



## (In,Ga,Al)N Optoelectronic Devices with Thicker Active Layers for Improved Performance

Tech ID: 23146 / UC Case 2013-329-0

### BRIEF DESCRIPTION

A novel invention to enable the fabrication of (In,Ga,Al)N optoelectronic devices with thick active layers containing a high concentration of indium (In).

### BACKGROUND

Currently, the fabrication of heterojunctions for optoelectronic devices is limited to the combination of layers with either the same lattice constants or layers where the thickness of the lattice mismatched layers did not exceed its critical thickness. However, thick active regions are attractive for light emitting diodes (LEDs) with significantly reduced droop and solar cells requiring thick active regions for efficient absorption. Moreover, LED development is restricted by the green gap due to deep green LED sources being difficult to produce.

### DESCRIPTION

Researchers at the University of California, Santa Barbara have developed a novel invention to enable the fabrication of (In,Ga,Al)N optoelectronic devices with thick active layers containing a high concentration of indium (In). The In content of the active region can be increased while maintaining a low lattice mismatch between the active region and the current carrying layers, mitigating deterioration of device performance in the green gap. Consequently, relaxed (In,Ga,Al)N films with a lattice constant between GaN and InN can be fabricated on GaN layers of all orientations, including (0001) c-plane GaN.

### ADVANTAGES

- Improved performance of existing devices which require a combination of layers with large lattice mismatch
- Mitigation of defect formation in active layers
- Increase the thickness of the active layers

### CONTACT

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### OTHER INFORMATION

#### KEYWORDS

TIAlighting, lattice mismatch, heterojunctions, LED, solar, indssl, indled, cenIEE, indfeat

#### CATEGORIZED AS

- ▶ **Energy**
  - ▶ Lighting
  - ▶ Solar
- ▶ **Semiconductors**
  - ▶ Design and Fabrication

#### RELATED CASES

2013-329-0

## APPLICATIONS

- LEDs
- Solar Cells

*This technology is available for licensing.*

## PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	9,076,927	07/07/2015	2013-329

## ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- ▶ Vertical Cavity Surface-Emitting Lasers with Continuous Wave Operation
- ▶ Eliminating Misfit Dislocations with In-Situ Compliant Substrate Formation
- ▶ High-Quality N-Face GaN, InN, AlN by MOCVD
- ▶ 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
- ▶ Optimization of Laser Bar Orientation for Nonpolar Laser Diodes
- ▶ A Structure For Increasing Mobility In A High-Electron-Mobility Transistor
- ▶ Method for Enhancing Growth of Semipolar Nitride Devices
- ▶ Ultraviolet Laser Diode on Nano-Porous AlGaIn template
- ▶ Improved Reliability & Enhanced Performance of III-Nitride Tunnel Junction Optoelectronic Devices
- ▶ Improved Fabrication of Nonpolar InGaIn Thin Films, Heterostructures, and Devices
- ▶ Growth of High-Quality, Thick, Non-Polar M-Plane GaN Films
- ▶ Methods for Locally Changing the Electric Field Distribution in Electron Devices
- ▶ High-Efficiency, Mirrorless Non-Polar and Semi-Polar Light Emitting Devices
- ▶ Oxyfluoride Phosphors for Use in White Light LEDs
- ▶ Technique for the Nitride Growth of Semipolar Thin Films, Heterostructures, and Semiconductor Devices
- ▶ Thermally Stable, Laser-Driven White Lighting Device
- ▶ MOCVD Growth of Planar Non-Polar M-Plane Gallium Nitride
- ▶ GaN-based Vertical Metal Oxide Semiconductor and Junction Field Effect Transistors
- ▶ 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
- ▶ Novel Current-Blocking Layer in High-Power Current Aperture Vertical Electron Transistors (CAVETs)
- ▶ III-N Transistor With Stepped Cap Layers
- ▶ 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
- ▶ 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
- ▶ UV Optoelectronic Devices Based on Nonpolar and Semi-polar AlInN and AlInGaN Alloys
- ▶ Defect Reduction of Non-Polar and Semi-Polar III-Nitrides
- ▶ Enhancing Growth of Semipolar (Al,In,Ga,B)N Films via MOCVD
- ▶ III-N Based Material Structures and Circuit Modules Based on Strain Management

