OUTLINE OF TECHNICAL COMMITTEES IN IEEJ

Dielectrics and Electrical Insulation (DEI)

Chairperson: Masayuki Nagao (Toyohashi University of Technology)
Secretaries: Yasuhiro Tanaka (Tokyo City University)
Yuichi Ashibe (Sumitomo Electric Co. Ltd.)
Assistant Secretaries: Toshihiro Takahashi (CRIEPI)
Takahiro Imai (Toshiba Co. Ltd.)

The activities of the Technical Committee on Dielectrics and Electrical Insulation (TC-DEI) have been covering mainly solid and composite dielectric materials and their related technologies. The important activity of TC-DEI is to hold the annual domestic Symposium on Electrical and Electronic Insulating Materials and Applications in Systems (SEEIMAS), formerly called Symposium on Electrical Insulating Materials (SEIM), and the International Symposium on Electrical Insulating Materials (ISEIM) being held in every 3 years.

Last year we held the 7th ISEIM in September in Kyoto followed by the Joint colloquium of CIGRE SC-A2 and D1. This year we held the 43rd SEEIMAS with the General Chair of Prof. M. Nagao on September 10-12, 2012, in Mishima city, Shizuoka, Japan with technically cosponsored by IEEE DEIS Japan chapter. Diagnosis of electrical insulation degradation, new materials and the improvement of their properties, functional materials, nano-composite materials, insulation systems under inverter surges, partial discharge and space charge measurement, outdoor insulations, thin dielectric films and other topics were discussed.

Next year we will hold the 44th SEEIMAS in Toyohashi city, Aichi, Japan in the autumn of 2013. We are expecting your participation.

Furthermore, the TC-DEI runs several Investigation Committees (IC's). The role of IC's is to organize several technical meetings a year to provide opportunities for the experts to discuss the recent R&D activities on the selected important issues in our field and finally to publish the Technical Report. The investigation committees are categorized into following four research areas:

Macro-view of DEI technology related

> Present Status and Future Perspective of Innovative Electrical Insulation Diagnosis of Electric Power Apparatuses (09/2012-08/2015, Chairperson: M. Ikeda (Japan Nuclear Energy Safety Organization)).

New materials including nano-materials related

> Controlling of Nano-Materials and Nano-Structure for Application to New Functional and High Performance Organic Devices (04/2011 - 03/2014, Chairperson: K. Kato (Niigata University)).

> Research Frontier on Organic Electrical / Electronic and Dielectric / Conducting Materials in Asia (10/2010 - 09/2013, Chairperson: M. Iwamoto (Tokyo Institute of Technology)).

> Advanced Polymer Nanocomposites and their Applications as Dielectrics and Electrical Insulation (04/2010 - 03/2013, Chairperson: T. Tanaka (Waseda University)).

Ageing and diagnosis of electric and electronic equipment related

> Degradation Diagnosis Technology based on Characteristics of Insulation Materials in Electric Power Apparatus (04/2007 - 03/2010, Chairperson: Y. Ehara (Tokyo City University)). The Technical Report was published and the succeeding committee is now under preparation.

> Electrical Insulation Diagnosis of Inverter Fed Motor Coils (01/2013 - 12/2015, Chairperson: M. Nagata (University of Hyogo)). This committee is cosponsored by the TC-DEI and TC of Electrical Discharge.

Basic dielectric and breakdown phenomena related

> Standardization of Calibration and Development of Application on Space Charge Measurement using PEA Method (03/2009-02/2012, Chairperson: Y. Tanaka (Tokyo City University)). Technical report will be published soon.

> Properties Evaluation and Improvement Technology of Polymeric Insulating Materials for Outdoor Use (04/2010 - 03/2013, Chairperson: H. Homma (CRIEPI)).

Electrical Discharges (ED)

Chairperson: F. Tochikubo (Tokyo Metropolitan University)
Secretaries: A. Kumada (The University of Tokyo)
H. Kojima (Nagoya University)
Assistant Secretaries: Y. Yamano (Saitama University)
N. Shimura (Toshiba Corporation)

The Technical Committee on Electrical Discharge (TC-ED) belongs to the Fundamentals and Materials Society (A-Society) of the IEE Japan. The purposes of the TC-ED are mainly in the wide promotion of the research activities concerning to a variety of electrical discharges in vacuum, gas, liquid and on surfaces of materials and their applications to high technologies.

Several investigation committees, which are the affiliates of the TC-ED, are established every year to survey the up-to-date research subjects. The activities of these committees usually continue for three years. The chairpersons shown in Table 1 currently run three investigation committees.

The TC-ED organizes about six domestic technical meetings on electrical discharges every year. In these meetings, about 200 full papers are presented in total from both academic and industrial sides by researchers, engineers, professors and students. The domestic technical meetings are sometimes co-organized by other Technical Committees such as High Voltage Engineering, Pulse Electromagnetic Energy, Plasma, and Dielectric/Electrical Insulating Materials.

In order to promote the international activities in electrical discharges, “Japan-Korea Joint Symposium on Electrical Discharge and High Voltage Engineering” has been organized by the TC-EC. This year, the J-K symposium will be held jointly with the eighth International Workshop on High Voltage Engineering on November 16-17 in Kanazawa.

The TC-ED also contributes to the organization of a young researcher seminar every year in cooperation with the Institute of Engineers on Electrical Discharges in Japan to encourage the young researchers in the field of electrical discharges. About 40 young researchers and engineers participate in the seminar and discuss vigorously the topics related to electrical discharges for two days. The seminar in this year will be held on November 30 and December 1, 2012.

Table 1 Investigation Committees in TE-ED

Chairperson	Research subjects and established time
K. Satoh (Muroran Institute of Technology)	Atomic and molecular collision cross section and fundamental parameters of discharges (established in April 2011)
T. Oda (The University of Tokyo)	Electrostatic discharges as electromagnetic interference source (established in April 2011)
K. Miyagi (Kanazawa Institute of Technology)	Electrical/chemical behavior and application technology in dielectric liquids (established in October 2012)

Plasma Science and Technology (PST)

Chairperson: Hiroshi Akatsuka (Tokyo Institute of Technology)
Secretaries: Yasunori Ohtsu (Saga University)
Jaeho Kim (National Institute of Advanced Industrial Science and Technology)
Assistant Secretaries: Nozomi Takeuchi (Tokyo Institute of Technology)
Naoki Shirai (Tokyo Metropolitan University)

The Technical Committee on Plasma Science and Technology (TC-PST) was founded in April 1999. This committee has the basis on the plasma researcher’s society that had organized Technical meeting on plasma science and technology in IEE Japan several times every year since about 30 years ago. The field of activity of this committee includes researches and investigations of various plasmas over wide ranges of their density, temperature, ionization degree, and applications such as nuclear fusion, plasma processing, and plasma chemistry.

