Laser Diode With Tunnel Junction Contact Surface Grating
Tech ID: 31761 / UC Case 2019-938-0

BACKGROUND
Tunnel junction contacts substantially improve the conductivity and reduce operating voltages for current laser diodes. Distributed feedback (DFB) gratings enable the wavelength compatibility, high spectral purity, and frequency stability of current laser diodes. Combining these two elements in a single device affords new design, fabrication and performance benefits.

DESCRIPTION
Researchers at the University of California, Santa Barbara have symbiotically merged the performance-enhancing properties of tunnel junction contacts and DFB gratings to realize new opportunities for laser diode design. The individual fabrication properties of the DFB grating and the tunnel junction contact complement each other by improving the fabrication techniques of the other component. Using a tunnel junction contact allows the DFB grating to be closer to the active region, improving the coupling between the grating and the lasing mode. Using a DFB grating leaves areas of exposed p-type GaN, facilitating activation of the p-type layers without additional device processing that is typically necessary for MOCVD-grown tunnel junction designs.

ADVANTAGES
▶ Improved conductivity
▶ Reduced operating voltage
▶ Single longitudinal mode emission
▶ Reduced optical losses
▶ Simple fabrication

APPLICATIONS
▶ Laser Diodes

PATENT STATUS
Patent Pending

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
▶ III-Nitride Tunnel Junction with Modified Interface
▶ Hybrid Growth Method for Improved III-Nitride Tunnel Junction Devices
▶ III-Nitride Tunnel Junction LED with High Wall Plug Efficiency
▶ Polarization-Enhanced Tunnel Junction Using A Double Heterojunction Between A Wurtzite Material And A Rocksalt Material

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS
▶ Method for Improved Surface of (Ga,Al,In,B)N Films on Nonpolar or Semipolar Substrates
▶ High Efficiency LED with Optimized Photonic Crystal Extractor
▶ Enhanced Optical Polarization of Nitride LEDs by Increased Indium Incorporation
▶ Lateral Growth Method for Defect Reduction of Semipolar Nitride Films
▶ Flexible Arrays of MicroLEDs using the Photoelectrochemical (PEC) Liftoff Technique
▶ Vertical Cavity Surface-Emitting Lasers with Continuous Wave Operation
Achieving "Active P-Type Layer/Layers" In III-Nitride Epitaxial Or Device Structures Having Buried P-Type Layers

High-Quality N-Face GaN, InN, AlN by MOCVD

Low-Cost Zinc Oxide for High-Power-Output, GaN-Based LEDs (UC Case 2010-183)

Internal Heating for Ammonothermal Growth of Group-III Nitride Crystals

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

Highly Efficient Blue-Violet III-Nitride Semipolar Laser Diodes

Hybrid Growth Method for Improved III-Nitride Tunnel Junction Devices

Phosphor-Free White Light Source

Control of Photoelectrochemical (PEC) Etching by Modification of the Local Electrochemical Potential of the Semiconductor Structure

Low Temperature Deposition of Magnesium Doped Nitride Films

Device Structures Utilizing Barrier Enhancement Conductive Materials on N-polar III-N

Transparent Mirrorless (TML) LEDs

Improved GaN Substrates Prepared with Ammonothermal Growth

Optimization of Laser Bar Orientation for Nonpolar Laser Diodes

High Efficiency Semipolar AlGaN-Cladding-Free Laser Diodes

Deep Ultraviolet Laser Pumped by Trap-Assisted Two Photon Absorption

High Mobility Group-III Nitride Transistors with Strained Channels

A Structure For Increasing Mobility In A High-Electron-Mobility Transistor

Method for Enhancing Growth of Semipolar Nitride Devices

III-Nitride Tunnel Junction with Modified Interface

Growth of Polyhedron-Shaped Gallium Nitride Bulk Crystals

Nonpolar III-Nitride LEDs With Long Wavelength Emission

Fabrication of Relaxed Semiconductor Films without Crystal Defects

Improved Fabrication of Nonpolar InGaN Thin Films, Heterostructures, and Devices

Growth of High-Quality, Thick, Non-Polar M-Plane GaN Films

Methods for Locally Changing the Electric Field Distribution in Electron Devices

Increased Light Extraction with Multistep Deposition of ZnO on GaN

Method for Manufacturing Improved III-Nitride LEDs and Laser Diodes: Monolithic Integration of Optically Pumped and Electrically Injected III-Nitride LEDs

