# Filling the green gap

Could a practical green laser diode finally be within sight? The latest research looks optimistic.

Researchers at the Japanese company Nichia have fabricated an InGaN semiconductor laser diode that operates at a wavelength of 515 nm and emits milliwatt-level powers in continuous-wave mode at room temperature. This news offers renewed hope that a practical commercial green laser diode may be close to fruition[1,2].

For many years, the photonics community has had access to efficient and powerful red and blue laser diodes, based on the AlInGaP and GaN material systems, respectively. These are used in a wide variety of applications, from data storage to scientific research. However, a laser diode that directly emits green light at 520–530 nm, the desired wavelength for green, has not been found. Despite intensive research, the blend of elements that has the right bandgap and supports operation at the current densities required for lasing has proved elusive.

So what is the key motivation for developing a green laser diode? As Michael Lebby, president of the Optoelectronics Industry Development Association in the US, explained in our July 2007 Technology Focus[3], it offers exciting opportunities for full-colour displays and projectors that use laser diodes.

"If you have high-quality semiconductor sources of red, green and blue light and then combine that with a MEMS [microelectromechanical system] scanner, then you can make high-quality full-colour laser-based displays for mobile phones, PDAs [personal digital assistants] and televisions," Lebby explained. "You could also make bright laser-based backlights for LCDs." Coupled with other applications, the motivation is clear.

To get around the green laser diode problem, companies have instead used compact frequency-doubled green lasers, which use a nonlinear crystal to perform second-harmonic generation of a near-infrared laser diode. Indeed, green laser pointers and miniature colour laser projectors rely on this approach and commercial devices are widely available from firms such as Corning, Osram Opto Semiconductors and Oxxius.

However, this indirect approach is not ideal for several reasons. In particular, there are limitations with efficiency, cost, the ability to miniaturize and integrate the lasers, and the capacity for mass-production. In principle, a laser diode that directly generates green light and is made entirely using well-understood semiconductor fabrication techniques would be preferable.


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> Will Nichia replicate its previous success with blue GaN laser diodes when commercializing green InGaN laser diodes?

Nichia's latest demonstration suggests that the InGaN material, which was previously confined to operation in blue–green wavelengths below 500 nm, could indeed be the best candidate for a practical green laser diode. The prototype output power of 5 mW and estimated lifespan of several thousand hours are indeed promising for a commercial device. Furthermore, the laser was fabricated by metalorganic chemical vapour deposition (MOCVD), a well-known semiconductor fabrication technology. The challenge is now to shift operation to longer wavelengths of 520–530 nm, as 515 nm is still too short for the required green colour. Other desirable improvements are to increase the laser output power and to reduce its threshold voltage from the relatively high value of 5 V.

If successful, it is not unreasonable to wonder if Nichia may experience a case of déjà vu, with the Tokushima-based firm replicating the previous financial success that it achieved with its commercialization of blue GaN laser diodes in the early 1990s.

## Editorial announcements

Two-and-a-half years after the first issue of *Nature Photonics*, the journal has received its first impact factor and achieved a value of 24.98 for 2008. The impact factor is calculated annually by Thomson Reuters and reported in their ISI Journal Citation Reports every summer. The 2008 figure represents the average number of citations in 2008 for papers published in the two preceding years (2006–2007). A more detailed explanation of impact factors can be found on the ISI web site (http://isiwebofknowledge.com/products_tools/analytical/jcr/). The editorial team would like to take this opportunity to thank all those that have supported the journal since its launch, especially authors and reviewers.

The other important news that we would like to bring to the attention of authors is that *Nature Photonics*, in common with other *Nature* research journals, has now made author contribution statements compulsory for all published papers. This policy change affects all papers with a submission date of 30 April 2009 onwards. The practice of adding such author contributions — brief statements at the end of a paper that clarify the role of each author in the published findings — has previously been optional, but recommended by editors and embraced by most authors. However, in the interests of greater transparency and to help deter unethical behaviour, it has now been decided that all published papers should carry such statements. Although it would be overly optimistic to assume that this policy change alone will eliminate scientific misconduct, it should improve the accountability of co-authors and help prevent the unscrupulous behaviour of adding inappropriate authors to a paper. ❒

### References


1. Miyoshi, T. *et. al. Appl. Phys. Express* **2,** 062201 (2009).
2. Khan, A. *Nature Photon.* **3,** 432–434 (2009).
3. Graydon, O. *Nature Photon.* **1,** 379–380 (2007).