NEC's New Vertical-Cavity Surface-Emitting Laser: Significant Step Toward Ultra-High-Speed Optical Interconnection

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NEC Corporation today announced the successful development of a vertical-cavity surface-emitting laser (VCSEL) that boasts the world's fastest 25 gigabit per second (Gbps) per channel operation speed. It subsequently achieves ultra-high-speed optical interconnection among LSI chips/boards, representing a major step toward the realization of next-generation supercomputing systems.

NEC joined "Optical Interconnection Research for Ultra-Fast Computers" in April, 2005. This research is part of the "Elementary-Technology Research for Future Supercomputers" project, which is being supported by the Japanese Ministry of Education, Culture, Sports, Science and Technology. The realization of a high-speed and highly reliable VCSEL has been long sought after in the race to develop next-generation supercomputing systems.

A transmission speed of over 20 Gbps will be required for optical interconnection among LSI chips in supercomputers in 2010. The newly developed VCSEL has great potential in the field of optical interconnection because it can double conventional transmission speeds. In particular, this device is essential to the enhancement of data transmission speeds between CPUs and memories, which is currently the bottleneck hindering the calculation speed of next-generation supercomputing systems. This development is expected to contribute to the rapid progress of the performance of next-generation

supercomputing systems.

The features of the newly developed high-speed VCSEL are as follows:

(1) High-speed operation is achieved by adopting optimal material and a structure with light-emitting layers to improve the efficiency of electro-optics transition and reducing resistance and capacitance through the introduction of a new design and process.
(2) Enhanced reliability of the VCSEL will be realized through the utilization of material that prevents crystal degradation.

The largest issue in current supercomputer performance is the data-transmission speed among LSI chips or boards in comparison to the data processing speed in LSI chips. Replacing the electrical signals with optical signals is a logical move as optical interconnection enables high-speed operation and high-density mounting. Among semiconductor lasers, VCSEL is advantageous since it can operate at low power and carry out high-density integration. Therefore, the features of the newly developed VCSEL are very beneficial to next-generation supercomputing systems, in which high-density optical interconnection will be carried out between CPUs and memories.

On the other hand, 850-nm-range VCSELs have become popular in short-range optical communications such as the Ethernet. The main transmission speed is less than 2.5 Gbps, but 10 Gbps transmission is also commercially available. However, there are several issues with current 850-nm-range VCSELs, including operation speed limitations of 10 Gbps due to overheating caused by an increase in current density for faster operation, or decreased reliability due to defects in the crystal.

By employing original materials and an improved structure, NEC's newly developed VCSEL realizes highly efficient electro-optic transition and high-speed operation over 20 Gbps. In the future, the use of optical

interconnection is expected to spread not only to servers and PCs, but also to intelligent home networks, portable terminals, and to the automotive and medical fields owing to its many merits including high-speed and low-noise operation. This research breakthrough will significantly contribute to expansion in this field.

The features of the developed VCSEL are as follows:

Wavelength/Material: 1070 nm / InGaAs (Conventional: 850 nm / AlGaAs)
Modulation Speed: 25 Gbps(Conventional: up to 10 Gbps)
Threshold Currents: 0.33 mA @ 25 degrees Celsius, 0.58 mA @ 85 degrees Celsius
Operation Currents: 7 mA @ 25 Gbps operation

The results of this research will be presented at the Optical Fiber Communication Conference & Exposition 2006, being held in Anaheim, California, U.S.A. from March 7 to 10, 2006.

Notes:
VCSEL: A vertical-cavity surface-emitting laser (VCSEL) emits its coherent light perpendicular to the substrate. VCSEL has several advantages over conventional edge-emitting laser diodes. VCSEL is smaller, consumes less power and operates faster. Furthermore, there are great expectations for VCSEL as a light source to enable mass production and high-density 2D array.

Source: NEC

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