Highly Compact, High-Index Dielectric Nanostructures for Deep-Ultraviolet Devices
Tech ID: 32699 / UC Case 2022-761-0

BACKGROUND
Efficient generation and management of deep ultraviolet (UV) light (wavelengths from 180 to 300 nm) is important for disinfection, remediation of toxic waste, spectroscopy, electronics manufacturing, and solid-state optoelectronic applications. While significant progress has been made in solid-state AlGaN-based UV light emitter materials, current device configurations utilize absorbing metal reflectors combined with traditional spreading material layers that reduce light-extraction and wall-plug efficiency. As such, new optical elements that reduce absorption losses, maximize UV reflection, and improve thermal management are necessary for accelerating the implementation of solid-state deep UV emitters.

DESCRIPTION
Researchers at University of California, Santa Barbara have created wavelength-tunable, compact optical elements for efficient deep-UV reflection. These novel elements minimize absorption with a low extinction coefficient and >90% reflectance for the entire relevant UV wavelength range (180-365 nm) — all with improved wall-plug efficiency. Unlike reflective UV surfaces and protective dielectric coatings, this optical structure achieves upwards of 85% specular reflection near 200 nm and does not easily oxidize, making the devices commercially competitive compared to their counterpart’s high oxidation rates. Additionally, this invention enables back-end fabrication adaptability to a range of design wavelengths since the reflectors can be formed after epitaxial heterostructure growth and optical testing. This invention leverages intense, wavelength-tunable reflection, and narrow-band wavelength selectivity to become suitable for cleanup filters and narrow-band reflectors for commercially available lasers and LEDs. The compactness, efficiency, fabrication adaptability, and natively-nitride-based and freestanding nature of these elements positions them well to disrupt their current industry alternatives.

ADVANTAGES
▶ Provides intense wavelength-tunable reflection
▶ Achieves high reflectance (>90%) for the entire UV wavelength range
▶ Enables narrow-band wavelength selectivity and free-standing, compact, natively nitride-based device integration

APPLICATIONS
▶ UV LEDs and UV Optoelectronics
▶ Med devices for disinfection and sterilization
▶ Spectroscopy

PATENT STATUS
Patent Pending

RELATED CASES
2022-761-0

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
▶ 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

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OTHER INFORMATION
KEYWORDS
Ultraviolet, UV, disinfection, AlGaN, solid-state, optoelectronic, UV emitter, wavelength-tunable, UV reflection, optical, LED, LD, laser, nitride, wavelength, sterilization, Spectroscopy

CATEGORIZED AS
▶ Optics and Photonics
▶ All Optics and Photonics
▶ Energy
▶ Lighting
▶ Semiconductors
▶ Design and Fabrication
- 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
- 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
- Improved GaN Substrates Prepared with Ammonothermal Growth
- 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
- 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
- Increased Light Extraction with Multistep Deposition of ZnO on GaN
- Method for Manufacturing Improved III-Nitride LEDs and Laser Diodes: Monolithic Integration of Optically Pumped and Electrically Injected III-Nitride LEDs
- Selective-Area Mesoporous Semiconductors And Devices For Optoelectronic And Photonic Applications
- 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
- Reduced Dislocation Density of Non-Polar GaN Grown by Hydride Vapor Phase Epitaxy
- 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/LD 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 Patternning of Photonic Crystals
- 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
- 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

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