The major activity of this committee is to succeed

to organize several technical meetings on plasma science and technology every year. In 2012, three technical meetings were held; in May at Toyohashi University of Technology in Aichi, in August at Iwate University in Iwate, and in December at The University of Tokyo in Tokyo. In 2011, also three technical meetings were held. At each symposium, about 20–60 presentations are made. Presentations by young researchers in bachelor course and master course are strongly encouraged and appreciated. Some of the technical meetings are jointly organized with TC-PPT.

TC-PST currently runs four investigation committees as shown in Table 1. Here we introduce their activities. In the committee of atmospheric pressure plasma source for analysis of trace-order element, physics and chemistry of atmospheric pressure plasmas as well as their appropriate diagnostic methods and applications are being investigated. In addition, innovative technologies required for the various industrial applications are widely surveyed. In the committee of generation and application of metal vapor plasmas with high density and high ionization degree, upon the research outputs of the advancement of metal sputtering plasma committee held in 2006–2008, investigations are made over their characteristics, overview and perspectives to activate related research activities in domestic institutes. In the committee of the standardization of experiment and simulation modeling in liquid interface plasma, upon the research outputs of the advancement of the plasma–water applications and their reacting processes committee held in 2008–2010, investigations are made over the characteristics on plasma–water interface, overview and perspectives to activate related research activities in domestic institutes. Finally, in the committee of the propulsion performance of electrical propulsive rocket engine and its internal plasma physic phenomena, the progress of the propulsion performance and the understanding of physical phenomena in plasma are investigated by researchers of electrical engineering or plasma engineering.

Table 1. Investigation Committees in TC-PST.

Atmospheric Pressure Plasma Source for Analysis of Trace-Order Element	3 years from 2010, Chairperson: A. Okino (Tokyo Institute of Technology)
Generation and Application of Metal Vapor Plasmas with High Density and with High Ionization Degree	3 years from 2010, Chairperson: T. Ikehata (Ibaraki University)
Standardization of Experiment and Simulation Modeling in Liquid Interface Plasma	3 years from 2011, Chairperson: K. Yasuoka (Tokyo Institute of Technology)
Propulsion Performance of Electrical Propulsive Rocket Engine and Its Internal Plasma Physic Phenomena	3 years from 2011, Chairperson: K. Tahara (Osaka Institute of Technology)

Pulsed Electromagnetic Energy (PEE)

Chairperson: Eiki Hotta (Tokyo Institute of Technology)
Vice-Chairperson: Sunao Katsuki (Kumamoto University)
Secretary: Takashi Kikuchi (Nagaoka University of Technology)
Assistant Secretary: Jun Hasegawa (Tokyo Institute of Technology)

The Technical Committee on Pulsed Electromagnetic Energy (TC-PEE) was founded under the Fundamentals and Materials Society of the IEE Japan in June 1999. The activity of TC-PEE covers the collection and spread of information on pulsed power technology and its applications. Using pulsed power technology, very high power electromagnetic pulses can be produced, which are used for generation of high power lasers, high power electromagnetic waves, short wavelength light or high power particle beams. In addition, while huge machines with extremely high output power released in a single shot are developed at the start of the pulsed power technology, many smaller devices equipped with a lot of modulators, which are able to control the pulse waveform accurately by using high speed semiconductor switch elements but possess only the ability of smaller output energy, are now being developed and used in series-parallel connection to attain higher average power in high repetition rate operation.

The application of this technology is now extended to the following broad fields; new material development, thin film synthesis or ion implantation in industrial field; sterilization or medical treatment in biological and medical field; toxic gas decomposition and ozone or radical production in environmental field; nuclear fusion or particle beam accelerator technologies in energy field; and moreover the destruction of rocks or concrete blocks in the civil engineering field and growth promotion of plant in the field of agriculture science. Thus the pulsed power

technology becomes to be widely recognized as the basis of many technologies.

Recent activities of TC-PEE

The major activity of TC-PEE is to organize several technical meetings every year. In 2012, five technical meetings have been held or planned to be held, including the meetings in cooperation with the Technical Committees on Electrical Discharges or Plasma Science and Technology; in March at Kumamoto University in Kumamoto, in May at Yamagata University in Yamagata, in August at Iwate University in Morioka, in October at Saga University in Saga and in December at Tokyo University in Tokyo. A photograph of joint meeting held in last December at Tokyo Institute of Technology in Tokyo is shown in Fig. 1. Presentations by young researchers are strongly encouraged and selected young researchers who make excellent presentations are awarded.

Fig. 1 Joint technical meeting in cooperation with the Technical Committee on Plasma Science and Technology held in last December at Tokyo Institute of Technology in Yokohama.

Investigation Committee on Agricultural Applications Using Pulsed Power and Plasmas

In order to conduct an investigation on the present status of research and development in agricultural applications using pulsed power and plasmas, a committee chaired by Prof. Takaki was organized in January of this year. The topics include applications based on biological effects such as plant germination, inactivation of bacteria, electroporation, preservations of agricultural and marine products, gene injection, cell manipulation, and bioelectric science. Goals of the committee are to develop new fields for application of pulsed power technologies and to contribute for a food supply chain and a sustainable society.

Investigation Committee on the Status and Outlook of Pulsed Power Technology in Extremely High Power Level

In order to conduct an investigation on the present status of research and development in extremely high power level of pulsed power technology, a committee chaired by Prof. Horioka was also organized in January of this year. The topics include its applications to high energy density physics, laboratory astrophysics, high power accelerators, energetic radiation sources, material science at extreme state, radiation hydrodynamics, intense plasma shock waves, and fusion science. Goals of the committee are to overview the state of the art of the pulsed power technology, and to get an outlook on the future direction of the technology at more than GW power level.

Reported by

Eiki Hotta (Tokyo Institute of Technology)
Koichi Takaki (Iwate University)
Kazuhiko Horioka (Tokyo Institute of Technology)

Electro-Magnetic Compatibility (EMC)

Chairperson:	T. Funaki (Osaka University)
Secretaries:	K. Kawamata (Hachinohe Institute of Technology)
	T. Ushio (Osaka University)
Assistant Secretaries:	Y. Hayashi (Tohoku University)

The Technical Committee on Electro-Magnetic Compatibility (EMC) has a vital role of researching following subjects;

1. Comprehensive understanding of electrical power system and EMC issue,
2. Establish the interdisciplinary cooperation among several groups and/or institutes related with EMC problem,
3. Investigations on new and high technology for EMC,
4. Advertisement to the public on EMC issue and key technologies,
5. Introductory advertisement of international EMC standard to the domestic EMC researchers.

