Cleaved Facet Edge-Emitting Laser Diodes Grown on Semipolar GaN
Tech ID: 21809 / UC Case 2007-423-0

BRIEF DESCRIPTION

Highly-efficient cleaved facet edge-emitting laser diodes grown on semipolar gallium nitride substrates.

BACKGROUND

Current group-III nitride lasers are grown on polar c-plane substrates and usually employ dry-etched facets, which are inherently rough. Since these devices suffer from reduced efficiency due to high polarization-induced electric fields and scattering loss, there is a need for a high-efficiency laser diode that avoids these shortcomings.

DESCRIPTION

Researchers at the University of California, Santa Barbara have developed cleaved facet edge-emitting laser diodes grown on semipolar gallium nitride substrates. Because the devices are grown on a semipolar orientation, they have lower thresholds and higher efficiencies. The efficiency is further increased due to smooth, low loss cavities achieved by cleaved mirror facets. These devices are applicable to high brightness lighting displays, high resolution printers, projection displays, next generation DVD players, medical imaging, and efficient solid-state lighting.

ADVANTAGES

▶ Lower thresholds and higher efficiencies than standard polar c-plane laser diodes
▶ May offer higher wall-plug efficiencies than can be achieved with LEDs
▶ Smooth low loss mirror facets with high reflectivity

APPLICATIONS

▶ High Brightness Lighting Displays
▶ High Resolution Printers
▶ Projection Displays
▶ Next Generation DVD Players
▶ Medical Imaging
▶ Efficient Solid-State Lighting

This technology is available for licensing. See below for a selection of the patents and patent applications related to this invention.

Please inquire for full patent portfolio status.

PATENT STATUS

<table>
<thead>
<tr>
<th>Country</th>
<th>Type</th>
<th>Number</th>
<th>Dated</th>
<th>Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States Of America</td>
<td>Issued Patent</td>
<td>8,541,869</td>
<td>09/24/2013</td>
<td>2007-423</td>
</tr>
</tbody>
</table>

RELATED CASES

2007-423-0

INVENTORS

▶ DenBaars, Steven P.
▶ Nakamura, Shuji
▶ Speck, James S.
▶ Tyagi, Anurag

CATEGORIZED AS

▶ Engineering
▶ Energy
▶ Lighting
▶ Other
▶ Optics and Photonics
▶ All Optics and Photonics
▶ Semiconductors
▶ Design and Fabrication

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
Edge-Emitting Laser Diode with Via-Activated Tunnel Junction Contact
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 Photocathodic (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
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
Volumetric Hole Injection with Intentional V-Defects
Control of Photocathodic (PEC) Etching by Modification of the Local Electrochemical Potential of the Semiconductor Structure
Low Temperature deposition of Magnesium Doped Nitride Films
Transparent Mirrorless (TML) LEDs
Improved GaN Substrates Prepared with Ammonothermal Growth
Laser Diode With Tunnel Junction Contact Surface Grating
Optimization of Laser Bar Orientation for Nonpolar Laser Diodes
High Efficiency Semipolar AlGaN-Cladding-Free Laser Diodes
Method for Growing Self-Assembled Quantum Dot Lattices
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
Near-Infrared, Flip-Chip, TCO-Clad, InGaN Quantum Dot Laser Diode
Incorporating Temperature-Sensitive Layers in III-N Devices
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
MOCVD Growth of Planar Non-Polar M-Plane Gallium Nitride
Reduced Dislocation Density of Non-Polar GaN Grown by Hydride Vapor Phase Epitaxy
Heterogeneously Integrated GaN on Si Photonic Integrated Circuits
(Al, In,Ga, B)N Device Structures
Reduction in Leakage Current and Increase in Efficiency of III-Nitride MicroLEDs
Methods for Fabricating III-Nitride Tunnel Junction Devices
3D Hole Injectors for InAlGaN Light-Emitting Diodes
Formation of Transparent Integrated MicroLED Displays
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
Semi-polar-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

Solid Solution Phosphors for Use in Solid State White Lighting Applications

Multifaceted III-Nitride Surface-Emitting Laser

Tunable White Light Based on Polarization-Sensitive LEDs

III-Nitride VCSEL with a High Indium Content Active Region

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

Photoelectrochemical Etching for Chip Shaping Of LEDs

III-V Nitride Device Structures on Patterned Substrates

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

GaN-Based Thermoelectric Device for Micro-Power Generation

Limiting Strain-Relaxation in III-Nitride Heterostructures by Substrate Patternning

Improved Manufacturing of Semiconductor Lasers

LED Device Structures with Minimized Light Re-Absorption

Improved Light Extraction with Geometrically Tuned LED Arrays

Growth of Planar Semi-Polar Gallium Nitride

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

Wafer Bonding for Embedding Active Regions with Relaxed Nanofeatures

Enhancing Growth of Semipolar (Al,In,Ga,B)N Films via MOCVD