# NICT NEWS

NICT National Institute of Information and Communications Technology

No.455 JAN 2016

FEATURE

## The Future with Nano ICT —It's right there

NICT NEWS No.455 JAN 2016
National Institute of Information and Communications Technology

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**Cover photo**
Separation and purification of synthesized organic material. Compounds are separated into layers, identified, and only the desired molecules are extracted with high purity.

# New Year's Greeting 2016

**President of National Institute of Information and Communications Technology**
**Dr. Masao SAKAUCHI**

## Happy New Year!

NICT now welcomes the new year as a National Research and Development Agency. On the occasion of starting this milestone year, I have renewed my determination for more results-oriented research and development than ever before and to raise our contribution to society to a new level.

When we transitioned to a National Research and Development Agency, it was our intention to strengthen our focus in four viewpoints, namely "Strategically Prioritized R&D", "Open Innovation", "Global Expansion", and "Aggressive Frontier Research."

One example of Strategically Prioritized R&D is the "Social ICT Project", launched in 2014. This initiative creates new value by gathering a variety of information in society using sensors and processing it as big data. It is expected to contribute greatly to resolving social issues such as traffic and disaster prevention.

With regard to Open Innovation, we have started a project to make NICT a platform for Open Innovation in various fields such as optical networks and speech translation, to carry out research and development smoothly and to promote efficient implementation in society.

As for Global Expansion, we have concluded MOUs with 91 research institutes in 25 countries around the world, actively promoting international collaboration in research. We have also enriched our funding for young researchers to promote challenging research and development. In particular, young researchers are producing new technologies likely to have a large impact on society, such as deep-ultraviolet LEDs that show promise for germicidal irradiation and other applications, and gallium-oxide high-voltage devices, which are receiving attention as next-generation electrical power devices. These are opening up bright prospects for the future.

Turning our eyes to the future, modern society is surely approaching what can only be called the "Fourth Industrial Revolution", with IoT, big data and artificial intelligence bringing a new wave of technical innovation.

In this April, NICT will begin a new period of medium-to-long term objectives, and this period will surely be critical for ICT research organizations around the world. It is our intention to bring reform and new direction to Japanese society by putting intensive effort into intelligent activities to produce our own new trends. We again ask for your continued understanding and support in this.

Finally, I would like to wish everyone a happy new year and I hope you all have a wonderful year.

INTERVIEW

# Opening up New Possibilities in Communications using Nano-technology

**Akira OTOMO**
**Director of Nano ICT Laboratory, Advanced ICT Research Institute**

After completing a doctoral program, he joined the Communications Research Laboratory (currently NICT) in 1996. Engaged in research on applications of molecular photonics and nano-photonics for optical control technologies. Current position held since 2011. Ph.D.

**Information and communications networks have become essential for our lives in society. However, as systems become faster and increase in capacity, we cannot ignore the increasing power consumption and heat generated, and new technical breakthroughs are needed urgently. A development promising for answers to these issues is the appearance of nano-technology materials and devices. We spoke with Dr. Akira OTOMO, Director of Nano ICT Laboratory, Advanced ICT Research Institute.**

## Nano-technology in information and communications

**— We often hear about "nano-technology" as an advanced technology that gets a lot of attention, but beyond "the world of the extremely small," it is difficult to form an image of exactly what it is, or how it is related to information and communications technology.**

**OTOMO** It's true, the word 'nano-scale' alone might not give a clear image of what we're talking about. A nanometer is a unit that is one billionth of a meter. If I say that one tenth of a nanometer is on the scale of atoms and several nanometers is on the scale of molecules, does that convey how tiny this is?

The Nano ICT Laboratory deals with applying materials and processing technologies at these scales in the field of information and communications technology. We are conducting R&D on innovative ICT hardware that would not be possible by only making small advances of existing technologies. Nano-technologies open up possibilities for devices that have much higher performance and efficiency, and are smaller than ever before. This has huge benefits for network infrastructure, which continues to grow in scale.

## Two fields producing innovative hardware

**— Can you describe specific examples of the research you are doing?**

**OTOMO** We are working on two main research themes.

The first is organic materials. In organic materials, $\pi$ electrons in the molecules are resonant with the optical electromagnetic fields, so they have faster, more efficient photoresponsivity than inorganic materials. However, this feature is affected by molecular structure and arrangement, so design, control and synthesis at the molecular level—of just a few nanometers—is necessary (Figure 1). Our Organic Nano-Device Group handles this area.

The other theme is superconducting materials. As you know, superconductivity is the phenomenon by which the electrical resistance of certain materials drops to zero be-

Figure 1 Synthesis of new organic molecular materials

low a particular temperature. There is great potential for devices that make use of unique properties, such as perfect conductivity and flux quantization, which occur in that state. To develop such superconducting devices, atoms must be deposited to thicknesses in the range of ten nanometers, requiring technologies for nano-processing and forming thin films. Our Superconductive Device Group handles this area.

## ■Results coming into practical use

**── Are there any technologies from your R&D that are at or near the stage of practical application?**

**OTOMO** One device that is particularly oriented to practical use is our superconducting nanowire single photon detector (SSPD) (Figure 2), which was developed based on niobium nitride (NbN) thin film deposition and nanowire fabrication techniques from our superconducting device research. This photon detector has higher performance than the avalanche photodiodes (APD) that are currently in wide use and it is becoming a key device for quantum cryptography communication systems in the field of information and communications.

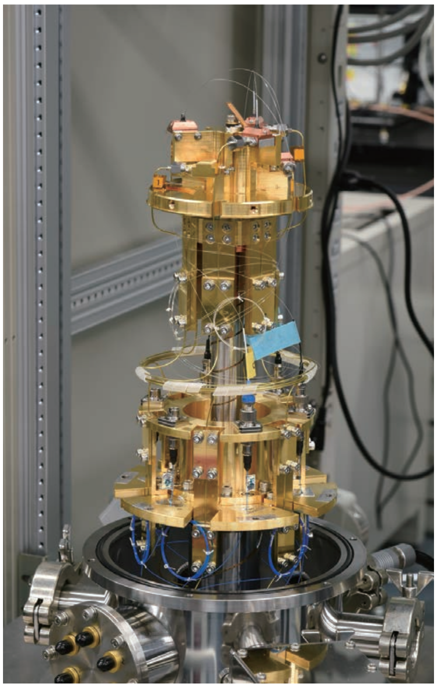


**Figure 2 Inside of the superconducting nanowire single photon detector (SSPD) system**

The SSPD also promises to have broad influence in fields other than information and communications. Dramatic improvement in performance and speed can be expected in fields such as fluorescence microscopes and laser ranging technologies, by replacing the current semiconductor devices with SSPDs.

