Electrical Insulation News in Asia

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IEEJ

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TECHNOLOGIES FOR TOMORROW

TECHNOLOGIES ALERT

MISCELLANEOUS

PREFACE

Prof. Mitsumasa Iwamoto

Organic Materials Electronics Needs Knowledge of Electrical Insulation Engineers

I have been involved with research and education regarding organic materials electronics for over 30 years in a University, after I completed my Doctor's study concerning the electrical properties of insulating films. About 30 years ago, this research field was fresh for Electronics and Electrical engineers, and it was merely a dream for researchers to realize organic molecular devices. However, the circumstances in this Organic Materials Electronics have changed drastically during the last 30 years, mainly due to the discovery and development of new functional materials, including conducting polymers, organic semiconductors, etc. The discovery of new functional materials has attracted chemists, physicists, electronics engineers, etc, and also attracted young researchers to this field. Consequently a variety of new ideas, methods and techniques to utilize new organic materials have been developed. Recent progress in this field is very rapid, and studies of Organic field effect transistors (OFETs), Organic Electroluminescent (OEL) devices, Organic solar cells, and so forth are very active all over the world. Organic Materials Electronics world is expected coming together with a very huge production market in near future. However the performance of these electronics devices is still not sufficient. I must say as that we are merely standing in front of so-called this new research field. This situation would be totally different from that of Electrical insulation and of High voltage engineering, where researchers have wealth knowledge of the research and technology in their field for the future technology. Researchers are still not aware of physics and engineering for Organic materials electronics. Electronics engineers prefer to think of things related to Organic Materials Electronics, on the basis of semiconductor device physics. However the actual device performance is totally different, mostly owing to the dielectric nature of materials used therein. Electrical Insulation Engineers are well aware of the physics and engineering in which so-called electric field makes a significant contribution. Ideas and knowledge from the insulation engineering field is definitely useful for Organic Materials Electronics. In the meantime, the EINA magazine have focused on research activities in the field of electrical insulation engineering and helped peoples who are working and studying in this field. However I believe that the EINA magazine will also give an impact to the research and education in the field of Organic Materials Electronics.

Professor Mitsumasa Iwamoto
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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.

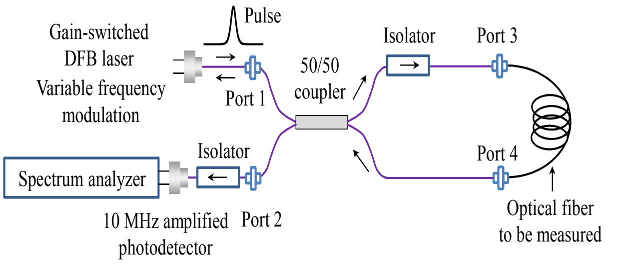

Fig. 1 Experimental setup for measuring the optical length of an optical fiber.

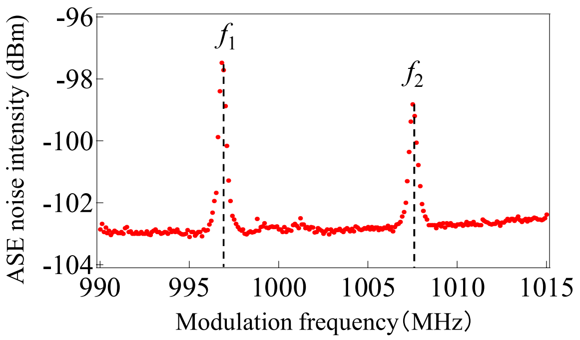

Fig. 2 Variation of the output ASE noise level as a function of the modulation frequency.

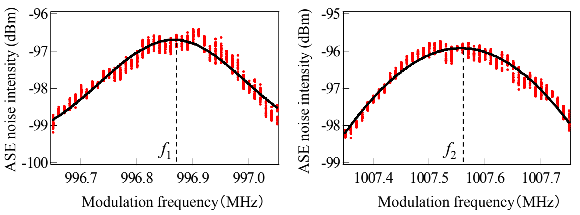

Fig. 3 Variations of the output ASE noise levels when the modulation frequency was varied around f_1 and f_2 in 0.01 MHz steps.

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

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

$e_l(\boldsymbol{r})$ 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.

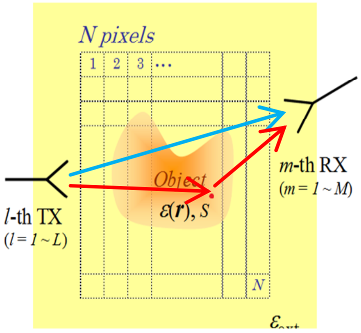

Fig. 4 CT analysis by the first Born approximation.

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.

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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.

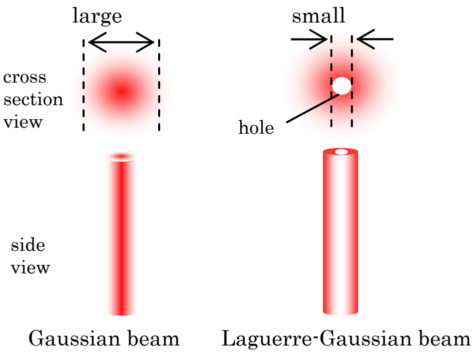

Fig. 1 Conventional laser line and novel line by LG beam.

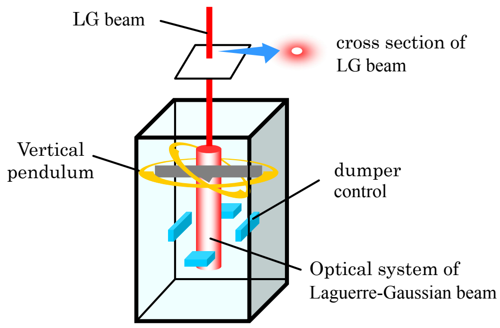

Fig. 2 Equipment of plumb laser with LG beam.

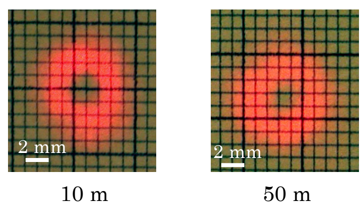

Fig. 3 Laguerre-Gaussian beam.

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 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.

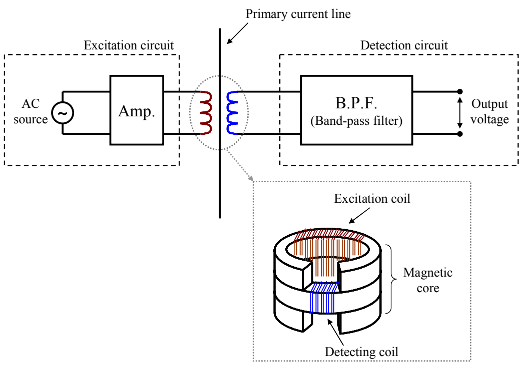

Fig. 4 Schematic diagram of developed flux-gate current sensor.

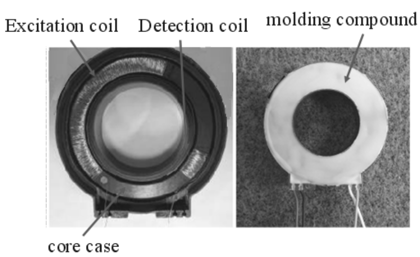

Fig. 5 Prototype of developed flux-gate current sensor.

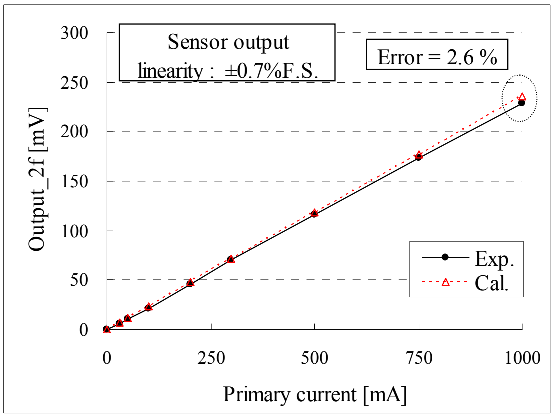

Fig. 6 Compared results between experimental and analytical sensor output.

Fig. 7 Capacitance national standard in Japan.

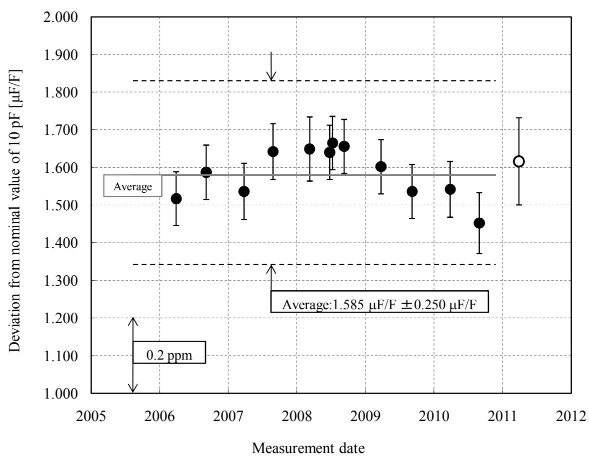

Fig. 8 Long-term monitoring results of capacitance (10-pF fused silica standard capacitor).

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.

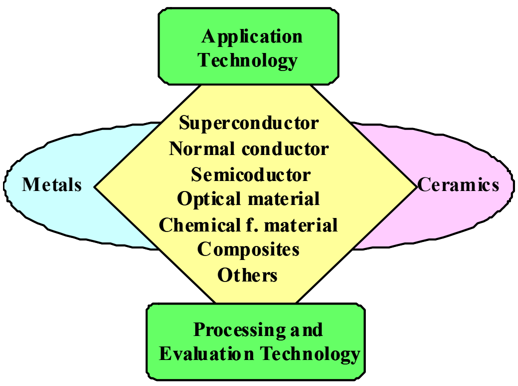

Figure 1 Activity scope of the TC-MC

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)

Conference Records

International Conference on Electrical Engineering (ICEE 2012)

International Conference on Electrical Engineering (ICEE 2012) was successfully held at Ishikawa Ongakudo and ANA Crown plaza Hotel in Kanazawa, Japan from July 8 to 12, 2012.

The ICEE is hosted by the Institute of Electrical Engineers of Japan (IEEJ), the Chinese Society for Electrical Engineering (CSEE), the Hong Kong Institution of Engineers (HKIE) and the Korean Institute of Electrical Engineers (KIEE). ICEE aims to provide a forum for sharing knowledge, experience and creative ideas among international electrical engineers with focus on Asia, and to contribute to technical development in electrical engineering. It was the 18th conferences and the 5th time held in Japan, following Matsue in 1997, Kita-kyushu in 2000, Sapporo in 2004 and Okinawa in 2008.

With the theme *"Renovation and Innovation by Electrical Engineering"*, ICEE 2012 was well attended by 503 delegates from Japan (355), Korea (95), China (30), Thailand (9), Hong Kong (7) and some other overseas countries (7) (Table 1). Total 350 technical papers were submitted (Table 2). There were 5 Keynote speeches, 35 Oral sessions (166 papers), 7 Poster sessions (164 papers) and 3 Panel discussions.

