

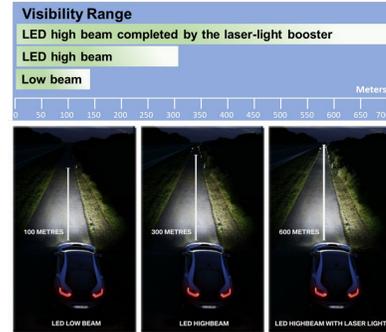
MBE-Grown III-Nitride Based Blue Laser Diodes on c-plane GaN Substrates

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MOTIVATION

Automotive lighting



- Improved visibility, resulting in increased road traffic safety.
- Laser-based headlights will have the longest range provided by any current headlight technology

Blue lasers



Illumination



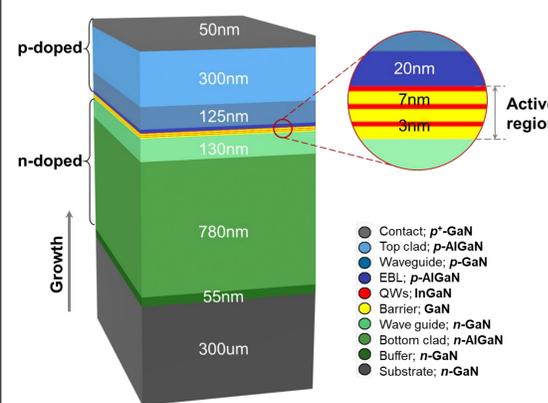
Display



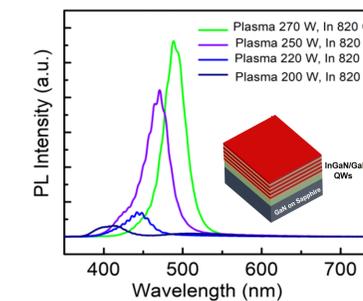
Replacing energy-inefficient incandescent and halogen filament bulbs and even light emitting diodes (LEDs) and serve as a mainstream lighting source, which would be particularly beneficial due to their low-energy requirements

MATERIAL DESIGN

MBE-epilayers of blue laser

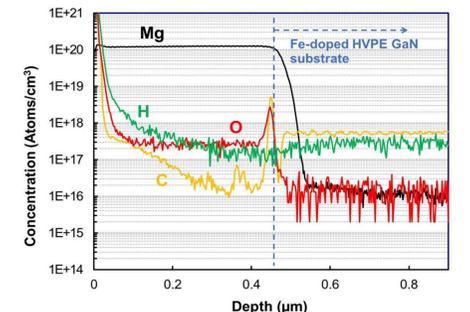


Photoluminescence spectra



PL spectra for planar InGaIn/GaN quantum wells grown with same indium flux and varied plasma power. Schematic illustration of the PL structure grown on GaN-on-Sapphire substrate is shown as an inset

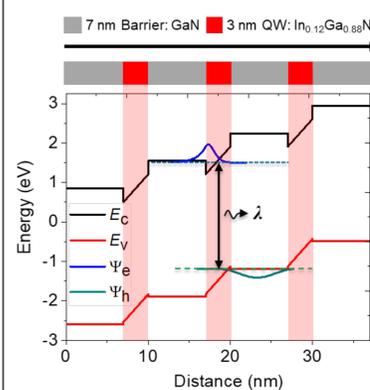
Secondary Ion Mass Spectrometry



SIMS depth profiles for Mg doped GaN layers grown under nitrogen rich condition (III/V = 0.8 : 1) but with Ga flux interruption. The growth temperature was 580°C, and Mg beam equivalent pressure at 4x10⁻¹⁰ Torr.

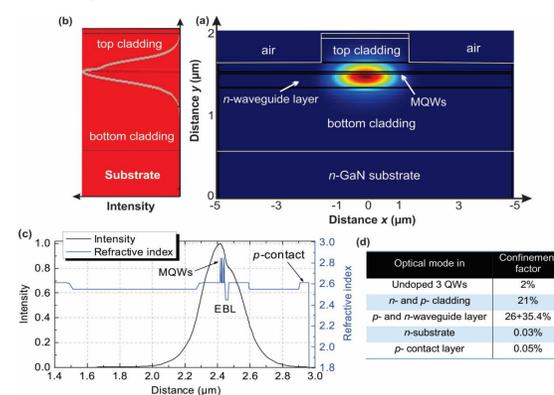
DEVICE DESIGN

Band diagram



- Simulated equilibrium energy band diagram of the active region
- 3 compressively strained 3-nm-thick InGaIn quantum wells
- Symmetric Fabry-Pérot structure