We are also planning to make organic electro-optic (EO) polymers more practical. These are needed for optical modulators and other components in optical communications, which forms the foundation for information and communications technology. We can increase speed and save energy by using efficient organic materials. We have already achieved modulation at speeds exceeding 100 GHz.

Conventionally, organic materials have had the disadvantage of being susceptible to environment compared to inorganic materials, but we are developing technologies to make them more practical, such as developing heat-resistant EO polymers, and protecting materials from surrounding oxygen and water by covering the surface with a layer of atoms of an inorganic material.

NICT overall is also promoting research on terahertz (THz) technologies, and organic materials are having a great influence on this field as well. The frequencies are higher than the gigahertz (GHz) band, where modulators generally operate, but the interactions are basically the same. Thus, using the materials and devices we have created for ultra-high-speed optical modulators will enable us to implement THz generators that are more efficient and compact than before. This is another theme we are pursuing vigorously.

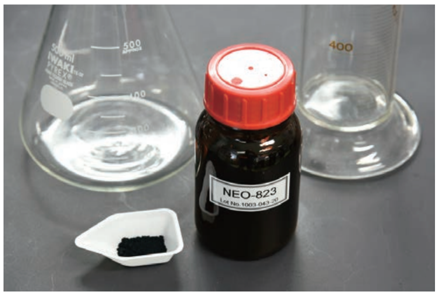



**Figure 3 High-performance organic EO material to go on the market**

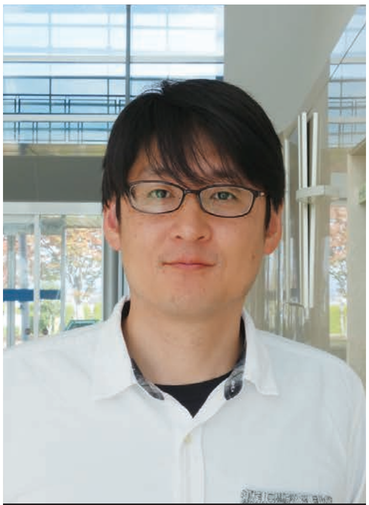
## ■Strength in an R&D system integrated from materials to devices

**── It sounds like you will be producing some very interesting results in the future. What are your laboratory's particular features or strengths, in terms of research organization?**

**OTOMO** Generally in materials research, devices are divided into their own specialties, and usually they don't cooperate well. But in our Nano ICT Laboratory, we synthesize our own materials, and have integrated development from instrumentation to design and device development. As such, we have a good understanding of the characteristics of the materials when we create a device, and we can go back to basic principles for ideas in finding solutions to whatever issues we meet. We are getting many inquiries about collaborative research and are planning to sell the materials themselves for an appropriate price, in order to expand the foundation for R&D (Figure 3).

Of course, the market for what we are working on will be small initially, and there are many issues, but considering the future of information and communications technology, there should be strong demand. We feel our responsibilities in this area strongly.

# Superconducting Nanowire Single Photon Detector System and its Application



**Shigehito MIKI**
**Senior Researcher**
**Nano ICT Laboratory,**
**Advanced ICT Research Institute**

After completing a doctoral program, worked as a researcher at the Japan Science and Technology Agency before joining NICT in 2005. Engaged in research related to a superconducting nanowire single photon detector. Ph.D. (Engineering).

**The unique phenomena produced by superconducting materials and the ultra-low thermal noise conditions in cryogenic environments make it possible to produce ultra-sensitive, low-noise receivers and detectors. Our superconducting nanowire single photon detector (SSPD) is one such detector. It exceeds the performance of other detectors, is able to detect the smallest unit of light, a single photon, and has been used in quantum data communications technology and various other research fields.**

## SSPD system

The SSPD device developed at NICT is composed of a superconducting thin-film niobium-nitride (NbN) nanowire, a cavity layer able to absorb photons efficiently, electrode lines and other components. Advanced device fabrication techniques including deposition of the NbN thin film only a few atoms thick and processing of the nanowire less than 100 nm wide. These were all created using technologies accumulated at the NICT Advanced ICT Research Institute (Kobe) through long years of superconducting device development in the superconducting device clean room (Figure 1). The fabricated SSPD device was implemented in a package able to make an efficient optical connection with the fiber guiding the incident light and then mounted in a compact mechanical cooling system (Figure 2). The compact mechanical cooler used in this system does not require use of difficult-to-handle liquid helium and its compressor can operate continuously on 100 V AC, so the cryogenic environment can be easily utilized in practical applications. This cooling system already fits in a 19-inch rack, but we are also conducting contract research to reduce the size further for applications in various other fields. We have already increased the performance of our SSPD system greatly, as introduced in the December, 2013 issue of NICT NEWS*1, achieving 80% or greater detection efficiency in the 1,550 nm wavelength band, dark count rate of 100 counts/s or less, and time resolution of under 100 ps. This is more than 200-times*2 the performance of avalanche photo diodes (APD), which have been used till now.

