UV Optoelectronic Devices Based on Nonpolar and Semi-polar AlInN and AlInGaN Alloys

Tech ID: 24987 / UC Case 2009-258-0

BRIEF DESCRIPTION
A device structure that can be used to create high-power and high-efficiency LEDs and LDs in the UV range of the spectrum.

BACKGROUND
Nitride-based optoelectronics have been studied extensively in order to fabricate visible and UV light-emitting devices. While high-power and high-efficiency LEDs and LDs that emit in the visible spectrum have been achieved, devices that emit in the deep UV region of the spectrum (less than roughly 360 nm) with similar desirable qualities have not due to growth difficulties resulting in poor material quality.

DESCRIPTION
Researchers at UC Santa Barbara have developed a device structure that can be used to create high-power and high-efficiency LEDs and LDs in the UV range of the spectrum. The devices emit in the wavelength range from 280 nm to 360 nm using a nonpolar or semi-polar AlInN and AlInGaN layer grown on a nonpolar or semi-polar bulk GaN substrate. In this device configuration, the piezoelectric field is reduced as the AlInN and AlInGaN layers are lattice-matched to GaN. Polarization is minimized by growing along nonpolar or semi-polar orientations, thus creating a relatively wide bandgap and minimizing the reduction of the radiative recombination efficiency and the effects of the quantum-confined Stark effect.

ADVANTAGES
- Higher efficiency UV light emitting devices
- Reduced spontaneous polarization effects
- Reduction in the quantum confined Stark effect (QCSE)

APPLICATIONS
- UV LEDs and LDs
- Water- and air-purification systems

CONTACT
University of California, Santa Barbara Office of Technology & Industry Alliances
padilla@tia.ucsb.edu
tel: 805-893-2073.

INVENTORS
- Chen, Zhen
- Chung, Roy B.
- DenBaars, Steven P.
- Nakamura, Shuji

OTHER INFORMATION
KEYWORDS
indssl, indled, UV

CATEGORIZED AS
- Engineering
- Energy
- Lighting
- Other
- Semiconductors
- Design and Fabrication

RELATED CASES
2009-258-0
Germicidal and biomedical instrumentation systems

### 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>8,653,503</td>
<td>02/18/2014</td>
<td>2009-258</td>
</tr>
<tr>
<td>United States Of America</td>
<td>Issued Patent</td>
<td>8,357,925</td>
<td>01/22/2013</td>
<td>2009-258</td>
</tr>
<tr>
<td>United States Of America</td>
<td>Issued Patent</td>
<td>8,084,763</td>
<td>12/27/2011</td>
<td>2009-258</td>
</tr>
</tbody>
</table>

### ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Lateral Growth Method for Defect Reduction of Semipolar Nitride Films
- Vertical Cavity Surface-Emitting Lasers with Continuous Wave Operation
- Eliminating Misfit Dislocations with In-Situ Compliant Substrate Formation
- III-Nitride-Based Vertical Cavity Surface Emitting Laser (VCSEL) with a Dielectric P-Side Lens
- Aluminum-cladding-free Nonpolar III-Nitride LEDs and LDs
- 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
- Implantable Light Irradiation Device For Photodynamic Therapy
- Low Temperature Deposition of Magnesium Doped Nitride Films
- Transparent Mirrorless (TML) LEDs
- Improved GaN Substrates Prepared with Ammonothermal Growth
- Optimization of Laser Bar Orientation for Nonpolar Laser Diodes
- Method for Enhancing Growth of Semipolar Nitride Devices
- Ultraviolet Laser Diode on Nano-Porous AlGaN template
- Improved Reliability & Enhanced Performance of III-Nitride Tunnel Junction Optoelectronic Devices
- 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
- 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
- Group III-N Light Emitting Devices Enhanced By Stress From Post-Growth Deposited Films
- Thermally Stable, Laser-Driven White Lighting Device
- MOCVD Growth of Planar Non-Polar M-Plane Gallium Nitride
- 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
- 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
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
Novel Multilayer Structure for High-Efficiency UV and Far-UV Light-Emitting Devices
III-V Nitride Device Structures on Patterned Substrates
Method for Increasing GaN Substrate Area in Nitride Devices
High-Intensity Solid State White Laser Diode
Nitride Based Ultraviolet LED with an Ultraviolet Transparent Contact
GaN-Based Thermoelectric Device for Micro-Power Generation
Limiting Strain-Relaxation in III-Nitride Heterostructures by Substrate Patterning
LED Device Structures with Minimized Light Re-Absorption
Growth of Planar Semi-Polar Gallium Nitride
High-Efficiency and High-Power III-Nitride Devices Grown on or Above a Strain Relaxed Template
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