Electrical Insulation News in Asia

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IEEJ

CONTENTS

TECHNOLOGIES FOR TOMORROW

TECHNOLOGIES ALERT

MISCELLANEOUS

PREFACE

Dr. Tatsuki Okamoto

Small talk on my engineering study

I have received many important lessons from respect professors and even from my classmates. One is concerning with the essence of engineering. When I was an undergraduate student of Nagoya University about 40 years ago, a famous professor of electrical engineering, Prof. Minoru Ueda gave us a very impressive lesson on the essence of engineering. One day he said, "Good engineering work does not simply mean to design better performance machine but to design a machine to meet its specifications". At the beginning, I could not understand what he wanted to say because I believed that to design better performance machine was the purpose of learning engineering at that time. He continued, "Think about power motors, for example. One motor is a bit heavy but strong for overload and has longer life than its expected life and it is cheap. The other one is light but weak for overload beyond its specification and has shorter life and it can barely satisfy its expected life but it is expensive. Now, everybody, which one, do you think, gets the higher evaluation as good engineering work?" I thought "Of course, the former one!"

By the contrary to my thought, he continued, "The latter one is the better engineering work because it satisfies all its specifications and there are little redundancies. The latter product is designed by knowledgeable engineers who could design the machine with the minimum redundancy. They are knowledgeable because they know how to reduce the redundancy. Large safety factors mean that the designers have less confidence and as a result the machine becomes unnecessarily strong for overload or has too long life. Therefore to reduce the redundancy is the essence of good engineering." Now I really understand what he wanted to say and I always try to say the same thing to young students when I have chances to give a lesson to them.

The second important lesson about my engineering study is geopolitics. There seems to be no relations between engineering and geopolitics at a glance. However I realized that there were strong connections. After I joined CRIEPI, I had a chance to see my university classmates in a liberal arts course of Nagoya University. He had studied abroad in a university in England for several years and he told me some of his experiences. He said there was a class where he could learn geopolitics for engineers.

The word, "geopolitics" was new to me and I wondered what kind of lessons he could get. He continued, "Geopolitics is a science that deals with strategy and students of the engineering course have to learn it and therefore I took the course. It was really interesting for me because I could learn how to plan the strategy under given conditions that cannot learn in the engineering courses in Japan. To learn individual technical methods are very important but also sometimes to make a strategic plan to organize the individual methods becomes much more important." I was shocked with his words. I myself have never learned geopolitics but if it is the science to give how to think in a macroscopic way then I believe that even engineering course students must learn geopolitics or equivalent.

Many of my recent research works concern with asset management of power equipment and I always recall my friend's words. It is often said that Japanese people are good at techniques but not good at making a strategy. Learning geopolitics may be necessary for Japanese young engineers and also for all Asian students of engineering. "Essence" of asset management works has strong relationship, I believe, with geopolitics because both of them concerns with how to plan the strategy under given conditions or requirements.

I would like to conclude my small talk with the word "Essence". Finally, as Prof. M. Hara and many professors said in their Prefaces of previous EINA Magazines, I also hope that the EINA contributes to strengthen the partnerships among Academia and Industry of High Voltage and High Field engineering in Asia.

Dr. Tatsuki Okamoto
Executive Research Scientist, CRIEPI,
Japan

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 Technical Committee on Dielectrics and Electrical Insulation (TC-DEI) had the 200th anniversary of TC meeting in March 2011 and the special lecture meeting by the past and the present chairpersons. TC-DEI was renamed to this name in 1990 and was set up in 1979 upon the reorganization of IEEJ, succeeding the Permanent Committee on Electrical Insulating Materials started in 1971. The activities of the Committee 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.

This year we held the 7th ISEIM with Honorary Chair of Prof. Y. Ohki and the General Chair of Prof. M. Nagao, in September 6-10, 2011 in Doshisha University, Kyoto, followed by the Joint colloquium of CIGRE SC-A2 and D1 in Sept.11-16, 2011, in the same place. The ISEIM was technically cosponsored by IEEE DEIS Japan chapter, CIGRE Japanese National Committee and locally arranged by the colleagues of Doshisha University. 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 assessment, asset management regarding to insulation performance, outdoor insulations, thin dielectric films and other topics were discussed.

Next year we will hold the 43rd Symposium on Electrical and Electronic Insulating Materials and Applications in Systems (SEEIMAS) in Numazu city with the General Chair of Prof. M. Nagao in the autumn of 2012, We are expecting your participation.

Furthermore, the TC-DEI runs Investigation Committees (IC's) that organize several technical meetings a year. The investigation committees are categorized into four research areas:

Macro-view of DEI technology related

> Asset Management for Electric Power Equipments Based on Insulation Diagnosis (04/2008-03/2011, Chairperson: M. Ikeda (Nippon Petroleum Refining Co.)). The Technical Report is under processing and the succeeding committee is now under consideration.

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 is under processing and the succeeding committee is now under consideration.
> Partial Discharge Measurement under Repetitive Impulse Voltage Application (08/2007 - 07/2010, Chairperson: M. Hikita (Kyushu Institute of Technology)). The Technical Report has been published. The committee is cosponsored by the TC-DEI and TC of Electrical Discharge and the succeeding committee is now under consideration.

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

Electrical Discharges (ED)

Chairperson: M.Hikita (Kyushu Institute of Technology)
Vice-chairperson: T.Nakano (National Defense Academy)
Secretaries: F.Tochikubo (Tokyo Metropolitan University)
A.Kumada (University of Tokyo)
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 four 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 on 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 (JKS on ED&HVE)" has been organized by the TC-EC and has been held every two years. The last J-K Symposium was held on November 5-7 of 2009 in Busan, Korea. Next JKS on ED&HVE will be held in Kanazawa, Japan in November 16 and 17, 2012 as the joint conference with the International Workshop on High Voltage Engineering.

