Size-Independent Forward Voltage Micro-LED with an Epitaxial Junction

Tech ID: 32268 / UC Case 2020-714-0

BACKGROUND

Conventional tunnel junction micro-LEDs currently face challenges of higher voltage penalties and varied voltage with different device sizes. Unfortunately, size-dependent voltage characteristics limit the applications of micro-LEDs and result in a lack of device reliability. Thus, overcoming the size dependence of the forward voltage in tunnel junction micro-LEDs would increase their potential to meet the demands of next-generation display applications.

DESCRIPTION

Researchers at the University of California, Santa Barbara have fabricated size-independent forward voltage micro-LEDs with an epitaxial tunnel junction comprised of p+GaN and n+GaN layers. This technology employs n+GaN layers with patterns of holes or vias to provide activation of the p+GaN type layer. The micro-LEDs produced using this approach with a Si doping concentration in the n+GaN layers higher than $1.7 \times 10^{20} \text{ cm}^{-3}$ demonstrated a forward voltage at $20 \text{ A cm}^{-2}$ that was stable and uniform around 3.4V. Therefore, this technique solves the issue of forward voltage variation in different size tunnel junction micro-LEDs by realizing a size-independent low forward voltage.

ADVANTAGES

› Size-independent forward voltage
› Increases reliability of micro-LEDs in expanded applications

APPLICATIONS

› Micro-LEDs

PATENT STATUS

Patent Pending

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
› Vertical Cavity Surface-Emitting Lasers with Continuous Wave Operation
› 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
› Low Temperature Deposition of Magnesium Doped Nitride Films
› Transparent Mirrorless (TML) LEDs
› Improved GaN Substrates Prepared with Ammonothermal Growth
› Optimization of Laser Bar Orientation for Nonpolar Laser Diodes

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OTHER INFORMATION

KEYWORDS

micro-LED, epitaxial tunnel junction, n+GaN, p+GaN, forward voltage

CATEGORIZED AS

› Energy
› Lighting
› Semiconductors
› Design and Fabrication

RELATED CASES

2020-714-0
High Efficiency Semipolar AlGaN-Cladding-Free Laser Diodes
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
Improved Fabrication of Nonpolar InGaN Thin Films, Heterostructures, and Devices
Growth of High-Quality, Thick, Non-Polar M-Plane GaN Films
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
Controlled Photoelectrochemical (PEC) Etching by Modification of Local Electrochemical Potential of Semiconductor Structure
Incorporating Temperature-Sensitive Layers in III-N 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
MOCVD Growth of Planar Non-Polar M-Plane Gallium Nitride
Reduced Dislocation Density of Non-Polar GaN Grown by Hydride Vapor Phase Epitaxy
Heterogeneously Integrated GaN on Si Photonic Integrated Circuits
Reduction in Leakage Current and Increase in Efficiency of III-Nitride MicroLEDs
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
Improved Manufacturing of Solid State Lasers via Patterned of Photonic Crystals
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
Activation of P-Type Layers of Tunnel Junctions in Micro-LEDs
Hexagonal Wurtzite Type Epitaxial Layer with a Low Alkali-Metal Concentration
Method for Increasing GaN Substrate Area in Nitride Devices
Nitinride Based Ultraviolet LED with an Ultraviolet Transparent Contact
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
Limiting Strain-Relaxation in III-Nitride Heterostructures by Substrate Patternning
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 AlInN and AlInGaN 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