For these purposes the committee pays their attention to the causes of electromagnetic interference phenomena, the situation of electromagnetic interferences occurrence, the novel measurement techniques and method for EMC, the protection technology and counter measurement for EMC and international and domestic EMC regulations. The committee has been organizing four dedicated

research sub-committees to realize the effective activity.

1. Investigation committee on technical trends in evaluation of biological protection and compatibility with electromagnetic field.
2. Investigation committee on the analysis technology of electromagnetic filed including human body.
3. Investigation committee on the characteristics of noise accompanied with discharge.
4. Investigation committee on smart grid and EMC.

These sub-committees basically work independently, and each sub-committee meeting is held every two or three months regularly to announce their investigations and to share the obtained knowledge among sub-committee members. The practical period for the sub-committee activity is two or three years, and they are expected to publish their investigating results as a technical report of investigation committee or to have special conferences, which are related to their research theme. The investigation committee on EMC technologies for ElectroStaic Discharge, which finished the research work and dissolved in March 2011 presented their research work as the journal paper in the special issue of IEEJ transaction on fundamentals and materials in (May 2012).

The ad-hoc research committee for in vivo influence of electro magnetic field, which belongs to the head quarter of IEEJ, was dissolved on March 2012. Then, the function of responsibility and authority for research work of this ad-hoc committee was transferred to this technical committee on EMC.

Electromagnetic environment is the field, where electromagnetic phenomena exist. They are electromagnetic fields due to naturally-originated sources like lightning and earthquake, and artificial ones generated from electrical and electronic equipment as well as radiated from power lines or communication cables, and so force. EMC is the capability of electrical and electronic systems, equipment and devices to operate in the above-mentioned electromagnetic environment, without suffering or causing unacceptable degradation as a result of electromagnetic interference. In other words, a system is considered as electromagnetically compatible if it satisfies the following three criteria:

1. It does not cause interference with other systems;
2. It is not susceptible to emissions from other systems;
3. It does not cause interference with itself.

The problems related to EMC had been discussed in the “Special Research Committee of EMC Engineering”, which was established in 1997 by IEICE and IEEJ joint venture. The high activity of the committee promoted the establishment of the technical committee on EMC in the Fundamentals and Materials Society of IEEJ. The committee was established to substitute the former committee in April 1999. Then Prof. T. Takuma of Kyoto University was elected as the first chair of the committee. After that, Prof. O. Fujiwara and Prof. Z-I. Kawasaki chaired the committee respectively from 2002 to Apr. 2005, and from May 2005 to Apr. 2008. Currently, Prof. T. Funaki succeeds the chair since May 2008. The committee holds some technical conferences. They were June, 24th(47th), November 2nd(48th) for 2011. March 12th(49th) , June 22th(50th) for 2012.

1. Investigation committee on technical trends in evaluation of biological protection and compatibility with electromagnetic field.

This committee, chaired by Assoc. Prof. A. Hirata of Nagoya Institute of Technology, was established in Apr. 2010. The mission of this committee is to survey the formulation of guidelines of human protection against to the electromagnetic field and to investigate the trend in the standardization of product safety. Moreover, this committee aims at publicity work in clarifying the scientific basis of these guidelines and standards with applying former research work nurtured by antecedent committees. The investigation subjects are summarized as followings.

1. Trend survey in the guideline related to the human safety;
2. Trend survey in the standardization of product safety;
3. Scientific study in the guidelines and standardizations;
4. Find an issue for future work.

To this end, this committee recruited biological specialist as committee members in addition to the conventional electrical engineers.

2. Investigation committee on the analysis technology of electromagnetic field including human body.

This committee, chaired by Assoc. Prof. Y. Kamimura of Utsunomiya University, was established in Apr. 2010 to respond to the diversifying electromagnetic environment; such as popularization of wireless and radio wave sensitive appliances. The mission of this committee is to develop and establish the fast and precise calculation and evaluation method of electromagnetic field for internal and external of human body under complex electromagnetic environment. The committee is working on the following subjects.

1. Survey the analytical and quasi-analytical calculation method of electromagnetic field inside and outside of human body;
2. Survey the numerical calculation method of electromagnetic field suitable for medium frequency band;
3. Study on the fast calculation method on the basis of surveyed calculation technology.

This committee envisions providing adequate calculation method for evaluating the exposure of

human body under the complex electromagnetic environment.

3. Investigation committee on the characteristics of noise accompanied with discharge.

This committee, chaired by Prof. K. Kawamata of Hachinohe Institute of Technology, was established in Apr. 2011. The mission of this committee is to measure and figure out the characteristics of voltage and current response associated with ESD from the view point of EMC, and to clarify the mechanism in emission of electromagnetic field by ESD with associating the characteristics of electromagnetic field and parameters for discharge. The investigation subjects are summarized as followings.

1. Systemize the interfering object by ESD;
2. Basics and mechanisms of ESD;
3. Dominant factors and parameters of current waveform by ESD;
4. Measurement and prediction of transient waveforms by ESD;
5. Characteristics of electromagnetic field y ESD;
6. Optimization of ESD immunity test;
7. EMC modeling and simulation of ESD.

This committee envisions to clarify the difficulties of noise immunity for electric and electronic appliances, and to offer basic data to deal with.

4. Investigation committee on smart grid and EMC.

This committee, chaired by Emer. Prof. M. Tokuda in Tokyo City University, was established in Apr. 2011. The mission of this committee is to sort out the international and domestic EMC problem related to smart grid, and to clarify the difference in the research and development of smart grid technology stemming from the difference in the regulation of EMC over the world. The committee is working on the following subjects.

1. Overall conditions of research and development of smart grid technology over the world;
2. Trend in the standardization of smart grid;
3. EMC regulations related to smart grid;
4. EMC problems in generation and transformation of electricity;
5. EMC problems in transmission and distribution of electricity;
6. EMC problems in communication network for smart grid;
7. EMC problems in load and energy storage.

This committee envisions clarifying the EMC problems expected to occur in smart grid.

Light Application and Visual Science (LAV)

Chairperson: Yoshiaki Tsunawaki (Osaka Sangyo University)
Secretaries: Mitsuhiro Kusaba (Osaka Sangyo University)

Activities of the technical committee on light application and visual science (TC-LAV) have been covering fields of visual/optical information processing and various kinds of application of optical engineering in the wavelength region from far-infrared (THz-wave) to extreme ultraviolet. In this report, two recent topics of light application including THz-wave/microwave are introduced.

The first topic is “Simple method for measuring optical fiber length using a gain-switched DFB laser as a pico second-time-gated amplifier”.

