

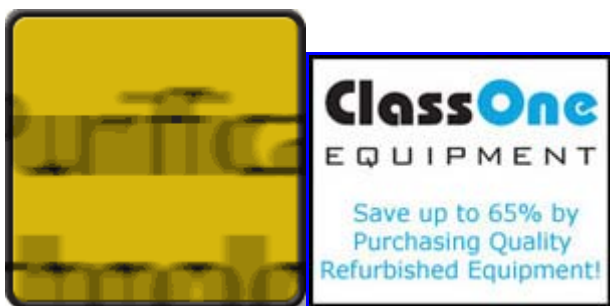
This Site Web

Search

[CMP PROCESSING](#)

Learn more about R&D [chemical mechanical polishing](#) by requesting our **FREE** informational CD.

[MORE INFO](#)



FREE subscription

[Subscribe for free to receive each issue of Semiconductor Today magazine and weekly news brief.](#)

News

24 September 2007

First blue and first cw AlGaIn-cladding-free blue-violet nonpolar InGaIn/GaN lasers

Last week's 7th International Congress of Nitride Semiconductors (ICNS-7) in Las Vegas, NV, USA saw reports of the latest progress in nonpolar laser diodes from the likes of University of California Santa Barbara and Japan's Rohm Co Ltd.

Conventional gallium nitride lasers are grown on a substrate such as sapphire oriented along the crystallographic c-plane. However, strong polarization fields along the c-plane, together with related piezoelectric effects, segregate electrons and holes in the laser's quantum well active light-emitting region, reducing their efficiency in recombining to produce light. The quantum efficiency is reduced more severely as the lasing emission wavelength shifts from blue-violet (about 400nm) through blue (up to about 490nm)

towards green (beyond 500nm - much sought-after for combination, e.g. in full-color RGB laser displays).

In contrast, using a nonpolar GaN substrate whose crystal is oriented instead along the {1-100} m-plane gives much lower polarization fields and piezoelectric effects in the laser's active layer, so electrons and holes can recombine more efficiently.

Using bulk m-plane GaN substrates from Tokyo-based Mitsubishi Chemical Corp, early this year the first nonpolar m-plane blue-violet nitride laser diodes were reported coincidentally by both Rohm Co Ltd of Kyoto, Japan and the group led by Shuji Nakamura, Steven DenBaars and James Speck at University of California Santa Barbara (Jpn J. Appl. Phys. 46 (2007) issue 9 (23 February): Okamoto et al L187; Schmidt et al L190).

Rohm says its InGaN/GaN multi-quantum-well lasers had threshold current densities comparable to that of conventional c-plane lasers: 3.1kA/cm² for pulsed operation and 4.0kA/cm² for continuous-wave (cw) operation emitting at 401nm (blue-violet).

UCSB's broad-area InGaN/GaN multi-quantum-well devices lased at 405.5nm (blue-violet) with a threshold current density of 7.5kA/cm² in pulsed operation.

Subsequently, UCSB demonstrated the first nonpolar m-plane InGaN/GaN laser without any Al-containing waveguide cladding layers (Daniel F. Feezell et al, Jpn J. Appl. Phys. 46 (2007) issue 13 (23 March) L284). Instead, transverse optical mode confinement is achieved due to the ability to grow thick (>8nm) m-plane InGaN active-region quantum wells (unlike for c-plane material, where thick AlGaIn layers can increase the series resistance, operating voltage, operating temperature and threshold current density, as well as leading to cracking due to tensile strain). Pulsed lasing operation was demonstrated with a threshold current density of 3.7kA/cm².

Most recently, at last week's ICNS event, Mathew Schmidt presented UCSB's latest achievement of the first cw operation of a nonpolar m-plane InGaN/GaN laser without any AlGaIn waveguide cladding layers (Farrell et al, Jpn J. Appl. Phys. 46 (2007) issue 32 (10 August) L761) . The threshold current density is 6.8kA/cm².

Meanwhile, Rohm's Kuniyoshi Okamoto presented the first nonpolar m-plane InGaN/GaN laser emitting at longer, pure blue wavelengths: 430nm using GaN guiding and 452nm using InGaN guiding (Okamoto et al, Jpn J. Appl. Phys. 46 (2007) issue 35 (7 September) L820) - since extended to 456nm. The threshold current density was 22.3kA/cm² at 452nm. As well as providing optical waveguides for longer lasing wavelengths, the InGaN guiding layers prevent macroscopic cracks developing parallel to the c-plane, which is indispensable for fabricating nonpolar lasers at longer wavelengths beyond the blue region, Okamoto says.

Okamoto reckons the latest results suggest that there is a good possibility of achieving the goal of a green laser diode on m-plane GaN. However, he concedes that indium incorporation is an issue for such longer wavelengths.

*UCSB's Anurag Tyagi also presented the first semi-polar nitride laser diode, using (10-1-1) bulk GaN substrates (Tyagi et al, Jpn J. Appl. Phys. 46 (2007) issue 19 (11 May) L444). Pulsed lasing (at a duty cycle of 0.025%) at 405.9nm has been observed with a threshold current density of 16.5kA/cm². Improvement is planned by using a ridge waveguide structure, says Tyagi.

See related item:

[First nonpolar blue-violet laser diodes demonstrated by UCSB](#)

Visit ICNS: www.tms.org/Meetings/specialty/icns7

Visit Rohm: www.rohm.com

Visi UCSB: www.sslcd.ucsb.edu

Laser Diodes & Gain Chips

1050nm - 1320nm,
unique wavelength
high-power + broad-
band devices
www.innolume.com

Laser Diodes, 405nm-840nm

3mW- 80W optical
power output,
industrial, medical,
scientific OEM
www.photonic-product.com

Destructive Lasers

100mw, 75mw,
50mw, 40mw from
\$160 Satisfaction
Guaranteed. Buy
Now!
www.destructivegear.com

DPSS YVO4 Laser Source

Compact, air cooled,
TEM00 system High
peak power - 355,
532, 1064nm
RMILaser.net

Laser sources UV to IR

Pulsed and CW
lasers 266, 355, 405
473, 488, 532, 561,
633, 1064 nm
www.markettechinc.com



Juno Publishing & Media Solutions Limited

©2007 Juno Publishing and Media Solutions Ltd. All rights reserved.

Semiconductor Today and the editorial material contained within it and related media is the copyright of Juno Publishing and Media Solutions Ltd. Reproduction in whole or part without permission from Juno Publishing and Media Solutions Ltd is forbidden. In most cases, permission will be granted, if the author, magazine and publisher are acknowledged.

Disclaimer: Material published within Semiconductor Today and related media does not necessarily reflect the views of the publisher or staff. Juno Publishing and Media Solutions Ltd and its staff accept no responsibility for opinions expressed, editorial errors and damage/injury to property or persons as a result of material published.

Semiconductor Today, Juno Publishing and Media Solutions Ltd, Suite no. 133, 20 Winchcombe Street,
Cheltenham, GL52 2LY, UK

Web site [by No Name No Slogan](#) 