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

Table 1 Investigation Committees in TE-ED

Chairperson	Research subjects and established time
T. Oda (The University of Tokyo)	Electrostatic discharges as electromagnetic interference source (established in April 2011)
K. Yoshida (Kitami Institute of Technology)	Atomic and molecular collision cross section and fundamental parameters of discharges (established in October 2010)
M. Amakawa (Central Research Institute of Electric Power Industry)	Technologies of arc and glow discharge applications (established in May 2008)

Plasma Science and Technology (PST)

Chairperson: Ken Yukimura (National Institute of Advanced Industrial Science and Technology)
Vice-chairperson: Hiroshi Akatsuka (Tokyo Institute of Technology)
Secretary: Yasunori Ohtsu (Saga University)
Assistant Secretaries: Nozomi Takeuchi (Tokyo Institute of Technology)
Shinji Ibuka (Tokyo Institute of Technology)

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 in terms of plasma physical parameters as density, temperature and ionization degree, and application fields as nuclear fusion, plasma processing, and plasma chemistry.

The major activity of this committee is to succeed to organize several technical meeting on plasma science and technology every year. In 2011, three technical meetings were held; in May at Toyama University in Toyama, in August at Osaka Institute of Technology in Osaka, in December at Tokyo Institute of Technology in Kanagawa. In 2010, also four technical meetings were held. At each symposium, about 20 - 30 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 five investigation committees as shown in Table 1. Here we introduce their activities. In the committee of the kinetic description of low-temperature plasmas with applications to modeling and simulation, with the widespread use of low-temperature plasmas in the field of energy conversion and environmental control, development of numerical models incorporating physical and chemical phenomena play a key role. The goal of this committee is to provide recent advances in plasma kinetic theory and its potential impact on their work. 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 their characteristics, 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

Kinetic Description of Low-Temperature Plasmas with Applications to Modeling and Simulation	3 years from 2008, Chairperson: S. Kambara (Gifu University)
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)
Scientific Secretary: Takashi Kikuchi (Nagaoka University of Technology)
Scientific Secretary Assistance: Shinji Ibuka (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.

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 2011, four 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 June at Iwate University in Morioka, in August at Ehime University in Matsuyama, in October at Chiba Institute of Technology in Chiba and in December at Tokyo Institute of Technology in Yokohama. 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.

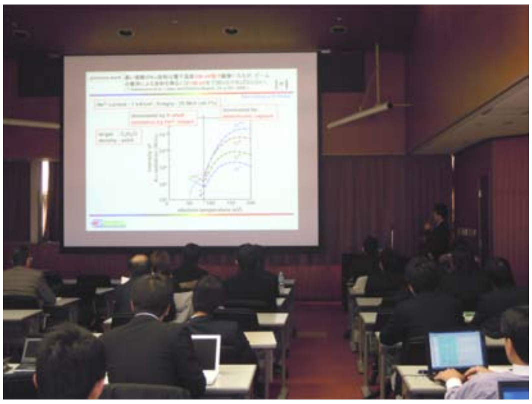

Fig. 1 Joint technical meeting in cooperation with the Technical Committee on Plasma Science and Technology held at Tokyo Institute of Technology in last December.

Activity of investigation committee in TC-PEE

An investigation committee named "biological effects of pulsed electromagnetic energy and their industrial applications" has been running under the TC-PEE since January, 2009. The committee covers the basic studies on the biological effects of the extreme reactive fields produced by pulsed electromagnetic energy such as intense electric/magnetic fields, atmospheric pressure non-thermal/thermal plasmas, plasmas in fluids, shock waves, intense radiations, etc., which have been found to be novel physical stimuli or stresses for cells, organisms and bacteria as well as their applications to biotechnology, medical, cosmetic, agricultural and food industries. This research field has been called "bioelectrics". The bioelectrics research is growing worldwide in the 21 century, on the basis of great progress of pulsed power technology and collaboration between engineers and bio scientists. The committee hosted a symposium on bioelectrics in March, Kumamoto, and organized a special session on bioelectrics in 2011 Annual Conference of Fundamentals and Materials Society in September, this year. Concerning the international activity, the International Bioelectrics Symposium has been held annually since 2004 at various places in Japan, United States and Europe. This year, the symposium was hosted by Institute of Pharmacology and Structural Biology (IPBS), Toulouse, France, in May 4-6, and included approximately 150 attendees. The next symposium is scheduled to be held at Kumamoto, September 5-8, 2012 (See Fig. 2).

(Reported by Eiki Hotta and Sunao Katsuki)

Kumamoto University

BIOELECTRICS 2012

9th International Bioelectrics Symposium

September 5-8, 2012, KKR Hotel Kumamoto, JAPAN

http://bioelectrics2012.coe.kumamoto-u.ac.jp/

Kumamoto Castle

Organized by
Kumamoto University
Global COE Program on Pulsed Power Engineering
Bioelectrics Research Center of Kumamoto University

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Objectives: Advances in pulsed power technology, involving the generation of intense, ultra short electrical pulses, provides an opportunity to explore and utilize the effects of these pulses. Pulsed electric fields have been shown to target the cell interior and permeabilize membranes, leading to new applications including the use of novel pulse delivery devices such as wideband antennas. Efforts to create a consortium to foster this new research field originated with three research institutions which are known for vibrant pulse power research:
- Old Dominion University, USA,
- Kumamoto University, Japan,
- Karlsruhe Institute of Technology, Germany.