Because a gain-switched laser diode is insensitive to its optical feedback, the gain-switching technique is often used in disc systems, optical communication systems, and optical sensor systems, to avoid oscillation instabilities in laser diodes. However, output ASE (amplified spontaneous emission) noise from a gain-switched distributed feedback (DFB) laser was found to be increased remarkably only if picosecond output pulses were fed back to the laser at the precise moment that the laser generated gain-switched pulses. This means that a gain-switched DFB laser operates as a sensitive optical amplifier with a time-gate of tens of picoseconds. In this study, we demonstrated a simple method for measuring the optical length of an optical fiber using a gain-switched DFB laser as a time-gated optical amplifier.

Figure 1 shows the experimental setup. A fiber pigtailed 1550 nm DFB laser was connected to Port 1 of a 50/50 fiber coupler. The two ports (Port 3, 4) of the other side of the fiber coupler were connected with a fiber to be measured (fiber optical length: L_1). The rest port (Port 2) was connected to an amplified photodetector with 10 MHz bandwidth. The DFB laser was dc-biased at its threshold and sinusoidally gain-switched with 10 dBm microwave power around 1 GHz modulation frequency. Then, the noise level of the gain-switched DFB laser was measured as a function of the modulation frequency f of the DFB laser, as shown in Fig. 2. The noise peaks were found at the modulation frequencies, f_1 and f_2 respectively, where output pulses were fed back to the DFB laser just when the time-gate in the laser was fully-open. At those noise peak conditions, the following relation between the modulation frequencies f_1, f_2 and the optical length L_0+L_1 holds:

$$L_0 + L_1 = \frac{c}{f_2 - f_1} \qquad (1)$$

where c is the light speed, L0 is the sum of the optical lengths from the laser facet to Port 3 and from Port 4 to the laser facet.

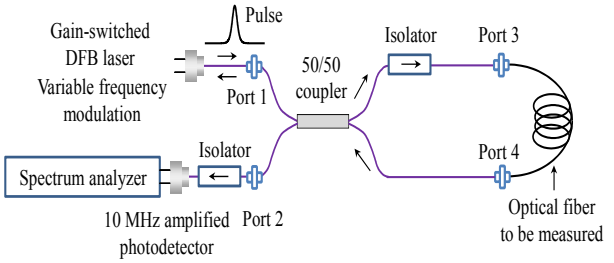

Fig. 1 Experimental setup for measuring the optical length of an optical fiber.

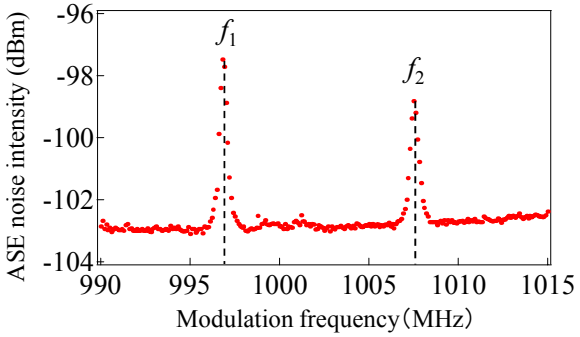

Fig. 2 Variation of the output ASE noise level as a function of the modulation frequency.

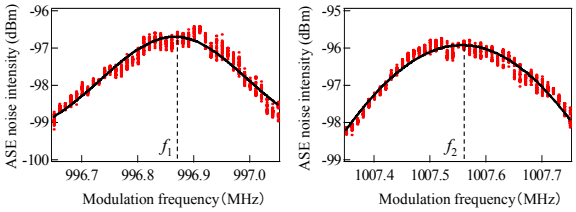

Fig. 3 Variations of the output ASE noise levels when the modulation frequency was varied around f_1 and f_2 in 0.01 MHz steps.

Figure 3 plots noise levels when the modulation frequency was varied around f1 and f2 in 0.01 MHz steps. The noise level was measured 30 times at respective modulation frequencies. As a result, the modulation frequencies f1 and f2 at the noise peaks were precisely estimated as 996.866±0.001 MHz and 1007.557±0.001 MHz, respectively. By substituting these values into Eq. (1), the optical length L0+L1 was obtained to be 28.060±0.005 mm. The optical length L0 was also estimated as 13.150 ± 0.002 m, employing the same technique as used in estimating the optical length L0+L1, after directly connecting Ports 3 and 4. By subtracting L0 from L0 + L1, the optical length of the fiber under test was successfully estimated as 14.910 ± 0.007 m.

The second topic is "microwave computer tomography (CT) for breast cancer screening".

CT method is under development for breast cancer diagnostics. This CT method utilizes high contrast in electrical properties between normal tissues and malignant tissues. High permittivity of malignant tissues causes microwave reflection and scattering in the breast. The electric property is available to sensitive detection of small malignant tissues from normal tissue in breast.

A main circuit of the microwave CT system is similar to a heterodyne. This CT system has become available by recent progress in mobile communications with effective and low-cost microwave Integrated Circuits (ICs). The system development cost can be reduced by using low-cost frequency converter and quadrature. An illumination source outputs continuous microwave at the frequency of 8 to 12 GHz. The illumination plane wave is transmitted from a corrugated horn antenna. A crystal oscillator is used as a reference signal source with the precise frequency of 110 MHz. The reference signal is compared with an intermediate frequency signal of the scattering wave from the dielectric target. A local oscillation signal is up converted by 110 MHz by using a single-side up converter. The scattering wave is received by an aperture antenna for the X-band frequency. The mixer diode outputs the intermediate frequency of 110 MHz. The intermediate frequency signal is converted to the in-phase and quadrature signals by the quadrature mixer. The amplitude of the receiving signal is measured by a power monitor. These signals calculate a complex amplitude of the scattering wave. These signals are recorded by PXI/Compact-PCI data acquisition system.

An analysis method of Microwave CT is under consideration in order to determine the complex permittivity profile in a semi-transparent weak scattering object. The complex permittivity profile of the object is directly calculated by solving a nonlinear complex matrix equation. The scattering wave can be described in the first Born approximation as

$$e_l(\mathbf{r}) = e_l^i(\mathbf{r}) + \iint_S k_0^2 C(\mathbf{r}') e_l(\mathbf{r}') G(\mathbf{r},\mathbf{r}') d\mathbf{r}' \qquad (2).$$

$e_l(\mathbf{r})$ is total electric field, $e_l^i(\mathbf{r})$ is incident electric field, k_0 is wave number, $G(\mathbf{r},\mathbf{r}')$ is Green's function. The object and its surrounding area are separated by N pixels as shown in Fig. 4. T_X is transmitter, R_X is receiver. The contrast function is defined to be complex permittivity difference between the object and its surrounding area as as $C(\mathbf{r}) = \varepsilon(\mathbf{r}) - \varepsilon_{exp}$. The complex matrix equation is obtained by discretizing (2) and by solving it for the contrast function matrix as

$$\mathbf{C} = (k_o^2 \mathbf{G}_l^S \mathbf{E}_l \mathbf{C})^{-1} \mathbf{e}_l^S, \quad \mathbf{E}_l = \mathbf{I}(\mathbf{I} - k_o^2 \mathbf{G}\mathbf{C})^{-1} \mathbf{e}_l^i \qquad (3).$$

$e_l^s(\mathbf{r})$ is scattering electric field, $\mathbf{G}_l^S$ is Green's function for the scattering wave, and $\mathbf{I}$ is a unit matrix. In the weak scattering approximation, the matrix $\mathbf{E}_l$ is equal to the incident electric field matrix $\mathbf{I}\mathbf{e}_l^i$. When the complex amplitude matrix of the measured microwave is substituted into Eq (3), the contrast function matrix $\mathbf{C}$ and the complex permittivity $\varepsilon(\mathbf{r})$ can be obtained numerically. The CT method should be improved for the material with high permittivity and microwave absorption such as human body. This is an important research issue.