In the opening ceremony on July 9, 2012, Prof. K. Hidaka of IEEJ made his greeting speech and Mr. F. Chen of CSEE, Ir Prof. K.K. Choy of HIKE, Prof. J.Y. Koo of KIEE and Mr. Y. Yamano of Kanazawa city gave their congratulations (Fig.1). After the opening ceremony, 4 keynote speeches were given by Dr. Makoto Toyoma, Dr. Ben Hua, Dr. F.C. Chan and Dr. Young-Hyun Moon. In the morning on July 10, 2012, Dr. Makoto Yoshikawa gave his keynote speech also (Table 3, Fig.2).

Table 1 Number of participants from each country.

No	Country	No. of participants
1	Japan	355
2	Korea	95
3	China	30
4	Thailand	9
5	Hong Kong	7
6	USA	2
7	Other countries	5
	Total	503

(Above numbers include accompany persons.)

Table 2 Number of papers at each session

Sessions	Number of papers
Oral session	166
Poster session	164
Keynote speech	5
Panel discussion	15
Total	350

Fig.1 Prof. Hidaka gave greeting speech at opening ceremony.

Table 3 Presenters and titles of keynote speeches.

No	Name of Speaker	Title of Presentation
1	M. Toyoma (The Federation of Electric Power Companies, Japan)	Power system damage, recovery and challenges from Great East Japan Earthquake
2	B. Hua (South China University of Technology, China)	Coordination of Distributed Energy System with Power Balancing & Reliability
3	F.C. Chan (The Hong Kong Institution of Engineers, Hong kong)	Global Outlook of Electric Vehicles Development & Their Infrastructure
4	Y-H Moon (Yonsei University, Korea)	Energy Crisis and Electric Power Industry
5	M. Yoshikawa (Japan Aerospace Exploration Agency, Japan)	Missions to Asteroids : Challenges of Hayabusa and Hayabusa2

Fig.2 Dr. Toyoma at his keynote speech.

In the oral and poster sessions, technical presentation and discussions were made for some separated topics, such as Power Systems and Energy, Materials, Information & Control Systems, Electrical Machines, Power Electrics & Industry Applications, Sensor & Micro-machines and etc. (Fig.3 & 4). As the panel discussions, 3 important themes were prepared and active and meaningful discussions were done for two hours and more (Table 4).

Fig.3 A view of oral session.

Fig.4 A view of poster session.

Welcome reception, banquet and technical tours were also arranged as the social events of ICEE 2012. Banquet was scheduled in the evening of July 10, 2012 at ANA Crown Plaza Kanazawa.

Dr. Masaki Sakuyama, conference chair of ICEE 2012, chairman of IEEJ gave his greeting at the opening of banquet (Fig.5).

Table 4 Titles of panel discussions

No	Title of panel discussion
1	Development and Standardization of Smart Grid and Smart Community
2	Battery as a Key Element of Smart Grid
3	Education and Human Resources Development in Electrical Engineering

Fig.5 Dr. Sakuyama gave his greeting speech at the opening of banquet.

All participants enjoyed some kinds of local foods and historical Japanese music and attractions in Kanazawa. At the end of the banquet, Mr. Fen Chen of CSEE announced the next conference, ICEE 2013 to be held in Xiamen, China.

Finally, Prof. Yoshihiko Uesugi, the Chairman of Local Organizing Committee of ICEE 2012, passed the flag of ICEE to the representatives of the host of ICEE 2013, Mr. Fen Chen (Fig.6).

Fig.6 Prof. Uesugi (right) passed the flag of ICEE to Mr. F. Chen (left).

Prof. Yoshihiko Uesugi
University of Kanazawa
Chairman, Local Organizing Committee of ICEE 2012

International Conference on Properties and Applications of Dielectric Materials (ICPADM 2012)

The 10th ICPADM, International Conference on Properties and Applications of Dielectric Materials was held in Bangalore, India on July 24-28, 2012. The Conference was hosted by CPRI, the Central Power Research Institute in Bangalore with the following Institute members providing a dominant role in the conference organization:

Mr. N. Murugesan,
Director General, CPRI & Conference Chair
Dr. Seetharamu, Conference Co-chair,
Dr. R.S. Shivakumara Aradhya,
Conference Co-chair & Technical Chair
Mr B. Nageshwar Rao, Finance Chair
Dr. N. Vasudev, Publication Chair
Dr. M. Shekhar Kumar, Secretariat Chair
Dr P. Sampath Kumaran, Member
Dr. H.N. Nagamani, Member
Ms. S. Ganga, Member
Dr. C. Viswanatha, Member
Mr. K. Mallikarjunappa, Member

Dr. Seetharamu, the ICPADM 2012 Conference Co-chair, reported that there were 299 abstracts submitted of which 225 were accepted. The number of papers accepted after review was 175 plus a further attrition of 15 papers occurred due to suspected plagiarism. The final number of papers presented was 137 out of which 66 were from abroad and 71 from India. In addition some papers were withdrawn due to Visa issues.

The total delegates for the conference were 156 of which 44 were overseas delegates represented from China, Japan, UK, Australia, USA, Canada, Germany, Italy, Romania, Poland, Indonesia, and Switzerland. The pre-conference tutorial program was held on July 24, 2012 covering the topics on Nano-dielectrics, Outdoor insulation and Insulation aspects of Power System Components with 80 participants. The ICPADM 2012 commenced with the inauguration by Mr. D.N. Narasimha Raju IAS, Principal Secretary, Energy Department, Government of Karnataka, India on July 24, 2012 and this is followed by the addresses of Dr. Harry Orton and Prof. Len Dissado. Mr. N. Murugesan presided over the function. This was followed by a welcome dinner. In the inaugural speech, Mr. Narasimha Raju stressed the need for improved infrastructure within the Indian Power Sector and further he remarked that the ICPADM 2012 is a very timely event for India for this reason.

Fig.1 Inauguration – Lighting the Lamp

The Technical program started with Ziyu Liu Memorial Lecture delivered by Dr. Keith Nelson, Professor Emeritus at the Rensselaer Polytechnic Institute, NY, USA followed by other plenary presentations by invited speakers. The lists of plenary speakers are given below.

Fig.2 Dr. J. Kieth Nelson delivering the Ziyu Liu Memorial Lecture

Fig.3 Lectures delivered by Dr. Toshikatsu Tanaka

Table 1 Lists of plenary speakers at ICPADM 2012

Speaker	Affiliation	Title of the plenary talk
Ziyu Liu Memorial Lecture		
Dr. J. Kieth Nelson	Rensselaer Polytechnic Institute, NY, USA	The Continuing Evolution of Nanodielectrics
Invited Lecture		
Dr. Toshikatsu Tanaka	Waseda University, Japan	Partial discharges, treeing and tracking
Dr. Greg Stone	IRIS Power L.P., Canada	Partial discharge measurement
Dr. Tatsuki Okamoto	CRIEPI, Japan	New methods of degradation estimation of insulation paper of power transformer windings based on the load history
Dr. L. Satish	Indian Institute of Science, Bangalore	Some Innovative Applications of Frequency Response Data of Transformer Windings
Dr. Len A. Dissado	Leicester University, UK	Space charge and its relationship with aging
Dr. Sivaji Chakravorti	Jadhavpur University, India	Charge modified field computation in high voltage
Mr. B. Gunasekaran	CPRI, India	CPRI experience in 1200 kV transmission line design
Dr. Rajeswari Sundararajan	Purdue University, USA	Impedance spectroscopy studies of bio dielectrics – cancer cells and tissues

Fig.4 Lecture delivered by Dr. Greg Stone

Fig.6 Dr. L. Satish at his lecture.

Fig.5 Dr. Tatsuki Okamoto at his lecture.

Fig.7 Dr. Len A. Dissado at his lecture.

Fig.8 Dr. Sivaji Chakravorti at his lecture.

Fig.9 Mr. B. Gunasekaran at his lecture.

The contributory papers presented in various technical sessions were of high technical standard, although there was a mixture of papers. It was pleasing to note that there were a large number of student papers presented from Universities and by young engineers from Industries, which were well recognized and appreciated. Finally, ICPADM had 129 papers, 60 papers from abroad and 69 from India. Among the 60 papers presented from overseas countries, 41 papers were from China.

The Banquet Dinner organized on July 26, 2012 at the RMV Club Terrace Hall close to CPRI was an informal networking affair for the participants. Social events included an evening of light classical music / Veena recital, by the musical troupe "Sunadha Lahari", plus Bangalore sightseeing tours were made available. Technical tours of the extensive CPRI facilities including the High Voltage Division, Short Circuit Laboratory, Dielectrics Cables & Capacitors Laboratory, Materials Technology Laboratories and Earthquake Vibration Research Centre were conducted upon request.

On the final day, a concluding session was held on July 27, 2012 with panel discussions on "Future of Dielectrics" chaired by Mr. N. Murugesan, Director General, CPRI and steered by Dr. Harry Orton, Canada. The panelists were Dr. Keith Nelson, USA, Dr. Tatsuki Okamoto and Dr. Yoshimichi Ohki, Japan, Dr. Toan Phung, Australia and Dr. Zheng Xioquan. Each panelist gave a five minute dissertation on their views of what holds for the future of dielectrics. Lively audience participation followed during a question and discussion session.

Fig.10 Dr. Rajeswari Sundararajan at her lecture.

Fig.11 View of audience participation.

Fig.12 View of Poster Session.

CPRI organized an R&D Expo of Indian industry from July 24 – 26, 2012 coinciding with ICPADM 2012. This included exhibition by nine major industries of their latest products & interaction with R&D institutions, Academicians and Industry personnel.

The nine exhibitors were:

- ✓ BHEL Electro Porcelain Division
- ✓ CPRI (Central Power Research Institute)
- ✓ Gharda Chemicals Ltd.
- ✓ Hindustan Vidyut Products Ltd.
- ✓ KVTEX Power Systems.
- ✓ Oblum Electric Industries
- ✓ PCI Ltd.
- ✓ Raychem and
- ✓ Vijai Electric Ltd

During the ICPADM 2012 conference the IAC met to discuss the next ICPADM 2015 venue. All those present endorsed the decision to hold the next ICPADM 2015 at the UNSW, the University of New South Wales in Sydney, Australia.

Fig.13 Closing Session – Panel Discussions.

Dr. Subramanyam Seetharamu
Co-chair ICPADM 2012
CPRI, India

Dr. Harry Orton,
Chair Int. Advisory Committee of ICPADM 2012
Canada.

Fig.14 Group photo of all participants of ICPADM 2012.

International Conference on Condition Monitoring and Diagnosis (CMD 2012)

2012 International Conference on Condition Monitoring and Diagnosis (CMD 2012) has been held successfully in very famous place Bali, Indonesia on 23-27 September 2012. The venue of the conference was The Grand Bali Beach Hotel which is located at the beautiful Sanur Beach Bali. CMD 2012 was co-organized by School of Electrical Engineering and Informatics, Institut teknologi Bandung and Department of Electrical Engineering Udayana University, Bali, Indonesia and sponsored by IEEE DEIS. The previous conferences were held in Beijing (2008) and Tokyo (2010).

Fig.1 Welcome reception.

