First Demonstration of New Widegap Semiconductor Gallium Oxide Transistors

—A New Candidate for Next-generation High-Performance Power Devices—

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After completing graduate school and Postdoctoral Research as a Fellow of the Japan Society for the Promotion of Science, Higashiwaki entered the Ministry of Posts and Telecommunications, Radio Research Laboratory (currently NICT) in 2000. There, he engaged in research related to areas such as semiconductor crystal growth, device processing, and characterization. He currently holds posts as a JST PRESTO researcher and Kogakuin University part-time lecturer. Ph.D.(Engineering).

Background

Currently, along with the creation of new energy alternatives to fossil fuel, the development of innovative power-saving technology is being pursued as a global issue. In addition, partly due to the effects of the 2011 Great East Japan Earthquake, people in our country are more than ever strongly appealing for cooperation to reduce power demand. In fact, including electrical energy transformation, the electricity transmission and distribution loss rate in Japan now at 5.5% is very substantial. From this state of society, the widegap semiconductor materials[*4] silicon carbide (SiC)[*2] and gallium nitride (GaN)[*3] that promise superior device characteristics such as higher breakdown voltage and lower loss[*1] than even the current silicon (Si) are garnering attention and being actively researched and developed, not only in Japan but also in USA and Europe. From gallium oxide's (Ga_2O_3) [*5] properties represented by a larger bandgap[*6] compared to those of SiC and GaN, when applied to power devices, superior device characteristics with higher voltage and lower loss can be expected. Also, as single-crystal substrates are capable of being made based on simple melt growth methods[*7], enlarging substrate size and reducing production costs are possible. As a result, mainly in industry where goods can be produced with low cost, this is a favorable characteristic (Figure 1). However, despite high material potential, the reality worldwide up to now was largely untouched research and development. At the end of 2010, we began researching and developing Ga_2O_3 power devices, and in the short period up to now developed various elemental technologies, resulting in the most notable accomplishment—the world's first experimental proof of its transistor operations.
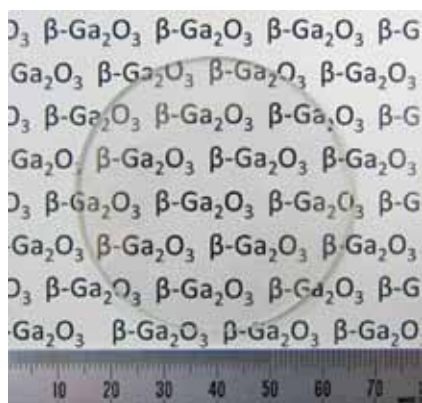

Figure1 ●Single-crystal Ga2O3 substrate with a 2-inch diameter manufactured with the melt growth method

The world's first Ga2O3 transistor, operation demonstration

This time, applying Ga_2O_3 single-crystal substrate fabrication, thin-film crystal growth, and device processing technology—all developed in collaboration with TAMURA Corporation and KOHA Co., Ltd.—we fabricated a field effect transistor[*8] and became the first in the world to successfully demonstrate its operations. The prototype transistor we made is a structure called MESFET[*9]. This is structurally the simplest out of many types of transistors in existence and was the most suitable for the prototype's main objective this time, which was to demonstrate operation. In producing this prototype, single-crystal substrate manufacturing and thin-film crystal growth were done at TAMURA and KOHA, and the later device processing and characterization at NICT. Figures 2(a) and (b) are a cross-sectional schematic illustration of the MESFET structure we fabricated and its optical micrograph, respectively. For the sake of process simplification, we adopted a circular FET pattern.

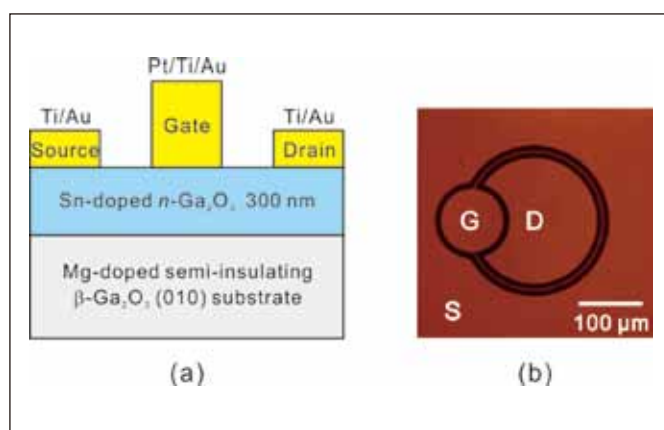Figure 2●Ga2O3 MESFET's (a) cross-sectional schematic illustration of device structure (b) optical micrograph

