



High-Efficiency and High-Power III-Nitride Devices Grown on or Above a Strain Relaxed Template

Tech ID: 33099 / UC Case 2022-775-0

BACKGROUND

Long wavelength InGaN emitters are challenging to fabricate and typically less efficient due to the >10% lattice mismatch between indium nitride (InN) and gallium nitride (GaN). The large lattice mismatch causes high strain in the active region which results in defects, degradation of surface morphology and a reduction of indium incorporation (compositional pulling). Growing the InGaN active region on a strain-relaxed InGaN buffer layer will, however, reduce the lattice mismatch between the two layers. This reduces the compositional pulling effect and allows for higher indium incorporation by hotter growth using MOCVD, the dominant method of commercial epitaxial InGaN growth. Hotter growth temperatures tend to lead to higher crystal quality as well, and together these advancements have realized efficient red InGaN LEDs. Until now, this method was not available to InGaN emitters in the green wavelengths.

DESCRIPTION

Researchers at the University of California, Santa Barbara have achieved high efficiency and high power emission in green emitters while growing the devices on or above a strain-relaxed template (SRT). The SRT uses a thin thermally decomposed InGaN underlayer (DL) below an n-type GaN or low indium composition InGaN decomposition stop layer (DSL), on top of which is grown a buffer layer comprising an n-type InGaN/GaN superlattice (SL). For an LD structure, an n-type InGaN waveguiding layer is then grown, followed by an active region, p-type electron blocking layer (EBL), p-type InGaN waveguide and p-type GaN or p-type InGaN layers. For an LED structure, the n-type, p-type or both InGaN waveguiding layers may be omitted. This technology improves the layer structure and growth conditions for green InGaN emitters, resulting in higher power output and higher efficiency.

ADVANTAGES

- ▶ Enables high-quality, long-wavelength active regions by mitigating the compositional pulling effect
- ▶ Improves the design of the DSL, buffer, waveguide, active region, and p-type cladding layers
- ▶ Improves power output and efficiency

APPLICATIONS

- ▶ III-Nitride LEDs and Laser diodes
- ▶ Emitters in green wavelengths

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OTHER INFORMATION

KEYWORDS

LED, MOCVD, laser diode,
green, strain, InGaN

CATEGORIZED AS

- ▶ **Semiconductors**
 - ▶ [Assembly and Packaging](#)
 - ▶ [Design and Fabrication](#)
 - ▶ [Processing and Production](#)

RELATED CASES

2022-775-0

PATENT STATUS

Country	Type	Number	Dated	Case
Patent Cooperation Treaty	Reference for National Filings	WO 2023/150550	08/10/2023	2022-775

Patent Pending

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- ▶ 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
- ▶ Ultraviolet Laser Diode on Nano-Porous AlGaIn template
- ▶ Methods for Fabricating III-Nitride Tunnel Junction Devices
- ▶ Contact Architectures for Tunnel Junction Devices
- ▶ 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
- ▶ III-Nitride Based VCSEL with Curved Mirror on P-Side of the Aperture