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NEWS

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Massive power boost for non-polar GaN LEDs

Thanks in no small part to improved substrate material, the Santa Barbara team working on non-polar GaN has produced a blue-violet LED with record output power and an external quantum efficiency of 41 percent at a very high drive current.

The UCSB team, led by Steve DenBaars and Shuji Nakamura, produced an InGaN multi-quantum-well structure with an output power of 28 mW and a peak wavelength of 402 nm when driven at 20 mA - equivalent to an external quantum efficiency of 45.4 percent.

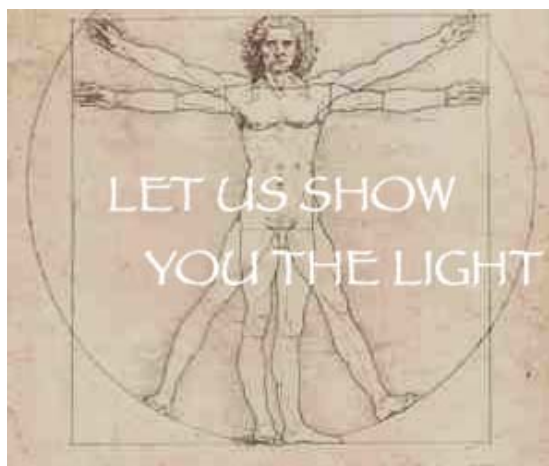
Crucially, that impressive conversion efficiency was maintained at much higher currents, with the device emitting 250 mW when driven at 200 mA. Previous efforts have shown promise, but this new result represents a huge increase in output power.



Non-polar GaN LED

Developing non-polar GaN, in which the crystal structure is arranged in the m -plane, has long been seen as a way to generate a step-change in the performance of LEDs and lasers for applications such as solid-state lighting and high-definition optical data storage.

That's because conventional c -plane GaN LEDs suffer from strong polarization fields that reduce the rate of radiative recombination, and which also cause emission wavelengths to shift when the applied drive current changes.



Until recently, however, chips based on non-polar GaN had not shown a conversion efficiency or an output power anywhere near that of conventional structures (see related stories).

Much of the latest hike in performance is attributable to the development of improved *m*-plane GaN substrates supplied by the Japanese firm Mitsubishi Chemical. This base material was sliced from conventional *c*-plane GaN grown using hydride VPE.

There is still room for improvement, says the UCSB team. In the latest work, the LED chips were fabricated using standard processing techniques, and with indium tin oxide (ITO) contacts. This suggests that extraction efficiencies could be increased by using some of the more advanced approaches that have been developed by commercial LED manufacturers (see related feature article from Philips Lumileds).

Commenting on the latest UCSB results in an article co-authored by Ulrich Schwarz, GaN expert Michael Kneissl from the Technical University of Berlin said, "The achieved external quantum efficiency is clearly a remarkable result."

"Most important, only a small drop of the EQE over the current density range from 1 A/cm² to 350 A/cm² is observed."

But, as Kneissl and Schwarz point out, there are still many technical challenges to overcome before these non-polar devices can make an impact in the real world. Chief among these is the fact that the *m*-plane substrates, while of very high quality, are too small and too expensive for application in a production MOCVD system.

The substrates used by the UCSB team measured only about one square centimeter, whereas 2-inch diameter material is typically used in a commercial setting.

- Find out more about the latest developments in both LEDs and lasers based on non-polar GaN in the forthcoming June issue of *Compound Semiconductor* magazine, where guest authors Steve DenBaars, Jim Speck and Shuji Nakamura write about the latest developments in the UCSB labs.

About the author

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