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NEWS

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II-VI on InP has cascade laser potential

In early-stage research, a US team demonstrates electroluminescence from a novel II-VI-on-InP system, suggesting that a new type of laser based on the unusual combination of materials might be possible.

A new type of quantum cascade laser could be on the cards after a university research team showed electroluminescence from layers of II-VI material deposited onto an InP substrate.

Using MBE as their deposition method, Claire Gmachl and co-workers at Princeton University and The City College of New York (CCNY) reported in their recent *Applied Physics Letters* paper (see restricted link) that the ZnCdSe/ZnCdMgSe structures formed could be designed to lase at wavelengths as short as 1.5 µm.

Although quantum cascade lasers (QCLs) can now be purchased commercially, it is very difficult to make these structures emit at wavelengths shorter than 4 µm - the current best is 2.75 µm with antimonide-based structures.

If Gmachl's team can produce a QCL that operates in the near-infrared region, it ought to greatly increase the number of applications open to such devices.

To fabricate the novel QC emitters, the Princeton team worked with II-VI epitaxy specialist Maria Tamargo at CCNY. According to Kale Franz, part of the research team at Princeton, Tamargo's group "does some of the best II-VI MBE growth in the world".

Starting with a low-doped InP substrate, Tamargo and colleagues deposited a 0.25 µm-thick $In_{0.53}Ga_{0.47}As$ buffer layer, and followed this with a zinc flux treatment to prepare for II-VI epitaxy.

"Both the ZnCdSe and ZnCdMgSe compositions used in this work have the same lattice constant as InP, so in that respect the buffer layer isn't as critical as growing on silicon," Franz explained. "However, one key to starting the II-VI growth on InP is the zinc flux treatment, and this is a critical step."

After the zinc flux step, the team grew ten periods of active regions, including ZnCdSe wells and ZnCdMgSe barrier layers. Using lithography and a wet chemical etch to define the electroluminescent structures, they then deposited gold contacts and cleaved the mesas to form semi-circular emitters.

The end result was a conventional two-well active region QC structure that showed an emission centered at 4.8 µm when driven electrically - very close to the "design" wavelength of 4.4 µm, and indicative of a red-shift that is also seen in III-V QCLs. Encouragingly, for such early-stage work, this emission could be measured from 78 K all the way up to room temperature.

Future development towards a laser is already in progress, with the team currently working on its second-generation designs.

"A II-VI quantum cascade laser would be a technological accomplishment on its own, as it would be the first such non-III-V device," Franz said. "It would make concrete the idea that the quantum cascade is a (synthetic) material class in, and of, itself, with properties completely decoupled from the constituent materials used to fabricate the structure."

And, even though a lot more work will be required before the team can build a useful laser, the Princeton team has shown that making such a device ought to be possible.

Demonstrating that these electroluminescent II-VI structures can be fabricated on InP substrates could also turn out to be an important step, and the Tamargo team is sure to have learned a lot about II-VI epitaxy into the bargain.