High-Efficiency, Mirrorless Non-Polar and Semi-Polar Light Emitting Devices

Tech ID: 25552 / UC Case 2007-317-0

BRIEF DESCRIPTION
An (Al, Ga, In)N light emitting device in which high light generation efficiency occurs by fabricating the device using non-polar or semi-polar GaN crystals.

BACKGROUND
The thickness of the quantum well (QW) in conventional GaN-based LEDs and LDs is only around 2-5 nm, due to the c-axis oriented GaN crystals which limit the thickness of the QW that can be achieved without losing efficiency. Conventional LEDs also utilize mirrors to increase the light output power from the front side of the LED. Reflected emissions are partially re-absorbed by the LED, further reducing the output power and efficiency of the LED.

DESCRIPTION
Researchers at UC Santa Barbara have developed an (Al, Ga, In)N light emitting device in which high light generation efficiency occurs by fabricating the device using non-polar or semi-polar GaN crystals. This geometry allows for a QW layer larger than 5 nm with low piezoelectric effects so that higher efficiencies at higher current densities can be achieved. The device also minimizes internal reflections within the LED by eliminating mirrors and/or mirrored surfaces, in order to minimize re-absorption of light by the emitting or active layer of the LED.

ADVANTAGES
▶ More effective generation of polarized light than c-plane devices
▶ Higher efficiency LEDs
▶ Reduced internal reflections within the LED

APPLICATIONS
▶ LEDs and LDs

PATENT STATUS

<table>
<thead>
<tr>
<th>Country</th>
<th>Type</th>
<th>Number</th>
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<tr>
<td>United States Of America</td>
<td>Issued Patent</td>
<td>9,130,119</td>
<td>09/08/2015</td>
<td>2007-317</td>
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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 Photoelectrochemical (PEC) Liftoff 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)
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