(Press Release)

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Nippon Telegraph & Telephone Corporation
NTT Electronics Corporation

NTT introduces a high-output, high-bandwidth super luminescent diode light source ideal for in-vivo optical coherence tomography

On September 13, as a result of advances made by Nippon Telegraph & Telephone Corporation (NTT; Head office: Chiyoda-ku, Tokyo; President: Norio Wada) and NTT Electronics Corporation (NEL; Head office: Dogenzaka, Shibuya-ku, Tokyo; President: Tomoyuki Toshima) in the development of light sources suitable for in-vivo optical coherence tomography,*1 NEL will commence sales of a high-output, high-bandwidth super luminescent diode (SLD*2) light source.

The commercialization of this technology with NEL was brought about based on NTT's policy of "Comprehensive Commercialization Functions"*3 which has been in effect since July 2003, and was achieved by drawing on the techniques cultivated at NTT Photonics Laboratories for the design and fabrication of communication light sources.

Further details about this product will be introduced at ECOC2004 (European Conference on Optical Communication),*4 which will be held in Stockholm, Sweden from September 5.

1 Background to the development

SLD light sources with a wide optical bandwidth are being applied not only to telecommunications equipment but also to an ever-expanding range of fields including industry and medicine. In particular, they have recently been finding applications in the field of optical coherence tomography (OCT). OCT is a non-invasive in-vivo tomography technique that is already being put to practical use in retinal examination equipment with an 810 nm SLD, but there is still a demand for improvements to the capabilities of this technique, such as integrating it with endoscopes. This would make it possible not only to observe the outer layers of internal organs but also to gain information about their inner structures, which would be helpful in the early detection and treatment of cancer. These applications require an SLD emitting longer wavelength light than conventional ones. It is no exaggeration to say that the performance of OCT equipment is determined by the performance of its light source, and it has thus become important to develop an optimal SLD light source for OCT equipment with a wider optical bandwidth and a greater light output between which exists the trade off. NTT and NEL have already built up advanced design and fabrication techniques in their efforts to improve the performance of semiconductor laser light sources for optical communications in order to meet the demand for optical communication systems with greater capacity. These techniques realize an SLD light source with a large optical bandwidth and a great light output at the same time.

2 Advantages of the product

This product (see Fig. 1, attached) is mounted in a 14-pin butterfly package,*5 which is

the most widely used package type for optical communication light sources. The package also incorporates temperature monitor and control functions, allowing a steady light output to be obtained in a wide range of environments. It can also be customized to specific user applications, which we are willing to discuss.

The advantages of this product are as follows (see Table 1, attached):

(1) Emission wavelength
The central emission wavelength of this product is in the 1310 nm infrared region. It is a wavelength region in which water and hemoglobin (the constituents of living tissue that exhibit the greatest light absorption) both exhibit minimal absorption and in which the light is less susceptible to scattering, and thus living tissue exhibits the greatest transparency at this wavelength. Consequently, the light produced by this product can penetrate deep into the body from the surface of the skin, allowing deep tomography data to be obtained.

(2) Large light output
This product can achieve a spatial output of at least 50 mW and a single-mode fiber-coupled output of at least 30 mW, thereby dispelling the conventional view that SLD light sources have low optical output. For in-vivo optical coherence tomographic imaging, the information-bearing signals obtained from the subject tend to be weak and obscured by noise. Accordingly, there has been a growing need for a high output light source that can be used to obtain highly precise data signals from living subjects. Usually, as the output of the SLD devices increases, the light radiated outwards from the end surfaces is reflected back into the SLD device at these end surfaces. These ripples lead to ghosting and reduced contrast in the tomography images produced by OCT equipment, which has been a major problem. In this product, we have been able to resolve these reflection problems by employing an end surface structure made specifically to prevent reflections.