Figure 3 shows the current-voltage output characteristics of the Ga_2O_3 MESFET. The maximum drain current was 16 mA at a gate voltage of +2 V. As a high-voltage power device, the three-terminal off-state breakdown drain voltage, an important function equivalent to the highest applicable drain voltage in a state with
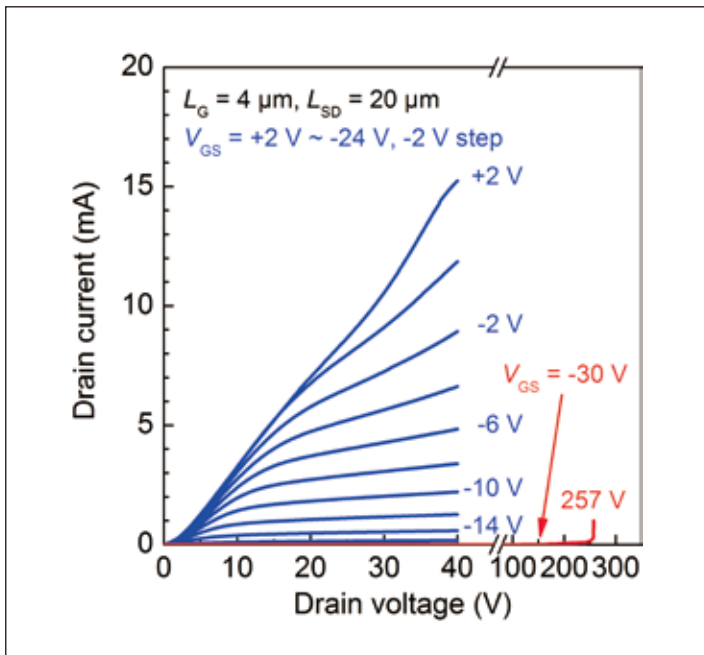
Figure 3●Ga₂O₃ MESFET current-voltage output characteristics

drain current turned off by applying a gate voltage (in the device made this time, when -30 V was applied), yielded an extremely large value at approximately 250 V. Furthermore, the drain leakage current in a pinch-off state was extremely small at 3 μA, and as a result, the drain current on/off ratio yielded a large value of approximately 10,000. Despite being an extremely simple transistor structure for the early stage of our research and development, these device characteristics are numerically excellent. The favorable device characteristics yielded this time can be primarily attributed to (1) the high material potential of Ga₂O₃ as a semiconductor, and (2) the use of the high-quality homoepitaxial thin-film on the single-crystal substrate.

Future Prospects

Based on our success this time developing transistors and diodes that use new widegap semiconductor material, Ga₂O₃, we believe we have opened the possibility for the next generation of high-performance power devices. With Ga₂O₃ power devices, we can expect direct contributions towards global energy conservation issues as well as economic merits with the creation of a new transistor industry originating in Japan. In the near future, we can expect its applications in an extremely broad range of areas, including high-voltage electricity transmission and railways, mid-voltage electricity and hybrid automobiles, and low-voltage appliances such as air conditioners and refrigerators, producing a large-scale market over hundreds of billions of yen a year. In order to accelerate research and development focused on practical use, we will continue proactively pursuing outside partnerships and tackling the goal of manufacturing Ga₂O₃ power devices within the next 10 years.

Glossary

*1 Power Device
Power device is a general term of semiconductor devices for use in electrical devices to control power. The structure is an electronic component optimized for power control, central to power electronics. Compared to logic semiconductor devices used in home electrical appliances and computers, it is characterized by its ability to handle high-voltage and large-current.

*2 Silicon Carbide (SiC)
Silicon carbide is a semiconductor of 1:1 compound of silicon (Si) and carbon (C), expressed by the chemical formula, SiC. Its bandgap*6 at room temperature is 3.3 eV (electron volts). Due to its large bandgap, research and development is currently actively in progress for its use as a material of next generation power devices.

*3 Gallium Nitride (GaN)
Gallium nitride is a semiconductor of 1:1 compound of gallium (Ga) and nitrogen (N), expressed by the chemical formula, GaN. Its bandgap at room temperature is large at 3.4 eV (electron volts). It is currently primarily used as material in light-emitting devices such as blue light emitting diodes and laser diodes. Recently, even as an electronic device, research and development on its use in power devices similar to SiC is actively in progress.

*4 Widegap Semiconductor
The general term for semiconductors with large bandgaps—the most basic parameter that decides a transistor's material property. A typical widegap semiconductor includes silicon carbide (SiC), gallium nitride (GaN), and zinc oxide (ZnO). When used in electrical devices, it exhibits characteristics suitable for power devices such as high-voltage, high-output, and low-loss. Due to this, research and development on it as next-generation power device materials alternative to silicon (Si) is currently actively in progress.

*5 Gallium Oxide (Ga₂O₃)
Gallium oxide is a semiconductor with 2:3 compound of gallium (Ga) and oxygen (O), which is expressed by the chemical formula Ga₂O₃. As for its crystal structure, it is known to exist in 5 different forms—α, β, γ, δ, and ε. Among these, the bandgap of the most stable structure, β-Ga₂O₃, is 4.8-4.9 eV (electron volts) at room temperature.

*6 Bandgap
The energy difference between the peak of the valence band—the highest electron-occupied energy band in semiconductors and insulators—and the bottom of the conduction band; equivalent to the band of the lowest region. It is one of the most basic parameters that determines material properties.

*7 Melt Growth Method
A single-crystal growth method utilizing fused materials. Characteristics suitable for semiconductor substrate fabrication include (1) easy single-crystal substrate enlargement, (2) elimination of the need for high temperature and pressure conditions when manufacturing, making low-energy, low-cost manufacturing possible, and (3) high raw material efficiency. Based on these characteristics, it is a very suitable method for actual production.

*8 Field Effect Transistor
The field effect transistor (FET) is a type of transistor that controls current in source-drain terminals on a principle that establishes a gate in electrons based on field channels, or in a flow of holes, by applying voltage to a gate electrode.

*9 MESFET
MESFET (Metal-Semiconductor Field Effect Transistor) is a type of field-effect transistor. It has a structure formed on a transistor with Schottky metal as a gate. In general, MESFET is used in compound semiconductors (GaAs, InP, Sic, etc.) and also in various types of high-frequency components due to its high performance compared to Si MOSFET.