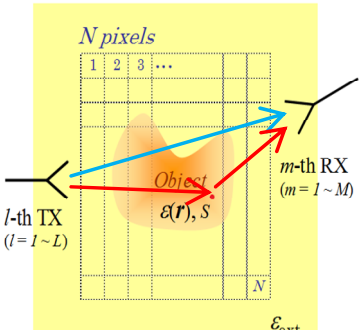

Fig. 4 CT analysis by the first Born approximation.

As new proposals in the CT analysis, a basis set of the scattering wave patterns may be utilized to estimate an initial dielectric profile in iterative tomographic reconstruction. And boundary surfaces between different dielectric medium may be well estimated by using a sub system of microwave pulse radar. These developments are future work.

Authors
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Instrumentation and Measurement (IM)

Chairperson: Kazuo Tanabe (CRIEPI)
Vice-Chairpersons: Yoshitaka Sakumoto (JEMIC), Akihito Otani (Anritsu)
Secretaries: Terumitsu Shirai (JEMIC), Kazuaki Kodaira (JEMIC)

Three valuable and unique contents, which were presented in the workshop of the technical committee, are roughly introduced in this manuscript.

1) Development of Plumb Laser system for Long Range [1]

In construction fields, slender threads are used as vertical lines to build structures, for example pillars and lifts. In recent years, laser beams are widely used instead of threads because of easy to use. But conventional plumb lasers with Gaussian beams can be hardly used as base lines for tall structures because Gaussian beams cannot transmit keeping small diameter covered long range. The diameter of a Gaussian beam expands about 5mm for 50m, but a diameter of a slender thread is 1-2 mm.

The novel plumb laser system with a Laguerre-Gaussian beam (LG beam) was developed and solved that problem. Cross-sections of LG beams are doughnut shape and holes do not light. This hole has a good point that it can keep a small diameter for long range. That is why the hole of LG beam can be used like a slender thread (Fig. 1).

This system has to not only generate a LG beam but also keep beam vertical and be handy to use in construction fields. So, it has three components, (1) an optical system of Laguerre-Gaussian beam, (2) a vertical pendulum for the optical system, and (3) a damper control (Fig. 2). This LG beam is made from a laser diode, because the optical system has to be a small size to install the handy system. A laser diode is easy to downsize because of its small size, but difficult to control wavefront and keep a small hole of LG beam for long range. The optical system which consists of some pinholes and lenses is designed to overcome this problem. It achieves a small diameter of the hole about 1-2 mm for a range of 50 m (Fig. 3). As a result, this novel plumb laser system can be used for tall structure.

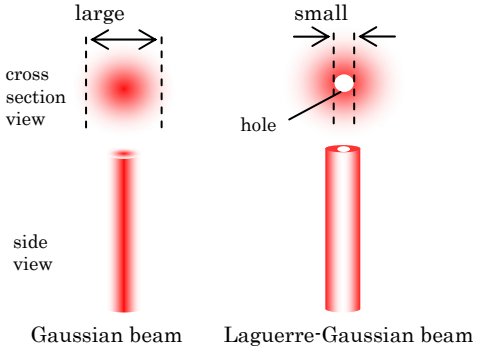

Fig. 1 Conventional laser line and novel line by LG beam.

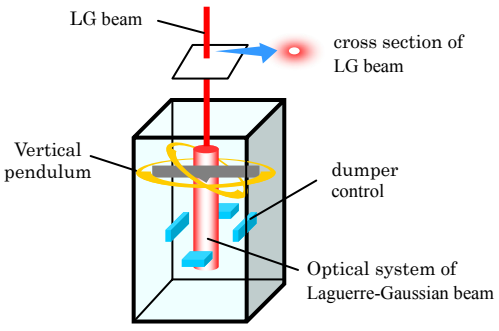

Fig. 2 Equipment of plumb laser with LG beam.

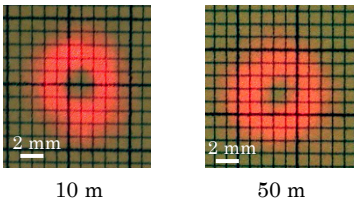

Fig. 3 Laguerre-Gaussian beam.

2) Development of a flux-gate current sensor [2]

High-precision direct current sensors are necessary to control small current flowing through many kinds of systems, such as electric vehicle systems or solar power generation systems. Flux-gate magnetic sensor technology has a high potential for this application. The flux-gate current sensor determines the current value by evaluating the second harmonic of the detected voltage. The sensitivity of the sensor is proportional to the increase in the volume of the magnetic core. Because the more volume core is used, the more current needs to get enough magnetic flux to saturate the magnetic core, increasing in the volume of magnetic core has a disadvantage in the current consumption.

Fig. 4 shows a schematic diagram of developed flux-gate current sensor. In order to reduce the current consumption, a new magnetic core structure that consists of ring core and C-shaped core was applied. The shape of the sensor was optimized by means of the magnetic field simulation using the finite element method (FEM), and a prototype is shown in Fig. 5.

Fig. 6 shows the comparison result between experimental and analytical results of the sensor output characteristics. The difference between them is less than 3 %. This difference is due to the magnetic properties of the core. Our prototype shows that the sensor can be operated in low current consumption (7 mA), and has a valiant linearity output(±0.7 % Full Scale 300 mA).