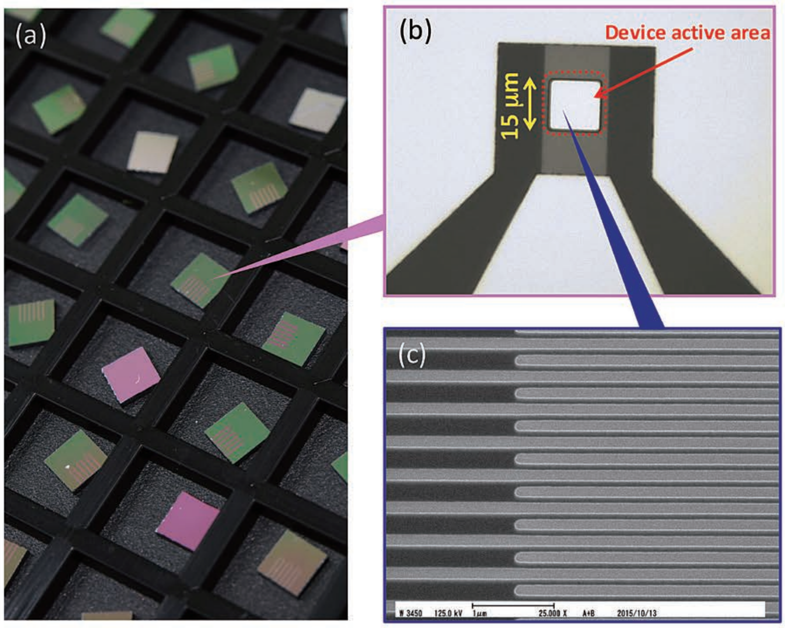



**Figure 1 SSPD device created in the Nano ICT Laboratory**
(a) Chips, (b) Microscopic view of device active area, (c) Electron microscope view of superconducting nanowire

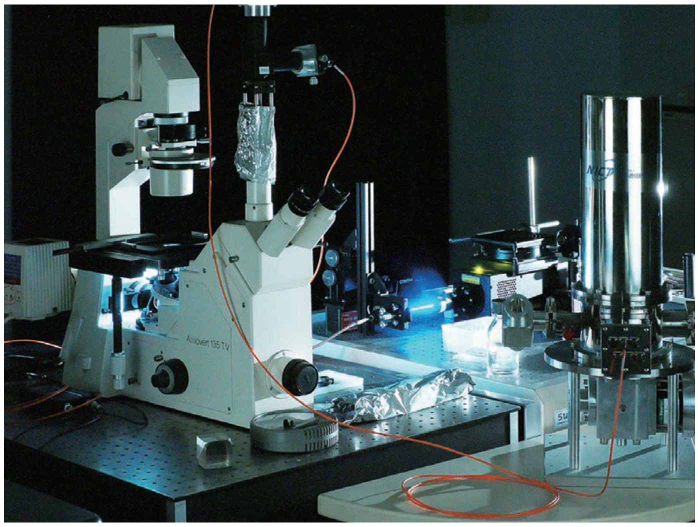


Figure 3 FCS microscope system using the SSPD

## ■Expanding into SSPD application fields

The SSPD system currently being developed at NICT is being expanded into application areas through collaborative research with research groups within and outside of NICT. For example, in the field of quantum data communications technology, a single photon detector that is highly sensitive, low-noise and capable of high time resolution in the communication wavelength band, is needed to exchange information using photons. In quantum key distribution experiments using existing fiber being done by the NICT Quantum ICT Laboratory, the SSPD system has been installed and in stable operation for over a month and has yielded performance improvements an order of magnitude better than earlier results among other results. It has also been applied in various quantum optics experiments including characterizing single photon sources and multi-photon interference, and these results have been published in many journals including Nature Scientific Report, Physical Review A, and Optics Express.

Fluorescence Correlation Spectroscopy (FCS) is an important measurement technique in the field of life sciences and can be used to measure the number or size of molecules in a cell while it is still alive. For FCS, the faint light from molecules with fluorescent labeling must be detected, so a highly sensitive single-photon detector for visible light wavelengths is needed. Till now, APDs have generally been used, but due to signals generated by APDs called after pulses, it has been difficult to observe molecular behaviors on short time scales below sub-microsecond. In collaborative research with Hokkaido University and Osaka University, we used an SSPD for FCS (Figure 3) and were able to observe fluorescent molecule rotation diffusion components in a sub-microsecond time frame, which was not possible earlier.

## ■Future prospects

Beyond the above example applications, the SSPD system shows promise for application technologies such as deep-space laser communications, laser sensing, and spectroscopy. More-advanced features are needed for such applications, such as improvements in performance, spatial resolution, and photon number resolution. We are conducting R&D on an SSPD array system and other projects. We will continue development of photon detector technologies, providing a platform that will stimulate paradigm shifts in a variety of application fields.

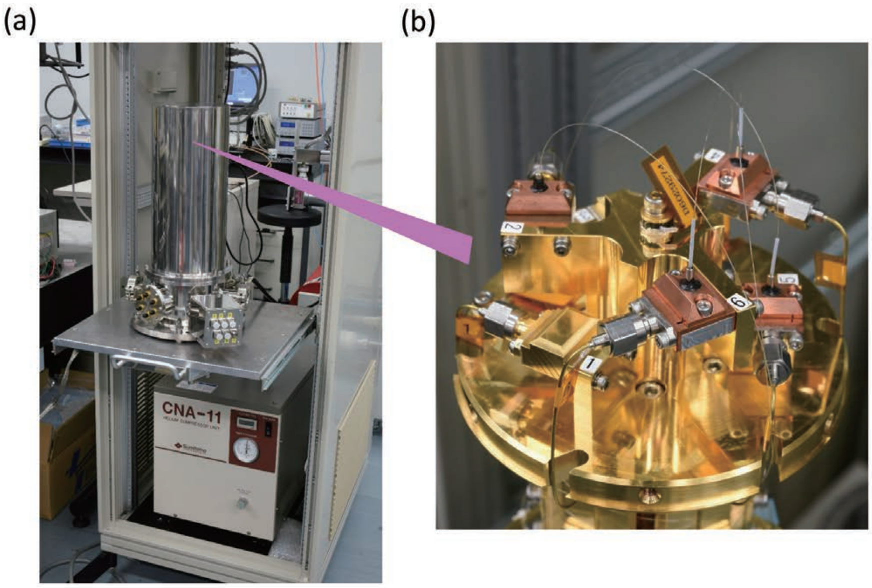



**Figure 2 SSPD cooling system**
(a) External view of SSPD system installed in 19-inch rack
(b) SSPD installed inside the cooling system

＊1 http://www.nict.go.jp/en/data/nict-news/NICT_NEWS_1312_E.pdf
＊2 Overall performance evaluated as detection efficiency ÷ (dark count × timing jitter)

# Research and Development of Organic Electro-optic Polymers Toward Practical Applications

**Toshiki YAMADA**

**Senior Researcher**
**Nano ICT Laboratory,**
**Advanced ICT Research Institute**

After completing his doctoral course, he became JST-CREST researcher in 1996. He joined Communications Research Laboratory (currently NICT) in 1999. Engaged in research on new thin film fabrication techniques, single molecule spectroscopy, organic electro-optic polymers. Ph. D. (Engineering).