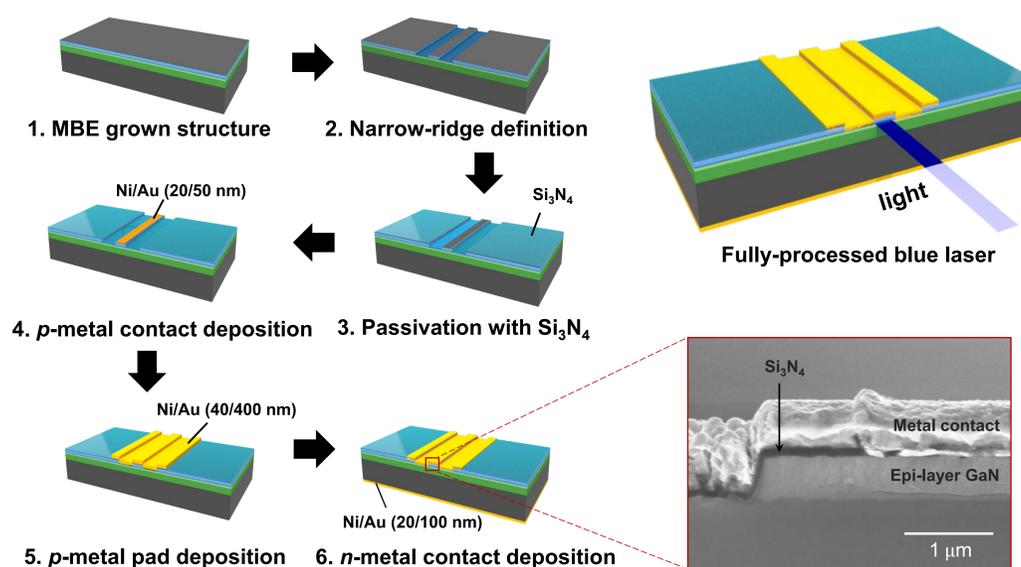
Waveguide simulation



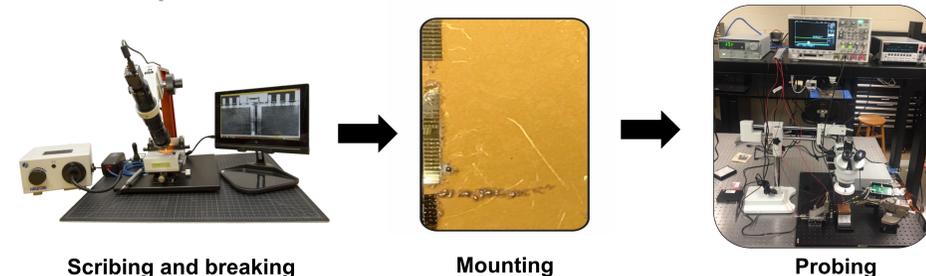
(a) Cross section of a laser structure along with a 2D surface plot of the light intensity of the fundamental transverse mode, (b) 1D intensity distribution of the fundamental TE-mode in the waveguide, (c) refractive index profile and mode intensity distribution, and (d) confinement factors in several sections of the laser structure.

DEVICE FABRICATION

Front-end processes

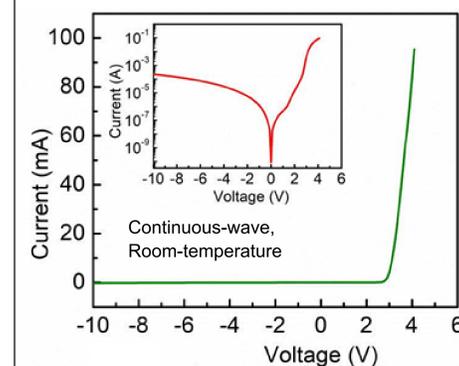


Back-end processes



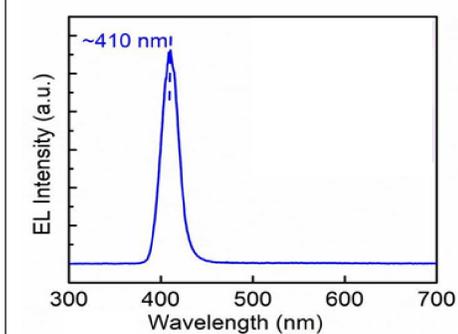
DEVICE RESULTS

I-V characteristics



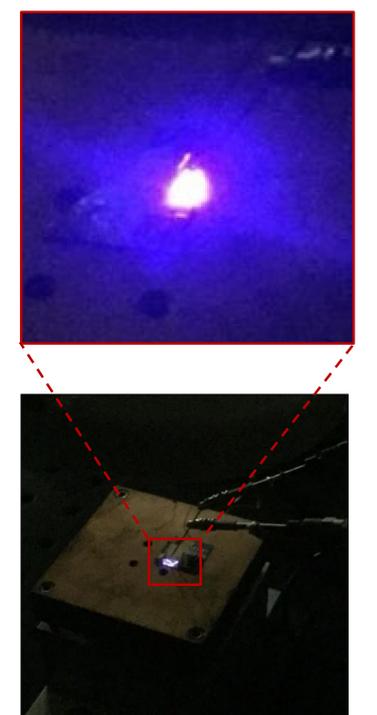
I-V characteristics of a ridge laser with 20 μm × 1 mm in linear scale. Device exhibits good turn-on and low dark current. Semi-logarithmic plot shown as inset.

Spectral characteristics



Electroluminescence spectrum at room temperature

Device under test



Devices exhibit strong electroluminescence at room temperature even at a current density of 20 kA/cm². No lasing is yet observed. The reason of this non-lasing behavior could be due to unoptimized active region that will be investigated.