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

BRIEF DESCRIPTION


BACKGROUND

Existing methods of producing semipolar nitride films are extremely cumbersome and yield areas too small for device fabrication, thus there is a need for a new method that overcomes these obstacles in order to take advantage of the performance benefits of using semipolar nitride films.

DESCRIPTION

Researchers at the University of California, Santa Barbara have developed a method for enhancing growth of semipolar (Al,In,Ga,B)N films via metalorganic chemical vapor deposition (MOCVD). This method involves growth of nitride films on the semipolar {11 22} plane to overcome performance limitations associated with the polar c-plane, thus increasing device efficiencies. It yields samples grown on 2-inch diameter substrates, compared with areas of a few micrometers accomplished using existing methods. This method also results in a planar film surface, few surface undulations, and a reduced number of crystallographic defects, all necessary features to support application to state-of-the-art nitride semipolar electronic devices.

ADVANTAGES

- Large available surface area (samples grown on 2-inch diameter substrates, compared to areas on the order of a few micrometers achieved by prior art)
- Increased device efficiencies compared to c-plane devices
- Planar film surface
- Minimized surface undulations and crystallographic defects

APPLICATIONS

- High-Performance Nitride-Based Optoelectronics and Semiconductor Devices
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>8,405,128</td>
<td>03/26/2013</td>
<td>2006-178</td>
</tr>
<tr>
<td>United States Of America</td>
<td>Issued Patent</td>
<td>7,687,293</td>
<td>03/30/2010</td>
<td>2006-178</td>
</tr>
</tbody>
</table>

### ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- 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
- 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
- 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
- Reduced Dislocation Density of Non-Polar GaN Grown by Hydride Vapor Phase Epitaxy
- 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

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

High-Efficiency and High-Power III-Nitride Devices Grown on or Above a Strain Relaxed Template

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