ID/Locator Split-based New Generation Network

Ved P. Kafle

Senior Researcher, Network Architecture Laboratory, Photonic Network Research Institute

Dr. Kafle joined NICT in 2006. He is currently involved in the design, implementation, and evaluation of new generation network architectures and protocols, as well as standardization activities.

Introduction
—Why New Generation Network—

The Internet has already become an indispensable part in our daily life. And soon the Internet would be so ubiquitous that it would interconnect a multitude of heterogeneous devices such as home appliances, vehicles, and health and environment monitoring sensors. But when the Internet was designed 40 years ago, its main usage was for communication among remote computers used by people mostly known to one another. In the design phase the following requirements were not considered: connecting mobile and tiny devices wirelessly, providing security and quality of service, and efficiently transporting large amounts of data while consuming low electric power. Since the new applications gradually required the above features, various new functions have been randomly added to the original Internet architecture without thinking about overall optimization. Thus, the current Internet has been overloaded and is gradually losing its scalability feature. Therefore, in order to support all of the above requirements and enable it efficiently support future ones, we have been designing a new generation network with a clean-slate approach.

The new generation network, also called "Future Internet" or "Future Network" in other countries, is a global-scale network that would not inherit any limitations of the current Internet. It would scale for a huge number of mobile, heterogeneous devices and support various networking protocols. In this article, I explain the ID/Locator split concept necessary to achieve the above goal while comparing it to the current Internet architecture.

ID/Locator Split Concept

Figure 1(a) shows the current Internet protocol stack. An IP address is used in the application and transport layers as an identifier (ID) to identify the host, sessions or services, and same IP address is used in the network layer as a locator to denote the location of the host in the network. The use of one IP address as both ID and locator makes the current Internet not suitable for supporting heterogeneous protocols, mobility, multihoming, security and scalable routing. When the host moves from one network to another network, it changes its IP address (both its ID and locator), thus terminating the ongoing communication session that used the original IP as an ID. The main purpose of multihoming is to transfer sessions from one interface to another when the other network it is connecting with becomes congested or disconnected. However, since every interface has its own IP address, the host cannot smoothly transfer a communication session from one interface to the other because such transfer would change the session ID. Similarly, any security context related with an IP address becomes invalid when the host changes the IP address. Moreover, the core network creates an entry in its routing table for each and every edge or access network, but if the edge network size becomes smaller, and the number of edge networks becomes very large, the core routing table size would become very large. When frequent changes in the edge network IP address configuration occur, it creates high overhead for updating the core routing table, and the core routing function would ultimately be in trouble.
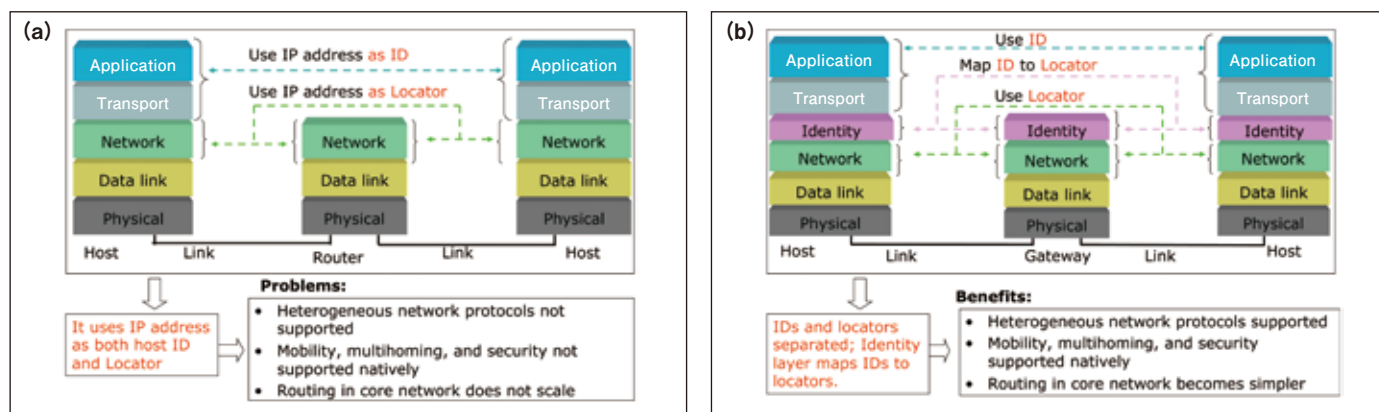

Figure 1 ●Protocol stack   (a) Current Internet's protocol stack   (b) ID/locator split-based New Generation Network's protocol stack

Therefore, the new generation network's protocol stack must separate IDs from locators (called ID/locator split) as shown in Figure 1(b). The identity layer inserted between the transport and network layers maintains ID to locator dynamic mappings so that the application and transport layers can use the same ID to identify the host or communication sessions while the network layer can change locators in the case of mobility or multi-homing. This feature allows for the use of different protocols in the network layer. Data packets include both the source, destination IDs, and locators in their headers. The gateway uses the IDs as reference values to translate network protocols or locators in the packet header when packets traverse from the edge network to the core network. This allows the new generation network to use different types of network layer protocols in the edge and core networks.

HIMALIS Architecture

Based on the ID/locator split concept, NICT has proposed HIMALIS (Heterogeneity Inclusion and Mobility Adaptation through Locator ID Separation) architecture. Figure 2 shows the HIMALIS architectural major components, which are the edge networks, core network, and logical control network. The core network consists of high speed routers and links to interconnect edge networks.