**The electro-optic (EO) effect is a phenomenon by which the refractive index of a material changes when an electrical field is applied to it. The EO effect is used in devices such as optical modulators and optical switches, which convert electrical signals to optical signals and are key devices for optical communications. NICT is conducting research to improve the characteristics of polymers exhibiting the EO effect (EO polymers) and their applications, developing various types of optical modulators and switches as well as terahertz generation and detection. Here, we introduce development of EO polymer materials, research to improve their thermal stability, on device applications, and the excellent characteristics of EO polymers.**

## Introduction

Recently, with further increases in the transmission capacity of communications networks, increasing speed of data processing, and diversification of applications, both increasing the bandwidth and decreasing power consumption of optical modulators and switching devices, which are important technical elements of optical communications, have become important issues. EO polymers have a low dielectric constant in the microwave frequency region and the difference between the refractive index for optical waves used in optical communications and the effective refractive index for microwave modulation can be made small, so they are promising for ultra-high-speed operation at 100 GHz or more. Recently, the characteristics of EO chromophores have improved dramatically, as shown below. The EO coefficient, $r_{33}$, of EO polymers has exceeded 100 pm/V, and they exceed lithium niobate ($LiNbO_3$) in terms of the figure of merit (FOM = $n^3r_{33}$). As such, EO polymer devices are attracting attention, having both ultra-high-speed response and low power consumption. Ultra-high-speed communication over 100 Gbit/s is also becoming needed for medium and short-distance data communications, in addition to long distance communication networks, and the transition from electrical wiring to optical "wiring" (optical interconnections) has begun. For such applications, reduced size and low cost are important, in addition to high speed and low power consumption. For this reason, hybrid devices combining silicon waveguides with EO polymers are attracting attention.

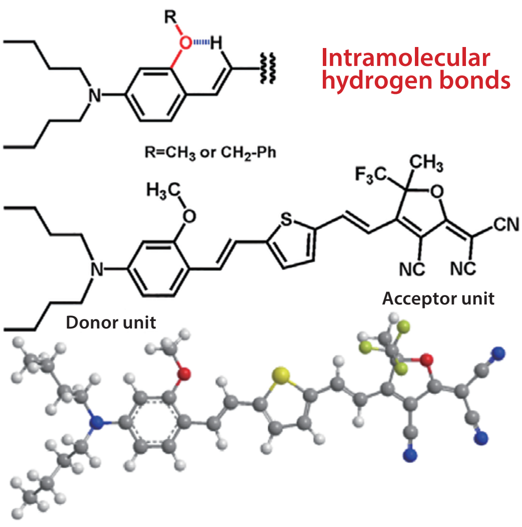



Figure 1 An example of high-performance organic electro-optic (EO) chromophore utilizing intramolecular hydrogen bonds

## Design and synthesis of new EO chromophores and a technique to evaluate EO coefficients for EO polymers

EO chromophores are composed of an electron donor unit, an electron acceptor unit, and a π-conjugated unit, and thus EO chromophores have an asymmetric structure. When atoms within the molecule create a double bond, the electrons forming the first bond (σ electrons) bond tightly, while the electrons forming the second bond (π electrons) are more mobile. A π-conjugated system, which is a collection of π electrons, plays an important role in determining the optical and electrical characteristics of a molecule, and it is important to consider the length and orientation of π conjugated systems when designing EO chromophores. We have found that EO performance can be improved by introducing an alkyloxy group at a particular position in the electron donor unit

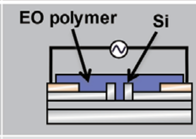
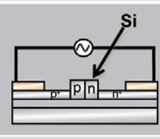
| Material/Device | EO polymer/ Si waveguide | Si |
|---|---|---|
| Structure |   |   |
| Bandwidth(GHz) | > 300 | 37 ~ 70 |
| VπL*Loss (dBV) | 2 | 10 |
| Operation Voltage(V) | < 1 | 1.1 |
| Power Consumption (mW/GHz) | 0.03 | 3 ~ 6 |

**Figure 3 Comparison of performance of silicon-waveguide/EO-polymer hybrid modulator and silicon-only modulator**

(meta-position of aminobenzene), and using intramolecular hydrogen bonds to stabilize the structure of the π-conjugated system. This has provided new molecular design guidelines for further increasing performance of EO chromophores (Figure 1), and we have successfully developed one of the best EO chromophores in this field. In the EO polymers we developed, this type of EO chromophore is introduced as a side chain on the polymer main-chain. The EO effect is generated in the EO polymer by a process called polling. We also developed a new, highly-reliable method for evaluating the EO coefficient, $r_{33}$, called the transmission ellipsometric method without an aperture, which we are using for feedback into EO polymer material design (Figure 2).

## Development of new EO polymers with better thermal stability

EO polymers are applicable in ultra-high-speed modulation at 100 GHz or more, and can be operated with lower power consumption than existing materials, but the thermal stability has been an issue preventing practical application so far, due mostly to orientation relaxation of EO chromophores. At NICT, we have developed EO polymers with a glass transition temperature above 160℃, and found that they show good thermal stability in an environmental-stress test maintaining a temperature of 85℃, as required for optical communications devices.