CMD 2012 was opened on September 24th by Prof. Puti Farida, The Vice Rector of Institut Teknologi Bandung.

The Organizing committee received more than 400 abstracts and after rigorous review, finally 302 papers from 33 countries from 5 continents were accepted. The number of papers from each country is shown in table 1.

Fig.2 Opening remarks by Prof. Suwarno.

Table 1 Number of papers from each country.

No	Country	Number of papers
1	China	73
2	Indonesia	46
3	Japan	43
4	Republic of Korea	29
5	Germany	19
6	The Netherland	17
7	Malaysia	13
8	Austria	12
9	India	8
10	Others	42

The papers deal with

1. Condition monitoring and diagnosis for power equipments such as transformers, GIS, cables and electric machines
2. Condition monitoring and diagnosis in power plants
3. Failure phenomena based on electrical, mechanical, chemical and thermal causes
4. Degradation assessment for power equipment
5. Modern maintenance tools for effective replacement
6. Advanced sensing techniques for condition monitoring and diagnosis
7. Applications of artificial intelligence for data mining and condition assessments
8. Asset management for power equipments
9. Strategic planning and management for condition monitoring and diagnosis

The papers were presented in 21 oral sessions, 2 plenary sessions and 2 poster sessions. Keynote plenary invited lectures was given by Dr. Tatsuki Okamoto from CRIEPI Japan and Dr. Jitka Fuhr (AF Engineer and Consultants, AFEC) while plenary

Fig.3 Invited plenary lecture by Dr. Okamoto.

invited speeches were given by Prof. Cengrong Li from North China Electric Power University, China, Ir. Yanuar Hakim MSc. from Indonesian Electric Power Company PT PLN Indonesia and Dr. Sang-Jin Kim from Korean Electric Power Company (KEPCO KDN) Korea.

Fig.4 View of oral session.

Fig.5 View of poster session.

CMD 2012 was attended by 239 participants. Number of participants from each country is shown in table 2.

Table 2 Number of participants from each country.

No	Country	No. of participants
1	China	52
2	Indonesia	38
3	Japan	34
4	Republic of Korea	22
5	Germany	12
6	Austria	7
7	Malaysia	7
8	The Netherland	6
9	UK	6
10	Others	55

On September 25, the meeting of international advisory and corresponding members was held. Members attended the meeting were Dr. Okamoto, Prof. Cheng Rong Li, Prof. Ja-Yoon Koo, Dr. H. Orton, Dr. W. Koltunowicz, Prof. Shengtao Li,Prof. M. Hikita, Prof. E. Gockenbach, Prof. J. Smit, Prof. G. Chen, Prof. M. Muhr, Prof. Guan Zhicheng, Prof. A. Beroual, Prof. Dae Hee Park, Prof. Hyun Hoo Kim (replaced by Prof. Jun Hoo Lee), Prof. N. Hozumi and Prof. Suwarno, Dr. Resi Zarb (IEEE DEIS representative), Dr. Ahmed Abu Siada (from Curtin University Australia, presented a proposal to host CMD 2016 in Australia), Dr. Umar Khayam (General secretary), Prof. Dayu (Local arrangement committee) and Dr. Ariastina (secretariat).

Prof. Suwarno reported the progress of on-going CMD 2012 while Prof. Ja Yoon Ko, firmly explained the preparation for CMD 2014 which will be held in Jeju Island, Korea. After presentation from Dr. Ahmed Abu Siada from Curtin University and Prof. Shengtao Li from Xian Jiaotong University as candidate for hosting CMD 2016, finally the meeting decided Xian as the venue of CMD 2016.

On September 25 evening, a banquet dinner was held at open stage with live Balinese dances and gamelan.

Fig.6 Balinese dance at banquet.

Fig.7 International corresponding members with dancers at banquet

Fig.8 Voluntary students, the green team with Prof. Suwarno, General Chairman.

The conference was officially closed on September 26 evening by Dr. Resi Zarb as the representative of IEEE DEIS. Post conference full day culture tour was arranged to famous places such as watching Barong Dance at Batubulan, visited the centre of Balinese gold and silver handicraft Celuk and Mas, where one can meet Balinese woodcarvers in every angle of the village. A lunch was served in Kintamani at 1,500 meters above sea level and participants enjoyed a breathtaking view of the Crater Lake Batur.

Prof. Suwarno
General Chairman of IEEE-CMD 2012
Institut Teknologi Bandung, Indonesia

Fig.9 All participants of CMD 2012.

International Conferences to be held in Asia

ISH 2013 (International Symposium on High Voltage Engineering)

Dates: August 25~30, 2013
Venue: Hanyang University (Seoul Campus)
Chairman: Prof. Ja-Yoon KOO (Hanyang University.)
Organizer: Organizing Committee ISH 2013
Co-organizer: KIEE, Hanyang University
Official Website: www.ish2013.org

18th International Symposium on High Voltage Engineering (ISH 2013), which will take place in Hanyang University in Seoul, Republic of Korea from August 25 to 30, 2013.

The ISH 2013 promotes opportunities to be an effective rallying point for a broad range of constituencies, government officials, pioneering engineers, scientists, academics, researchers and many other professionals working in the pertinent fields to discuss the challenges of the day and to provide a platform for all to share cutting-edge technology and up-to-date knowledge and experience.

Seoul, the designated venue for the ISH 2013, is an ineffable world-class city where contemporary lifestyle meets long-standing history. Seoul offers the warmest hospitality, world-class services, high value-added accommodation and the state-of-the-art convention facilities. The ISH 2013 Organizing Committee is working around the clock to prepare for forward-looking programs and to ensure the effectual communications amongst interested parties from four corners of the world.

Topics

1. *Electromagnetic fields: computation, measurements, environmental effects*
2. *Transient voltages: lightning, switching, repetitive impulses, surge arrester, insulation coordination, overvoltage protection*
3. *High voltage and high current testing techniques*
4. *High voltage measuring techniques: dielectric parameter, space charges, partial discharges*
5. *High voltage insulation materials and system: outdoor, indoor, gas insulated, nano-dielectric, eco-friendly materials and applications*
6. *Monitoring and diagnostics: evaluation procedures, knowledge rules, data mining, smart sensors and applications*
7. *High voltage systems aspects: asset management, smart grids, live line working, maintenance and on-site repair*
8. *HVDC technologies and applications*

Key dates:

Abstract Submission:	October 31, 2012
Notification of Acceptance:	January 31, 2013
Full Paper Submission:	April 15, 2013
Speaker Registration:	May 31, 2013

Secretariat:
Mr. Jin Woo Lee
Email: secretariat@ish2013.org
Phone: +82-2-6288-6327
Fax: +82-2-6288-6399

ICEE 2013 (International Conference on Electrical Engineering)

Dates: July 14~18, 2013
Venue: Xiamen, China
Organizer: CSEE
Co-organizer: HKIE, IEEJ, KIEE
Official Website: www.icee-con.org

Activities of Laboratories

Dielectrics Laboratory at Indian Institute of Technology Ropar

Dr. C.C. Reddy

C. C. Reddy, J. S. Chahal, Ashish Gupta
Department of Electrical Engineering
Indian Institute of Technology Ropar, Rupnagar, Punjab-140001

1. Introduction

The Indian Institute of Technology Ropar (IIT Ropar) is a new generation IIT, set up by the Ministry of Human Resource Development (MHRD), Government of India, in 2008, to expand the reach and enhance the quality of technical education in India. Currently the institute operates from a transit campus, situated in Rupnagar town of Punjab state in northern India. It has been allotted a land of 500 hectors on the bank of river Sutlej in Rupnagar, where the permanent campus will be set up within a few years.

The institute has already initiated dielectric research laboratory as well as several central facilities (already established), that are useful for carrying research on dielectric materials in the transit campus. Also, plans to build a new generation high voltage laboratory are already floated for future new campus.

The objectives of current dielectrics laboratory are as follows:

1. Education: The laboratory is useful for under-graduate study in electric fields and space charges in dielectrics supplementing lecture courses.

2. Research: The laboratory contributes to various research fields including space charges and electric fields in dielectrics, measurement techniques, nano-composite materials for electrical insulation, development and applications of novel dielectric materials for high-speed circuits.

State-of-art space charge measurement equipment, electrometer (pico ammeter), a 100 kV hv source for breakdown test and a hv amplifier (±20 kV) are on track for the laboratory. Apart from these equipments, institute's central research facilities augment the dielectrics lab for nano-composite dielectric research.

As a part of this facility Scanning Electron Microscopy (SEM), Energy Dispersive Spectroscopy (EDS) facilities have been created by the institute, Fig. 1. The SEM uses a focused beam of high energy electrons to generate a variety of signals that reveal the information about the sample including external morphology, chemical composition, crystalline structure and orientation of materials making up the sample. The EDS is an analytical technique used for elemental analysis or chemical characterization of sample.

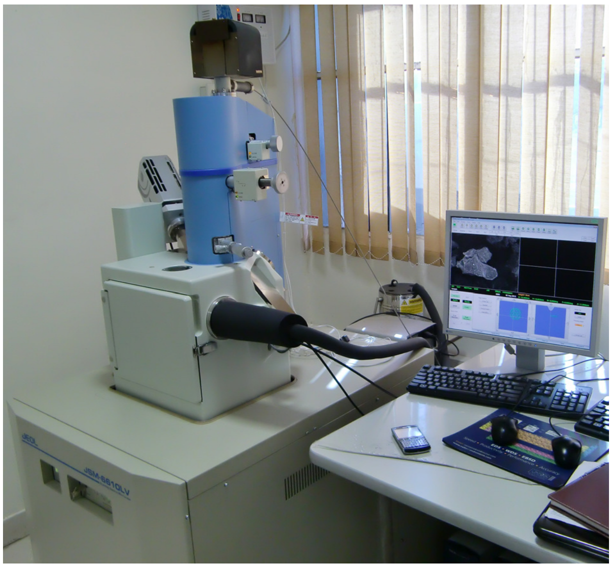

Fig. 1: Scanning Electron Microscope at IIT Ropar

2. Research

In the area of space charges, the dielectrics laboratory deals with both the techniques of measurement of space charges as well as the space charge phenomena in dielectrics.

(i) Measurement Techniques

Among the measurement techniques the laboratory is currently engaged on the research on pulsed electro-acoustic (PEA) method. It is planned to develop a novel measurement system that has added capabilities than the existing systems in the world. Simulations that are discussed in sub-section below are already carried out for this purpose.

(ii) Space charge phenomena

The Space charge phenomena are not understood completely until now. The research in this lab is directed towards understanding the relation between various physical properties of materials and space charges in dielectric. Effect of space charge on dielectric breakdown is also being investigated. Measurements of space charge, conduction current and breakdown strength form prime measurements in this research.

In the area of nano-composites, novel dielectric materials for several applications are being researched.

2.1 Simulation of Pulsed Electro-Acoustic Measurement Technique

With the aim to understand the design and develop an improved measuring system simulation tool is used. Pulsed electro-acoustic measurement technique, whose block diagram is given in Fig. 2, was simulated using PSpice software, Fig. 3, and this helped in understanding some design related issues of PEA system e.g. effect of coupling capacitor during voltage polarity reversal, as shown in fig.3.

