Novel Multilayer Structure for High-Efficiency UV and Far-UV Light-Emitting Devices

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OTHER INFORMATION

KEYWORDS

Multilayer structure, UV LEDs, Far-UV LEDs, Doped layers, Al composition, Radiative recombination, Efficiency improvement, Output power, Surface morphology, Quantum well heterostructures, Electron and hole localization, Enhanced performance, Improved reliability, Longer lifetime, Uniformity across growth wafers

CATEGORIZED AS

- **Semiconductors**
  - Assembly and Packaging
  - Design and Fabrication
  - Materials

BACKGROUND

The demand for efficient UV LEDs has been emphasized in recent years. Wavelengths below 300nm are universally germicidal, making UV disinfection one of the most promising means to fight pandemic disease outbreaks, improve water quality, and sterilize medical environments. Other applications include short-range optical communication, 3D printing, curing, medical devices, and much more. Current state-of-the-art UV LEDs are about five times less energy-efficient and 100 times more expensive per Watt than more commonly-used Hg-vapor lamps. However, solid-state LED-based UV light sources can provide many advantages such as miniaturization, rapid on/off/dim switching for smart functionality, wavelength tunability, durability, and low power consumption. In order to realize these advantages and replicate the disruption achieved by white and blue LEDs, novel technologies for efficient UV LEDs are needed.

DESCRIPTION

Researchers at the University of California, Santa Barbara have introduced a design for ultraviolet (UV) or far-UV LEDs that incorporates a novel doped multilayer structure that dramatically improves the performance of these devices. The novel multilayer structure combines regions of higher Al composition (compared to adjacent layers) with an undulating emitting region and controlled buffer layer crystal quality to promote radiative recombination and enhance efficiency. Compared to nitride UV LEDs without the novel multilayer structure, this technology demonstrates an approximate 300% improvement in output power and the surface morphology of the active region is extremely smooth by comparison. This plays an important role in upgrading light emission efficiency due to electron and hole localization from the disc-hillocks, and extremely smooth surfaces on top of the disc-hillocks enable sharp quantum well heterostructures which increase carrier localization further.

ADVANTAGES

- 300% improvement in output power
- Higher efficiency
- Improved reliability and lifetime
- Higher uniformity across growth wafers and enhanced surface morphology of active regions

APPLICATIONS

- LEDs
- UV and far-UV LEDs

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Published Application	20230369538	11/16/2023	2022-794

RELATED MATERIALS

- Ultraviolet Light Emitting Diodes Grown on Sapphire and Silicon Carbide Substrates - 03/01/2022

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Lateral Growth Method for Defect Reduction of Semipolar Nitride Films

- Other
- Processing and Production
- Testing

RELATED CASES

2022-794-0

- 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)
- 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
- 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
- Method for Growing High-Quality Group III-Nitride Crystals
- Controlled Photoelectrochemical (PEC) Etching by Modification of Local Electrochemical Potential of Semiconductor Structure
- Technique for the Nitride Growth of Semipolar Thin Films, Heterostructures, and Semiconductor Devices
- 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
- 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
- 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