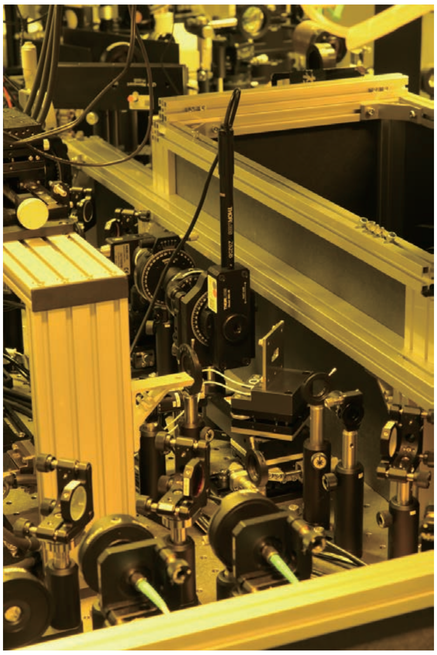


**Figure 2 Measurement system for the electro-optic constant, $r_{33}$ (transmission ellipsometric method without an aperture)**

## Development of silicon-waveguide/ EO-polymer hybrid devices

As shown in Figure 3, silicon-waveguide/EO-polymer hybrid modulators have promising characteristics including small size (approx. 1 mm), ultra-high-speed (100 GHz or greater), and low power consumption (0.1 mW/GHz or less). This is achieved by combining a silicon waveguide, which has excellent light confinement effect due to the high refractive index of silicon, with the strong EO effect and ultra-high-speed operation of the EO polymer. In contrast, the operating principle of silicon modulators is the free-carrier plasma effect (change in free-carrier density) rather than the pure EO effect, and there are limits to reduction of power consumption and increase of operation speed because of the current flow. Since they are not using the pure EO effect for optical modulation, there is a correlation between phase and amplitude when performing optical modulation, and this may cause difficulty in practical applications.

To apply optical communications for medium and short distance data communications (optical interconnections), NICT is developing silicon waveguide/EO polymer hybrid devices using organic EO materials with high performance and thermal stability, yielding ultra-high speed, low power consumption and size reduction.

## Future prospects

We are developing EO polymer optical modulators and switches and silicon waveguide/EO polymer hybrid devices based on our technologies for developing EO pigments and EO polymer materials, and we are deploying them in society in collaboration with industry. Beyond applications in long, medium, and short-range communications as described above, EO polymers in combination with light sources can be applied to generate ultra-high-speed pulses with low power consumption for sensor applications. The EO polymers we have developed are also very promising for terahertz generation and detection, and we expect they will be developed in a variety of applications.

# Development of Organic Terahertz Devices

## Towards high-performance and compact terahertz sources

**Takahiro KAJI**
**Senior Researcher**
**Nano ICT Laboratory,**
**Advanced ICT Research Institute**

After completing graduate school, he was a Specially Appointed Assistant Professor of the Global COE Program before joining NICT in 2009, and he has held his current position since May, 2015. He is engaged in research on fabrication of organic photonic devices. Ph. D. (Engineering).

**Terahertz waves hold promise in applications such as non-contact, non-invasive sensing and ultra-high-speed wireless communications. To promote their use in society, it will be necessary to reduce the size and increase the performance of terahertz equipment. We are developing organic polymers with excellent properties, as well as devices that use them, in the hope of realizing terahertz sources and detectors that are more compact and have higher performance than ever before.**

### Background

Terahertz waves are electromagnetic waves with frequencies between those of radio waves and light (0.1 to 10 THz). They are higher in frequency than radio waves, so they are promising for applications in ultra-high-speed wireless communications. They are also highly penetrating of objects, and materials produce characteristic absorption patterns called *fingerprint spectra*, so they are also promising for use in sensing. When using terahertz waves for sensing, the internal structure of an object can be imaged in a non-contact and non-invasive way, information can be obtained about things (materials, biomaterials, etc.) in the immediate surroundings, and materials composing the object can be identified. Such information about objects is difficult to obtain using conventional sensors, and using it in society will enable increases in productivity and efficiency in all kinds of scenarios related to security, health, medicine, the environment, science, industry and agriculture. We will also be able to detect dangers in society quickly.

To accelerate utilization of terahertz waves in society for sensing and wireless communications, it will be important to reduce the size and increase the performance of terahertz equipment (terahertz sources and detectors) (see Figure 1). A number of current terahertz sources generate terahertz waves by changing the wavelength of laser light using non-linear optical materials. However, such wavelength conversions are extremely inefficient, so they require large laser light sources with high output, and the equipment is large. Most current terahertz wave equipment for emission and detection is also limited to lower frequencies (approx. 0.1 to 4 THz), so for *fingerprint spectra*, it has been difficult to obtain many of the absorption peaks in the higher-frequencies, which are useful for identifying materials. To advance the use of terahertz waves in sensing, the bandwidth of terahertz wave emitters and detectors needs to be increased.

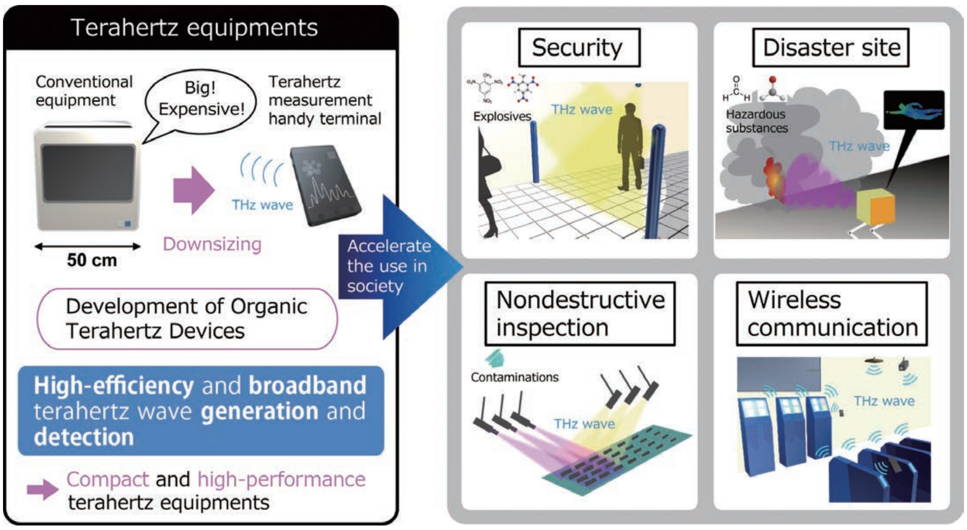



Figure 1 Expansion of the use in society by reducing size and increasing performance of terahertz equipment

