High Efficiency III-Nitride Devices with Smooth Relaxed InGaN Buffer and Strain Compliant Template
Tech ID: 32663 / UC Case 2022-763-0

BACKGROUND
The demand for high resolution, high brightness, wide color gamut, and highly efficient displays has increased significantly in recent years with the development of near-eye technologies, smartphones and other boundary-pushing innovations. Indium gallium nitride (InGaN) micro-LEDs are a promising alternative to liquid crystal displays (LCDs) and organic light emitting diodes (OLEDs) displays because they span the visible spectrum with higher power efficiency, brightness, and lifetime. However, red InGaN emitters still face efficiency obstacles due to the large lattice mismatch between their material layers. Strain compliant templates (SCTs) provide a solution by relaxing the strain caused by the lattice mismatch in the active layer, but their performance is limited by rough surface morphology which reduces crystal quality and, in turn, efficiency.

DESCRIPTION
Researchers at the University of California, Santa Barbara have improved the efficiency of red InGaN emitters by growing smooth buffer layers on mechanically flexible strain compliant templates (SCTs) for III-nitride based devices. This technology produces a smooth surface morphology on the InGaN buffer layer and top surface of each device, improving the crystal quality of the SCT and providing better metal contact for n- and p-type layers. These improvements translate to increased external quantum efficiencies (EQE), which is especially welcome in red light-emitting devices. Higher crystal film quality, lower defects, and higher EQE in LEDs and laser diodes (LDs) are necessary improvements for pioneering the next generation of display technology.

ADVANTAGES
▶ Higher external quantum efficiency (EQE) in III-nitride devices
▶ Fewer defects

APPLICATIONS
▶ LEDs and LDs
▶ Near eye technologies (VR/AR)
▶ Micro-LED displays

PATENT STATUS
Patent Pending

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS
▶ 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
▶ III-Nitride-Based Devices Grown With Relaxed Active Region
▶ 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

INVENTORS
▶ Chan, Philip
▶ DenBaars, Steven P.
▶ Nakamura, Shuji

OTHER INFORMATION
KEYWORDS
InGaN Buffer, InGaN micro-LED, Strain compliant template, SCTs, smooth buffer, flexible, crystal quality, external quantum efficiencies, EQE, red, lower defects, LEDs, laser diodes, Near eye technologies, AR, VR, display

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

RELATED CASES
2022-763-0
▶ 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,Al)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 Patterned of Photonic Crystals
▶ 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
▶ 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 Patternning
▶ LED Device Structures with Minimized Light Re-Absorption
▶ Growth of Planar Semi-Polar Gallium Nitride
▶ Nonpolar (Al, 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
▶ Enhancing Growth of Semipolar (Al,In,Ga,B)N Films via MOCVD