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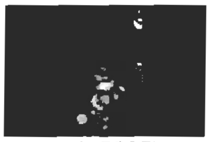
External cavity VCSEL goes visible

14 January 2005

A UK-Finland team unveils a high-power VECSEL which directly emits red wavelengths at room temperature.

Researchers in the UK and Finland have fabricated what they believe to be the first high-power vertical external cavity surface-emitting laser (VECSEL) to emit directly at visible wavelengths. (*Optics Express* **13** 77)


RedVECSEL

The VECSEL emits continuous wave and according to the authors currently produces a maximum output power of 390 mW at 674 nm with an M^2 of 1.05. However, the team believes that power scaling to in excess of 1W is possible in the near future. What's more, the device was tunable by 10 nm around 674 nm.

"There are numerous applications that would benefit from this technology," researcher Jennifer Hastie from Strathclyde University told *Optics.org*. "Photodynamic therapy for example requires high-power tunable sources at red wavelengths and the tuning range also covers a number of atomic transitions used in atom optics."

The current VECSEL structure was grown on a GaAs substrate by molecular beam epitaxy. The gain region contains 20 GaInP compressively-strained quantum wells separated by AlGaInP barrier layers. The VECSEL was then bonded to a diamond heat-spreader.

"The sample and heatspreader were clamped in a brass, water-cooled mount and optically pumped with up to 3.5 W of power at 532 nm in a 75 micron spot," explains Hastie and her colleagues from Strathclyde and the Optoelectronics Research Centre in Finland. "With the VECSEL sample mount cooled to 0°C, 390 mW was achieved with a slope efficiency of 17%."

The standard cavity contains the gain structure, a high-reflector folding mirror and a plane output coupler. To tune the output, a birefringent filter is added into the cavity and rotated to adjust the VECSEL's emission wavelength.

As well as ramping up the power of its device, the team is also looking to extend its wavelength into the 635 – 670 nm range and into the ultraviolet using frequency doubling. "To achieve shorter wavelengths, we are making changes to the

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composition and thickness of the layers in the structure," said Hastie.

She added that the overall dimensions of the system could be reduced by using multi-watt GaN diode lasers to pump the VECSEL as opposed to the large frequency-doubled $Nd:YVO_4$ system which is used currently.

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