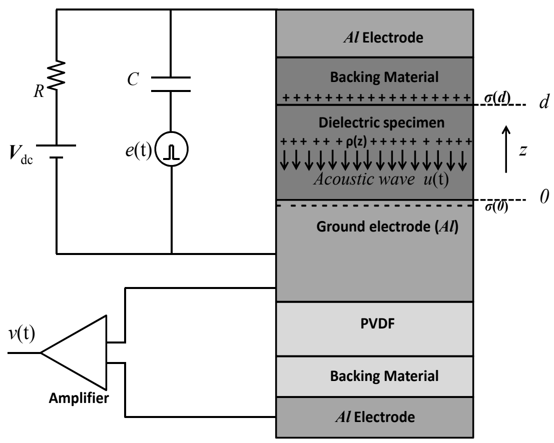

Fig. 2 Depicting the principle of PEA method

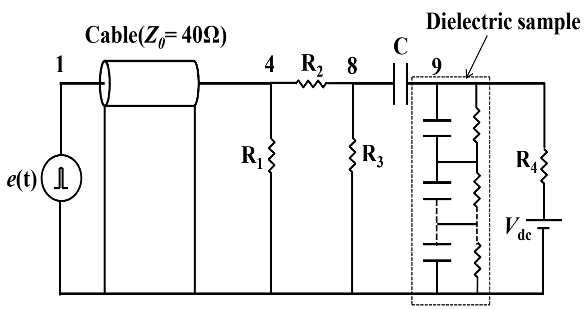

Fig. 3. Model circuit of PEA method

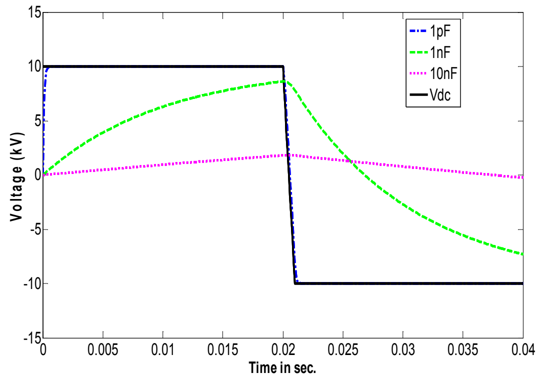

Fig. 4. Voltage at sample during polarity reversal with different coupling capacitance values

2.2 Space Charge Phenomena

Despite copious experimental results, space charge formation in dielectrics is yet to be understood. Dynamics of current conduction across dielectric specimen is attributed for the formation of different types of space charges.

The research in this area is focused on relationship between conduction and different types of space charge formation in dielectrics, namely, charge-packet evolution in certain dielectrics, homo space charge and hetero space charge.

The lab was partly successful in relating steady state space charge distribution to conductivity, diffusion constant and permittivity as,

$$\rho = \varepsilon \frac{dE}{dx} = \varepsilon \sqrt{\frac{\sigma}{\varepsilon D_c}} \left(E_0 - \frac{J_0}{\sigma} \right) \frac{Sinh\left(\left[x - \frac{d}{2} \right] \sqrt{\frac{\sigma}{\varepsilon D_c}} \right)}{\cosh\left(\frac{d}{2} \sqrt{\frac{\sigma}{\varepsilon D_c}} \right)}$$

and the electric field distribution as,

$$E = \left(E_0 - \frac{J_0}{\sigma} \right) \frac{\cosh\left(\left[x - \frac{d}{2} \right] \sqrt{\frac{\sigma}{\varepsilon D_c}} \right)}{\cosh\left(\frac{d}{2} \sqrt{\frac{\sigma}{\varepsilon D_c}} \right)} + \frac{J_0}{\sigma}$$

where, standard symbols are used to mean various quantities. The experimentally observed phenomena of homo and hetero charge profiles have been explained by these equations

Referring to Fig. 5, imbalance in charge profile has been shown to be due to imbalance in diffusion coefficient of positive and negative charge carriers.

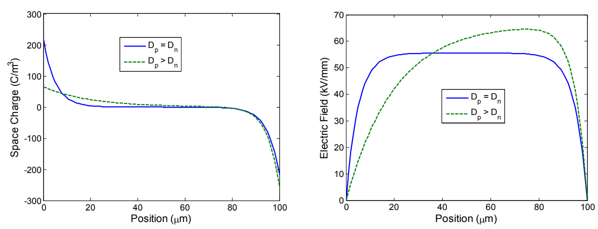

Fig. 5 Space charge profile and electric field due to unbalanced diffusion

The research is still continuing with a hectic activity of young institute shaping its future with modern technology.

Acknowledgment

We would like to thank all the editorial board members for the opportunity to introduce our young laboratory in the EINA magazine.

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China Corner

Research Development of Nanodielectrics in China

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1. Overall

Nanodielectrics have attracted more and more attention from universities, research institutions and companies in China due to their potential benefits as dielectrics. Since Xiangshan-science conference whose topic was the multilevel structure and macro perfor– mances of nanodielectrics was held in Beijing in 2009, some progresses have been made in nanodielectrics research field.

The homogeneous distribution of nanoparticles in polymer matrix is a problem of nanodielectrics researches. Nanoparticles are chiefly dispersed in matrix by shear force diffusion and chemical modification in the majority of experiments. The viscosity of the matrix is an important factor for shear force diffusion. Chemical modification will alter the surface states of nanoparticles to increase the electrostatic force between fillers and matrix.

As a result, the experimental results of nanodielectric properties have little comparability and poor reproducibility, owing to the different preparation processes. The interfaces around the nanoparticles are hard to describe clearly at the present stage, but important for understanding the physical and chemical properties of nanodielectrics.

2. Properties of Nanodielectrics

Nanodielectrics exhibit a series of unique outstanding properties, such as electrical, mechanical, optical and magnetical, owing to nanoparticles with a giant specific surface area, quantum size effect and the special interface between particles and polymer matrix.

The surface activity, surface energy, surface tension, and surface area of nanoparticle increase with decreasing the particle size. The surface atoms exhibit high chemical activity, and they are easy to bond with other atoms. This will lead to nanometer fillers difficult to uniformly disperse in the preparation process. On the other hand, this will result in the strong interaction between the particles and the polymer matrix to form a very complex interface structure, thus changing the electrical, thermal, mechanical and other properties of the material, which is the theoretical basis of the modified nano-doping.

It has been known that the polarity of polymeric matrix, the type and the surface states of nanoparticles have a combinative influence on the interface. The interface is widely recognized to play a key role in determining the macroscopic electrical performance, short-term breakdown, long-term aging properties. Its detailed structure and properties need to firstly be understood.

3. Research Development of Nanodielectrics in China

It is very urgent to develop new high insulation materials with higher breakdown field and superior ageing-resistant performance to meet the need in super/ultra-high voltage electrical equipment, high energy storage devices and equipment, aerospace and so on. Nanodielectrics as the third generation insulating materials with superior electromechanical performance open a new window for the industry development as well as correspond to the development strategy. Therefore, it is significant to investigate and develop nanodielectrics.

In the recent years, researchers in China have done a lot of works and have made great progress in the field of nanodielectrics. Various methods were used to prepare nanodielectrics and various polymer matrixes such as polyethylene (PE), silicone, epoxy resin (EP), polyamide (PA), polyimide (PI) doping various fillers such as alumina (Al_2O_3), titania (TiO_2), silica (SiO_2), layered silicates.

The current research is concentrated on invesitigating the properties of nanodielectrics, such as, dielectric response behaviores, breakdown properties, space charge effect, partial discharge (PD) resistance, electrical aging resistance and so on.

3.1 Dielectric Properties of Nanodielectrics

It was reported that the relative permittivity will be deviated from the original value when there are trace amount of nanoparticals in the polymer matrix.

3.1.1 Development of high permittivity nanodielectrics

Dielectric materials with a high dielectric constant are expected to be used as dielectric materials of flexible multi-layer capacitors. In general, nanopaticles, such as Al_2O_3, TiO_2, $BaTiO_3$, are used as fillers to improve the relative permittivity of polymers.

PI/nano $BaTiO_3$ composite films were prepared by direct mixing poly (amic acid) and silane coupling agent modified $BaTiO_3$ particles followed by imidization. Experimental result showed that the dielectric properties of the composites displayed good stability within a wide range of temperature and frequency. The dielectric constant of this nanocomposite increased with an increase of the volume fraction of $BaTiO_3$ particles. For example, the dielectric constant was 35 at 10 kHz when the content of $BaTiO_3$ was 50 vol%, which was 10 times of that of the pure polyimide.

Stearic acid gel method was used to prepare nanocrystalline $BaTiO_3$ composites. It was found that dielectric constant of nanocrystal was much larger than that of bulk materials. As the particle size decreased, the dielectric constant of nanocrystal initially increased and then decreased to a small value.

3.1.2 Development of low permittivity nanodielectrics

Nanometer silicon tube was added in PI to reduce the dielectric constant. When the content of nanometer silicon tube was less than 3 wt%, the complex dielectric constant decreased with increasing the content of nanometer silicon tube.

The low density polyethylene (LDPE) and EP doping with various concentration of nano Al_2O_3 and TiO_2 fillers were studied. It was found that the dielectric constant of nanocomposites show a reduction as long as the concentration of nano particles in an appropriate range. The reduction of dielectric constant is due to the increase of free volume and the restriction of dipolar around the interaction zone.

3.2 Volume Resistivity of Nanodielectrics

The PI/Al_2O_3 nanocomposite films were prepared by sol-gel process. With the volume resistivity test of polyimide/nano-alumina composite film, it was found that the volume resistivity was the highest and higher by an order of magnitude than pure polymer when the content of nano-alumina was about 10%.

LDPE and EP doping with various concentration of nano Al_2O_3 and TiO_2 fillers were investigated. It was found that the conductivity of nanocomposites showed a reduction as long as the concentration of nano particles in an appropriate range. The reduction of charge mobility is likely to be the reason for the decrease of conductivity.

The high field conductivity of LDPE with nano-SiO_2 particles was studied. It was found that the high field conductivity of LDPE was based on space charge limited current, while that in LDPE/Nano-SiO_2 was based on ion hopping conductance.

Some metal nano particles, such as Ag, Sn, also have influence on polymer volume resistivity when their contents are very low. Some researches showed that the volume resistivity could be increased by an order of magnitude when the content of nano-metal was about 0.1%. The invesitigation on the DC volume resistivity and high field conductivity of nano-Ag/EP polymer composite showed that after trace addition of Ag nanoparticles with small sizes, the composite had obviously higher volume resistivity than pure EP. The increase of resistivity was related with the size and addition of Ag particles, and characteristics of base polymer. High field conductivity tests showed that the coulomb blockade effect appeared when Ag particles of small nanosize disperse uniformly in the polymer. When the addition of Ag nanoparticles was too much or their size was too big, the composite showed space charge limited current property.

The investigation on the volume resistivity of nano-Ag/PVAc nanocomposite found that the conductivity decreased to lower than 10% of the original ones at a certain the nano-Ag addition. However, when the addition of metal nanoparticles increased, the polymer might transit to good conductor.