●Network Access Function

When a host (say Host1 in Figure 2) wants to connect with the edge network, it gets the edge network's parameters such as the IDs and locators of the AA, LNS, and GW by running an initial configuration protocol such as Dynamic Host Configuration Protocol (DHCP). The host then contacts the AA for authentication and local registration. After authentication, the host is assigned with a new locator. The host's hostname, host ID, locator, and public key are stored in the LNS's Host Table, and the host ID and locator in the GW's ID Table. The host is also assigned with an access key which is used to authenticate or encrypt messages exchanged by the host with the AA, LNS, and GW. The host then registers its new locator in the HNR by sending a locator update message. Now the host is ready for communication with any other host.

●Session Initialization Function

When Host1 wants to communicate with Host2, due to Host1 knowing only the hostname of Host2, Host1 must obtain Host2's ID, locator, and public key by sending a hostname resolution request to the LNS. The LNS first, accessing information from DNR and HNR, receives back Host2's ID, locator and public key and forwards this to Host1. Then, Host1 begins exchanging control packets with Host2 to establish security contexts in them and to store their ID/locator mappings in both GWs' ID tables. The GW performs network protocol or locator translation in the packet header by using ID/locator mappings from its ID Table.

●Mobility Function

When the mobile host (say Host1) moves from an old edge network to a new edge network, it performs the following signaling functions: (a) accesses the new edge network to receive a new locator; (b) updates locator information of Host1 on the old GW with a new locator so that the old GW can forward packets to the new GW during handover, (c) updates Host2 and its GW so that they can forward packets to Host1's new location; (d) updates Host1's HNR record; and (e) disconnects gracefully from the old edge network. In HIMALIS architecture, security contexts established in the host and network during the network access and session initialization processes are used to secure the mobility management functions.

Implementation Status

ID/locator split based HIMALIS architecture is an important component of the new generation network research in NICT. It has been implemented over testbed networks which have been interconnected by JGN-X (NICT's new generation network testbed infrastructure consisting of nodes distributed throughout the country). The name resolution functions have also been implemented in PlanetLab nodes (PlanetLab is a global overlay testbed network consisting of about 1000 nodes). We are doing extensive experiments to validate the architectural functions and working to improve them continuously. We demonstrated the operation of the HIMALIS network system at Interop Tokyo 2012.
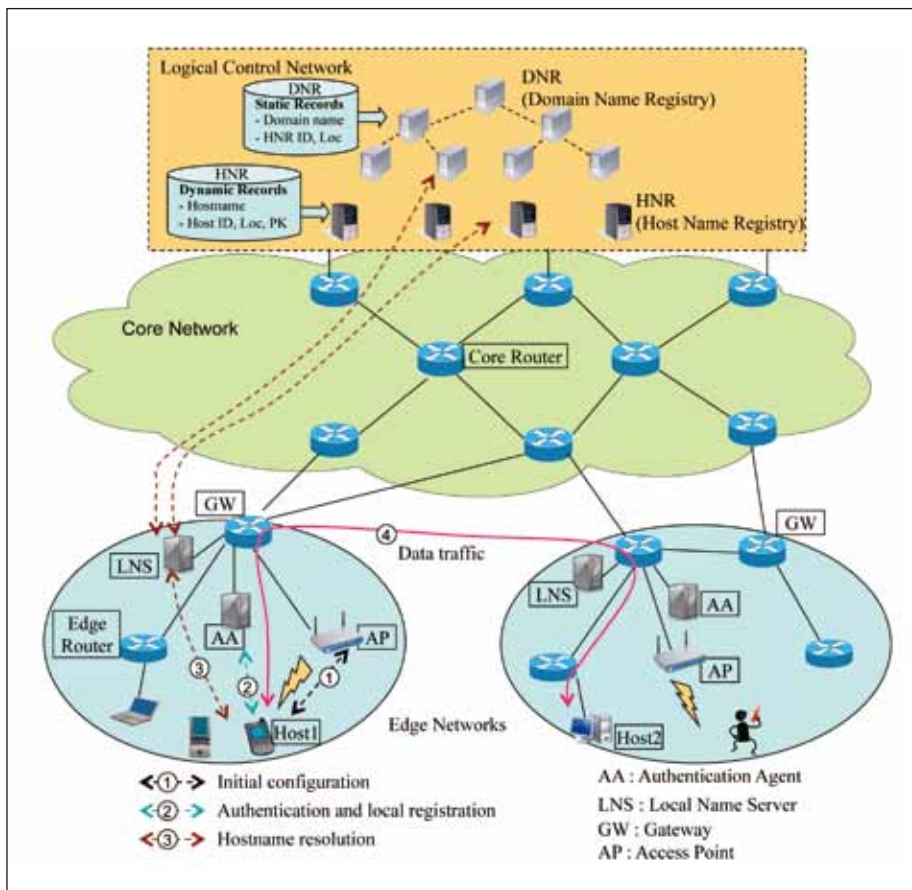

Figure 2●HIMALIS architectural components

Prototype Key Components for Next-Generation Free-Space Optical Communication
— Developing a 1.5μm wavelength wide field-of-view optical antenna using commercially-available lenses —

■ **Researcher who uses Prototype Development services**

Yoshinori Arimoto
Senior Researcher, Space Communications Group, New Generation Wireless Communications Research Center

After completing graduate studies, Arimoto entered the Ministry of Posts and Telecommunications, Radio Research Laboratory (currently NICT) in 1979. Having previously engaged in research on satellite operation, satellite communications, and optical intersatellite communications, he is currently involved in free-space optical communication system. Ph.D. (Engineering).

