Hitachi, Ltd.
Opnext Japan, Inc.

Low-power-consumption semiconductor laser diode
for 10 Gbps metropolitan area optical transmission
40 km un-cooled fiber transmission achieved within 0℃ - 85℃ range

Tokyo, 14th July 2005 - Hitachi, Ltd. (NYSE: HIT / TSE: 6501) and Opnext Japan, Inc. (CEO: Mr. Kei OKI), have succeeded in the development of a new semiconductor laser diode for use as a light source in 10 gigabit-per-second (Gbps) wide-area and metropolitan-area networks. The new laser diode monolithically integrates a distributed feedback laser and an electro-absorption optical modulator which produces optical signals, on a device measuring 0.8 mm x 0.3 mm, and can be operated in a wide temperature range from 0℃ to 85℃ without temperature control. A new aluminum-based temperature tolerant semiconductor material (InGaAlAs: indium-gallium-aluminum-arsenide) was adapted for the optical modulator, and a new multi-step monolithic integration technique was developed to minimize the optical loss between the laser light source and the optical modulator. Both 40-km normal fiber transmission and 10 Gbps high-speed operation were achieved within a wide operating temperature range of 0℃ to 85℃ without temperature control. This result will expand the application of low-power-consumption optical transceivers, until now used only in limited distances, to wide-area and metropolitan-area networks.

The proliferation of high-speed Internet access services in recent years has brought on a qualitative change in social systems and lifestyles. To ensure the evolvement of a convenient/comfortable/accessible IT society, the development of communication equipment for a high-speed large-capacity optical fiber network is required. To increase the functionality of optical communication equipment, it is necessary not only to improve the performance of individual optical components, but also to increase the number of mounted components. The number of components which can be installed in the equipment, however, is limited by component size and power requirements thus the development of compact and low-power-consumption components is imperative. With conventional laser light sources used in mid- to long-distance transmission, the optical modulator, which generates the ultra-high-speed optical signals, needs to be maintained below a set temperature for stable operation and thus requires a temperature control unit - an obstacle to decreasing size and power consumption. Thus there was a need for the development of a laser light source which did not require temperature control, and could operate stably within a wide temperature range for mid- to long-distance transmission.

In response to this need, Hitachi and Opnext Japan developed a 10 Gbps semiconductor laser

diode capable of stable operation within a wide temperature range for 40 km non-relay optical transmission.

(1) A 10 Gbps optical modulator operational under a wide temperature range

The new aluminum-based semiconductor material, InGaAlAs, was used to double the temperature range for the electric field under which the optical modulator can be stably operated. As a result, the adjustment margin for the bias voltage was expanded in the optical modulator, enabling stable modulation at 10Gbps within a wide temperature range of 0℃ to 85℃. Also, as wavelength fluctuation was also suppressed at the same time, the transmission distance of 40 km, limited by the dispersion characteristics of optical fibers, was achieved.

(2) Process technology suitable for monolithic integration of Al-based materials

New process technology to monolithically integrate a high-performance optical device containing the chemically reactive aluminum, was developed: precision processing of the InGaAlAs material at a nanometer level, and an anti-oxidation process to maintain a clean crystal surface while fabricating the laser structure.

Using the semiconductor laser diode developed, 10 Gbps transmissions were conducted for a wide temperature range of 0℃ to 85℃, and high-quality signal transmission over 40 km was confirmed. This is the first time that high-quality signal transmission over 20 km, without temperature control, has been achieved. The dimensions of the laser diode developed are 0.8 mm (l) by 0.3 mm (w), and can be incorporated into the compact package currently being proposed as an industry standard for the 10 Gbps optical transceiver module. Thus, future application as a communication interface module in PCs, servers and routers which also increase in temperature, can be envisaged. The next step will be to develop peripheral technology for its practical application, as well as to uptake the developmental challenge of 80 km transmission, 40 Gbps transmission speed, and increase its application range.

These results were presented at the Pacific Rim Conference on Lasers and Electro-Optics 2005 (CLEO-PR 2005), held in Tokyo, Japan, from 11th – 15th July 2005.

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