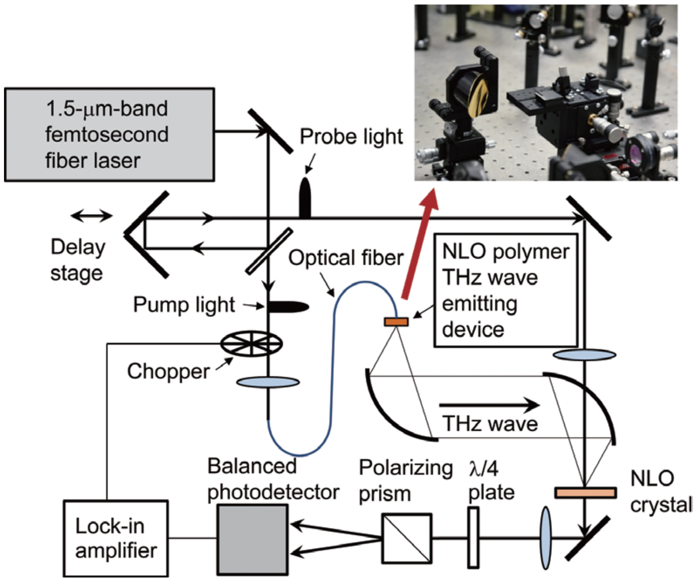


**Figure 2** Apparatus for evaluating a non-linear optical polymer terahertz wave emitting device

## ■Terahertz technology using non-linear optical polymers

We have developed non-linear optical polymers and devices that use them in order to greatly increase the efficiency and bandwidth of terahertz wave emitters and detectors.

Compared to inorganic and organic non-linear optical crystal materials that have been used for emission and detection of terahertz waves, such as lithium niobate ($LiNbO_3$), zinc telluride (ZnTe) and DAST, non-linear optical polymers have a large electro-optical coefficient (> 100 pm/V) and their figure of merit (FOM) values for terahertz wave emission, considering the effects of refractive index of the materials, exceed the values for the materials above (see Table).

For inorganic crystal materials such as $LiNbO_3$ and ZnTe, the bandwidth of emitted terahertz waves is narrow because high-frequencies are absorbed due to crystal lattice vibration. For non-linear optical polymers, the absorption coefficient is small over a wide range of the terahertz domain, so emission and detection of terahertz waves over an ultra-broad band (0.1 to 20 THz) is possible.

Non-linear optical polymers can also be used with micro-processing to fabricate waveguide devices, so we can expect to realize devices that yield large increases in terahertz wave emission efficiency through use of optical confinement effects.

## ■Terahertz wave emitting devices using non-linear optical polymers

To realize a compact terahertz source, we are developing a terahertz emitter device using 1.5 μm band laser light that can lase in small semiconductor lasers and fiber lasers and can be used in various optical communication technologies.

Earlier, we successfully generated terahertz waves by taking laser light from a femtosecond titanium-sapphire laser, converting it to laser light of wavelength 1.5 μm using an optical parametric amplifier, and then exposing a non-linear optical polymer to this light. We also built a system to evaluate a terahertz emitter device using an even smaller, low-power 1.5 μm-band erbium-doped fiber laser (Figure 2), and succeeded for the first time in observing terahertz wave emission from a non-linear optical polymer device under weak pump light intensity conditions. To further increase the terahertz wave emission efficiency, we are continuing to develop terahertz wave emitter devices using micro-waveguide structures and conducting experiments using a 1.5 μm-band ultra-short pulse fiber laser able to emit terahertz waves over a very wide bandwidth.

## ■Future prospects

To further improve the performance of terahertz devices, we are developing materials that greatly reduce terahertz wave absorption losses, and by applying the organic-silicon hybrid optical modulator technology that our group is developing, we will develop devices with dramatically increased terahertz wave emission efficiencies. Use of non-linear optical polymers will also make more-sensitive terahertz wave detectors possible. Improved performance of both emission and detection will make it possible to implement compact terahertz equipment not seen before, and this will contribute to a safer, more secure ICT society using terahertz waves.

**Table** Comparison of non-linear optical materials used for terahertz wave emitters and detectors

| | THz frequency range | Refractive index $n_o$ , $n_{THz}$ | EO coefficient $r$ (pm/V) | FOM of THz generation | Micro-fabrication |
|---|---|---|---|---|---|
| Nonlinear optical polymer | 0.1 - 20 THz | ~1.7, ~1.7 | > 100 | > 8900 | Feasible |
| Lithium niobate ($LiNbO_3$) | 0.1 - 2 THz | 2.2, 4.96 | 32 | 1500 | |
| Zinc telluride (ZnTe) | 0.1 - 4 THz | 2.83, 3.16 | 4 | 160 | Modestly |
| DAST | 0.3 - 16 THz | 2.13, 2.26 | 47 | 5600 | |

TOPICS

# Report on NICT Open House 2015

**NICT Open House 2015 was held at six facilities this year, opening our facilities and introducing our latest research results to the general public, including facilities in Koganei, Kobe, Keihanna, Umekita, Kashima, and Okinawa.**
**In this issue, we introduce the open houses held at the five facilities besides Kobe which was introduced in the last issue.**

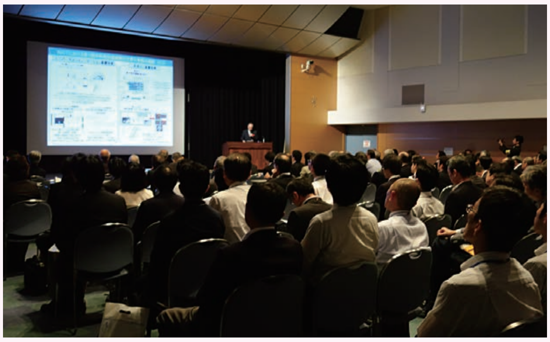
## NICT Open House 2015

NICT Open House 2015 was held at NICT headquarters (Koganei City, Tokyo) over two days on October 22 and 23, 2015. This was the largest event by NICT, including all local research facilities and introducing the latest research results through lectures, demonstrations, panel exhibits, and laboratory tours.

