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

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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

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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	12,471,410	11/11/2025	2018-260
United States Of America	Issued Patent	11,158,760	10/26/2021	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
- Enhanced Light Extraction LED with a Tunnel Junction Contact Wafer Bonded to a Conductive Oxide
- Methods to Produce and Recycle Substates for III-Nitride Materials with Electrochemical Etching
- (In,Ga,Al)N Optoelectronic Devices with Thicker Active Layers for Improved Performance
- Thermally Stable, Laser-Driven White Lighting Device
- III-Nitride Tunnel Junction LED with High Wall Plug Efficiency
- 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
- A Wafer-Scale, Low Defect Density Strain Relaxed Template for III-Nitride-Based High Efficiency and High-Power Devices

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