Background

At NICT, I have been involved with a new free-space optical communication terminal shown in Figure 1. This device's feature, which was introduced in the NICT News May 2010 issue, is to transmit narrow laser beam from a single mode fiber[*1] and to hit it on the counter terminal properly so that the signal modulated in the laser beam can be transmitted again through optical fiber to connect to a node on the other network without the use of large-scale, expensive equipment. To do so, we had to develop new laser focusing optics compatible with a dual laser wavelength; one is at 0.98μm for beacon beam to identify counter terminal and another is at 1.55μm for fiber optic communications. It took about 5 years to understand the design principle, and be able to create an optical antenna with adequate performance at any time in the laboratory.
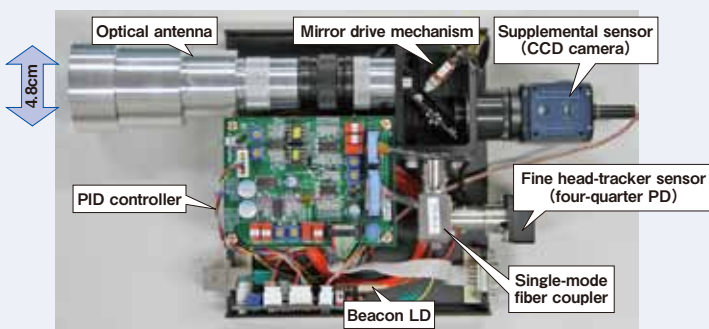

Figure 1●Free-space optical communication terminal with a 17x optical antenna attached. With a signal beam diameter of 40.9mm, internal loss at 1.9dB, diffraction limited field of ±0.3 degrees, and tracking bandwidth over 10kHz, it is the world's highest-performing device.

Significance of Creating Optics in the Laboratory

In amateur astronomy, some people make their own astronomical telescopes. However, there are very few engineers or researchers designing and making high-precision laser focusing optics, such as a 10x beam expander[*2] on their own. This is because it is not easy designing and making optics for lasers that require below 1/10 wavelength precision. Even if you are familiar with a specialized optics design software you would have to procure optical glass that fit your design, rework it into a precise lens shape, and after applying an antireflective coating that matches the wavelength to be used, make an assembly mechanism (lens holder) configured for the design. This would cost over one million yen and take months to do.

As for optical antennas for wireless communication, which is one of my subject of research, most people including me would make a specifications documents for them and request the design and manufacturing from vendors with good track records until a few years ago. However, if the side accepting the order lacked the technical capabilities, one had to make weak specifications, and these often excessively challenging technical limitations led to tremendous costs, so you came to terms with the fact that a certain level of compromise was inevitable.

Creating New Optics with the Same Approach to Electronic Circuits

Although a rough example, here I would like to explain the production of optics by comparing it with that of electronic circuits. In optics design and production, lenses and mirrors that create optics can be considered as passive components, such as registers and capacitors, in electronic circuits, and laser sources, photodiodes, and steering mirror mechanisms are corresponding to the active components, such as transistors, diodes, and operational amplifiers, in electronic circuits. As a circuit simulator becomes popular in electronic circuits design, so many commercial optics design software packages have been sold, and they will immediately provide the result of aberration calculation for a coupling lens that took a few days a hundred years ago. However, just as simply having a circuit simulator doesn't mean that a new circuit system can be devised, even with the advanced automatic design capability of optics design software, you cannot design high performance optics with new functions. It is often not known what should be optimized, or rather the assessment function. Furthermore, with the traditional development approach in optics, starting to make prototypes means creating new resistors or capacitors. Naturally, this will take much time and cost.

And so, I decided to take the same approach as electronic circuit production. When producing electronic circuits, after a circuit is designed with existing passive and active components in mind, its characteristics will be simulated or evaluated by a real circuit with parts assembled temporarily, and then a printed circuit board will be

Many research activities at NICT require parts that cannot be found in the market. Such parts must be made in-house. "Prototype Development", one of the services offered by the R&D Activities Support Office of the Outcome Promotion Department, is meeting these needs by fabricating the parts that researchers require. This production and development result was introduced from a researcher's standpoint as a part of a four-part series. This is the final installment.

designed, and finally production is finished when the parts are mounted on the board. When you substitute this procedure with optical antenna optics, first you systematically check the commercial lens that is applied with antireflective coating between 0.98μm~1.55 μm and laser focusing precision. From this, you find the optimum combination, design the optics, and after verifying its capability via optics design software, design and produce the lens holder and assemble the optics to complete the process. Fortunately, a few lens combinations were found that can use this wavelength range.

To put together high-precision optics, you must design and produce a high-precision assembly mechanism that corresponds to the electronic circuit printed substrate, and fit it to a commercial lens. In the process, the machining facility in prototype development at the Information Distribution Platform Laboratory and the experience in utilizing it were extremely helpful. The 5x beam expander and fiber coupling lens optics I designed are shown in Figure 2(a) and the actual object produced in Figure 2(b). In order to fine-adjust the second lens' position to the laser's wavelength, we use a commercial helicoid mechanism[*3] in Figure 2(b)'s black part. Remaining lens holders are designed to fit this mechanism. If one has this kind of drawing when making their own, it is possible to process a lens holder in one day and assemble it and evaluate its performance at night, so if there is a performance problem, you can keep designing, producing, and evaluating many times. Also, even if mistakes are made during processing, if it is your own design, you can tweak the drawing and continue processing as-is. Even if there are some sort of failures, you can determine the cause on your own, so it results in valuable experience for your next design. In the test production cycle, new discoveries are also made. The beam expander in Figure 2 implements a full-width 2.5 degree diffraction limited field-of-view with only three commercial lenses, a capability I could never had imagined a few years ago.

