BACKGROUND

Current commercially-available III-Nitride light-emitting diodes (LEDs) and edge-emitting laser diodes (EELDs) use an active region in a biased p-n junction to allow for electron and hole injection. However, since p-type gallium nitride (p-GaN) is difficult to contact electrically and has low hole concentration and mobility, p-GaN cannot be used as a current spreading layer and 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).

A tunnel junction is a diode comprised of a very highly doped (n+/p+) interface that allows for electrons to tunnel between the valence band conduction band. Although in principle a highly doped Esaki-type homojunction diode should provide the lowest-loss tunnel junction, there have been a number of difficulties achieving high quality tunnel junctions in the GaN material system.

DESCRIPTION

Researchers at the University of California, Santa Barbara have satisfied the need for improving the performance of III-nitride devices by overcoming the limitations currently in the field. Improvements include alternative methods for creating tunnel junction devices, including physical vapor deposition (e.g., sputter deposition) and MOCVD regrowth deposition, and III-Nitride tunnel junction improvement through reduction of the magnesium memory effect. Self-emissive III-V micro LED-based displays using low resistance tunnel junctions leveraging these improvements have been fabricated.

ADVANTAGES

- Eliminates the need for a TCO or silver mirror
- Easy wide scale adoption of sputter deposition tools
- Reduction of excess magnesium in the fabrication of III-nitride junctions
- Fabrication of III-nitride tunnel junction devices using MOCVD for growth

APPLICATIONS

- LEDs
- Tunnel Junctions
- III-nitride devices

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	10,985,285	04/20/2021	2017-130

RELATED TECHNOLOGIES

- Contact Architectures for Tunnel Junction Devices
- III-Nitride Tunnel Junction LED with High Wall Plug Efficiency
- Enhanced Light Extraction LED with a Tunnel Junction Contact Wafer Bonded to a Conductive Oxide

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- 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
- Enhanced Light Extraction LED with a Tunnel Junction Contact Wafer Bonded to a Conductive Oxide
- Ultraviolet Laser Diode on Nano-Porous AlGaN template
- Improved Reliability & Enhanced Performance of III-Nitride Tunnel Junction Optoelectronic Devices
- (In,Ga,Al)N Optoelectronic Devices with Thicker Active Layers for Improved Performance
- Thermally Stable, Laser-Driven White Lighting Device
- Contact Architectures for Tunnel Junction Devices
- III-Nitride Tunnel Junction LED with High Wall Plug Efficiency
- Novel Multilayer Structure for High-Efficiency UV and Far-UV Light-Emitting Devices
- A Method To Lift-Off Nitride Materials With Electrochemical Etch
- High-Intensity Solid State White Laser Diode
- Nitride Based Ultraviolet LED with an Ultraviolet Transparent Contact
- High-Efficiency and High-Power III-Nitride Devices Grown on or Above a Strain Relaxed Template
- III-Nitride Based VCSEL with Curved Mirror on P-Side of the Aperture

University of California, Santa Barbara
Office of Technology & Industry Alliances
342 Lagoon Road, ,Santa Barbara,CA 93106-2055 |
https://www.tia.ucsb.edu
Tel: 805-893-2073 | Fax: 805.893.5236 | padilla@tia.ucsb.edu