Increased Light Extraction with Multistep Deposition of ZnO on GaN
Tech ID: 25742 / UC Case 2016-114-0

BRIEF DESCRIPTION
A method of depositing ZnO on III-nitride materials using a multistep approach involving the deposition of a thin seed layer followed by the deposition of a thicker bulk layer.

BACKGROUND
Conductive Zinc Oxide (ZnO) films are especially well suited for application as transparent electrodes on III-nitride-based optoelectronics. Given that ZnO and III-N materials share the same wurtzite crystal structure and are closely lattice matched to one another, epitaxial films of ZnO can be deposited on this material system. This allows for the growth of ordered crystalline ZnO films with high carrier mobilities and low optical absorbance, due to the reduction of photon/electron scattering centers such as grain boundaries, point defects, and lattice distortions. In addition, ZnO’s high refractive index of ~2 allows for more efficient light extraction from III-N light emitters such as GaN, whose refractive index is ~2.5, by increasing the critical angle for total internal reflection. Moreover, the ease of pattern ability, whether through selective area growth, patterned etching, or roughening etches, further increases light extraction.

DESCRIPTION
UC Santa Barbara researchers have developed a method of depositing ZnO on III-nitride materials using a multistep approach involving the deposition of a thin seed layer followed by the deposition of a thicker bulk layer. This method yields high quality films and can be employed on a wide scale. It also allows for ZnO to compete with materials such as indium tin oxide (ITO) as a transparent conducting oxide for optoelectronic applications such as III-nitride light emitters and photovoltaics.

ADVANTAGES
▶ High quality films
▶ More efficient light extraction

APPLICATIONS
▶ Optoelectronic applications
▶ III-nitride light emitters and photovoltaics

PATENT STATUS

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ADDITIONAL TECHNOLOGIES BY THESE INVENTORS
▶ Method for Improved Surface of (Ga,Al,In,B)N Films on Nonpolar or Semipolar Substrates
▶ Enhanced Optical Polarization of Nitride LEDs by Increased Indium Incorporation
▶ Vertical Cavity Surface-Emitting Lasers with Continuous Wave Operation
▶ Eliminating Misfit Dislocations with In-Situ Compliant Substrate Formation
▶ III-Nitride-Based Devices Grown With Relaxed Active Region
▶ 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

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OTHER INFORMATION
KEYWORDS
indled, indssl, optoelectronics, III-nitride light emitters, photovoltaics, efficient light extraction, ZnO, indium tin oxide, indfeat

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

RELATED CASES
2016-114-0
Enhanced Light Extraction LED with a Tunnel Junction Contact Wafer Bonded to a Conductive Oxide

Highly Efficient Blue-Violet III-Nitride Semipolar Laser Diodes

Hybrid Growth Method for Improved III-Nitride Tunnel Junction Devices

Low Temperature Deposition of Magnesium Doped Nitride Films

Transparent Mirrorless (TML) LEDs

Optimization of Laser Bar Orientation for Nonpolar Laser Diodes

Size-Independent Forward Voltage Micro-LED with an Epitaxial Junction

Method for Enhancing Growth of Semipolar Nitride Devices

III-Nitride Tunnel Junction with Modified Interface

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

Growth of High-Quality, Thick, Non-Polar M-Plane GaN Films

Selective-Area Mesoporous Semiconductors And Devices For Optoelectronic And Photonic Applications

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

(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

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

Highly Compact, High-Index Dielectric Nanostructures for Deep-Ultraviolet Devices

Reduction in Leakage Current and Increase in Efficiency of III-Nitride MicroLEDs

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/LED Devices on Relaxed Template with Misfit Dislocation at Hetero-interface

Photoelectrochemical Etching Of P-Type Semiconductor Heterostructures

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

Improved Manufacturing of Solid State Lasers via Patterning of Photonic Crystals

High Efficiency III-Nitride Devices with Smooth Relaxed InGaN Buffer and Strain Compliant Template

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-Nitride Device Structures on Patterned Substrates

Activation of P-Type Layers of Tunnel Junctions in Micro-LEDs

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

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