Epitaxial Light Control Features in Light Emitting Diodes

Tech ID: 34602 / UC Case 2022-769-0

BACKGROUND

Increasing internal quantum efficiency (IQE) and light extraction efficiency (EXE) are the two main approaches to improving the overall efficiency of LEDs. EXE can be increased by improving the directionality of light emission, and the introduction of photonic crystals (PhCs) to LEDs provided a promising advancement toward this goal. However the delicate fabrication requirements of PhC LEDs keeps them from realizing large scale production. A solution that circumvents this delicate fabrication process would enable widespread implementation of PhC LEDs and usher in a significant increase to the overall efficiency of LEDs.

DESCRIPTION

Researchers at the University of California, Santa Barbara have developed highly efficient PhC LEDs of micro and macro size (100000 μm2 to 1 μm2) with epitaxially integrated light control features. As a departure from conventional PhC LED fabrication, this invention does not etch directly on the active layer, which eliminates possible damage to the quantum wells (QW). Instead, light-controlling structures are epitaxially integrated directly onto the device layer at the initial stage of growth. The epitaxial layers are defect-filtered through epitaxial lateral overgrowth (ELO), providing controlled light extraction and directionality and improving EXE. This technology integrates PhCs on the n-GaN side of micro-LEDs which also addresses the color mixing issues of burgeoning high pixel density micro-displays. Micro-displays that demonstrate these performance features will represent the future of AR/VR/Mixed reality applications where light directionality is crucial.

ADVANTAGES

- Improved efficiency through optimized light extraction and directionality
- Avoids damage caused by physical etching on the active layer
- Decreased defect density
- Can be used with native or foreign substrates regardless of crystal orientation

APPLICATIONS

- LEDs and micro-LEDs
- AR/VR
- Next generation displays

PATENT STATUS

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OTHER INFORMATION

KEYWORDS

LEDs, Light emitting diodes, Light extraction efficiency, EXE, Photonic crystals, PhCs, AR, VR, Micro-LEDs, Displays

CATEGORIZED AS

- **Semiconductors**
  - Other

RELATED CASES

2022-769-0

Country	Type	Number	Dated	Case
United States Of America	Published Application	20240405158	12/05/2024	2022-769

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
- Method For The Removal Of Devices Using The Trench
- Thermally Stable, Laser-Driven White Lighting Device
- Novel Multilayer Structure for High-Efficiency UV and Far-UV Light-Emitting Devices
- A Method To Lift-Off Nitride Materials With Electrochemical Etch
- Activation of P-Type Layers of Tunnel Junctions in Micro-LEDs
- High-Intensity Solid State White Laser Diode
- Nitride Based Ultraviolet LED with an Ultraviolet Transparent Contact
- 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

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