Carbon nanotube CNT was used to add into polymer to acquire the expected properties. The different properties were found in the multi-wall carbon nanotube (MWNT)/polymer-based composites with the MWNT before and after chemical modification. The percolation threshold was very low in the composites with one dimension MWNT compared with that of composites with conducting sphere particles in micron size. When the content of original MWNT fillers was 0.02 vol%, the conductance of the composite was highest which was 5×10^{-4} S/m, while that for TFP-MWNT composite was 10^{-2} S/m.

3.3 Electric Breakdown Performance

Breakdown strength of dielectric is an extremely important electrical parameter for dielectric material in engineering. Researchers in China have studied the electric breakdown performance of nanodielectrics, and found that the BD performance was dependent on the addition of nanoparticles.

Ag/PVA nano-polymer matrix composites have been prepared by the sol-gel method, and the electrical properties were investigated. The results showed that the composite with a proper nano-Ag addition had a high breakdown strength, which was obvious at cryogenic temperature.

The breakdown strength of nanocomposites initially increased and then decreased with nano particle addition. Under power frequency applied field (ac), breakdown field of nanocomposites reached to the maximum at nanoparticle concentration of about 1 wt%. For example, it was about 43 kV/mm for epoxy nanocomposite, which had an increase of 16% compared with pure epoxy (37 kV/mm). For LDPE nanocomposite, ac strength had a maximum value of 50 kV/mm, indicating an increase of 19% compared with pure LDPE (42 kV/mm). Under DC applied field, the maximum breakdown fields were 125 kV/mm and 400 kV/mm for epoxy nanocomposites and LDPE nanocomposites, which could be improved 13.6% and 33.3%, respectively.

Although quiet a lot of research works on nanodielectric breakdown properties under ac, dc and pulse voltage have been done so far. It is unfortunate that the results of breakdown properties of nanodielectrics have little comparability and poor reproducibility until now. This may be caused by the polymer matrix, type of nanoparticles, dispersion situation of nanoparticals, sample thickness, voltage waveform and so on.

In order to conveniently comment on the BD properties of nanocomposite, a ratio k, which is defined as the breakdown voltage of composite divided the breakdown voltage of polymer matrix, was introduced in 2010. And it was found that the cohesive energy density (CED) of polymer matrix strongly affects the BD properties of nanocomposites, and the breakdown performance could be improved as long as nano particle addition in an appropriate range.

3.4 Long-term Ageing

At present, the investigation on the ageing resistance of nanodielectrics in China is booming. Although the results from different researchers have little comparability, and the mechanism of ageing resistance is different, the ageing resistance of polymer will be great improved for the introduction of nanopaticles.

The nano-TiO_2 particles was introduced to the PI by using in-site dispersion polymerization. It was found that the corona-resistant lifetime of the nanodielectrics was 40 times longer than pure PI film at the electrical stress of 12 kV/mm, when the TiO_2 addition was 15%.

The aging resistance of PI with nano-SiO_2 particles was investigated. It was found that the nano-SiO_2 particles would extremely improve the aging resistance of PI. The investigation on the effect of TiO_2 on the aging resistance of nanodielectrics found that the nano-TiO_2 particles could moderate the electric field distribution, increase the heat conduction and extend the lifetime of nanodielectrics. At the same time, the nano TiO_2 precipitate formed an electron and UV shielding layer to capture the electric charge and absorb UV generated by corona.

In order to extend the lifetime of variable frequency motor, investigation on the aging resistance PI films 100CR found that this material could increase the corona inception voltage and breakdown voltage.

In order to investigate the relation between the nanoparticle content and ageing resistance, the ratio *k* was introduced and defined as electrical ageing performance of nanocomposite divided by that of matrix. It was found that adding micro and nano particles could effectively improve the ageing resistance and with the ageing time prolonging, nano-composite was superior to micro-composite.

4. Application Prospect of Nanodielectrics

Nanodielectrics have broad application prospects in electrical engineering.

Capacitor insulation: Nanodielectrics have high breakdown field strength at the same time keeping relative high dielectric constant. It will develop the performance of the storage density of capacitor, miniaturize the capacitor. The excellent anti-aging properties can ensure the stable performance of the capacitor during the work.

HVDC cable: The excellent space charge properties of nanodielectrics can moderate the internal electric field. Meanwhile, the operating voltage level and reliability of HVDC cable will increase owing to the breakdown performance and anti electrical aging properties of nanodielectrics.

Generator insulation: The application of nanodielectrics will be favor to the reduction of the size of generator, increase the reliability of generator, and reduce the cost. In addition, the lifetime of generator will been extended for the corona-resistant property of nanodielectrics.

Insulating paint: Nanodielectrics can be used as insulating paint due to the waterproof, fire resistance and flashover properties.

Insulation in extreme work environment: Nanodielectrics can be used as the insulation of spacecraft and nuclear reactor.

In addition, nanodielectrics can be used in micro electronic device, optical device, electrostriction material and sensor.

Prof. Shengtao Li
Deputy Director of State Key Laboratory of Electrical Insulation and Power Equipment, Xi’an Jiaotong University, China

Korea Corner

Road Map of HVDC Deployment in Korea

Dr. Yong-Joo Kim
KERI, Korea

1. Introduction

HVDC transmission systems, when installed, often provide high reliability with a long useful life. Furthermore HVDC link avoids some of the disadvantages and limitations of AC transmission by offering no technical limit to the length of a submarine cable connection and improving the AC system's stability as shown in Figure 1. In 1954, the first HVDC (10MW) transmission system was commissioned in Gotland. Since then HVDC Current Source Converter of 800kV/6.4GW and Voltage Source Converter of 320kV/800MW are the mature technologies and have played a vital part in both long distance transmission and in the interconnection of renewable energy.

2. Korean Experiences on HVDC T/L

Since 1998, although the system's catastrophic submarine cable failure in 2006, Jeju#1 HVDC T/L has been operated successfully. Until 2007, the total return on investment beyond the initial capital cost ($300M) reached more than $ 500 M. Due to the urgent need for the enhanced system reliability, the construction of the extra HVDC T/L has been initiated. In 2012, Jeju #2 HVDC T/L Project (Construction Cost $600 M) was finally completed and now ready for commercial operation. Table 1 shows the technical brief on Jeju #1 and Jeju #2.

Table1. HVDC Converter Jeju #1 and Jeju #2

Factor	Jeju #1	Jeju #2
Commercial Operation	Since 1998	Since 2012
U_0(kV)	180	250
MW	300	400
Converter	Alstom	Alstom
Cable	Alcatel	LS Cable
Thyristor	5.2kV 1,128 units/pole	8.5kV 864 units/pole

3. Roadmap on HVDC T/L

Recently KEPCO (Korea Electric Power COmpany) has announced the long term deployment planning of HVDC T/L as shown in Figure 2. Under smart grid environment, large scale off-shore wind power generation plants will be connected via HVDC T/L in West Sea by 2018 as illustrated in Figure 3. The project is divided into three steps – Prototype, Demonstration and Large Scale Project.

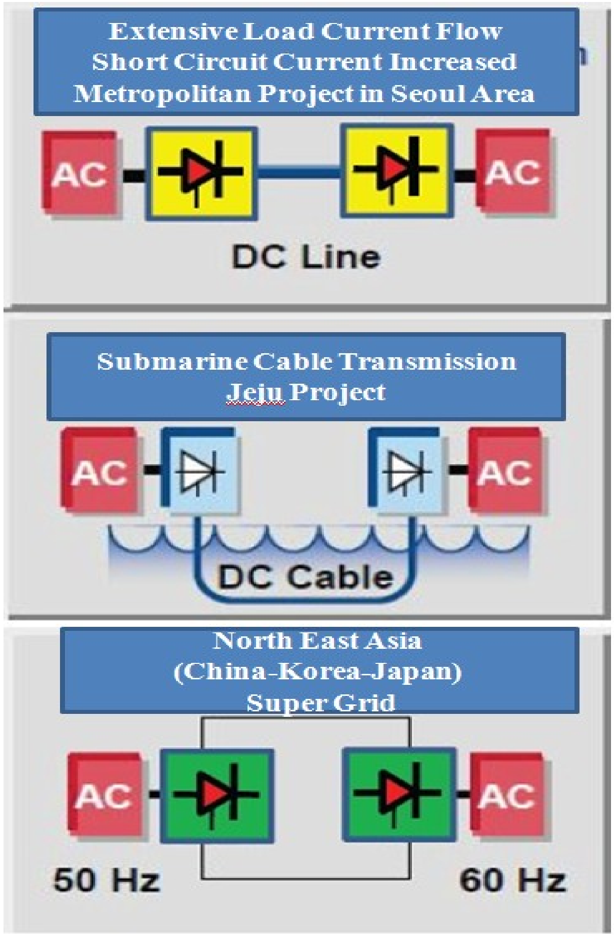

Figure 1. Concept of HVDC T/L

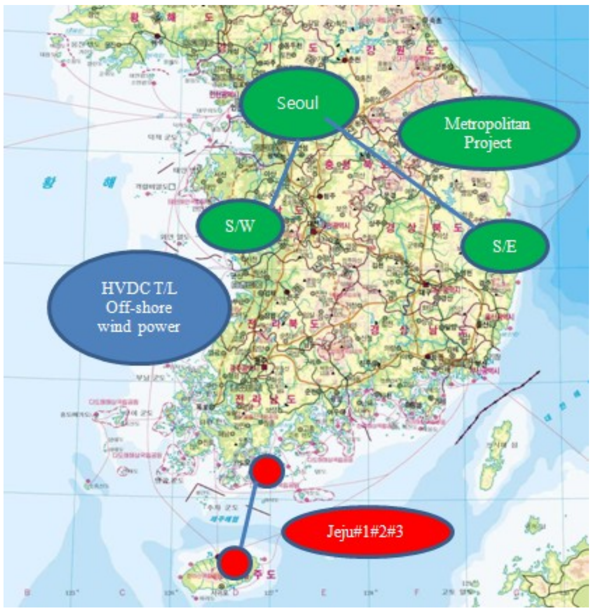

Figure 2. HVDC T/L Project in Off-Shore, Metropolitan and Jeju

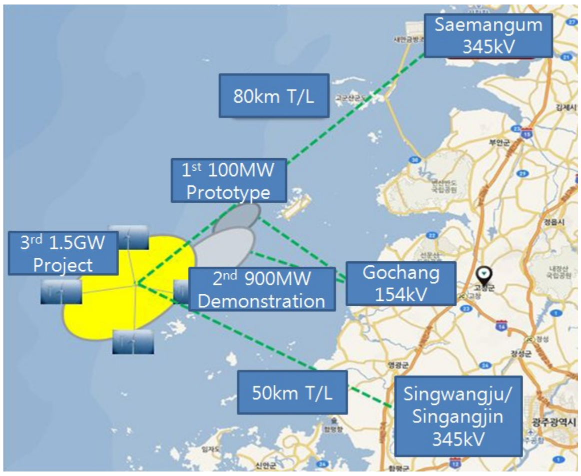

Figure 3. HVDC T/L Project in Off-Shore

The second project is focused on the reliability enhancement in Metropolitan area due to the long T/L distance from the power plants located both in South-East region and South-West region. The HVDC T/L project rated 1 GW is scheduled to complete its construction by 2015. The third project will be the extra HVDC T/L Project (200MW, by 2018) in Jeju Island. The future international project under consideration is China-Korea-Japan Super Grid via HVDC T/L.

