III-Nitride-Based Devices Grown With Relaxed Active Region
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BACKGROUND

Fierce market competition in high-resolution displays and augmented/virtual reality (AR/VR) technologies is increasing the demand for highly efficient micro-LEDs, driving researchers to investigate indium gallium nitride (InGaN)-based LEDs due their high blue and green external quantum efficiency (EQE). A substantial obstacle in fabricating high efficiency InGaN LEDs is growing a high-indium-containing InGaN layer while maintaining favorable structural and crystal qualities, due to the coherent strain of InGaN layers on the GaN substrate. Through indium desorption, crystal degradation, and rough surface morphology, strain between the device layers comes at a cost of overall device efficiency; especially for long-wavelength LEDs. Improving indium incorporation and crystal quality, decreasing defects, and growing devices at higher temperatures are key to enabling mass manufacture of long-wavelength III-nitride based devices.

DESCRIPTION

Researchers at the University of California, Santa Barbara have fabricated III-nitride-based devices with a relaxed active region that improve on the crystal quality, defect density, and surface morphology of previous demonstrations. This technology uses a thin thermally decomposed InGaN underlayer and a thin GaN or InGaN decomposition stop layer as the strain compliant layer. These novel components improve the crystal quality, reduce defects, improve surface morphologies, and ultimately enhance the final electrical and optical properties of the device. In addition, growing a relaxed active region will minimize the compositional pulling effect, which will allow for higher temperature quantum well growth and higher efficiency for long wavelength emitting devices.

ADVANTAGES

▶ Enhances key device performance with improvements to crystal quality, defect density, surface morphology and growth temperature
▶ Increases efficiency in long-wavelength devices

APPLICATIONS

▶ LEDs, micro-LEDs and Laser Diodes
▶ Augmented/virtual reality
▶ High-resolution displays

PATENT STATUS

Patent Pending

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

▶ Enhanced Optical Polarization of Nitride LEDs by Increased Indium Incorporation
▶ Lateral Growth Method for Defect Reduction of Semipolar Nitride Films
▶ Vertical Cavity Surface-Emitting Lasers with Continuous Wave Operation
▶ Low-Cost Zinc Oxide for High-Power-Output, GaN-Based LEDs (UC Case 2010-183)
▶ Defect Reduction in GaN films using in-situ SiNx Nanomask
▶ Enhanced Light Extraction LED with a Tunnel Junction Contact Wafer Bonded to a Conductive Oxide
▶ Highly Efficient Blue-Violet III-Nitride Semipolar Laser Diodes
▶ Hybrid Growth Method for Improved III-Nitride Tunnel Junction Devices