Both days were blessed with beautiful autumn weather, and approximately 1,000 visitors attended the event.

### Opening Ceremony

The opening ceremony on the first day featured an organizer greeting and activities report to a full house by Dr. Masao SAKAUCHI, President of NICT. This was followed by a special lecture by Dr. Hideyuki TOKUDA, Dean and Professor, Faculty of Environment and Information Studies, Keio University, titled "Creation of Smart Cities with IoT/CPS and Social Open Data."



**Opening Ceremony venue**

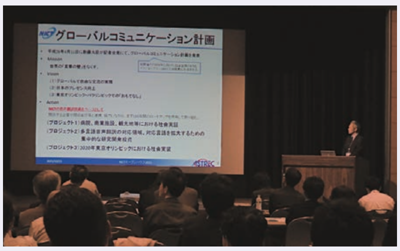
**Organizer Greeting by Dr. SAKAUCHI**

**Special Lecture by Dr. TOKUDA**

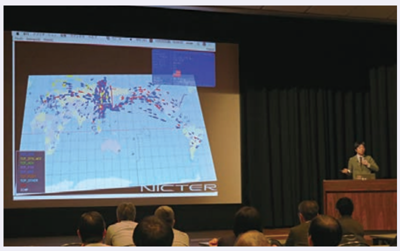
### Lectures

11 lectures were held over the two days, giving overviews, results and future prospects of the wide range of research fields at NICT to the many attendees.

**Radar sensing technologies contributing to a society resistant to natural disasters**
Dr. Minoru KUBOTA, Director of Radiowave Remote Sensing Laboratory, Applied Electromagnetic Research Institute




**Speech translation technology supporting global communication planning**
Dr. Hisashi KAWAI, Director of Spoken Language Communication Laboratory, Universal Communication Research Institute/Director of Advanced Speech Technology Laboratory, Advanced Speech Translation Research and Development Promotion Center




**NICTER (Network Incident analysis Center for Tactical Emergency Response)**
Dr. Masashi ETO, Senior Researcher, Cybersecurity Laboratory, Network Security Research Institute

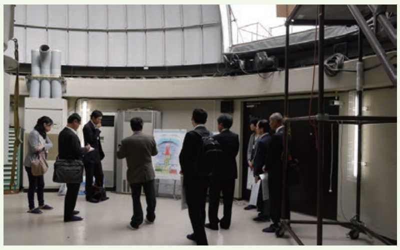
## Laboratory Tours

A total of 38 of the popular laboratory tours over nine tours were held this year. The opportunity to experience the latest research and technology in facilities that are not normally accessible to the public was one of the greatest features of these open house events.

Attendees listened intently to the explanations from the researchers and commented on how many questions they answered and what a great learning experience it was.

**Advanced optical semiconductor device production environment (clean room) tour**
Attendees actually entered the clean room, which maintains a clean-air environment with almost no dust, and saw a variety of test equipment.

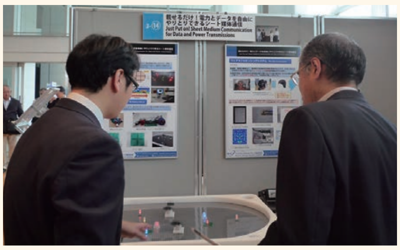
**Space Weather Forecast meeting tour**
Attendees toured the meeting room of the Space Weather Forecast Center, where members meet and collaborate every day with other facilities around the world, to monitor and forecast fluctuations in the space environment surrounding the earth.



**Telescopes enabling optical communications with satellites tour**
Optical communications is taking on a principal role in space (satellite) communications. Attendees viewed the 1.5 m aperture large telescope, which is one of the largest telescopes in Japan capable of tracking artificial satellites.

## Demo/Panel Exhibit Area

Demonstrations and panel exhibits of NICT research results were held in 65 different booths. Some of the booths held Mini workshops introducing details of the exhibits. Attendees commented that seeing the actual equipment made it easier to understand, and that researchers explained it proactively, giving a valuable chance for exposure to various research activity.



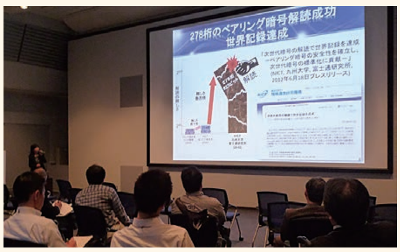
**Just place on! Sheet medium communication for data and power transmissions**

**"VoiceTra": The multilingual speech translation app to overcome language barriers**

**NICT radars: An eye on earth environment**

**Contract research results**

**Mini workshop**




**Lecture introducing research activities at the Network Security Laboratory**

## NICT Open House 2015 in Keihanna

NICT held the "Keihanna Information and Communications Fair 2015," in cooperation with organizations and universities involved in information and communications, in Keihanna Science City on October 29 to 31, 2015.

This event was held to publicize research results in information and communications technology and promote collaboration among related organizations. It also functions as our "NICT Open House 2015 in Keihanna" event.

Ceremony

NICT held a special lecture by Dr. Eiichi NAITO, Research Manager, Brain Networks and Communication Laboratory, The Center for Information and Neural Networks, titled "Learning from Neymar: Brain mechanisms that move the body—Cultivating Japanese who are competitive on the world stage by training the central nervous system—," in which he described how the brain moves the body and how motion is learned, as well as techniques to improve motion. The presentation was very accessible to and popular among attendees. Dr. Kentaro TORISAWA, Director of the Information Analysis Laboratory, Universal Communication Research Institute, also gave a technical lecture titled, "The 'WISDOM X' and 'DISAANA' Information Analysis Systems."

In the exhibit sessions, visitors were able to experience research results in universal communication technologies, including a multi-lingual speech translation applet that supports hosting of visiting foreign tourists, Disaster-information Analyzer for SNS, and fVisiOn, which now comprises much smaller hardware and is nearly ready for practical implementation.

A demonstration of trials being done in cooperation with the Wireless Networks Laboratory using the Seika KURURIN Bus in the Keihanna area was also announced.