4. Demonstration Project for Proposed Road Map of HVDC T/L

KEPCO, LS Industry and Hyosung Heavy Industry have been involved in the prototype development. In 2012, KEPCO and LS Industry completed the demonstration project of HVDC T/L ($35 M, 80 kV, HVDC Current Source Converter, HVDC Transformer) in Jeju Island. Based on the experience from the demonstration project, they are now planning to accommodate their technologies into the above mentioned large scale commercial projects such as Off-Shore, Metropolitan and Jeju projects. The commercial production up to 500 kV HVDC T/L is scheduled by 2019.

In addition, Hyosung Heavy Industry and KEPCO are now planning to develop Voltage Source Type HVDC Converter. And a feasibility study on 20 MW/±10kV (Target Model by 2020: 250kV, 100MW, Modular Multilevel Converter) is now under consideration

Figure 4. 80kV HVDC Transformer (LS Industry)

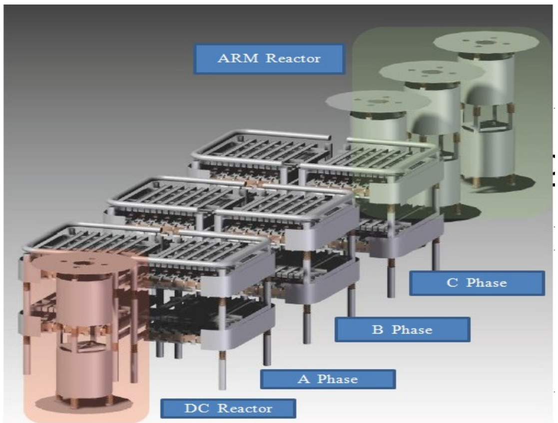

Figure 5. HVDC Voltage Source Converter (Hyosung Heavy Industry)

5. Further Studies on R&D Activities for New Installation of HVDC T/L

In HVDC T/L project, HVDC Converter and Transformer are the major power components. Due to the availability of higher voltage IGBT and the relatively lower DC polarity reversal effect in HVDC transformer, nowadays MMLC (Modular Multi Level Converter) Type HVDC Voltage Source Converter rapidly expands its market share in relatively short distance application such as Off-Shore Wind Power Connection. In this context, the major studies will be focused on the development of HVDC converter topology and its higher voltage application up to 250 kV.

Reference

[1] Internal Report, LS Industry, May 2012

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[3] “Special Session on HVDC”, Power Electronics Conference, Ulsan, May 2012

[4] “Special Report on HVDC Converter Topology”, Seoul National University, Seung Gi Sul, May 2012

[5] “HVDC Transmission" Chan-Ki Kim, Vijay K. Sood, Gil-Soo Jang, Seong-Joo Lim, and Seok-Jin Lee, 2009 John Wiley & Sons (Asia) Pte Ltd

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India Corner

High Voltage Engineering Laboratory
College of Engineering, Anna University

Prof. Usa Savadamuthu

The Division of High Voltage Engineering in the Department of Electrical and Electronics Engineering was established in the year 1960 in the College of Engineering, Guindy(CEG). CEG is one of the oldest engineering and technical institutions in the world ageing more than 200 years, now a constituent college of Anna University, which is one of the India's premier University.

Post Graduate course in High Voltage Engineering is offered since 1964 with an objective to produce high voltage engineers to cater to the needs of the industries in design, manufacturing and testing of power apparatus. The course has been awarded "A" grade by National Board of Accreditation. The curriculum of the M.E. High voltage engineering includes electromagnetic field computation and modeling, transients in power systems, insulation technology, HV generation and measurement, insulation design of HV apparatus, HV testing, EHV transmission, HVDC transmission, HV switchgear in addition to applied mathematics, EMI/EMC, digital signal processing and other interdisciplinary courses as electives. The students are well trained in the High Voltage Laboratory and in the Electromagnetic field computation laboratory to give hands on experience in the field of specialization. Around 25 students are registered for post graduation every year.

The Division is embellished with a library with collection of rare and valuable books, test standards in addition to proceedings and magazines. The Division has been nurtured successfully by the able guidance of highly motivated professors who have an acumen in academics, research and industry collaboration.

INFRASTRUCTURE FACILITIES

High Voltage Laboratory

The High Voltage Laboratory in the Division started with a 1540kV, 19kJ impulse generator (Fig.1) and 450kVA Cascaded transformer and now has been enhanced with the following facilities/equipment.

- A 400kV HVDC/Impulse generator and has been modified to generate impulse voltages from lightning impulse to very fast transients (front time from 0.05μs to 1.5μs and tail time from 6.0μs to 70 μs), oscillatory voltages and non-standard impulses as per CIGRE WG. C4.302 with resistive and capacitive dividers for measurement
- Partial discharge measurement laboratory
- Capacitance and tanδ measurement kit(12kV)
- Energy analyzer Kit
- Sweep frequency response analyzer (0.1Hz – 25MHz)
- Vacuum and high pressure vessel
- Test cells as per International standards to characterize gaseous, liquid and solid dielectrics.
- Digital storage oscilloscopes upto 1GHz, 5S/s.
- High precision impedance analyser (50MHz)

Fig.1 Impulse voltage generator set up

Electromagnetic field computation laboratory

The laboratory has facilities to compute electromagnetic fields using Finite Element Method (Maxwell V-9.0), Electromagnetic Transient Program (EMTP) in addition to circuit simulation packages.

The facilities in the Division are effectively used by both undergraduate (Electrical and Electronics Engineering) and post graduate students as part of their curricula. The Division has an active interaction with other departments in the University and industries. Many of the post graduate students carryout their project works in the industries and R&D centers in India and are mostly absorbed for placement by them. High Voltage Laboratory has been involved in high voltage dielectric tests such as Impulse voltage withstand test, Power frequency voltage withstand test, Partial discharge measurement test etc. as per Indian and International standards and the facilities are effectively utilized by the industries for quality assurance.

RESEARCH ACTIVITIES

The Division is actively involved in research activities in the diversified areas of power engineering and the ongoing research works are:

- High frequency modeling of power apparatus and estimation of transient overvoltage in GIS
- Characterization of insulating materials under non- standard impulses and repeated impulses
- Insulation design of high voltage polymeric insulators
- Fault detection in transformer winding
- Electromagnetic forces in transformers
- High voltage applications in food preservation, agriculture and textile industries.
- Characterization of nano dielectric materials

So far 20 scholars have completed their doctorate degree and 12 research scholars are pursuing their research at present in the Division of High Voltage Engineering.

The High Voltage Laboratory has received funds for research activities from government funding agencies like,

- University Grants Commission (UGC) – Centre for Advanced Studies (CAS)
- Ministry of Human Resource Development All India Council for Technical Education
- Technical Education Quality Improvement Programme (TEQIP)
- Department of Science and Technology – Promotion of University Research and Scientific Excellence (DST-PURSE)

Consultancy works are carried out in the Division for both government and non- government organizations. To name a few, Technology demonstrator for Compact storage devices for armored vehicle for Combat Vehicles Research and Development Establishment (CVRDE), India, Measurement of harmonics on arc furnace in Tamil Nadu grid, Tamilnadu Electricity Board, India, Computation of electric field distribution in polymeric insulators, surge arresters, etc for manufacturing industries.

Characterisation of Impulse strength of transformer insulation

The reliability of a power system depends on the insulation design of the equipment connected in the network. At present the dielectric strength of all equipment are checked by testing only with standard lightning impulse (1.2/50 μs). Even when the transformer is tested with standard waveshape, due to part winding resonance, the winding insulation is stressed with (unidirectional and bidirectional oscillatory) non-standard waves. On the other hand, in practice all the components in a power system are stressed with transient over voltages of wide variety of waveshapes from lightning to very fast transient (VFTO). Hence becomes necessary to estimate the dielectric strength of the insulation under both standard and non-standard impulses using the v-t characteristics.

Impulse strength of transformer insulation under non-standard lightning impulses

While observing the impulse voltage distribution within a transformer winding it can be seen that parts of the windings are excited by unidirectional and bidirectional oscillating voltages. The inter-turn and inter-disc winding failures are attributed to these oscillating voltages.

Attempts are made to study the behavior of air, transformer oil and OIP (Oil-Impregnated Paper) insulation under these voltages. Small gaps in the order of few millimeters, with different electrode geometries are chosen to incorporate the extreme electrical field configurations in practical transformer and experimental v-t characteristics are obtained using statistical procedures. Disruptive Effect method is used to evaluate the insulation strength under unidirectional non-standard impulse voltages. The insulation strength under bidirectional oscillating impulse voltages on these small insulation gaps are estimated using Unconditionally Sequential Approach. The polarity effect on the breakdown due to bidirectional waveshape is duly accounted.

Impulse strength of transformer insulation under impulses of varying front times (from μs to ns)

The behavior of the electrical component under very fast transient over voltages (VFTO) has been a problem of importance with the advent of Gas Insulated Substations. To predict the v-t characteristics of insulation for impulses of varying front times few impulses of different front times from nano seconds to microseconds (40ns to 1.2μs)are generated and their v-t characteristics are obtained for air, oil and OIP under uniform and non-uniform fields (Fig.2). From these v-t characteristics a generalized hyperbolic model is obtained by regression analysis to predict the v-t characteristics for any wavefront and this mathematical model is experimentally validated.

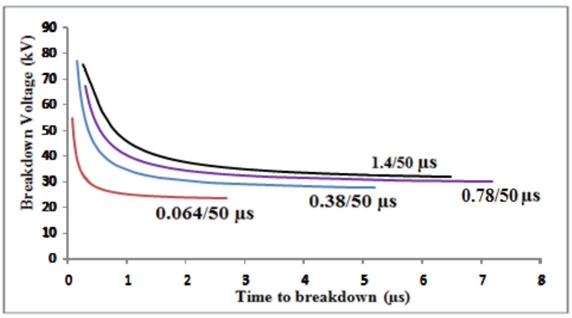

Fig 2. v-t characteristics of OIP for different wavefronts

Impulse strength of transformer insulation under repeated impulses

Apart from overvoltages of different shapes, the repeated switching operation of the disconnectors in a short period of time causes cumulative stresses in internal points of the winding and leads to failure of the transformer winding. The insulation gets deteriorated when it is subjected to repeated applications of impulse voltages even below their BIL rating. The voltage-number of impulses the insulation can withstand (V-N) characteristics will be useful in evaluating the effect of frequent surges on transformer insulation. V-N characteristics of insulation are obtained experimentally for few waveshapes (Fig.3) and modeled using exponential model. The V-N characteristics are also experimentally obtained for the CIGRE Working Group C4.302 represented waves. The effects of the front time and the tail time on the detoriation of insulation are also analyzed using the Degree of Polymerization under repeated impulse.

