



## Vertical Cavity Surface-Emitting Lasers with Continuous Wave Operation

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### OTHER INFORMATION

#### KEYWORDS

indfeat, VCSELs, LiFi,  
Augmented Reality, Virtual  
Reality, quantum wells, m-  
plane, semiconductors

#### CATEGORIZED AS

- ▶ **Communications**
  - ▶ Other
- ▶ **Energy**
  - ▶ Lighting
- ▶ **Imaging**
  - ▶ 3D/Immersive

#### RELATED CASES

2018-250-0

## BRIEF DESCRIPTION

An *m*-plane VCSEL with an active region that has thick quantum wells and operation in continuous wave.

## BACKGROUND

Vertical-cavity surface-emitting lasers (VCSELs) are semiconductor laser diodes that emit light normal to the substrate. This design has many advantages over edge-emitting lasers and light-emitting diodes, such as low threshold current, circular mode profile, high-speed direct modulation, ability for single longitudinal mode operation, and two-dimensional arraying capability. As opposed to arsenide and phosphide-based devices, electrically-injected III-nitride VCSELs have been relatively difficult to create, and only eight research groups have successfully demonstrated these devices in the past decade. While most of the reports have been on *c*-plane, *m*-plane VCSELs have been demonstrated and have many advantages, such as lack of the quantum confined Stark effect, higher material gain, and anisotropic gain that leads to 100% polarization ratio. However, *m*-plane VCSEL devices have not been able to achieve continuous wave operation.

## DESCRIPTION

Researchers at the University of California, Santa Barbara have created an *m*-plane VCSEL with an active region that has thick quantum wells and operation in continuous wave. This is the first report of a VCSEL capable of continuous wave operation. Thicker quantum wells (QWs) are possible on semipolar or nonpolar *m*-plane GaN, in contrast with standard *c*-plane GaN. These devices have improved thermal performance and a longer cavity length.

## ADVANTAGES

- ▶ III-nitride VCSEL with continuous wave operation
- ▶ 100% polarized VCSEL emission

## APPLICATIONS

- ▶ VCSELs
- ▶ AR/VR
- ▶ High-resolution displays
- ▶ LiFi
- ▶ Visible wavelength LIDAR

## PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	11,532,922	12/20/2022	2018-250

## ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- ▶ [Eliminating Misfit Dislocations with In-Situ Compliant Substrate Formation](#)
- ▶ [III-Nitride-Based Vertical Cavity Surface Emitting Laser \(VCSEL\) with a Dielectric P-Side Lens](#)
- ▶ [Enhanced Light Extraction LED with a Tunnel Junction Contact Wafer Bonded to a Conductive Oxide](#)
- ▶ [Methods to Produce and Recycle Substates for III-Nitride Materials with Electrochemical Etching](#)

- ▶ III-Nitride Tunnel Junction with Modified Interface
- ▶ Improved Reliability & Enhanced Performance of III-Nitride Tunnel Junction Optoelectronic Devices
- ▶ (In,Ga,Al)N Optoelectronic Devices with Thicker Active Layers for Improved Performance
- ▶ Thermally Stable, Laser-Driven White Lighting Device
- ▶ III-Nitride Tunnel Junction LED with High Wall Plug Efficiency
- ▶ Novel Multilayer Structure for High-Efficiency UV and Far-UV Light-Emitting Devices
- ▶ A Method To Lift-Off Nitride Materials With Electrochemical Etch
- ▶ High-Intensity Solid State White Laser Diode
- ▶ Nitride Based Ultraviolet LED with an Ultraviolet Transparent Contact
- ▶ Epitaxial Light Control Features in Light Emitting Diodes
- ▶ High-Efficiency Vertical Cavity Surface Emitting Laser Fabrication
- ▶ A Wafer-Scale, Low Defect Density Strain Relaxed Template for III-Nitride-Based High Efficiency and High-Power Devices
- ▶ High-Efficiency and High-Power III-Nitride Devices Grown on or Above a Strain Relaxed Template
- ▶ III-Nitride Based VCSEL with Curved Mirror on P-Side of the Aperture