At present, seven additional American and European Institutions have joined the International Bioelectrics Consortium (IBC). The International Advisory Committee of IBC has decided to hold the 9th International Bioelectrics Symposium in Kumamoto, Japan, on September 5-8, 2012 hosted by the Global COE Program on Pulsed Power Engineering and the Bioelectrics Research Center (BERC) at Kumamoto University.

Bioelectrics refers to the use of pulsed power, powerful pulsed electric or magnetic field for extremely short periods of time, non-thermal plasmas in gases or liquids and shock waves, to give novel physical stresses to biological cells, tissues and/or organisms as well as bacteria. Bioelectrics is an interdisciplinary academic field that includes physics, chemistry, biology, medical science, agriculture, environmental, mechanical and electrical engineering, and is expected to open up new science and technology. For example, nanosecond pulsed electric field can impart an unique stress on cells based on dielectric and electrostatic effects to sub-cellular bio-molecules and organelles, which is expected to lead to new biological reactions. Also, intense pulsed electric fields can be used to kill bacterial spores in liquid. Pulsed electric fields can have effects at the molecular level as well as be used to delivery molecules or eliminate cancer cells. Atmospheric pressure, non-thermal plasmas produced by pulsed power can be used not only for bacterial, viral and chemical decontamination, but also for medical treatments such as wound healing. Plasmas can be created even in liquid and used for the bacterial and chemical decontamination of water environment. Bioelectrics 2012 aims to provide an environment for experts to discuss the current state of the art for learning both in industry and universities.

Topics: The scope of the conference will cover but not be limited to:
- Pulsed power technology for Bioelectrics
- Energy conversion to shock wave, plasma, electric field, laser and others
- Effect of pulsed power and converted energy to bio
- Electroporation, apoptosis induction, cell differentiation, sterilization and other phenomena
- Medical, agriculture, food, environment and other applications

Paper submission: Prospective participants are invited to submit electronically one page abstract with A4 size. The details are available on the web site of the conference.

Deadlines and Important Dates:

Deadline of Abstract	June 10, 2012
Technical program available	June 30, 2012
Early Bird Deadline for registration	July 15, 2012

Fig. 2 First call of the International Bioelectrics Symposiums 2012, which will be held at Kumamoto, September 5-8, 2012.

Electro-Magnetic Compatibility (EMC)

Chairperson: T. Funaki (Osaka University)
Secretaries: K. Kawamata (Hachinohe Institute of Technology),
T. Ushio (Osaka University)
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. Building up 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, the situation of electromagnetic interferences, the novel measurement techniques for EMC, the protection technology 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 the 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.

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 Apr. 21th(43th), Jun. 18th(44th), Nov. 1st (45th) for 2010, Mar. 24th(46th) , and Jun. 24th (47th) for 2011.

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 Hachinone 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 the 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 to clarify the EMC problems expected to occur in smart grid.

Light Application and Visual Science (LAV)

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

Activities of the technical committee on light application and visual science (TC-LAV) have been covering fields of application of optical engineering and visual information processing, light sources from far-infrared to extreme ultraviolet, advanced lithography, and so on. Two investigation committees: ‘Technologies for Next Generation Lithography (IC-NGL)’ and ‘Future Technology of Infrared and Terahertz Waves (IC-FTITW)’ are affiliated to this TC and are surveying the technology trend of each field.

Two recent topics of light application are introduced.

The first topic is optional control of thick resist pattern profiles.

Lithography for fabricating semiconductor integrated circuits is entirely focused on the refinement of the patterning resolution. Because half-pitches of 23 and 16 nm are required for DRAM and flash memory, respectively in 2016, double patterning, EUV, EB, imprint, and directed self assembly technologies are earnestly researched. On the other hand, lithography for fabricating various micro electro mechanical systems (MEMS), mechanical components, fluidic devices, and biochemical or medical elements with minimum pattern sizes of 1-100 μm are also vigorously researched. In such large-pattern lithography, intended optional control of sidewall profiles of resist patterns is one of the remarkable technology topics.

Because the patterns are very tiny and depth of focus becomes as narrow as less than 100 nm in the lithography for advanced semiconductor device fabrication, there is not any margin to change the focus without degrading the resolution. On the other hand, in the case of large pattern lithography, the focal position can be changed almost without considering the degradation of resolution. As a result, if a resist with appropriate absorption for the exposure light is used, triangular, circular or elliptic cross sections are consciously obtained by changing the defocus and the exposure time, as shown in Figs. 1 and 2[1]. This advantage will be utilized to fabricate micro-dies of optical components such as lens and prism arrays.

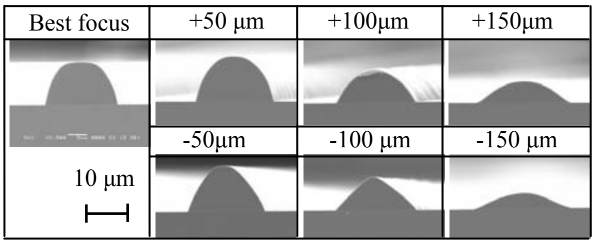

Fig. 1 Various profiles obtained by changing focal position. Wavelength and exposure time were fixed at 405 nm and 8 min. Plus defocus means that the wafer is placed far from the lens.

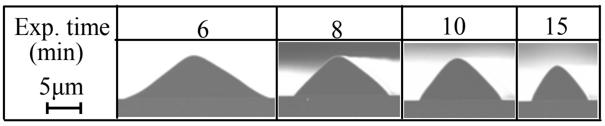

Fig. 2 Profile controllability changing the exposure time. Wavelength and defocus were fixed at 405 nm and -100 μm

The second topic is characteristics of random errors in intensity and phase measured with THz time domain spectroscopy

Terahertz time-domain spectroscopy is a leading technology in the present terahertz research and applications. THz-TDS has large dynamic range (10^6 to 10^8) which is defined by ratio of the maximum to the noise floor in intensity spectrum. Signal-to-noise ratio (SNR), however, is different from the dynamic range.

