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 $1.7 \times 10^{20}$ cm$^{-3}$ demonstrated a forward voltage at 20A 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
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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
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Technique for the Nitride Growth of Semipolar Thin Films, Heterostructures, and Semiconductor Devices
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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
GaN Interlayer Design to Fully Eliminate V-Pits from InGaN Pseudo-Substrates
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
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Solid Solution Phosphors for Use in Solid State White Lighting Applications
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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
NITride Based Ultraviolet LED with an Ultraviolet Transparent Contact
Growth of Planar, Non-Polar, A-Plane GaN by Hydride Vapor Phase Epitaxy
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GaN-Based Thermoelectric Device for Micro-Power Generation
Limiting Strain-Relaxation in III-Nitride Heterostructures by Substrate Patterning
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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