Engineering of V-Defects for Efficient III-Nitride LEDs
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BACKGROUND

The reduced efficiency of GaN-based LEDs at high injection levels (current droop) has not yet been solved. V-shaped defects have been employed to address current droop by reducing forward voltage and creating a lower barrier for hole injection in the sidewalls of the V-defects. However, current demonstrations’ reduction of current droop is marginal at best due to inhomogeneous lateral hole injection and large sidewall barriers. Successfully addressing current droop with V-defects will require a more reliable and comprehensive approach.

DESCRIPTION

Researchers at the University of California, Santa Barbara have created an engineered structure that tunes intentional V-defects to optimize lateral hole injection in GaN-based LEDs and laser diodes (LDs). This structure reduces and/or eliminates sidewall barriers to ensure volumetric injection in the whole quantum well (QW) stack. Unlike standard QW stacks, this invention leverages different compositions and thicknesses of QWs to circumvent the issue of preferential hole injection into the lowest energy QWs. This technology can be applied to other III-nitride light emitting structures such as micro-LEDs, UV LEDs, or lasers.

ADVANTAGES

- Improves efficiency in high-power LEDs
- Enables wider active regions with large QW numbers
- Produces higher modulation bandwidth for white LEDs
- Easily scaled with standard industrial equipment and procedures
- Compatible with all wavelength LEDs and LDs

APPLICATIONS

- III-nitride emitters
- LEDs and micro-LEDs
- UV 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
- Vertical Cavity Surface-Emitting Lasers with Continuous Wave Operation
- 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

Transparent Mirrorless (TML) LEDs

Optimization of Laser Bar Orientation for Nonpolar Laser Diodes

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

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

Improved Manufacturing of Solid State Lasers via Patterned 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

Method for Increasing GaN Substrate Area in Nitride Devices

Growth of Planar, Non-Polar, A-Plane GaN by Hydride Vapor Phase Epitaxy

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