We have found that random error in THz intensity spectra is much larger than the noise floor[2] whereas the random error in phase spectra is rather small[3]. The standard deviations in intensity and phase spectra measured with THz-TDS are almost proportional to THz intensity and phase respectively. We discuss on the characteristics related to these random errors.

A THz-TDS system used in this research is a transmission type and uses a compact femto-second (fs) fiber laser and low temperature-grown GaAs photoconductive antennas (LT-GaAs PCA) as THz emitter and detector. In the measurement, ZnTe crystals (Nippon Mining and Metals Co. Ltd) were used as samples.

Time-domain waveforms of THz electric field (Fig.3) are sampled 1024 data points by 12μm (40 fs) spacing of optical delay line for reference (R) and sample (S). The data was measured in a sequence like R_1, S_1, S_2, R_2, R_3, S_3, …, S_m, R_m ,
where m is 12 or 16, to take a pair of reference and sample data close in time. It takes ten minutes to measure one waveform and about 300 min to 400 min to carry out the course of measurement for a sample.

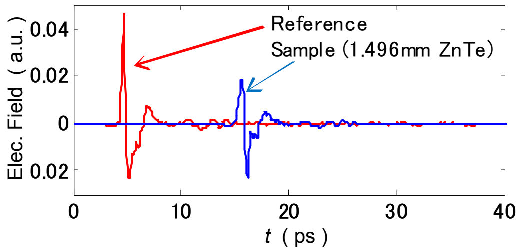

Fig. 3 THz electric-field pulse waveforms measured with a THz-TDS.

Measured electric-field waveforms in time domain are Fourier-transformed to intensity and phase spectra in frequency domain, in which the frequency resolution is 24.4 GHz. Mean and standard deviations are statistically calculated from numbers of intensity and phase spectra of reference and sample respectively. THz intensity spectra and standard deviations are displayed in Fig. 4, for which a sample is 1.496-mm thick ZnTe.

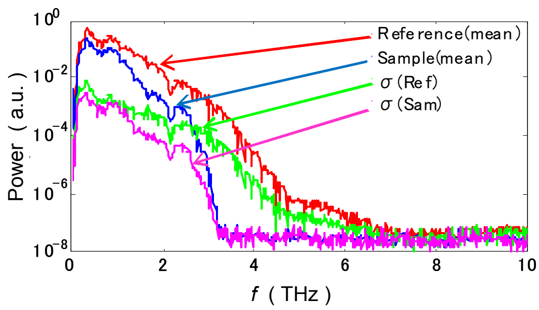

Fig. 4 THz intensity spectra and standard deviations of reference and sample.

Figure 4 shows that the random errors in THz intensity spectra are much larger than the noise-floor level and they are almost proportional to the THz intensity itself in the high SNR region.

The random errors in phase spectra are also almost proportional to the observed phase itself in the high SNR region[3].

We have directly examined the correlation of random error in intensity with random error in phase in frequency domain (Fig. 5). The results show the intensity error and phase error are independent from each other.

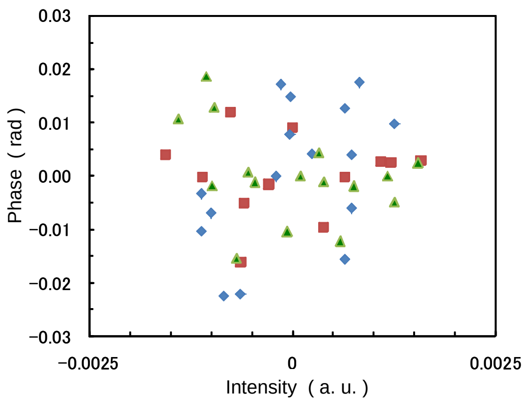

Fig. 5 Correlation of random errors in between phase and intensity spectra at 1.20 – 1.37 THz in frequency domain.

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Instrumentation and Measurement (IM)

Chairperson: K. Tanabe (CRIEPI)
Vice Chairperson: A. Otani (Anritsu)
Secretary: T. Shirai and K. Kodaira (JEMIC)

Annual activities

The Technical Committee of Instrumentation and Measurement of IEEJ was set up in Jan. 1980, succeeding the Committee on Electronics Instrumentation and Measurement.

The technical committee of instrumentation and measurement hosts the following activities.

1) The general meeting of the committee is held four times per year for discussing the various activities of the committee. Fifteen members including the chairperson, two secretaries, and two assistant secretaries constitute the committee. The chairperson has been also a chair of IEEE IM-09 so far.
2) Workshops for the presentation and discussion of studies and researches take place almost every month in principle as a main activity of the committee.
3) Visits to various professional facilities are planned once or twice a year.
4) A special volume of the transaction of the society A (Fundamentals and Materials) in IEEJ is planned.

Fig. 1. Snapshot in Workshop at Ibusuki City

The workshops mainly take place in the Tokyo area, and occasionally in other areas such as Kyushu, Kinki, and Shikoku. The themes of presentation in the workshop are usually focused on electromagnetic measurement, remote control instrumentation, application of optical measurement, biological electronic measurement, time and frequency measurement, application of magnetic miscellaneous subjects on measurement and instrumentation are accepted for presentation and discussion. The number of presentations in the workshops is around 70 per year. The workshop is supported by IEEE IM and sometimes by other organizations.

