Light-generating transistors to power labs on chips

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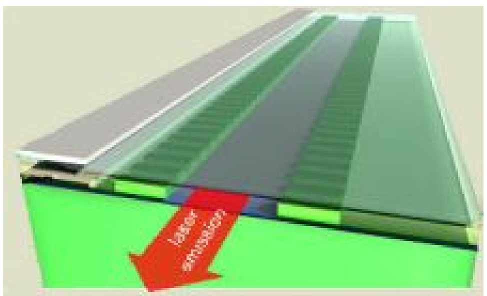

(PhysOrg.com) -- What started out as 'blue-sky' thinking by a group of European researchers could ultimately lead to the commercial mass production of a new generation of optoelectronic components for devices ranging from mobile laboratories to mobile phones.

Allowing doctors to field-test patients and, thanks to a highly portable laboratory, come up with quick results leading to an immediate diagnosis is one of the medical community’s most sought-after goals.

Projects have been launched all over the world to explore possible ways of doing this, with new methods of miniaturising components very much a key part of developing what is increasingly being called a “lab-on-a-chip”.

The chip in question is a silicon chip, the ubiquitous semiconductor which powers all things electronic. Chips come with thousands, even millions, of tiny electronics devices, such as transistors, embedded in them. While there are limits to how much smaller they can be made, keeping chips the same size but giving them extra functions produces a similar end result.

More efficient light generation

Against this background, two European funded research projects, ILO and OLAS, were set up to explore and identify more efficient ways to generate light from organic thin films. These are organic because they are carbon-based plastics, and the material is processed into a very thin film of a micron or less which is deposited onto a surface, or substrate - in this case a silicon wafer.

The ultimate goal of the projects was seen as developing an electrically powered laser from organic thin films, but it started with the researchers, from five European countries, looking at the most efficient ways of extracting light from an organic thin film.

“The advantage of working with thin films is quite clear in terms of the small amount of material required for a functional device,” says Michele Muccini from CNR, Italy and project coordinator of both ILO and OLAS. What the researchers did was to integrate the project partners’ experience with, and knowledge of, a number of technologies to create not just a functional transistor, but a truly multifunctional transistor.

Specific and unique knowhow

“Not only did we create a fully functional electronic device in the form of a field-effect transistor, but we were also able to get it to generate light," Muccini explains. While this was not the same as generating a focused laser beam, it was still a major breakthrough and something that had not been achieved elsewhere.

"We developed specific and unique knowhow giving us a key competitive advantage over international competitors," notes Muccini. OLAS' results are seen as an international benchmark for what Muccini describes as the "photonic field-effect heterojunction approach".

Field effect here relates to controlling an electrical charge in a semiconductor while a heterojunction is the interface between two layers of different semiconducting materials. "We demonstrated the first fully integrated fabrication of a heterojunction device where you had a field-effect structure with a photonic cavity embedded," he reveals.

So groundbreaking was some of the consortium's research that three new patents were taken out to prepare the way for possible commercialisation of the results.

"Using transistors instead of external sources allows you to greatly increase the efficiency of light generation and extraction. You expend much less energy driving devices because they are not only efficient but made from disposable organic material which is compatible with other platforms made from other material like silicon or glass," says Muccini.

Implications for medical diagnosis

Although the EU-supported part of the project officially finished at the end of 2008, several partners chose to continue developing on the results independently.

"We are proposing work to integrate our new structure into lab-on-a-chip devices for biomedical diagnostic purposes," he says. "What this would eventually mean to a doctor on the ground is the development of an affordable, portable, disposable device able to screen for a number of illnesses.

At the moment, the only equipment able to screen in this way is bulky and expensive and samples have to be sent to a lab before results can be reported back to a doctor, he suggests. But once mass production is feasible, the proposed new lab-on-chip would mean doctors get a lot of information in a readily available format, enabling early diagnosis and faster treatment.

Muccini points out that the potential applications are much broader than this; they stretch to any device, such as mobile phones and laptop PCs, where using less energy to generate light would increase battery life. The devices would also be cheaper to build.

But a lot more development work would be necessary to fully validate the results - the sort of work envisaged in the proposed follow-up. Still, OLAS has opened the door a little way and proved it is worth continuing down this track, Muccini concludes.

More information: OLAS project

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