Improved Fabrication of Nonpolar InGaN Thin Films, Heterostructures, and Devices

Tech ID: 25014 / UC Case 2004-495-0

**BRIEF DESCRIPTION**
A method for fabricating high-quality indium-containing epitaxial layers, heterostructures, and devices based on InGaN growth on GaN substrates.

**BACKGROUND**
GaN and its alloys (AlGaN, InGaN, AlInGaN) have been established as effective for fabrication of visible and ultraviolet optoelectronic devices and high-power electronic devices. These devices are most often grown along the polar c-direction, using a variety of growth techniques, including molecular beam epitaxy (MBE), metalorganic chemical vapor deposition (MOCVD), or hydride vapor phase epitaxy (HVPE). Growing devices in the polar c-direction results in charge separation, spontaneous polarization, and degraded device performance. Growth of such devices along a nonpolar axis could significantly improve their performance, but InGaN-based devices have previously encountered problems with growth conditions and material quality.

**DESCRIPTION**
UC Santa Barbara researchers have developed a method for fabricating high-quality indium-containing epitaxial layers, heterostructures, and devices based on InGaN growth on GaN substrates. These InGaN films are grown along the nonpolar direction using a metalorganic chemical vapor deposition technique, and result in the successful creation of violet and near-ultraviolet LEDs and LDs. Previous issues related to the growth of InGaN-based devices, such as gross surface roughening, low indium incorporation, and indium desorption in InGaN heterostructures have been overcome with this technique.

**ADVANTAGES**
- Variability in layer thickness
- Violet and near-ultraviolet light emission
- Growth of nonpolar InGaN at a reduced temperature
- Growth of InGaN layers at or near atmospheric pressure

**APPLICATIONS**
- LEDs
- Laser diodes (LDs)

**PATENT STATUS**

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<td>Issued Patent</td>
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**OTHER INFORMATION**

**KEYWORDS**
indsli, indled, GaN, thin films

**CATEGORIZED AS**
- Energy
- Lighting
- Semiconductors
- Design and Fabrication

**RELATED CASES**
2004-495-0

**INVENTORS**
- Chakraborty, Arpan
- DenBaars, Steven P.
- Haskell, Benjamin A.
- Keller, Stacia
- Mishra, Umesh K.
- Nakamura, Shuji
- Speck, James S.

**CONTACT**
University of California, Santa Barbara Office of Technology & Industry Alliances
dobis@tia.ucsb.edu
tel: View Phone Number.

**ADDITIONAL TECHNOLOGIES BY THESE INVENTORS**
High Efficiency III-Nitride Devices with Smooth Relaxed InGaN Buffer and Strain Compliant Template
Multifaceted III-Nitride Surface-Emitting Laser
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
High Light Extraction Efficiency III-Nitride LED
III-V Nitride Device Structures on Patterned Substrates
Method for Increasing GaN Substrate Area in Nitride Devices
Nitride Based Ultraviolet LED with an Ultraviolet Transparent Contact
Growth of Planar, Non-Polar, A-Plane GaN by Hydride Vapor Phase Epitaxy
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
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
Enhancing Growth of Semipolar (Al,In,Ga,B)N Films via MOCVD
III-N based Material Structures and Circuit Modules Based on Strain Management