The workshop that was held at Ibusuki city in the Kyushu district on Feb. 24-25, 2011, as the Joint Technical Meeting of the Technical Committee of “Light Applications and Visual Science, IEE Japan” and Instrumentation and Measurement was a big event in both of the technical committees (Fig. 1). Eighteen papers and a special invited paper, “Revealing an ancient village in 9C in Ibusuki-City, Kagoshima, Japan, by use of Ground Penetrating Radar”, IEEJ IM-09, No. IM-11-17, pp.4-45 (2011), were presented.

There were over 30 attendees including experts in the field of Light Applications and Visual Science and Instrumentation and Measurement, as well as local people because of the attractiveness of the invited paper.

Regarding the invited paper, attendees gave their full interest and asked many questions. The questions and answers are as follows:

Q1. How many days does a survey take?

Q2. How is the number of divisions of the ground surface for surveying the underground structure using Ground Penetrating Radar (GPR) determined?

Q3. How long does it take to survey one division?

Q4. What determines the spatial sweep interval of GPR on the ground surface?

A1-4. When surveying archaeological sites, measuring lines of 0.5-1 m intervals in gridlike fashion are usually set. A set of cross sectional diagrams under a measuring line was obtained from scanning along that line (Fig.2). Based on the set of cross sectional diagrams, the underground structure is estimated. Furthermore, by extracting signals at a certain depth (travel-time) from a set of cross sectional diagrams and lining up a set of time-slice diagrams, the whole underground structure under survey is estimated. In surveying the Shikiryou archaeological site, measuring lines of 0.5 m intervals in gridlike fashion is employed for all districts. The scanning speed along a measuring line is at a slow walk, and reflected waves were received every 4cm along a measuring line. The total surveying area in a day is 30x30 m^2, including the placement of measuring lines. Therefore, the rate of 25x25 m^2 per day is usually adopted.

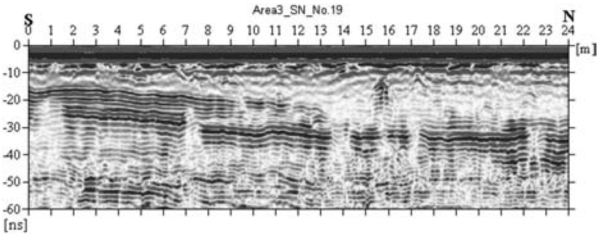

Fig. 2. Example of Cross Sectional Diagram obtained at Shikiryou Archaeological Site

Q5. What kinds of instruments are needed when surveying an archaeological site using GPR?

A5. An antenna, RADAR including controller and recorder, tape measures, and a personal computer system are needed, and are carried by a light truck.

Q6. How do you properly use GPRs having different detecting resolution?

A6. We select them based on the depth of targets. Higher frequency provides higher resolution, but the survey depth becomes shallower. In general, 200-500 MHz is used in Japan.

Q7. Can you estimate the depth and thickness of Murasaki-Kora ash, which is volcanic ash soils having hard pan?

A7. We can estimate the depth with a resolution of 10 cm, which is supported by excavation surveys. However, the estimation of the thickness is unsettled.

All experts stayed in the same hotel at Ibusuki city and an informal discussion on nondestructive inspection technology using infrared thermography was held after dinner.

Nondestructive inspection using infrared thermography has reached technical maturity and is in field use. For example, bad contacts in power equipment result in increased resistance and heat generation, and can be detected by thermal imaging. However, this passive technique cannot be applied to cases in which failures or defects do not result in heat generation. In that case, active thermography, which combines external heating and thermal imaging, can be used.

When a surface is heated, the local temperature rises. When the heating stops, the heated region cools and returns to the original temperature with a certain time constant, which is determined by the heat conduction to the surroundings. If the heat conduction changes due to a defect, the time constant changes. If the external heating is periodic, the temperature variation is also periodic, with a certain phase difference between the two. If the time constant decreases, the temperature response becomes faster, so the phase difference decreases. Therefore, by measuring the time constant under transient heating or the phase difference under periodic heating, defects and problems can be detected.

Active thermography is often used in civil engineering. This is because concrete is a good heat insulator, and heat escapes slowly. Therefore, the difference between a normal part and a defect is relatively easy to detect. As an example, a nondestructive inspection device of concrete railway viaducts by active thermography has been developed. For metals, application of active thermography to $Nd_2Fe_{14}B$ and S15C alloy has been reported. Artificial defects of 5, 10, 20 mm machined on the interior of the specimen could be detected.

In the informal discussion, the following topics were discussed: the minimum significant temperature difference that can be detected in thermography, the errors arising from local variations in the emissivity, the possibility of applying active thermography to highly reflective surfaces, the optimal period for periodic heating, and methods for heating (other than lamps, which are ordinarily used). Possible industrial applications were also discussed, which include detection of pipe lining delamination, detection of wall thickness of steel pipes. In applications using external heating, the importance of control algorithm of the heating device was mentioned.

WEB site and author

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

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Metal and Ceramics (MC)

Chairperson: Akio Kimura (Furukawa Electric Co., Ltd.)
Secretary: Genzo Iwaki (Hitachi, Ltd.)
Assistant Secretary: Ataru Ichinose (CRIEPI)

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 superconductivity, normal conductivity, semi-conductivity, mechanical strength, heat transfer, thermoelectric, photo-electricity, optical transmission, electrochemical affinity, radio-activity, composites etc.

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.