3) Validation for Capacitance National Standard in Japan Based on Long-term Monitoring Results of Standard Capacitors [3]

To verify the Calibration and Measurement Capabilities (CMCs) of capacitance national standard in Japan (Fig. 7), long-term monitoring of a fused

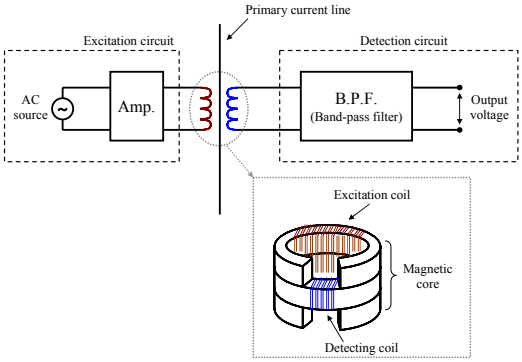

Fig. 4 Schematic diagram of developed flux-gate current sensor.

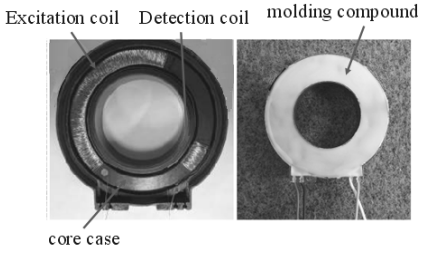

Fig. 5 Prototype of developed flux-gate current sensor.

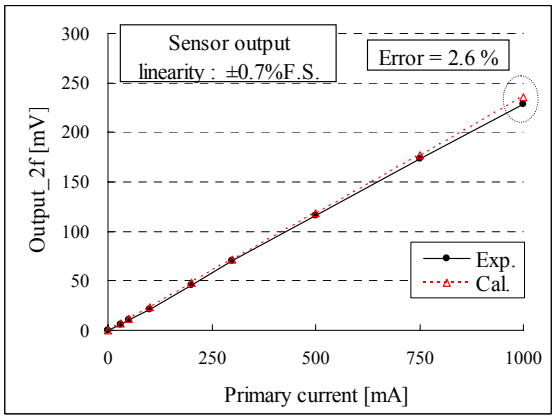

Fig. 6 Compared results between experimental and analytical sensor output.

silica standard capacitor and long-term monitoring of capacitance differences among a number of fused silica standard capacitors has been performing at National Metrology Institute of Japan (NMIJ). Analyzing the long-term monitoring results of capacitance differences in addition to the long-term monitoring results of the fused silica standard capacitor (Fig. 8) will enhance reliability of verification of the CMCs.

By using the results of these monitoring, the CMC of 10-pF capacitance national standard was validated promptly after the massive earthquake on March 11, 2011. Standard uncertainty of the validation conducted after the earthquake was estimated to be 0.144 μF/F.

Fig. 7 Capacitance national standard in Japan.

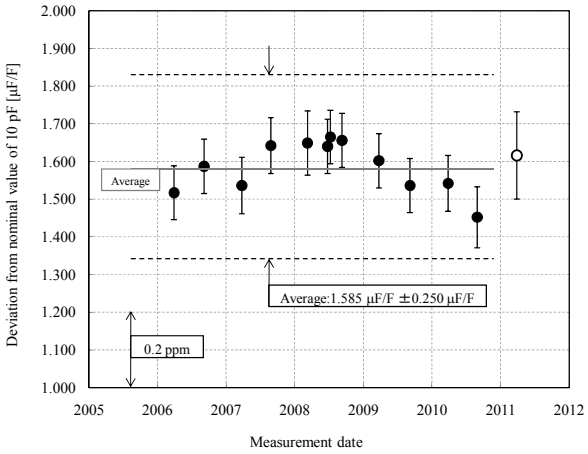

Fig. 8 Long-term monitoring results of capacitance (10-pF fused silica standard capacitor).

WEB site and authors

Activity of our committee is also described in our website (http://www2.iee.or.jp/~aim/).

Written by Dr. Kazuo Tanabe (Chairman, CRIEPI, e-mail: tanabe@criepi.denken.or.jp), E. Sano, Y. Watanabe and A. Domae.

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Metal and Ceramics (MC)

Chairperson: Akio Kimura (Furukawa Electric Co., Ltd.)
Secretary: Genzo Iwaki (Hitachi, Ltd.)
Assistant Secretary: Ataru Ichinose
(Central Research Institute of Electric Power Industry)

Welcome to our Technical Committee on Metal and Ceramics (TC-MC) in the Institute of Electrical Engineers of Japan (IEEJ). It is expected the TC-MC to promote the electrical materials and related technologies. Therefore, we have the pleasure to inform activities of the TC-MC and to communicate with each other.

Mission of TC-MC

The metal and ceramic materials are indispensable to electric and electronic fields and in front of advanced technologies all the time. In the twenty-first century, many advanced technologies need promising materials such as new materials or new functional materials for the diversification and renewable society. Therefore, the metal and ceramic materials are significant still more and will play an important role as a pioneer in the future.

As shown in Figure 1, the activities of the TC- MC have been covering mainly electric, electronic and optical materials, and their technologies. Namely their functions are extended such as super- conductivity, normal conductivity, semiconductivity, mechanical strength, heat transfer, thermoelectric, photo-electricity, optical transmission, electro-chemical affinity, radio- activity, composites etc.

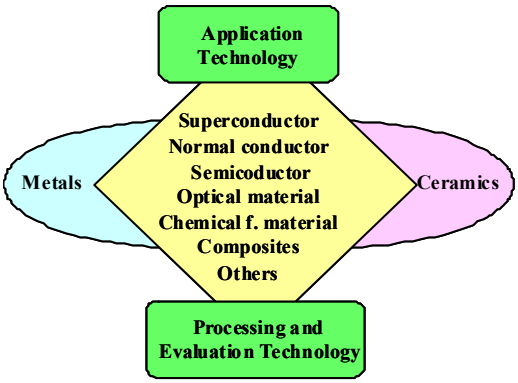

Figure 1 Activity scope of the TC-MC

Furthermore, our activities have been covering data base on their processing technologies and their evaluations in order to fit any applications.

History of TC-MC

The technical committee on the electrical materials in the IEEJ, predecessor of the present the TC-MC has been already set up in 1979. With several reorganizations of the technical committees, the TC-MC under the Fundamental and Materials Society (called A-Society) has been established in 1999 with other eleven technical committees, Research and Education, Electromagnetic Theory, Plasma Science and Technology, Electromagnetic Compatibility, Pulsed Electromagnetic Energy, Electrical Discharges, Light Application and Visual Science, Insulation and Measurement, Dielectrics and Electrical Insulation, Magnetics, and History of Electrical Engineering.

Recent activities of TC-MC

The activity of the TC-MC is based on the Symposium in the National Convention of the IEEJ, the Study Meeting and the Investigation Committee under the TC-MC. The following introduces the resent Symposiums in the National Convention of the IEEJ and Study Meeting under the TC-MC as shown in Table 1 and Table 2, respectively and the third activities will be found in the next section.

