Press Release

Long-Wavelength VCSELs: a Green Solution To High-Speed Communication

GRENOBLE, France – Feb. 10, 2010 – Long-wavelength VCSELs (Vertical-Cavity Surface-Emitting Lasers) for the next generation of high-speed communication systems have been developed in the European project MOSEL, a three-year joint research program lead by CEA-Leti.

The research on long-wavelength VCSELs is aimed at finding an efficient and reliable technological answer to the ever-growing demands for bandwidth in telecommunication networks. Moreover, VCSEL technology offers low power consumption (from five to 10 times less than the conventional edge-emitting lasers) and can be manufactured in volume at low cost.

During the three years of the project, the six partners have worked together to push long-wavelength VCSEL technology from lab to industry. The MOSEL project was lead by CEA-Leti (France) and included three academic partners: DTU Fotonik (Denmark), EPFL (Switzerland), and KTH (Sweden), and two industrial partners: Alight Technologies (Denmark) and BeamExpress (Switzerland).

The project demonstrated error-free 10GBASE-LR operation up to 100 °C, concurrently with record performance: single-mode (>30dB SMSR) power of >1mW up to 100°C (>2mW at room temperature) and 10Gbps modulation and transmission over 10-km single mode fiber with BER $<10^{-11}$ up to 100°C with <1-dB power penalty.

These performances allow industrial partners to address different previously established standards and pursue commercialization of the results. At the same time, the academic partners have demonstrated different proofs of innovative concepts, preparing the basis for the next device generation.

The ever-growing demands for bandwidth in telecommunication networks, mainly caused by the unprecedented growth in data traffic in local and access networks, necessitate the development of new, low-cost, high-speed optical links in the 1–100 Gbps range. In contrast to the earlier evolution of optical fiber networks, the needs for high-bandwidth transmission have shifted from the high-capacity links (such as intercontinental and intercity) towards the network environment of the end users. This development puts the emphasis on low-cost, intelligent and scalable networks that can be deployed throughout the entire network hierarchy, ranging from metropolitan and local area networks (LANs) to access networks such as fiber-to-the-home (FTTH) and passive optical networks (PONs).

Due to their intrinsic performances (power consumption, beam quality) and low cost potential (mass production already proven in the case of optical mice), long-wavelength VCSELs provide a technological solution to an economical problem. Indeed, employing novel concepts for mode control and current injection has enabled the consortium to demonstrate device performances similar to or, in some cases, surpassing those of conventional edge-emitting lasers.

The commitment of the MOSEL partners

DTU Fotonik

DTU Fotonik, previously COM, carried out extensive numerical investigation of VCSELs with nano- and micro-structures, aiming at high single-mode output power. By deeply understanding the single-mode mechanisms, it was found that nano- and micro- structures can feasibly suppress higher order modes or shape the optical mode profile to match well with a gain profile, promising three times enhanced strength of single-mode operation. Especially, a hybrid VCSEL structure incorporating III-V gain region and a silicon photonic crystal mirror was suggested for silicon photonics applications, which is expected to have better laser performance than existing technologies and require loose alignment precision.

Alight Technologies

Alight Technologies wants to supply long-wavelength VCSELs for tele- and data-communication applications. As a part of the Mosel project Alight has refined its photonic crystal structuring of its long-wavelength GaInNAs/GaAs VCSELs. The photonic crystal structuring is used to ensure stable single-mode operation of the VCSELs over the entire operation range. Alight has furthermore worked on extending the high-speed operation of its long-wavelength VCSELs and has recently demonstrated error-free 10GBASE-LR operation up to 100 °C. Alight is now pursuing commercialization of these results and expects to start limited sampling of devices in Q4 of 2009.

EPFL and BeamExpress

EPFL and BeamExpress worked closely together to improve the performance of 1310nm-waveband VCSELs and reach the commercialization stage based on their proprietary InP-GaAs wafer-fusion technology. The devices are fabricated using 2” wafer technology, incorporate patterned tunnel junctions and other intra-cavity structuring elements for efficient carrier and photon confinements, and show record performance: single-mode (>30dB SMSR) power of >1mW up to 100°C (>2mW at room temperature) and 10Gbps modulation and transmission over 10-km single- mode fiber with BER $<10^{-11}$ up to 100°C with <1-dB power penalty. The wafer-fusion technology is employed for producing VCSELs with similarly high performance in the entire 1,200-1,600nm wavelength range. Combining this with its precise (few nm) wavelength-setting capabilities makes them applicable in multiple-wavelength CWDM arrays for increasing the transmission bandwidth and providing bandwidth-on-demand. BeamExpress is pursuing the commercialization of such long-wavelength VCSELs working with a manufacturing partner in Europe, and first samples were available in Q4 2009.

KTH

KTH has employed a novel re-growth technology with mode-selective elements for high-power single-mode emission. The main attractiveness of this technology is its simplicity as it is based entirely on standard materials and processing methods, in principal allowing for direct implementation in a standard processing line for short-wavelength VCSELs. It thereby demonstrates a significant potential for improved efficiency, manufacturability and reliability as compared to other long-wavelength VCSEL concepts.

CEA-Leti

CEA-Leti has focused its attention on the development of a new VCSEL design using a recently suggested high-reflectivity-mirror concept based on sub-wavelength grating mirrors. The first results show sub-milliamp threshold current, a linearly polarized emission as well as single-mode maximum output power at 980nm of more than 4 mW (1mw) at room temperature (70°C). A high-index contrast between the photonic crystal membrane and the underlying material is obtained by selective oxidation of a high aluminium-content layer instead of using fragile air gap geometry as is suggested in the literature. These results build a bridge between a standard VCSEL and a hybrid laser, making them of potential use for the realization of silicon photonics.

About CEA Leti

CEA is a French technological research public organisation, with activities in three main areas: low carbon energies, technologies for information and healthcare, and defence and security. Leti, a CEA laboratory located in Grenoble, is one of the main European applied research centers in electronics. More than 85% of its activity is devoted to industrial research with 350 contracts a year. Since its creation in 1967, Leti has led to the creation of more than 30 start-ups in high-technology. The main areas of activity are micro- and nano-technologies for microelectronics (more Moore, More than Moore and Beyond CMOS), technologies, design and integration of microsystems, photonics and imaging technologies, micro- and nano-technologies for biology and health, communication technologies and nomadic objects. Leti operates with an annual budget of 200 M€ and employs 1,000 people with, in addition, more than 600 external collaborators (postgraduates, research and corporate partners). Leti has 8,000m² of clean rooms, an equipment portfolio worth 200 M€ and invests more than 40 M€ a year on new equipment. Leti has a dynamic Intellectual Property policy and has filed more than 250 new patent applications in 2008. For more information, visit www.leti.fr

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