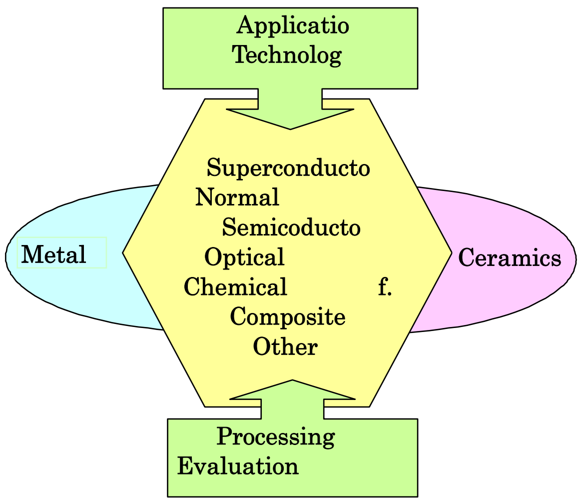


Figure 1 Activity scope of the TC-MC

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	2011.03.16	Osaka University

Table 2 Study Meetings in TC-MC

Theme	Date	Site
Development of advanced superconducting wires and their future problems	2008.03.14	CRIEPI
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 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.

The investigating R&D committee whose chairperson was Dr. Kumakura issued a technical report entitled "Fabrication and superconducting properties of advanced superconducting tapes and wires". This report won IEEJ outstanding technical report award in 2009. The forum using this technical report as a text book was held at CRIEPI on March 2008.

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. Jyun-ichi 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 and Y-based oxide 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 Nb_3Al conductors, Bi-based oxide superconductors, MgB_2 conductors and Y-based oxide 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 researchers 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	Jyun-ichi Shimoyama (University of Tokyo)	2008.10-2011.09	Open

High Voltage Engineering (HV)

Chairperson: S. Matsumoto (Shibaura Institute of Technology)
Secretaries: Y. Hoshina (Toshiba Corp.), T. Utsumi (Hitachi Corp.)
Assistant Secretary: T. Miki (CRIEPI)

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. Five investigation committees listed in Table 1 are active in September 2011.

The 7th International Workshop on High Voltage Engineering (IWHV2010) was held in Kita-Kyusyu city, following the 1st IWHV at Okinawa in 1999, 2nd IWHV at Tottori in 2000, 3rd IWHV at Fukuoka in 2003, 4th IWHV at Sapporo in 2004, 5th IWHV at Hamamatsu in 2007 and 6th IWHV at Kyoto in 2008.

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 and interesting findings will appear in a special issue of the Transactions of IEE of Japan.

There were 8 sessions, where 40-60 papers were presented orally for two days. All speakers presented their paper in English, following fruitful discussions.

The workshop banquet was also held and many participants exchanged various information of the worldwide technology of electric power industries, and the research on electric discharge phenomena while enjoying the food. Next IWHV will be held at Kanazawa in Nov. 16-17, 2012. We hope IWHV2012 will also 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 will be associated with a technical visit to Chubu Electric Power Co.

The members of the committee other than the chairperson of the investigation committees are from universities (5), a research institute (3), electric power utilities (4) and manufacturers (7).

Table 1. Investigation Committees in TC-HV

Research subjects	Active period	Chairperson
Lightning Protection for low-voltage power distribution systems	3 years from 2009	Akira Asakawa (CRIEPI)
Insulation coordination for non-effectively earthed and ultra-high voltage systems (Cooperative Study Group)	2 years from 2009	Kunihiko Hidaka (The Univ. of Tokyo)
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.)

Table 2. Technical Reports will be published

Research subjects	Chairperson
Insulation Coordination and EMC Technologies for Low-Voltage and Control Circuits at Power Stations and Substations	Akihiro Ametani (Doshisha Univ.)
Wind Turbine Grounding Systems for Lightning Protection	Shozo Sekioka (Shonan Inst. of Tech.)

RESEARCH ACTIVITIES AND TECHNICAL EXCHANGES IN ASIAN COUNTRIES

Conference Records

International Conference on Electrical Engineering (ICEE 2011)

The Hong Kong Institution of Engineers

International Conference on Electrical Engineering (ICEE 2011) hosted by the Hong Kong Institution of Engineers (HKIE) and jointly organized with the Chinese Society for Electrical Engineering (CSEE), the Institute of Electrical Engineers of Japan (IEEJ) and the Korean Institute of Electrical Engineers (KIEE), ICEE 2011 was successfully held from 10 July to 14 July 2011 in Hong Kong. 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. The next ICEE will be hosted by the IEEJ in Kanazawa, Japan from 8 to 12 July 2012.

With the theme "**Towards Smart & Low-carbon Electrical Engineering**", ICEE 2011 was well attended by more than 500 delegates from Hong Kong (109), China (25), Japan (196), Korea (148) and some other overseas countries (24).

The opening ceremony was held on 11 July. The occasion was officiated by Guest of Honor Mr. Edward Yau, GBS, JP, Secretary for the Environment of the HKSAR Government, who was also an Honorary Advisor of the Conference. The Conference covered the following major topics:

Table 1 Major topics of ICEE 2011

Power Systems	➢ Design and Planning of Railway system
➢ Smart Grid	➢ Railway Control and Signaling Systems
➢ Power System Protection, Operation and Control	➢ Rolling Stocks
➢ Power System Planning and Scheduling	➢ Safety and Security
➢ Power System Stability	➢ Condition Monitoring
➢ Power System Modeling, Simulation and Analysis	➢ Power Distribution in Railway
	➢ Operation and Fare Collecting Technology
➢ Power System Security and Reliability	
➢ T&D Systems and Apparatus	**Power Electronics, Motor Drives & Industrial Applications**
➢ HVDC and FACTS	
➢ Power Market and Power System Economics	➢ Inverter and Converter Technology
➢ Load Forecasting	➢ Power Quality and UPS
	➢ Driver Circuits and Applications
Energy and Environment	➢ LED Lighting and Other Lighting Technology
➢ Renewable Energy	➢ Control and Automation
➢ Energy and Sustainable Environment	
➢ Electric Vehicles and Hybrid Vehicles	**Fundamentals, Materials & Education**
➢ Energy Saving Technology	➢ Electrical/Electronic Materials and Process
➢ Energy Management & Related Systems	➢ Semiconductor Technology
	➢ Electromagnetic Fields
Sensors and Micro-machines	➢ Electrical Discharges and Insulation Technology
➢ Diagnosis and Sensing Systems	➢ Education and Training for Electrical Engineers
➢ Micro Machines	➢ Application of Information Technology
Electric Traction Systems	**Other Related Areas**
➢ Commuter, Higher Speed & Inter City Rail	

The four-day technical program featured six keynote presentations, three panel discussion sessions, a total of 320 oral and poster presentations and technical visits.

