New VECSEL could mean a step forward for spectroscopy

October 25 2010, By Miranda Marquit

(PhysOrg.com) -- "Unfortunately, for spectroscopy, the beam quality of quantum cascade lasers is not satisfying," Hans Zogg tells *PhysOrg.com*. "We are developing lasers for the mid-infrared range which have an especially good beam quality and the necessary features for absorption spectroscopy."

Hans Zogg, head of the Thin Film Physics Group at ETH Zurich in Zurich, Switzerland, worked with A. Khair, M. Rahim, M. Fill, F. Felder and F. Hobrecker to realize the first monomode, continuously tunable mid-infrared VECSEL. Their work is presented in Applied Physics Letters: “Continuously tunable monomode mid-infrared vertical external cavity surface emitting laser on Si.”

“Vertical external cavity surface emitting lasers, or VECSELs, are presently realized for wavelengths up to about 2.5 micrometers,” Zogg explains. “They have a number of properties considered attractive.” However, in many cases, it is necessary to build lasers emitting at still longer wavelengths. Zogg and his colleagues have created a VECSEL that operates around 5 micrometer wavelength and, in addition, has a large continuous mode-hop free tuning range, simplifying systems, and creating a laser useful in the field of spectroscopy.

Not only is the laser design presented by the Thin Film Physics Group continuously tunable, but it also has good beam quality. “Our VECSEL offer very good beam quality, much better than conventional lasers, which are edge emitters,” Zogg says. He points out that the laser setup in question is quite small, making it practical for a variety of spectroscopic applications. “You don’t need a lot of new equipment to do this, and the laser is small and cost effective.”

In order to create these VECSELs, Zogg and his colleagues begin with a silicon wafer as a substrate. The wafer is overgrown with a buffer layer, followed by a Bragg mirror. This mirror consists of four pairs of alternating layers of high refractive material and low refractive material. It is then overgrown with an active layer with a very small thickness below one micrometer. “We use very special lead chaclcogenides in our design,” Zogg says. “Many people have stopped using these materials, but they are actually quite good for this application.”

“Our laser has a short cavity, making it so only one mode is allowed. When it comes out, there is only one wavelength,” Zogg continues. “However, you can change the cavity length a little, which leads to a change in wavelength. This is the continuous tuning we mention in the paper.” Right now, the laser operates at low temperatures, but Zogg says that that they already have lasers that operate at room temperature. “This would be helpful in the development of uses for our VECSEL.”

The next step, Zogg explains, is to use less pump power while getting more output power. “This will – finally – lead to less input power demand and higher operation temperatures. The VECSELs are suited for all wavelengths between about 2.5 and 15 micrometers.”

Zogg says that his fellow researchers in the Group are founding a startup company to sell laser modules based on the technology. “There really is a market for our technology. It’s a scalable idea, and once we have transferred the know-how, such modules could be of use to a much wider audience.”

More information: A. Khiar, M. Rahim, M. Fill, F. Felder, F.

Hobrecker, and H. Zogg, “Continuously tunable monomode mid-infrared vertical external cavity surface emitting laser on Si,” *Applied Physics Letters* (2010). Available online: link.aip.org/link/APPLAB/v97/i15/p151104/s1