Big impact from tiny semiconductor lasers

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(PhysOrg.com) -- A massive European effort to develop high-brightness semiconductor lasers could transform healthcare, telecoms and display applications and make Europe an undisputed leader in the field.

A massive European project to develop a complete cycle of technologies for a new generation of high-brightness semiconductor lasers promises to transform the healthcare, telecom and display technology sectors.

The semiconductor lasers developed by the Brighter project offer high power and very high efficiency in a small, relatively low-cost package, and they have direct applications in cancer treatment and imaging, high-bandwidth fibre-optic communications, laser-based projectors, heads-up-displays, and even TV screens.

This 23-partner integrated project had a €16.2m budget, with EU funding of €9.7m. It followed on and further advanced two earlier projects Ultrabright and Bright. “We did not start from zero. Many of the partners from earlier projects joined this effort to develop very high-quality semiconductor lasers for specific, real-world applications,” notes Michel Krakowski, coordinator of the Brighter project.

“There are many semiconductor lasers and many application fields, but certainly for lasers in the spectral range between 355nm up to 1060nm, Brighter has developed state-of-the-art technology and become one of the leaders in the field,” he adds.

Vast range

The Brighter project also tackled fundamental issues in science, wafer production and manufacturing, as well as education and training in laser technology, among a vast range of activities.

The range and complexity of Brighter's work is so large that it is impossible to go through each achievement individually, but some illustrations convey the breath, depth and scope of its work.

Take green lasers. No semiconductor material exists capable of emitting laser light in green, which occupies the 530nm range of the spectrum. But there are materials capable of lasing at 1060nm.

By doubling the frequency of the 1060nm laser, Brighter was able to halve its wavelength, due to the inverse relationship between the two. By this method, Brighter used frequency doubling to produce a green laser at 531nm, with output power up to more than 1.5W, which is a world record for green frequency doubled diode laser, according to the project.

While frequency doubling is a well-known technique in principle, there was nonetheless a host of practical and scientific problems to overcome, and the Brighter project met and matched them all.

Tuning options

Similarly, external cavities on a lasing semiconductor material offer a wide range of 'tuning' options. Cavities can contain a grating, which helps to stabilise the beam of a laser, and they can also be used to double the frequency of light emitted, thereby occupying another region of the spectrum.

Finally, cavities can be used to help couple together a series of lasers, combining their power to create a much brighter laser using a so-called

Talbot cavity. Coupling lasers in this manner has important applications in telecoms. Brighter developed external cavities, and the required expertise to manufacture them for a wide range of lasers, greatly enhancing the flexibility of the lasers in the process.

To a lasing expert, these well-known principles may seem ho-hum. They have been around for a long time. But the range of applications these lasers can be used for - and the degree to which Brighter pushed the current state of the art - is a truly impressive testament to their research effort.

Practical impact

In practical terms, the project has dramatically improved the quality, efficiency, brightness and power of semiconductor lasers across a range of spectra and, in the process, it has racked up a remarkable number of world firsts.

“We have a red laser bar at 635nm with an output of 4.5W, which is state of the art. With the red tapered laser at 650nm, Brighter has achieved an output power up to 1W with a good beam quality. The M2 [a measure of beam quality] is 1.3 for this laser, close to a perfect beam,” explains Krakowski.

Wall plug efficiency, or the amount of current required to achieve a certain output of power, is a particular strength of the Brighter project. For their infrared laser at 980nm, Brighter achieved an efficiency of 70%, which is again state of the art.

The list of successes goes on: first to develop a green laser of this quality; first to develop infrared lasers of high brightness; first to achieve high modulation. Here, Brighter achieved a world record, controlling the output of a 1.7W laser using only an 80mA modulation current. “That is

20W per amp - a huge number - as well as a world record," reveals Krakowski.

The upshot of all this work and all these results is that Europe now has an enormously strong standing worldwide in the development and fabrication of lasers in these spectra. This opens up the prospect of valuable, high-impact applications in healthcare, telecoms and entertainment.

Even more important, Europe also now has the expertise to realise these applications in the short to medium term.

The Brighter integrated project has received funding from the ICT strand of the EU's Sixth Framework Programme for research.

This is the first of a two-part special feature on Brighter.

Provided by [ICT Results]

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