Opening Ceremony: (L to R) Mr. Kim Moon Duk (KIEE), Prof. Hitoshi Okubo (IEEJ), Mr. Edward Yau, the HKIE President Ir Dr. F C Chan, Mr. Chen Feng (CSEE) and ICEE 2011 Conference Chairman Ir Prof. C C Chan.

The following six keynote speeches were presented at the Conference:

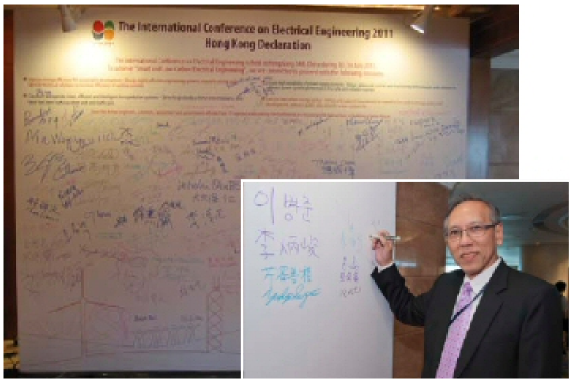
- *"Superconductivity: From Particle Accelerators to High Power Long Distance Electricity Transmission"* by Prof. Carlo Rubbia from Switzerland
- *"The Strategic Role of Power Grids in the Implementation of a European Energy Policy"* by Mr. André Merlin from France
- *"Smart Grid in Restructured Electric Power Systems"* by Dr. Mohammad Shahidehpour from USA
- *"The Strategy and Practice of Smart Grid at CSG"* by Dr. QI Dacai from the Mainland
- *"Green Growth & the Trend of Power Business in Korea"* by Prof. Koo Ja Yoon from Korea
- *"Renewables Integration to the Grid: System Approach & Local Approach – Towards Smart & Low-Carbon Electrical Engineering–"*by Dr. Hideki Hayashi from Japan.

At the three Panel Discussion Sessions, under the lead of moderators, delegates from difference regions came together to share their insight on discussion topics under three major themes. The first session on "Railway as a Smart and Green Transportation System" was chaired by Ir Chan Fan, while the second session on "Energy Choices to Achieve Low Carbon Economy" and the third session on "Realisation of Electric Vehicle in Asian Cosmopolitan" were chaired by Ir Prof. Wong Kit Po and Ir Prof. Chau Kwok Tong respectively.

The Conference was well attended
by more than 500 delegates.

During the Conference, delegates were invited to sign "Hong Kong Declaration," disclosing to the public their devotion and determination for continual researches and further back-up support toward low-carbon economy. To achieve "Smart and Low-Carbon Electrical Engineering", they are committed to proceed with the following missions:

- **Improve energy efficiency for sustainable development**
- **Construct and operate clean, efficient and intelligent transportation systems**
- **Ensure high reliability of power supply systems**
- **Execute low carbon energy policy**



The HKIE President Ir Dr. F C Chan
signing The Hong Kong Declaration.

Conference Chairman passing the flag to the representatives of the host of ICEE 2012, Prof. Yoshihiko Uesugi (left 2nd) and Dr. Yoshizumi Serizawa (right 1st) from IEEJ.

We believed our overseas guests and delegates would come home with happy memories and fulfilling time spent with ICEE 2011 during their stay in Hong Kong.

By **Conference and Function Section**
The Hong Kong Institution of Engineers

CIGRE SC A2 & D1 Joint Colloquium 2011 in Kyoto
Transformer, Materials and Emerging Test Technologies

Hiroya Homma
Central Research Institute of Electric Power Industry

CIGRE SC A2 & D1 Joint Colloquium 2011 in Kyoto was held at Doshisha University, Kyoto, Japan, from September 11 to 16, 2011. The Japanese National Committee of CIGRE (JNC) invited Study Committee A2 (Transformers) and Study Committee D1 (Materials and Emerging Test Technologies) to hold their Joint Colloquium and its associated working group meetings during the period.

Preferential subjects of the Joint Colloquium were as follows,

PS1: Transformer Maintenance, monitoring, diagnostics and related testing
- New approaches for maintenance, monitoring and diagnostics, development of health index
- Advanced monitoring technology and algorithms, example of early detection, criteria,
- Low maintenance transformers, transformer improvements, etc.

PS2: Materials
- New materials – compatibility, technical performance, economic value
- Ageing
- Dielectric performance under unconventional stresses

PS3: Transient phenomena and testing
- In service experience, measurements, failures, lesson learned
- Critical configurations, simulations, very fast transients, disconnector switching
- Experience with transformer testing, improvements, etc.

The Joint Colloquium had two days oral sessions and one day poster session and workshop (Table 1). Totally, 82 papers were accepted for oral/poster presentation and approximately 200 people participated to the joint colloquium. Numbers of accepted papers for each sessions and countries are shown in Table 2 and 3.

At the opening of the colloquium, Mr. C. Rajotte, SC A2 Chairman and Prof. J. Kindersberger, SC D1 Chairman gave a brief talk about Activities of SC A2 and D1, respectively. Three keynote speeches for the each preferential subjects and one special lecture were also made (Table 4). On the workshop, four presentations were made by five presenters. There were so many questions and answers, and discussion was heated during the colloquium.
Technical tour visited to the oldest Japanese hydro power station of the Keage Hydro Power Station in the Kyoto city with the Lake Biwa Canal and Incline.