(3) Broad bandwidth
Due to the trade-off that exists between bandwidth and optical output, there have hitherto been no SLD light sources that combine a large optical output with a wide bandwidth. In this product, by optimizing the active layer structure of the SLD device, which is the core region where light emission takes place, we have managed to achieve a large bandwidth of at least 50 nm even when operating with a large spatial output power of 50 mW or more. The bandwidth of light emitted from the light source has a large effect on the resolution of tomography images produced by OCT equipment.*6 A broader bandwidth increases the resolution, resulting in images with greater detail and allowing finer tissue structures to be observed.

(4) Low power consumption
Compared with a conventional SLD light source, this product can produce a large output with lower power consumption. This is achieved by employing advanced modularization techniques that facilitate efficient coupling to optical fibers, and advanced device design and fabrication techniques that have been cultivated by NTT and NEL. Reducing the power consumption of the SLD light source leads to OCT equipment with lower power consumption, which helps make the equipment less expensive and more compact.

3 Principal applications
This product is expected to be of use in the following applications:
(1) OCT
(2) Sensing systems*7

(3) Evaluation and measurement of optical components such as OTDRs*8

4 Selling price, etc.
Selling price:Open pricing

5 Future prospects
We are hoping to respond to the diverse needs of our customers by making further improvements to the efficiency and performance of this product, and by supplementing our line-up with a series of products that operate in other wavelength regions such as 1700 nm and 1550 nm. We also plan to create and develop new markets in this business region by following our policy of “Comprehensive Commercialization Functions”.

• Glossary
*1 Optical coherence tomography (OCT)
A tomographic imaging technique that uses the interference of light waves. It has already been put to practical use in retinal examination equipment, and concerted efforts are being made to develop OCT equipment for skin examinations and endoscopy. The main tomographic equipment currently used in medical fields are X-ray CT (computer tomography) and MRI (magnetic resonance imaging).
*2 Super luminescent diode (SLD)
A device that has the benefits of both a light-emitting diode (LED) and a laser diode (LD). This light source is less coherent*9 than a laser diode, rendering it safer when exposed to human eyes and allowing data to be transmitted at higher speed.
*3 Comprehensive commercialization functions
A policy whereby designated producers are made responsible for commercializing the products of research carried out at NTT's laboratories while cooperating with other businesses both within and outside of the NTT group. It is hoped that this policy, which has been in effect since July 2003, will continue to promote the widespread commercialization of various R&D achievements in the future.
*4 European Conference on Optical Communication (ECOC)
ECOC is the largest conference on optical communication in Europe, which is held once a year. A large exhibition is run in parallel to ECOC, covering a wide range of products and services in the field of optical communication. Participants and corporations from all over the world attend ECOC. ECOC2004 will be held in Stockholm, Sweden from September 5 to September 9.
*5 14-pin butterfly package
A 14-pin butterfly package is the most widely used package type for optical communication light sources. The package has 7 pins spreading from each side and seems like a butterfly.
*6 The resolution of optical coherence tomography (OCT)
The depth resolution of OCT is proportional to the square of the wavelength used (central light-emitting wavelength), and inversely proportional to the width of the wavelength region. Light with lower coherence occupies a broader wavelength region, and thus increases the resolution.
*7 Sensing systems
Molecule or gas has the light absorption at a special wavelength. The broadband spectrum of an SLD light source changes due to the absorption. Sensing systems measure concentration of the molecule or gas from the change of the spectrum.
*8 Optical time domain reflectometer (OTDR)
When optical losses occur due to a fault in an optical component, this equipment can be used to identify the location of the fault. Since it involves the use of low coherence

light interference, it is preferable to use a light source with a broad wavelength region.

*9 Coherence

When used in connection with wavelike signals such as light sources, coherence is a measure of how well the waves are lined up in step with each other. The greater the coherence of a light source, the more likely it is to undergo interference, whereby waves that have traveled along different paths either add together or cancel each other out. Light produced by lasers, in which the waves all have the same phase and amplitude, is said to be “coherent”.

- Attachments

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