Regularly, the TC-MC meetings are held four times a year. The main topics to be discussed in the regular meetings involve introduction and understand for advanced metal and ceramics, and development of our TC-MC itself. We previously provided new three technologies and related materials such the attractive carbon nano-tube, the fuel cell and the functional diamond except the superconductors.

Recent year, much attention has been paid on an investigation on advanced superconducting materials. The electrode materials for future batteries and fuel cells to be compatible with clean, green, renewable and sustainable society have been also focused.

Table 1 Symposiums in the National Convention of the IEEJ

Theme	Date	Site
High magnetic field characteristics and indications for magnetic application of the High-Tc superconducting wires	2008.03.19	Fukuoka Institute of Technology
Development and problem of the high-efficiency solar cell	2009.03.19	Hokkaido University
Metal and ceramic materials in energy strange systems	2010.03.19	Meiji University
The 100th anniversary symposium for superconductivity discovery	2011.12.12	IEEJ meeting room

Table 2 Study Meetings in TC-MC

Theme	Date	Site
Recent research progress in advanced superconducting materials	2010.10.31	University of Tokyo
Recent research progress in advanced superconducting materials	2011.10.23	University of Tokyo
Recent research progress in advanced superconducting materials	2012.12.16	University of Tokyo

Activities of investigation committee in TC-MC

At present, there is one investigating R&D committee under TC-MC as shown in Table 3, the name of which is "Structure and composition of advanced superconducting materials". The chairperson and secretary are Prof. Jyunichi Shimoyama (University of Tokyo) and Dr. Hiraku Ogino (University of Tokyo), respectively. Regularly, there are four meetings a year.

The meetings discuss fabrication technologies and evaluations on electromagnetic, thermal and mechanical properties mainly for Nb_3Al conductors, Bi-based oxide superconductors, MgB_2 conductors, Y-based oxide superconductors and iron-based superconductors. Most expecting investigation results are fabrication technologies to obtain the high performance and its possibility at a viewpoint of microstructures and chemical composition for various superconducting materials such as Nb3Al conductors, Bi-based oxide superconductors, MgB_2 conductors, Y-based oxide superconductors and iron-based superconductors. And their cost performances as the practical superconductors and their applied technologies to such as persistent current mode-coils, cables, transformers, fault current limiters and so on. The committee has a plan of the study meeting related with the advanced superconducting materials on October 2010. This meeting will be held to exchange information between young re-searchers belonging to several communities. Therefore, the new style of the presentation is adopted, which is combination of a short presentation and a poster session.

Table 3 Investigation Committee under the TC-MC

Research Subject	Chairperson (Affiliation)	Period	Remarks
Structure, composition and characterization of advanced superconducting materials	Jyunichi Shimoyama (University of Tokyo)	2008.10-2011.09	Open

History of Electrical Engineering (HEE)

Chairperson: Hiroshi Suzuki (Japan University of Economics)
Secretaries: Chihiro Fukui (Hitachi, Ltd.)
Tatsuya Kimura (Toshiba Corporation)
Assistant Secretaries: Takahiro Nishikawa (Mitsubishi Electric Corporation)
Yoshio Takeoka (Toshiba Corporation)

The Technical Committee on History of Electrical Engineering (HEE) belongs to the Fundamentals and Materials Society (FMS) of the IEE of Japan (IEEJ).

The main objective of HEE is to examine the direction in which electrical engineering should move in the years ahead by studying the past. Electrical engineering history constitutes the basis of technologies that we should develop. It is the starting point from which we should approach the future.

Currently, two investigation committees are organized in the HEE and are running actively for survey of the subjects listed in Table 1. The aim of the investigation committee for nuclear generation in Japan is to study the development history of nuclear generation technology in Japan. The investigation committer for oral history is one of the continuing activities on oral history which will be explained later.

We would like to explain three topics of recent HEE activities next. The first is the "Web Database of Noteworthy Japanese Contributions to Electrical Engineering Technologies (DB-JET)". This database archives outstanding research results made by researchers and disseminates them both within the Japanese and wider international academic community. Its objective is to widen an understanding of both process for advancing science and technology and of the importance of scientific research in supporting science and technology advancement. The DB-JET was developed through the close cooperation of National Institute of Informatics (NII) and five institutes including IEEJ. The first phase of the DB-JET Project ran from 2003 to 2008. It finished with the opening of the database in March 2008. The second phase began immediately afterwards. (http://dbnst.nii.ac.jp/)

The HEE has been conducting oral histories since the late 1990s. On the basis of this, seven electricity-related institutes including the IEEJ are now cooperating to promote oral histories. The term 'oral history' which was first used by Columbia University historian, is the recording of memories of people who have unique experiences and is obtained by interviews. To date, 55 people have been interviewed. The HEE created a document comprised of a biography, a summary by the interviewer, and the full text of an interview. This is done for each interview. Then, the document is distributed to universities with science and technology departments and national colleges of technology all over Japan. We are now considering additional means of utilization.

In 2008, IEEJ organized the Commemoration Committee and has begun to reward the past important contributions to the electrical technology innovations, such as Persons, Materials, Locations, etc. The HEE nicknamed this commemoration "One Step on Electro-Technology -Back to the Future-". As of 2012, thirty contributions were commemorated. Such kind of award enshrines the hidden stories of electric technology to the public.

Public information activities are running by HEE. One of these activities is the publication of a newsletter. Inaugurated in 1994, the newsletter reached its 58th issue this year. The 4 or 6 page publication features technological history-related articles, records of visits to museums and book reviews. Another important public information activity is the web site. This web site was opened in 2001 and it announces workshops, publishes the summaries of research papers presented at the meetings, and publicize the committee's activities as we have mentioned in connection with the activities. The newsletters and the web site are in Japanese only but the web site in English will be soon.

Please visit

http://www.iee.or.jp/fms/tech_a/ahee/index_e.html

Table 1 Investigation Committees in HEE

Research Subject	Chair Person
・History of nuclear generation in Japan	Tatsujiro Suzuki (Japan Atomic Energy Commission)
・Oral history of electrical engineering in Japan	Masazumi Yamamoto (Mitsubishi Electric)

Electromagnetic Theory (EMT)

Chairperson: Michiko Kuroda (Tokyo University of Technology)
Secretaries: Masahiro Tanaka (Gifu University)
Yoshio Inasawa (Mitsubishi Electric Corp.)
Assistant Secretary: Ryosuke Ozaki (Nihon University)

The Technical Committee on Electromagnetic Theory (EMT) is established in order to maintain the qualified position of Japan in the field of the electromagnetic theory, by promoting the collaboration with foreigners and by bringing up the young Japanese colleagues who would contribute to the global activation of the electromagnetic society. The activities of the Committee have been covering fundamental theory of electromagnetics, analysis theory of electromagnetics, numerical solutions and modeling of electromagnetic fields, simulation techniques or electromagnetic fields, scattering and diffraction of electromagnetic waves, interaction of electromagnetic fields with media(including laser, plasma, random media), nonlinear problems, inverse problem, inverse scattering, electromagnetic environment, electromagnetic effect on biological systems.

