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

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## BRIEF DESCRIPTION

A method for enhancing growth of semipolar (Al,In,Ga,B)N films for high-performance nitride-based optoelectronics and semiconductor devices.

## 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

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## OTHER INFORMATION

### KEYWORDS

GaN, Gallium Nitride, indssl, indled, cenIEE

### CATEGORIZED AS

- **Semiconductors**
  - Design and Fabrication

### RELATED CASES

2006-178-0

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

| Country | Type | Number | Dated | Case |
|---|---|---|---|---|
| United States Of America | Issued Patent | 8,405,128 | 03/26/2013 | 2006-178 |
| United States Of America | Issued Patent | 7,687,293 | 03/30/2010 | 2006-178 |

## 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
- 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
- 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

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