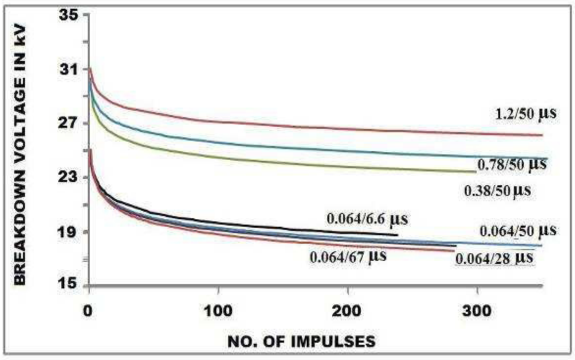

Fig 3. V-N characteristics of OIP for different Impulse waveshapes

Applications of High Voltage Engineering

The use of high voltage engineering has increased in many folds in diversified areas like, in-activation of microbes, food preservation for extended shelf life , production of nano- fibers for textile applications, assisted germination of hard and soft seed coat for increased yield .

Food Preservation

High intensity pulsed electric fields (PEF's) in food applications, such as fruit juices, is gaining popularity as a non-thermal sterilization technology alternative to the conventional method.PEF method involves the application of a high electric field (15–80 kV/cm) across a certain electrode geometry that contains the liquid food. Liquid foods namely, milk and juices of orange, apple, tomato, pine apple and papaya inoculated with gram negative(e.coli) and gram positive (bacillus subtillis) have been treated with high electric fields by varying the process and product parameters. The reduction in the microbes when compared to the control sample (untreated) of orange juice is shown in . Fig 4.

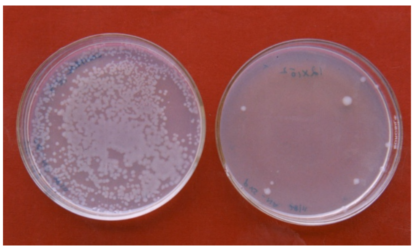

Fig 4. Reduction of E.coli concentration after treating orange juice with high electric fields.

Production of NanoFiber

The electro spinning process has been largely used by industries to produce filters, membranes, optical and electronics applications. Recently it is gaining momentum in production of both conducting and non conducting nanofibers used in textile industries. An attempt has been made to produce ployaniline (conducting) and polyacrylonitrile (non- conducting) nanofibers of various sizes ranging from 50 to 400 nm (Fig.5) by adjusting various electro-spinning parameters along with the Department of Textile Engineering. The electrical and thermal properties of the nano fibers thus produced are analyzed.

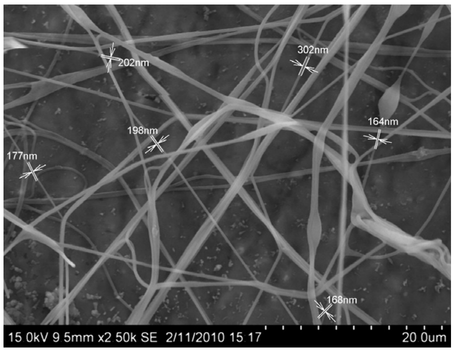

Fig 5. SEM image of Polyaniline conducting nanofiber

Agricultural Application

When the seeds of the paddy are treated with electric fields in the range of 20 kV/cm , improved germination rate and growth rate with increased yield are possible. The paddy seeds are treated with lightning impulses and an increase in germination rate and growth rate are observed when compared with that of untreated seed (Fig.6). Research work is in progress to

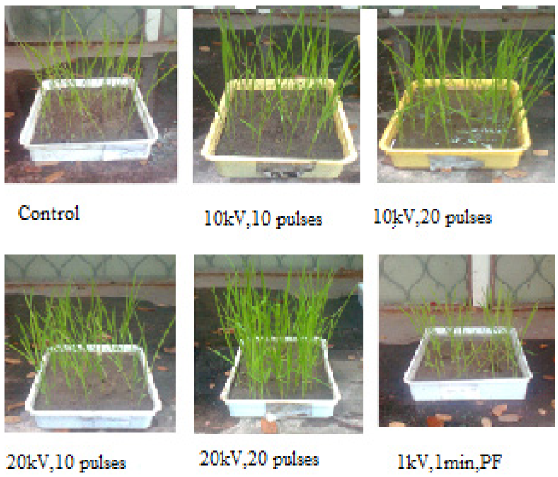

Fig6 Germination rate of Paddy on 17th day

optimize the shape of the impulse, magnitude of the electric field and the number impulses to increase the germination and growth rate.

Investigation on dielectric and thermal properties of nano dielectrics

The dielectric and thermal properties of different dielectric materials with various types of nano fillers (such as Alumina, Zirconia, Titania, and Silica) are analyzed. The nano fillers are added in different wt% with the dielectrics for analysis at different temperatures and frequencies.

The dielectric properties such as breakdown strength and partial discharge levels are measured as per standards. The parallel capacitance, admittance, loss tangent and quality factor of the nanocomposite samples are measured for different temperatures and frequencies using Dielectric Spectroscopy and thermal degradation is investigated using Thermo Gravimetric Analyzer. The appropriate percentage of the nano fillers are suggested for different dielectric materials like polyamide enamel, transformer oil and polyurethane (cable) based on the experimental analyses.

CONCLUSION

The High Voltage Laboratory in College of Engineering, Guindy, has a blend of academics, research and industry collaboration complementing each other. With many number of PG students and research scholars we are able to venture into the diversified areas of high voltage engineering and look forward for collaboration from other research institutes to strengthen our expertise in high voltage engineering.

Acknowledgement :

The author thank Dr Ramanujam Sarathy, Department of Electrical Engineering, Indian Institute of Technology, Madras, India for giving an opportunity to write about our laboratory.

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Development of Factory-Expanded Cold-Shrinkable Joint for 500kV XLPE Cable

Cold shrinkable joint (CSJ) has enabled easy assembly and simplified quality control on site compared to traditional ones. The main insulation rubber unit of CSJ, which is pre-expanded on special carrier pipe at factory, has advantage of shortening construction time. Therefore, CSJ has been becoming a mainstream over the world recently.

Particularly, the silicone rubber, the insulation material of CSJ, shows excellent electrical and elastic properties for long term operation. We have already supplied many joints up to 400kV class underground transmission lines. This paper describes development activities on challenging test conditions and 1 year prequalification test for 500kV CSJ.

The prequalification tests in accordance with IEC62067 with 500kV CSJ for 2500mm^2 Cu conductor XLPE cable was basically implemented under co-development with Tokyo Electric Power Company as shown in Table-1. However these tests included special conditions to meet with an extended consideration of requirement in JEC-3408. Hence, 105°C of conductor temperature, surge voltage and residual AC performance tests were carried out after loading cycle test. No defect was observed in the appearance test of disassembled CSJ.

Table-1 Results of the prequalification tests with special condition

Prequalification test IEC62067 for 500kV class		
Items	Conditions	Results
Loading cycle test	367 cycles Load condition * Tc = 90-95°C / 331 cycles * Tc = 105-110°C / 36 cycles Voltage condition 508 kV / 367 days	good
Lightning impulse voltage	±1550 kV / 10 shots ±1705 kV / 3 shots * Tc = 90-95°C	good
AC voltage	505 kV / 10 min at * Ta	good
Examination	Appearance check	good

* Tc = Conductor temperature
* Ta = Ambient temperature

To ensure the low-temperature environment performance of cable system, a special test with challenging condition was carried out for more than 30 days with cyclic condition between -30°C (Cooling room temperature) and 95°C (dummy cable conductor temperature outside cooling room). Applied voltage was 580kV, which is in accordance with IEC-62067 type test condition. Table-2 shows the results of the loading cycle test with the initial electrical performance tests.

Table-2 Results of the initial electrical test and the special condition test

Items	Conditions	Results
AC voltage	580 kV / 30 min	good
Lightning impulse voltage	±1550 kV / 10 shots	good
Loading cycle test	Loading cycle 10 times Cooling room temp. -30°C Cable conductor temp. 95°C Voltage condition 580 kV / more than 30 days	good

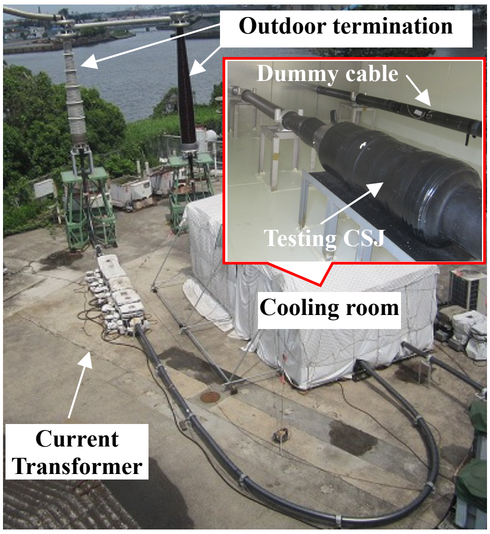

Fig.1 Loading cycle test loop for 500kV CSJ

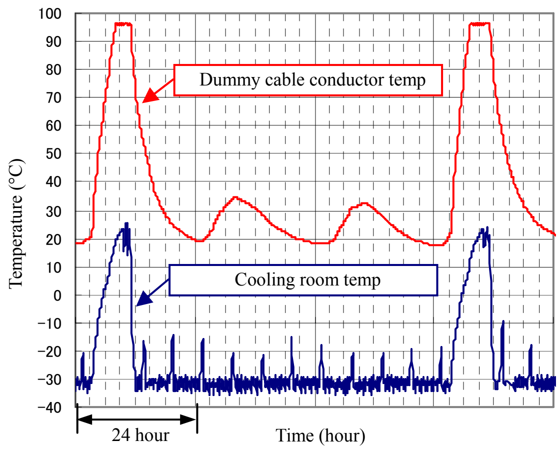

Fig.2 Example of loading cycle chart

The test results satisfied the requirements including special testing condition described above. CSJ has shown excellent performance to be applied in 500kV class transmission lines. CSJ is expected to be ready for 500kV class application in the near future.

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TECHNOLOGIES ALERT

Development of 230kV Factory Joint for Submarine Cable

Submarine cable system has been widely used as power transmission for interconnection, wind farm etc. For these usages, it can be said that the recent trend is increase of rating voltage and longer cable as also described in CIGRE TB 490. To satisfy these requirements, the reliable manufacturing technology for factory joint is necessitated.

VISCAS has been supplying submarine cable system with a rating voltage of from 66kV to 132kV since early 1990's, and some of them included factory joints. Based on our technological experience, and to meet the requirement such as increasing rating voltage, we have developed above 132kV tape molded type factory joint.

In this development, we have improved the insulation design of factory joint and applied it to 230kV factory joint. By the improved design, thinner insulation thickness of factory joint could be realized than that of one by conventional design we had applied so far, that is, the factory joint with a almost the same diameter as cable diameter could be designed.

To confirm the electrical performance including a long term test, new designed prototype factory joints have been tested. Those tests revealed that new designed factory joint had a good electrical performance.

Following confirmation of effectiveness of design by using prototype factory joint, we have manufactured 3-core submarine cable including factory joints and the type test has been carried out. Mechanical tests and electrical tests after mechanical tests according to CIGRE TB 490 have been successfully completed and then test results have been certificated.

As introduced above, VISCAS has already established 230kV submarine cable system, and has been ready to supply it to the world market.