Figure 3 shows the exterior of optical antennas developed here in the past two years. All achieve wide field-of-view and diffraction limited capabilities with only commercial lenses.

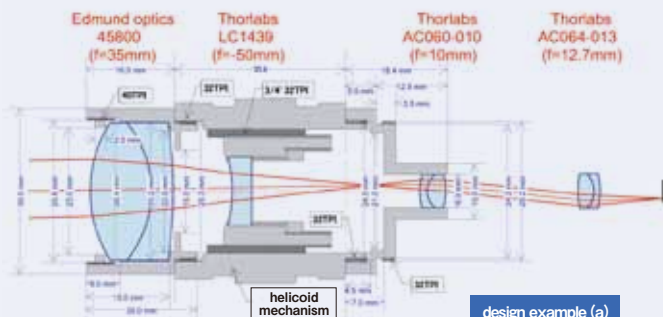

design example (a)

product produced (b)

Figure 2● 5-x beam expander and fiber coupling lens design example (a), and example of actual product produced (b). Diffraction limited field of view is ±1.25 degrees, andbeam diameter is 10 mm.

Future Prospects

With the method introduced here, 0.8μm~1.55μm laser focusing optics with under 5cm beam diameters can be produced in a short time. For the largest-magnification optical antenna in Figure 3, I requested additional production of multiple units from the production and development staff, and collaborated research with outside institutions. Furthermore, the optical antenna introduced here is also being presented in international academic societies as its patent is being filed.

Beam diameter: 42mm, 21x
Beam diameter: 20.3mm, 10.2x
Beam diameter: 12.9mm, 6.5x
Beam diameter: 20.1mm, 10.0x
Beam diameter: 10.4mm, 5.2x

Figure 3● Optical antenna we developed (5 types with the magnification of 5.2-21, diameters are between 10~42mm)

■ Glossary

*1 Optical Fiber

Multimode fiber whose core size is approximately 50μm and single-mode fiber whose core size is approximately 10μm are popular. In high-speed, high-capacity communication, single-mode fiber is used. In this article, single-mode optical fiber is referred to as optical fiber.

*2 Beam Expander

Optics that change laser beam diameters.

*3 Helicoid Mechanism

Mechanism that moves a camera lens back and forth with the helical grooves of the lens barrel.

■ Comments from prototype development staff

Junichi Komuro

Expert, R&D Activities Support Office, Outcome Promotion Department

The lens holder part of an optical antenna is designed into a simple form that can process with general-purpose lathe, but we are now attempting to process the difficult high-precision, specially sized thread. What we achieved was the world's highest-performing free-space optical communication device. We will take the hard work involved as learned techniques that we will continue to use in further research.

We, the production and research staff, are actively involved in advancing research activities through "making things" and achieving brilliant research to pass on to society.

A Letter of Appreciation Presented to Kawauchi village in Fukushima Prefecture

– For assistance in restarting the Ohtakadoya-yama LF Standard Time and Frequency Transmission Station –

On Thursday, April 5, 2012, NICT presented a letter of appreciation to Kawauchi village in Fukushima prefecture for their significant support on the post-Great East Japan Earthquake Ohtakadoya-yama LF Standard Time and Frequency Transmission Station..

NICT currently transmits standard radio waves from the Ohtakadoya-yama LF Standard Time and Frequency Transmission Station (hereinafter, referred to as "the transmission station", location: Kawauchi village, Fukushima Prefecture) as part of our duties of generation and dissemination of Japan Standard Time.

Due to the nuclear accident accompanying the Great East Japan Earthquake on March 11, 2011, an evacuation order was issued to the neighboring areas including the transmission station located in the area of 17km from Fukushima Daiichi Nuclear Power Plant, and NICT inevitably evacuates operators from the transmission station and temporarily halt transmission of standard radio waves on the following day, March 12. In addition, because the evacuation area was designated within 20km from Fukushima Daiichi Nuclear Power Plant from April 22, permission of the local government was required to enter the transmission station.

Under these circumstances, Kawauchi village provided much assistance to restarting transmission services operated by NICT. In particular, thanks to prompt and efficient processing of procedures necessary to enter the evacuation area, transmission services were able to restore on May 13, approximately 2 months after the temporary suspension, and subsequent operations and equipment renovation were also proceed smoothly.

As the public facilities in Kawauchi village have returned and reopened in this spring, Hiroshi Kumagai, Vice President, Toshio Iguchi, Director General of Applied Electromagnetic Research Institute, and others from NICT visited Kawauchi village office and presented a letter of appreciation and commemorative gifts from the President of NICT to Yuko Endo, mayor of Kawauchi village and other office workers in appreciation of cooperation and assistance to NICT for about one year after the earthquake disaster.

We would like to express our deepest gratitude to the village mayor and all officers for receiving us though being busy with handling the return of residents. Further, to all those affected by the disaster, we would like to express our heartfelt sympathy and pray for a speedy recovery.

●Presentation of a letter of appreciation to the mayor of Kawauchi village, Fukushima Prefecture (left: Hiroshi Kumagai, Vice President, NICT, right: Yuko Endo, mayor of Kawauchi village)

Soichi Watanabe, Research Manager at the Applied Electromagnetic Research Institute's Electromagnetic Compatibility Laboratory, elected into Main Commission of International Commission on Non-Ionizing Radiation Protection (ICNIRP)

ICNIRP (International Commission on Non-Ionizing Radiation Protection) is an independent, non-profit scientific organization established to formulate international protection guidelines concerning non-ionizing radiation[*1]. The guidelines that ICNIRP formulates on electromagnetic fields, light (infrared~ultra-violet rays), and ultrasonic waves are used by Japan, the EU, and in regulations/advisories of countries all over the world[*2].