Selective-Area Mesoporous Semiconductors And Devices For Optoelectronic And Photonic Applications

High-Efficiency, Mirrorless Non-Polar and Semi-Polar Light Emitting Devices

Method for Growing High-Quality Group III-Nitride Crystals

Incorporating Temperature-Sensitive Layers in III-N Devices

Controlling Linearity in N-Polar GaN MISHEMTs

Oxyfluoride Phosphors for Use in White Light LEDs

Technique for the Nitride Growth of Semipolar Thin Films, Heterostructures, and Semiconductor Devices

Enabling Epitaxial Growth On Thin Substrates

(In,Ga,Al)N Optoelectronic Devices with Thicker Active Layers for Improved Performance

MOCVD Growth of Planar Non-Polar M-Plane Gallium Nitride

Reduced Dislocation Density of Non-Polar GaN Grown by Hydride Vapor Phase Epitaxy

N-polar III-N Semiconductor Device Structures Enabled by Wet Chemistry

Heterogeneously Integrated GaN on Si Photonic Integrated Circuits

Al, In,Ga, BJN Device Structures

Reduction in Leakage Current and Increase in Efficiency of III-Nitride MicroLEDs

GaN-based Vertical Metal Oxide Semiconductor and Junction Field Effect Transistors

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

Photoelectrochemical Etching Of P-Type Semiconductor Heterostructures

Semipolar-Based Yellow, Green, Blue LEDs with Improved Performance

Growth of Semipolar III-V Nitride Films with Lower Defect Density

III-Nitride Tunnel Junction LED with High Wall Plug Efficiency

Novel Current-Blocking Layer in High-Power Current Aperture Vertical Electron Transistors (CAVEs)

Improved Manufacturing of Solid State Lasers via Patterning of Photonic Crystals

Iii-N Transistor With Stepped Cap Layers

Solid Solution Phosphors for Use in Solid State White Lighting Applications
Multifaceted III-Nitride Surface-Emitting Laser
- 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
- High Light Extraction Efficiency III-Nitride LED
- III-V Nitride Device Structures on Patterned Substrates
- Hexagonal Wurtzite Type Epitaxial Layer with a Low Alkali-Metal Concentration
- Method for Increasing GaN Substrate Area in Nitride Devices
- Growth of Planar, Non-Polar, A-Plane GaN by Hydride Vapor Phase Epitaxy
- Single or Multi-Color High Efficiency LED by Growth Over a Patterned Substrate
- GaN-Based Thermoelectric Device for Micro-Power Generation
- Polarization-Doped Field Effect Transistors with Increased Performance
- Limiting Strain-Relaxation in III-Nitride Heterostructures by Substrate Patterning
- Improved Manufacturing of Semiconductor Lasers
- LED Device Structures with Minimized Light Re-Absorption
- Growth of Planar Semi-Polar Gallium Nitride
- Nonpolar (Al, B, In, Ga)N Quantum Well Design
- UV Optoelectronic Devices Based on Nonpolar and Semi-polar AllInN and AllInGaN Alloys
- Defect Reduction of Non-Polar and Semi-Polar III-Nitrides
- III-Nitride Based VCSEL with Curved Mirror on P-Side of the Aperture
- Low-Cost Zinc Oxide for High-Power-Output, GaN-Based LEDs (UC Case 2010-150)
- Suppression of Defect Formation and Increase in Critical Thickness by Silicon Doping
- Wafer Bonding for Embedding Active Regions with Relaxed Nanofeatures
- Enhancing Growth of Semipolar (Al,Ga,B)N Films via MOCVD
- III-N Based Material Structures and Circuit Modules Based on Strain Management