Figure　Load cycle test in the type test

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MISCELLANEOUS

Photos on Front and Rear Covers

Front Cover

Rogowski Coil Installed at TOKYO SKYTREE

Lightning has been one of the serious problems for insulation design of power apparatus. Recently, highly sophisticated societal systems have been constructed using information and communication technologies (ICTs). These systems, however, are vulnerable to external disturbances such as lightning.

TOKYO SKYTREE, height of which is 634 m, is the tallest free-standing broadcasting tower in the world and it is considered that not a few lightning strikes to TOKYO SKYTREE will occur every year. To protect structures from lightning and evaluate the risk of ICT facilities inside the structures, measurement of the lightning current is essential. The observation of lightning is also useful for understanding the characteristics of natural lightning in detail.

Thus Central Research Institute of Electric Power Industry (CRIEPI) has collaborated with the University of Tokyo and Tobu Tower SKYTREE Co. LTD., to carry out observation of lightning to TOKTO SKYTREE and installed Rogowski coils on TOKYO SKYTREE at a height of 497 m to measure lightning currents. The shape of the Rogowski coils is a hexagon and the total length is more than 30 m. The lightning current measurement started from March, 2012 and 8 lightning data have been obtained by the end of September, 2012. .

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(The aerial photo of the Tokyo Sky Tree is provided by Obayashi Corporation (main contractor, Tokyo, Japan) with the permission of TOBU TOWER SKYTREE Co., Ltd (owner, Tokyo, Japan) to publish the photo.)

Rear Cover

Numerical Simulation of Partial Discharge (PD) -induced Acoustic Wave Propagation

Acoustic Partial Discharge (PD) detection method is useful tool to locate PD source in oil-filled transformers. We have studied acoustic wave propagation characteristics, to improve the diagnostic technique for electric power transformer. New PD location method was considered with oil-filled transformer internal structure by numerical simulation of acoustic wave propagation using finite element method. The numerical simulation was carried out for an actual transformer model in which a PD source was set between windings, iron core and a tank. Calculated acoustic signals were examined in time-frequency domain using the wavelet transform analysis. From these results, enhancement of identification precision of PD source location was discussed.

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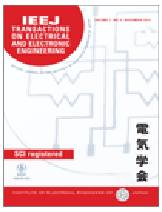
Journals of IEEJ

A Journal which is edited by the headquarters of the Institute and five transactions which are edited by five technical societies* A to E are monthly published.



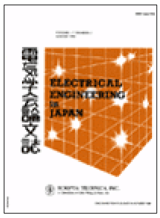
Another transaction “IEEJ Transactions on Electrical and Electronic Engineering (TEEE)” is edited in English by the five technical societies and published bimonthly by John Wiley & Sons.

A new English journal “IEEJ Journal of Industry Applications” was launched in July 2012. It is edited by the society D and published bimonthly. .

Papers in all kinds of journals published by IEEJ can be browsed at **http://www2.iee.or.jp/ver2/honbu/90-eng/14-magazine/index020.html**

You will be able to directly purchase the full text documents by PDF through the Pay-Per-View System.

Two journals “Electrical Engineering in Japan” and “Electronics and Communications in Japan” are translation of the IEEJ Transactions A, B, C, D and E from Japanese into English both edited and published by John Wiley & Sons (not all articles).



Right: Electronics and Communications in Japan
http://www3.interscience.wiley.com/journal/121413813/

Left: Electrical Engineering in Japan
http://www3.interscience.wiley.com/journal/35377/

(*) Five technical societies in IEEJ are as follows:

A: Fundamentals and Materials Society (This magazine is published from EINA Committee under this society.)
B: Power and Energy Society
C: Electronics, Information and Systems Society
D: Industry Applications Society
E: Sensors and Micromachines Society
(please visit **http://www.iee.or.jp/index-eng.html)**

IEEJ Technical Reports

Technical reports listed below were prepared by investigation committees in technical societies A to E in IEEJ and published from the end of September in 2011 to September in 2012. Their extended summaries can be browsed in English on the web site below but the texts of technical reports are described in Japanese.

No.	**Title**	**Pub. date**
1234	Insulation Coordination and EMC Technologies for Low-Voltage and Control Circuits at Power Stations and Substations	2011/ 9/30
1235	Technical Report of Studies concerning Contact Line Maintenance considering Environment in Railway	2011/ 9/30
1236	Lightning Accident Case and Protective Measures for Electrical Facilities in Factory	2011/10/25
1237	Control Techniques of Advanced Motors for Next Generation	2011/11/ 1
1238	The subject and future view about diagnosis and renewal of industrial electrical equipments	2011/11/25
1239	Industrial control technology considering energy saving and ecology	2011/11/25
1240	Advanced Scheduling and its Evaluation in Railways	2012/ 1/20
1241	Analyzing Models of Distributed Generations for Grid Interconnection	2012/ 1/25
1242	The Latest Power Semiconductor Switching Circuit Technology Corresponding to Global Environmental Issues	2012/ 1/25
1243	Asset Management for Electric Power Equipment Based on Insulation Diagnosis	2012/ 2/10
1244	Practical Performance Evaluation Techniques of Rotating Machines by Electromagnetic Field Analysis	2012/ 2/20
1245	Degradation Diagnosis Technology based on Characteristics of Insulating Materials in Electric Power Apparatus	2012/ 3/ 5
1246	Environmental Load Reducing Technologies for Power Receiving and Distribution Substations	2012/ 3/ 5
1247	Magnetic Suspension Technology and Application for Environment-conscious Systems	2012/ 4/20
1248	Electromagnetic Technologies for Forecasting and Monitoring Natural Hazards	2012/ 4/25
1249	Trend of the International Standard about the Electrical Safety in the Railway	2012/ 5/10
1250	Applications of Biomedical Photonics	2012/ 6/ 5

1251	Technology Trends in Energy Systems of Information Apparatuses in Homes and Offices	2012/ 6/20
1252	High-energy power capacitors, their applied technology and the trends	2012/ 6/20
1253	Frontier of variable speed AC drive technology	2012/ 7/10
1254	Thermal Assisted Nano-Spin Storage Technology	2012/ 7/20
1255	Recent Trend of Power Electronics for Automobiles	2012/ 8/10
1256	Present Condition and Future Trend of Wind Power Technologies	2012/ 8/10
1257	High-Performance Permanent Magnets and their Applications	2012/ 8/10
1258	Application Guide for Insulation Coordination in Non-effectively Grounded Systems and UHV Systems -Technical Explanation of JEC-0102-2010-	2012/ 8/30
1259	Transition of Linear Drive Technology and Usage for Industry Applications	2012/ 8/30
1260	Magnetic technology, medical treatment, bio-magnetics, magnetic measurement, guideline	2012/09/10
1261	Intelligent Control, System Control, Image Processing, Signal Processing, Robotics	2012/09/20
1262	Agent-Based Simulation; Artificial Intelligence; Social Systems	2012/10/05
1263	Fuel Cell, Energy, Network ,Renewable Energy	2012/10/05

Abstracts of the technical reports can be browsed on the web site:

http://www.iee.or.jp/index-eng.html ---> “Publications”
or **http://www2.iee.or.jp/ver2/honbu/90-eng/13-publication/index.html**

Application for Membership of IEEJ

Please visit http://www2.iee.or.jp/ver2/honbu/90-eng/12-bid/index.html

Way for Purchasing Proceedings of IEEJ Technical Meetings and IEEJ Technical Reports

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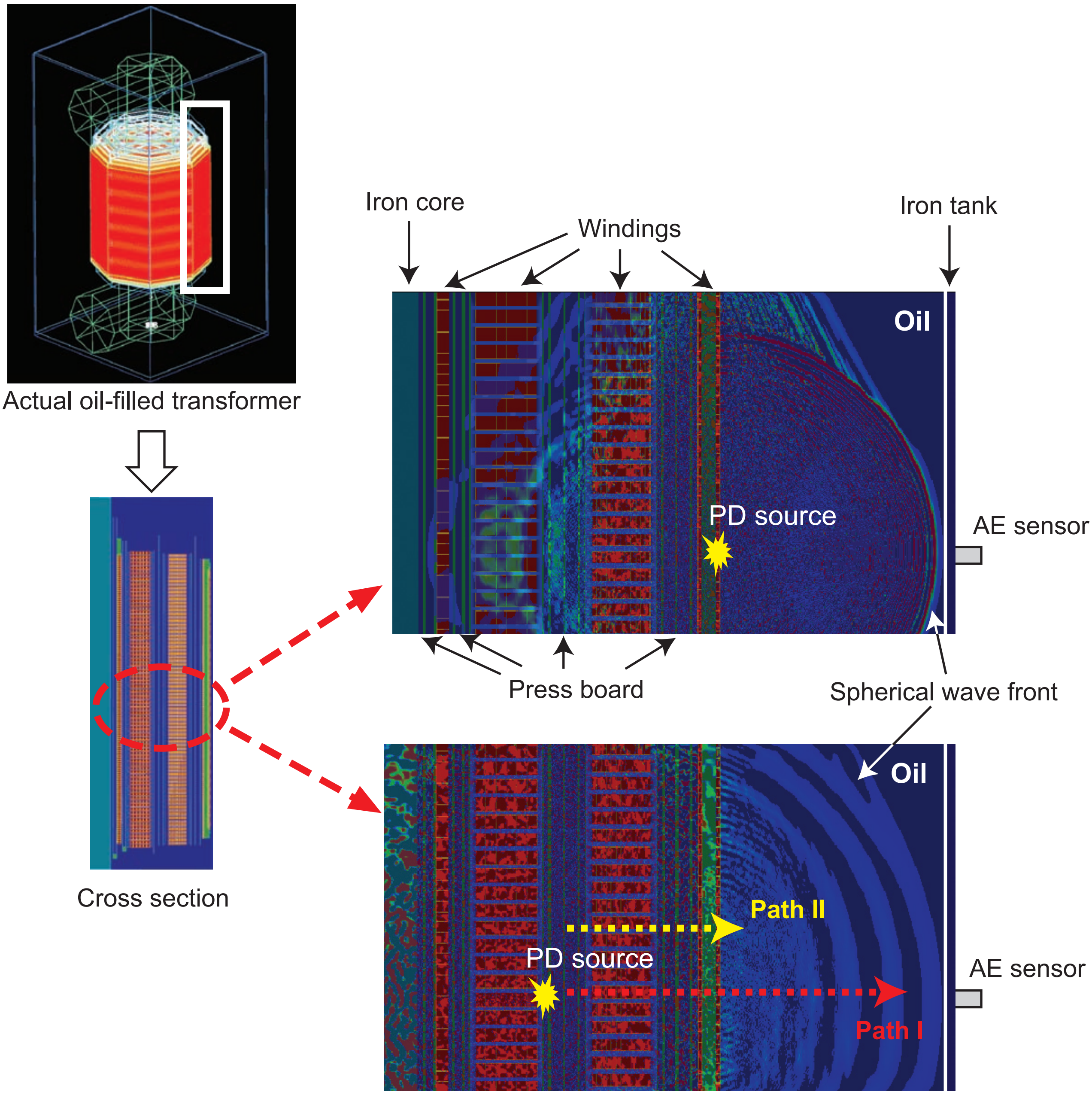

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