The ICNIRP Main Commission includes experts in disciplines such as medical science, biology, physics, and engineering, consisting of 14 members including a Chairman and Vice-Chairman. In November 2011, following the retirement of 3 members, elections were held by existing Main Commission members, and Research Manager Watanabe was elected as a new member. Since the establishment of ICNIRP in 1992, he becomes the third Asian member elected, and the second Japanese one following Masao Taki, Professor, Tokyo Metropolitan University (1996-2008). His term is 4 years, beginning in May 2012, and can be extended up to 3 terms (12 years).

ICNIRP Main Commission members are experts in a neutral, non-profit body who do not represent the interests of their countries of origin or institutes and are required to engage in work on non-ionizing radiation from a purely scientific standpoint. Because of this, organizations that produce ICNIRP Main Commission members receive much interest and respect internationally. Therefore, this time Research Manager Watanabe's election can be viewed as the result of an EMC biological research achievement at NICT being highly acclaimed internationally.

●Research Manager Soichi Watanabe, recently elected to be an ICNIRP Main Commission member

Hereafter at ICNIRP, the start of revision work is scheduled for guidelines on radiofrequency electromagnetic fields (100kHz-300GHz) used in various communication and broadcast systems. The revised guidelines are the result of radio wave carcinogen evaluation results[*3] issued by WHO/IARC (International Agency for Research on Cancer) in 2011 and are expected to have a large effect on radio wave protection regulations in Japan and countries all over the world. Furthermore, because all final decisions on important matters in the guidelines such as limit values rests on the Main Commission, The Main Commission, to which Research Manager Watanabe has been elected to, has great responsibility is expected to do well.

[*1]
ICNIRP's income, etc. is completely provided by donations and expenses for commission from neutral organizations (EU, WHO, etc.) and it is legally registered as an NPO in Germany. All ICNIRP members consist of experts from non-profit organizations.

[*2]
In Japan, the ICNIRP guidelines are adopted in partial-body absorption guidelines (an Ordinance of the Ministry of Internal Affairs and Communications) aimed at cellular phones, etc. and the exposure standard of extremely low frequency fields from electric power systems that went into effect as an Ordinance of the Ministry of Economy, Trade and Industry this year also employed values in the ICNIRP guideline.

[*3]
WHO/IARC decided "Possibly carcinogenic to humans; 2B" about radio wave carcinogenic in May 2011.

Cyber Attack Observation Data Released Online
— Promoting effective use of data collected by nicter —

nicter (Network Incident analysis Center for Tactical Emergency Response)—a complex system being researched and developed at NICT that quickly observes and analyzes various data security threats occurring in cyberspace in order to develop effective countermeasures—can capture broad cyber attack*1 and malware infection trends in real time. With the growth of national interest in network security these past few years, effective use of observation data collected by nicter was anticipated.

As a result, NICT recently decided to sequentially publish parts of the observation data (dark-net traffic) collected from nicter's large-scale dark-net*2 observation network. Widely releasing broad cyber attack trends will promote the sharing of information among information security organizations, corporations/university information security control departments, etc., help improve Japan's network security, and inform average users on the status of cyber attacks.
(Public URL: http://www.nicter.jp/)

The initial data published is as follows.
− Visual results of dark-net traffic [real-time]
− Statistical information on dark-net traffic
   [one week's worth]
− Various top 10 types of dark-network traffic
   [one week's worth]

NICT will continue improving the stability and quality of posted nicterWeb data, genuinely contributing to the improvement of Japan's network security, and making efforts that lead to the safety and peace of mind of public network usage.

*1　Cyber Attack

Acts in cyber space—consisting of computer networks—that harm countries and businesses via illicit access, malware infections, etc. In recent years, countermeasures against cyber attacks have become an urgent matter around the world, including cyber space on land, in sea, sky, and space, emphasized as a national security interest in the USA. The cyber attacks that NICT observes this time are scanned acts mainly for detecting PC vulnerabilities and do not cover all attacks in cyber space.

*2　Dark net

Refers to the accessible and unused IP address space on the Internet. Packets sent to unused IP addresses are rare within standard Internet usage, but when observing a target, you understand that a considerable number of packets arrive. Many of these packets result from some form of illicit activity such as malware infection activity, etc. Thus, by observing packets that reach the dark net, it is possible to grasp trends of illicit activity on the Internet.

●nicterWeb screenshots

Asia-Oceania Space Weather Alliance (AOSWA) Report of the First Workshop

Space Weather and Environment Informatics Laboratory, Applied Electromagnetic Research Institute

The first AOSWA (Asia-Oceania Space Weather Alliance) workshop was held at the Imperial Mae Ping Hotel, Chiang Mai, Thailand, from February 22 to February 24, 2012. This workshop was hosted by Space Weather and Environment Informatics Laboratory, NICT Applied Electromagnetic Research Institute. Kingdom of Thailand Chiang Mai University and NICT Asia Center co-hosted the workshop.

Various disturbances in the space environment caused by solar activity have an impact on satellites (eg. communications and broadcasting satellites), shortwave communication, manned space flight, and other things. Understanding the current condition of these disturbances and predicting the future condition of them is referred to as space weather forecast. In space weather forecast, the solar and the solar wind monitoring is the most important, because the solar activity is the driver of space weather disturbances. However, the constructing a regional, and global observation network to monitor ionospheric and geomagnetic condition is also important. Asia-Oceania countries are beginning to focus on space development and space utilization and recognize the need for space weather forecasting. As a result, the establishment of the center has occurred successively.

