III-Nitride-Based Devices Grown With Relaxed Active Region
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BACKGROUND

Fierce market competition in high-resolution displays and augmented/virtual reality (AR/VR) technologies is increasing the demand for highly efficient micro-LEDs, driving researchers to investigate indium gallium nitride (InGaN)-based LEDs due their high blue and green external quantum efficiency (EQE). A substantial obstacle in fabricating high efficiency InGaN LEDs is growing a high-indium-containing InGaN layer while maintaining favorable structural and crystal qualities, due to the coherent strain of InGaN layers on the GaN substrate. Through indium desorption, crystal degradation, and rough surface morphology, strain between the device layers comes at a cost of overall device efficiency; especially for long-wavelength LEDs. Improving indium incorporation and crystal quality, decreasing defects, and growing devices at higher temperatures are key to enabling mass manufacture of long-wavelength III-nitride based devices.

DESCRIPTION

Researchers at the University of California, Santa Barbara have fabricated III-nitride-based devices with a relaxed active region that improve on the crystal quality, defect density, and surface morphology of previous demonstrations. This technology uses a thin thermally decomposed InGaN underlayer and a thin GaN or InGaN decomposition stop layer as the strain compliant layer. These novel components improve the crystal quality, reduce defects, improve surface morphologies, and ultimately enhance the final electrical and optical properties of the device. In addition, growing a relaxed active region will minimize the compositional pulling effect, which will allow for higher temperature quantum well growth and higher efficiency for long wavelength emitting devices.

ADVANTAGES

▶ Enhances key device performance with improvements to crystal quality, defect density, surface morphology and growth temperature
▶ Increases efficiency in long-wavelength devices

APPLICATIONS

▶ LEDs, micro-LEDs and Laser Diodes
▶ Augmented/virtual reality
▶ High-resolution displays

PATENT STATUS

Patent Pending

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OTHER INFORMATION

KEYWORDS

AR, VR, micro-LED, InGaN, external quantum efficiency, EQE, indium incorporation, crystal quality, defect density, surface morphology, compositional pulling effect, long wavelength, High-resolution displays, Augmented/virtual reality

CATEGORIZED AS

▶ Optics and Photonics
▶ All Optics and Photonics
▶ Imaging
▶ 3D/Immersive

RELATED CASES

2022-760-0

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

▶ Method for Improved Surface of (Ga,Al,In,B)N Films on Nonpolar or Semipolar Substrates
▶ 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
▶ Eliminating Misfit Dislocations with In-Situ Compliant Substrate Formation
▶ Low-Cost Zinc Oxide for High-Power-Output, GaN-Based LEDs (UC Case 2010-183)
▶ 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
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
Size-Independent Forward Voltage Micro-LED with an Epitaxial Junction
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
Oxyfluoride Phosphors for Use in White Light LEDs
Technique for the Nitride Growth of Semipolar Thin Films, Heterostructures, and Semiconductor Devices
(In,Ga,AI)N Optoelectronic Devices with Thicker Active Layers for Improved Performance
Thermally Stable, Laser-Driven White Lighting Device
MOCVD Growth of Planar Non-Polar M-Plane Gallium Nitride
Reduced Dislocation Density of Non-Polar GaN Grown by Hydride Vapor Phase Epitaxy
Highly Compact, High-Index Dielectric Nanostructures for Deep-Ultraviolet Devices
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
III-Nitride-Based Devices Grown On Thin Template On Thermally Decomposed Material
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 Pattern of Photonic Crystals
High Efficiency III-Nitride Devices with Smooth Relaxed InGaN Buffer and Strain Compliant Template
Multifaceted III-Nitride Surface-Emitting Laser
Tunable White Light Based on Polarization-Sensitive LEDs
Cleaved Facet Edge-Emitting Laser Diodes Grown on Semi-polar 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
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
GaN-Based Thermoelectric Device for Micro-Power Generation
Limiting Strain-Relaxation in III-Nitride Heterostructures by Substrate Patterned
LED Device Structures with Minimized Light Re-Absorption
Growth of Planar Semi-Polar Gallium Nitride
Nonpolar (AI, 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