An exhibit of a tele-work system was also attempted for the first time this year, in the Open Lab on the first floor of NICT venue, with a live link to the Keihanna Plaza venue.

**Special Lecture**
Research Manager
Dr. Eiichi NAITO

**Technical Lecture**
Director
Dr. Kentaro TORISAWA

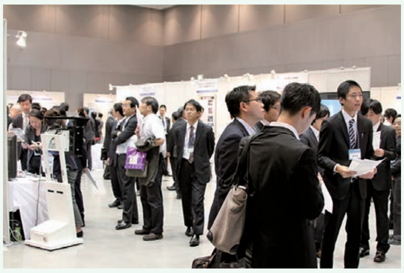


**Exhibit venues (Left: Keihanna Plaza, Right: NICT venue)**

## NICT Open House 2015 in Umekita

The "NICT Open House 2015 in Umekita" was held on November 21 to 23, 2015, comprised of two events: "Keihanna Information and Communications Fair 2015 @ The Knowledge Capital," and "Keihanna Experience Fair 2015 @ The Knowledge Capital."

The event featured the first-ever viewing of the "Hidden Buddha" from Hannyaji temple in Nara Prefecture on a 200-inch multi-view, glasses-free 3D display system. 1,100 visitors experienced the exhibit. 1,600 parents with children and other visitors were also able to experience the latest technologies in the Keihanna region at the Active Studio.

**200-inch 3D image: "The Hannyaji-temple Hidden Buddha"**

## NICT Open House 2015 in Kashima

The "NICT Open House 2015 in Kashima" event was held on November 21, 2015, opening the Kashima Space Technology Center in Kashima City, Ibaraki Prefecture, to the public.

The theme this year was "Getting familiar with radio waves and satellites!" and it featured accessible introductions to satellite communication research using the Wideband InterNetworking engineering test and Demonstration Satellite "KIZUNA" (WINDS), research on orbits of satellites and celestial bodies using optical telescopes, and VLBI research using the 34 m diameter parabolic antenna.

Many parents and children participating in the craft workshop


Touching the 34 m diameter parabolic antenna

Visitors from children to the elderly were able to experience the character of the Kashima Space Technology Center research facility through exhibits and activities, including satellite capture time trials using a commercial BS antenna, a movie describing the movements of artificial satellites, touching and climbing the 34 m antenna, a craft workshop and a stamp rally.

## NICT Open House 2015 in Okinawa

The "NICT Open House 2015 in Okinawa" was held on November 21, 2015 at the Okinawa Electromagnetic Technology Center. The day had unseasonably hot temperatures of 27˚C, and the event had 271 visitors; many more than the previous year. Research activities at the Center were introduced with facility tours and hands-on activities such as operation of simple radar. There were also other exhibits supported by NICT headquarters, including radar images of the Okinawa region taken using the airborne Polarimetric and Interferometric Synthetic Aperture Radar (Pi-SAR2) system, the SCALE (SCAlable Layer image display system for the Environment), the new "VoiceTra" multilingual speech translation applet, and the NICTER (Network Incident analysis Center for Tactical Emergency Response).

Furthermore, several activities were provided in cooperation with external facilities: demonstration of meteorological observation using radiosonde in cooperation with the laboratory of Dr. Hiroyuki YAMADA, Associate Professor at the University of Ryukyu, who is conducting joint research with NICT; an exhibit of an radio-wave monitoring car by the Okinawa Office of Telecommunications, Ministry of Internal Affairs and Communications; an electronics workshop by Clean DENPA NET, the Efficient use of Radio Spectrum Association of Okinawa Prefecture; and an amateur radio workshop from the Okinawa branch of the Japan Amateur Radio League.

Experience corner: Try operating the radar

Demonstration of meteorological observation using radiosonde

# A New Version of "VoiceTra" has been Released

(VoiceTra is a multilingual speech translation app that translates your speech into different languages.)

## VoiceTra

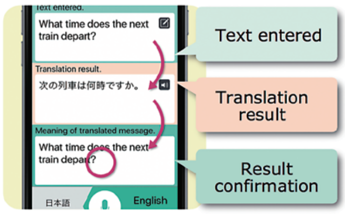
Try the new and improved "VoiceTra"!

### User-friendly

Simple and easy to use.
Help messages will also assist you on how to use the app.


### Check the translation results

The translation results are translated back into your own language. This feature allows you to confirm if the results are delivered with the intended meaning.




### What's New

★ Improved translation accuracy

Targeting the travel domain, we have improved the translation accuracy for 10 languages, including Japanese.

★ Enriched proper nouns and phrases

In addition to travel-related conversations, VoiceTra now supports conversations in hospitals, shopping facilities, sight-seeing spots, and many other scenes.

★ A new look and user-interface

### Using "VoiceTra"

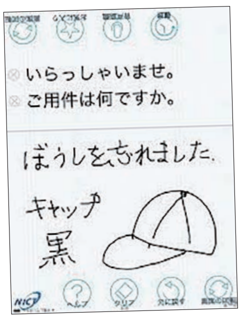
★ How to download: Search for "VoiceTra" on the App Store or Google Play.
★ Support page: http://voicetra.nict.go.jp/en/
★ VoiceTra video page: Watch our videos on the above support page.

※ App Store is a service mark of Apple Inc. Google Play is a trademark or registered trademark of Google Inc.

## Communicate with the world using "VoiceTra"!

## NICT facilitates the development of apps to support smooth communication between the hearing-impaired and people with normal hearing.

### SpeechCanvas




SpeechCanvas is an app that supports conversation between the hearing-impaired and people with normal hearing. It displays spoken words in text and allows participants to trace characters and images with their fingers on the screen. Operation is simple and intuitive so that anyone can use it easily.

Support page
http://speechcanvas.nict.go.jp/ (Japanese only)

### KoeTra


KoeTra is an app that supports smooth communication between the hearing-impaired and people with normal hearing by converting text to speech and vice versa, to convey your message to the other person.

＊This technology has been transferred to Feat Limited, which provides the service free-of-charge.

Support page
http://www.koetra.jp/en/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