Based on these background, in order to promote data (particularly ionospheric and geomagnetic observations) exchange, which are now collected independently by Asia-Oceania countries, and produce regional cooperative structure in space weather research and space weather forecast, NICT established the AOSWA with the 13 institutes from 7 countries in 2010. Thereafter, NICT has held meetings, and has transmitted information through Web as a leader organization. And AOSWA has come to hold its first workshop this time.

The workshop began with a greeting of the chair Dr. Toshio Iguchi, Director General of NICT Applied Electromagnetic Research Institute. 76 people in total participated in the workshop from 30 research institutes in 10 countries. We had 41 oral and 21 poster presentations related to the space weather research and services in the workshop. Every presentation generated a lot of interest, and extensions of the lecture time occurred successively. We think this is the reflection of the fact that space weather forecast and space weather research are pushed forward lively in Asia-Oceania area.

Because this was the first workshop, the presentations were focused on introducing each institutes in order to know well each other. On the last day, it was announced that the 2nd AOSWA Workshop would be held by Chinese space weather research institutes in 2013. Our workshop ended in a great success.

For more details on AOSWA and the workshop, please visit the link below.

AOSWA: http://aoswa.nict.go.jp/index.html   Workshop: http://aoswa.nict.go.jp/workshop.html

● Workshop participants/registrants and institution distribution map of countries (10 countries, 30 institutes, 76 people)

● Chair's greeting: Dr. Toshio Iguchi (Director General of NICT Applied Electromagnetic Research Institute)

● Co-chair's greeting: Dr. Akachai Sang-In (Former Vice President of Chiang Mai University)

● Facility tour (NICT Ionosonde Observation Site)

● Group photo of participants

# Interop Tokyo 2012 Exhibition Announcement

NICT will take part in Interop Tokyo 2012's exhibition at the Makuhari Messe from Wed, June 13 – Fri, June 15, 2012.

This year, NICT will exhibit its research activities under the theme of "Closer Step to the Realization of New Generation Network Technology."

We will demonstrate a Content Distribution System for Low Energy Consumption, New Generation Network Service Mobility System, and nicter. We will also introduce Optical Packet and Circuit Integrated Network, High-Availability Network Configuration Technology such as the ID/Locator Split System (introduced in current issue on pp. 3-4), An Advanced Service Platform for Sensor Information Aggregation and Analysis, JGN-X, StarBED3, RiskVisualizer, CAE/simulation cloud infrastructure technology, and others.

For more details, you can stay informed via Twitter (Account: NICT_Interop).

We look forward to greeting many visitors at our NICT booth.
(The NICT booth will be located in Hall 5, 5G28).
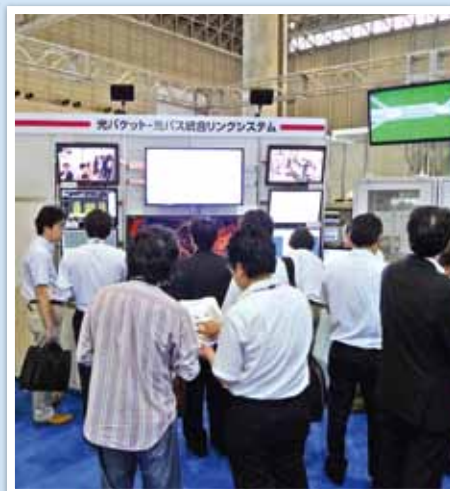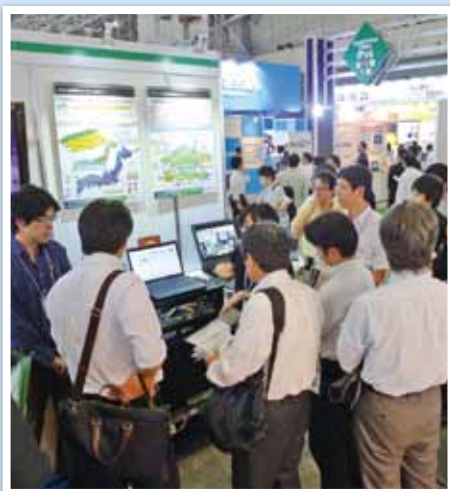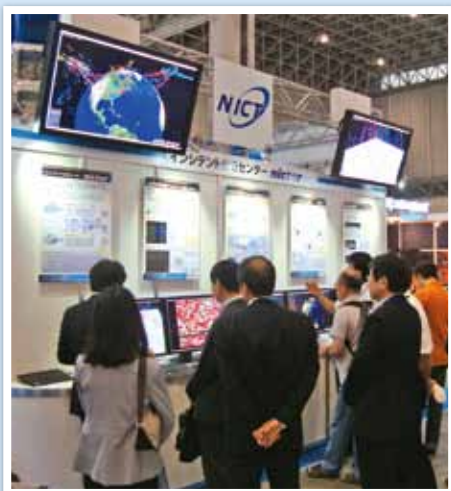
●NICT booth at Interop Tokyo 2011

（Note）
Entrance to Interop Tokyo 2012 is free if you register beforehand via their website.
http://www.interop.jp/2012/

Information for Readers

Next issue will feature topics such as cognitive brain functioning in periodic motion study, photonic technology that utilizes new nanotechnology-based light, and more.