Major activity of our committee is to pursue to organize several technical meetings and international conferences. Currently, we have four technical meetings on electromagnetic theory every year. In 2011, technical meetings were held in Osaka University, Osaka (January), Chuo University, Tokyo (May), Kitami Institute of Technology, Hokkaido (July), and Amaharashi Onsen, Toyama(November).

As for international conference, we put

particular emphasis on AP-RASC, PIERS, URSI EMTS, ISAP, APMC, which are closely related with EMT. In 2006, PIERS2006 was held in Tokyo.

Fig.1 Poster session in ICCE2012, Hue, Vietnam

Later ISAP2007 was held in Niigata. In 2010, AP-RASC'10 was held in Toyama. In Asia, KJJC2012, the Korea-Japan EMT/EMC/BE Joint Conference was held in May, 2012, in Seoul, Korea. The fourth ICCE2012, the International Conference on Communications and Electronics, which is held every two years, was held in Hue, Vietnam, in August, 2012. These international conferences were produced many fruitful results for us.

URSI Commission B EMTS2013 (http://ursi-emts2013.org/) will be held in International Conference Center Hiroshima, Hiroshima, Japan, in May 20-24, 2013, which is the 21st event and has been long-awaited by EMT Committee member. We hope the conference will be a great success.

High Voltage Engineering (HV)

Chairperson: M. Yashima (Central Research Institute of Electric Power Industry)
Secretaries: Y. Hoshina (Toshiba Corp.), T. Utsumi (Hitachi Corp.)
Assistant Secretary: T. Miki (Central Research Institute of Electric Power Industry)

This technical committee (TC) belongs to Power & Energy (P&E) Society of the IEE of Japan, and supervises activity of investigation on technical subjects related to high voltage engineering. Four investigation committees listed in Table 1 are active in September 2012 and three technical reports listed in Table 2 will be published in the near future. The 8th International Workshop on High Voltage Engineering (IWHV2012) will be held in November 16-17 at Kanazawa City, Ishikawa Prefecture, following the 1st IWHV at Okinawa in 1999, 2nd at Tottori in 2000, 3rd at Fukuoka in 2003, 4th at Sapporo in 2004, 5th at Hamamatsu in 2007, 6th at Kyoto in 2008 and 7th at Kita-Kyusyu in 2010. The objective of this workshop is to provide a forum to discuss novel findings in field of high voltage engineering, mainly in Asian countries. The workshop will be organized every alternate fiscal year. Selected contributions of the IWHV with original findings will appear in a special issue of the Transactions of IEE of Japan.

In this year, there will be 11 sessions, where 40-60 papers will be presented orally for two days. All speakers will present their paper in English, following fruitful discussions.

Moreover, IWHV of this year will be joint conference with the 2012 Japan-Korea Joint Symposium on Electrical Discharge and High Voltage Engineering. We hope IWHV2012 will be valuable workshop for exchanging the information related to rapidly moving technology of high voltage engineering.

TC on High Voltage Engineering meeting meets four times a year. One of the meetings was associated with a technical visit to Central Research Institute of Electric Power Industry.

The members of the committee other than the chairperson of the investigation committees are from universities (4), a research institute (3), electric power utilities (4) and manufacturers (9).

Table 1. Investigation Committees in TC-HV

Research subjects	Active period	Chairperson
Evaluation of lightning surge and EMC phenomena affected by grounding systems	3 years from 2010	Hideki Motoyama (CRIEPI)
Technical Assignment on the Application of Suspension and Hollow Polymeric Insulators	3 years from 2011	Takaie Matsumoto (Shizuoka Univ.)
Transient Analysis Technologies in the Smartgrid Era (Cooperative Study Group)	2 years from 2011	Akihiro Ametani (Doshisha Univ.)
Lightning Protection Technologies for Wind Turbine generation facility considering Lightning Parameters	2 years from 2012	Shigeru Yokoyama (Shizuoka Univ.)

Table 2. Technical Reports will be published

Research subjects	Chairperson
Wind Turbine Grounding Systems for Lightning Protection	Shozo Sekioka (Shonan Inst. of Tech.)
Insulation coordination for non-effectively earthed and ultra-high voltage systems	Kunihiko Hidaka (The Univ. of Tokyo)
Lightning Protection for low-voltage power distribution systems	Akira Asakawa (CRIEPI)

Electrical Wire and Cables (EWC)

Chairperson: Yasuo Suzuoki (Nagoya University)
Secretary: Kouji Miura (EXSYM Corporation)
Assistant Secretary: Akitoshi Watanabe (VISCAS Corporation)
Gaku Okamoto (J-Power Systems Corporation)

Technical Committee on Electrical Wire and Cables (TC-EWC) is a committee organized to support the IEEJ Power and Energy Society, and is comprised of members from universities, power utilities, East Japan Railway Company, Japan Electric Cable Technology Center（JECTEC）and cable manufacturers. The technical committee organizes technical meetings to promote R&D activities in this field and provides an opportunity to present technical achievements. Two technical meetings were so far held in 2012, one of which was on degradation diagnosis and asset management of wires, cables and power apparatuses and was held as a joint meeting with TC-DEI. The technical committee also held a forum on the development of cable technology in Japan by inviting prominent retired engineers who led the history of Japanese cable technology from the 60s to the 80s. This was to provide young and active engineers in this field with an opportunity to directly learn the valuable real experiences of their seniors who greatly contributed to the development of cable technology. The technical committee plans to organize 3 more technical meetings and 2 forums in FY2012. Two of the planned technical meetings will be jointly held with TC-DEI and the forums will be on trends in overseas cable technologies and overhead transmission lines, respectively.

In addition to organizing such technical meetings and forums, the technical committee supervises investigation committees dealing with subjects relating to electrical wire and cables. During the last several years, Investigation Committee for Technology of Wires and Associated Accessories for Overhead Transmission Lines, Investigation Committee for Accessories for 66kV and Higher Voltage XLPE Power Cable, Investigation Committee for Technology of XLPE Power Cable and Associated Accessories for Underground Distribution, Investigation Committee for Technical Trend of Environmental Tests for Insulation Materials of Distribution Wires and Cables, and Investigation Committee for Recent Technological Trends in Overseas Power Transmission Cables were organized. The technical report of the last committee will be published soon and Investigation Committee for Technical Trend of Recycling Technology for Wires and Power Cables is now in action.

Forum on the Development of Cable Technology in Japan (February 23, 2012, Tokyo)