III-Nitride-Based Vertical Cavity Surface Emitting Laser (VCSEL) with a Dielectric P-Side Lens

Tech ID: 33105 / UC Case 2023-847-0

BACKGROUND

Gallium nitride (GaN) vertical cavity surface emitting lasers (VCSELs) have attracted attention with their ability to emit in visible and ultraviolet (UV) wavelengths, affording a wide swath of exciting new applications in displays, solid-state lighting, sensing, and communications. Visible light communications (VLC) is a particularly attractive application for GaN VCSELs where they can be coupled with a phosphor to act as both a light source and data transmission device simultaneously. With the extensive proliferation of devices that can access networks, efficient data transmission has become a high priority, especially as bandwidths are becoming overcrowded. Realizing data transmission at visible wavelengths would greatly expand current bandwidth capabilities, but achieving this task will require solutions to the device degradation caused during lens growth and absorption loss within the long cavities of GaN VCSELs.

DESCRIPTION

Researchers at the University of California, Santa Barbara have produced a GaN VCSEL that achieves high efficiency, high peak power, and long device lifetimes by eliminating degradation to the active region, improving emission intensity, and significantly reducing absorption loss within the cavity. Key to the invention is the topside dielectric p-side lens which provides the mode control characteristics. Topside fabrication eases pain points with processing and alignment in addition to putting more distance between the active region and the planar DBR. The topside lens allows for the active region to be farther up in the cavity, increasing the maximum width of the beam and current aperture. The use of wider apertures enables higher packing densities, positioning this VCSEL design especially well for high-power directional lighting applications or other applications where an array of VCSELs with a wide divergence angle is of interest.

ADVANTAGES

- Improved VCSEL performance
- Dramatically increased output power
- Reduced threshold current density
- Increased device lifetimes

APPLICATIONS

- VCSELs

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OTHER INFORMATION

KEYWORDS

III-nitride-based VCSEL, Vertical cavity surface emitting laser, GaN VCSEL, Dielectric p-side lens, Efficiency improvement, High peak power, Long device lifetimes, Active region degradation, Emission intensity improvement, Absorption loss reduction, Topside fabrication

CATEGORIZED AS

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

PATENT STATUS

Country	Type	Number	Dated	Case
Patent Cooperation Treaty	Published Application	WO 2024/044567	02/29/2024	2023-847

Additional Patent Pending

RELATED CASES

2023-847-0

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

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