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
Patent Pending

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
▶ 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

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

Technique for the Nitride Growth of Semipolar Thin Films, Heterostructures, and Semiconductor Devices

MOCVD Growth of Planar Non-Polar M-Plane Gallium Nitride

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

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

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

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,Ga,B)N Films via MOCVD