3D Hole Injectors for InAlGaN Light-Emitting Diodes
Tech ID: 31879 / UC Case 2020-060-0

BACKGROUND
InGaN LEDs suffer from efficiency loss at high injection levels; commonly known as the “droop”. V-shaped defects provide a solution in principle, but they do not demonstrate a significant reduction of local carrier densities and do not strongly affect the droop. Furthermore, conventional LED designs incorporate multiple quantum well active regions where hole injection is vertically inhomogeneous, causing only the top quantum wells to be populated by holes thus restricting improvement of the droop.

DESCRIPTION
Researchers at the University of California, Santa Barbara have employed rectangular, pyramidal or triangular ridge injectors to introduce hole injection homogeneity and minimize efficiency droop by ensuring lateral and vertical hole injection. This technology can be implemented with standard industrial MOCVD, and can be applied to all wavelength LEDs and lasers. It can also obtain ultraviolet to infrared LEDs for high-power applications, and is even implementable in white LED fabrication.

ADVANTAGES
▶ Increases LED efficiency
▶ Reduces carrier density
▶ Applicable to all wavelength LEDs and lasers

APPLICATIONS
▶ LEDs
▶ Laser Diodes

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
▶ Etching Technique for the Fabrication of Thin (Al, In, Ga)N Layers
▶ Lateral Growth Method for Defect Reduction of Semipolar Nitride Films
▶ Flexible Arrays of MicroLEDs using the Photoelectrochemical (PEC) Lift-off Technique
▶ Vertical Cavity Surface-Emitting Lasers with Continuous Wave Operation
▶ Gallium-containing MicroLEDs for Displays
▶ High Speed Indium Gallium Nitride Multi-Quantum Well (InGaN MQW) Photodetector
▶ 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
▶ Photonic Structures for Efficient Light Extraction and Conversion in Multi-Color LEDs
▶ Highly Efficient Blue-Violet III-Nitride Semipolar Laser Diodes
▶ Hybrid Growth Method for Improved III-Nitride Tunnel Junction Devices
▶ Volumetric Hole Injection with Intentional V-Defects
▶ Transparent Mirrorless (TML) LEDs
Optimization of Laser Bar Orientation for Nonpolar Laser Diodes
Wavelength-Selective Phosphor Coating for Laser Lighting Devices
High Efficiency Semipolar AlGaN-Cladding-Free Laser Diodes
Method for Growing Self-Assembled Quantum Dot Lattices
III-Nitride Tunnel Junction with Modified Interface
Improved Fabrication of Nonpolar InGaN Thin Films, Heterostructures, and Devices
Growth of High-Quality, Thick, Non-Polar M-Plane GaN Films
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
Technique for the Nitride Growth of Semipolar Thin Films, Heterostructures, and Semiconductor Devices
MOCVD Growth of Planar Non-Polar M-Plane Gallium Nitride
Reduced Dislocation Density of Non-Polar GaN Grown by Hydride Vapor Phase Epitaxy
Methods for Fabricating III-Nitride Tunnel Junction Devices
Formation of Transparent Integrated MicroLED Displays
Contact Architectures for Tunnel Junction Devices
Semi-polar LED/LD Devices on Relaxed Template with Misfit Dislocation at Hetero-interface
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
In-Situ Methods Of Preventing Interfacial Impurities And Dry Etch-Induced Damage In Regrown III-Nitride Structures
Enhanced Hole Injection by P-Type Active Region and Lateral Injection in InAlGaN LEDs
Improved Manufacturing of Solid State Lasers via Patternning of Photonic Crystals
Cleaved Facet Edge-Emitting Laser Diodes Grown on Semipolar GaN
Growth of High-Performance M-plane GaN Optical Devices
Improved Anisotropic Strain Control in Semipolar Nitride Devices
High Light Extraction Efficiency III-Nitride LED
Photoelectrochemical Etching for Chip Shaping Of LEDs
Hexagonal Wurtzite Type Epitaxial Layer with a Low Alkali-Metal Concentration
Method for Increasing GaN Substrate Area in Nitride Devices
Burying Impurities And Defects In Regrown III-Nitride Structures
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
Limiting Strain-Relaxation in III-Nitride Heterostructures by Substrate Patterning
Improved Manufacturing of Semiconductor Lasers
Growth of Planar Semi-Polar Gallium Nitride
Defect Reduction of Non-Polar and Semi-Polar III-Nitrides
Suppression of Defect Formation and Increase in Critical Thickness by Silicon Doping