Table 1 Schedule of the Joint Colloquium

Date	Program
Sept. 11	Registration / Welcome Party
Sept. 12	Joint Colloquium Day 1: Oral Session for PS2 & PS3
Sept. 13	Joint Colloquium Day 2: Oral Session for PS1
	Banquet
Sept. 14	Joint Colloquium Day 3: Poster Session Workshop
Sept. 15	SC Meetings
Sept. 16	Technical Tour

Mr. C. Rajotte, SC A2 Chairman at Opening

Prof. J. Kindersberger, SC D1 Chairman at Opening

Table 2 Oral/Poster presentations

	Oral	Poster	Total
PS1	23	17	40
PS2	13	12	25
PS3	11	6	17
Total	47	35	82

Table 3 Paper number of each country

Country	Paper No.
China	21
Japan	12
Germany	7
USA, Canada,	5
France, Brazil, Austria	4
UK, Swiss, Sweden, Spain	3
Netherland, Belgium	2
Others	5
Total	82

Table 4 Opening/Keynote/Special lecture

	Presenter / Title
Opening	C. Rajotte (A2 Chairman) SC A2 Activities
	J. Kindersberger (D1 Chairman) SC D1 Activities
PS1	N. Fantana WG B3.12: Obtaining Value from On-line Substation Condition Monitoring
PS2	L. Lundgaard & S. Mehta Introduction / Keynote
PS3	M. Muhr Introduction / Keynote
Special Lecture	H. Okuyama The damage of T&D facilities due to "The Great East Japan Earthquake" on 11th March 2011 and present restoration situation

Oral session of the colloquium

Table 5 Workshop program

WS	Presenter	Title
1-1	M. Foata	Guide for Transformer Maintenance
1-2	R. Martin	Experience in Service with New Insulating Liquids
2-1	S. Gubanski	Dielectric Response Diagnoses for Transformer Windings
2-2	P. Wiklund I. Hoehlein	Oxidation Stability of Insulating Liquids

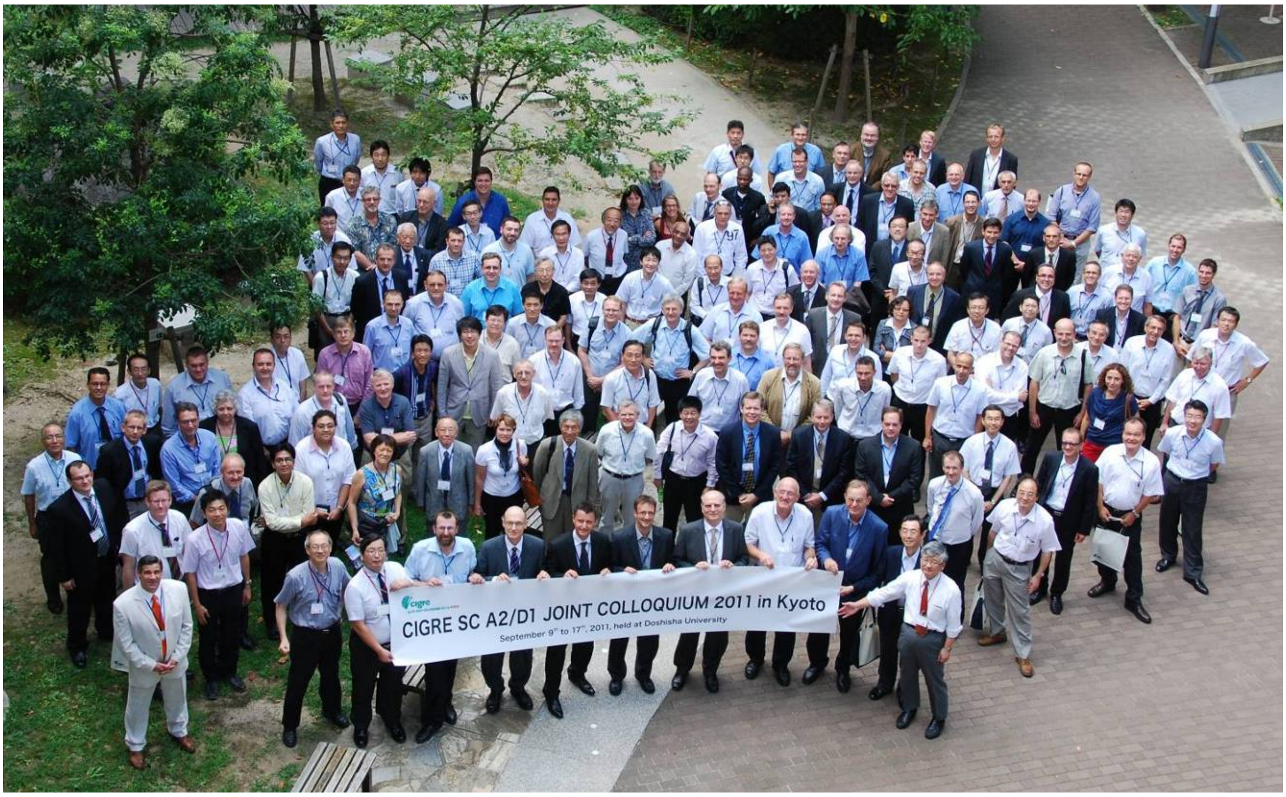
Prof. N. Hozumi, SC D1 Chairman of JNC managed each oral session

Poster session of the colloquium

All programs proceeded on schedule and each session was well organized during the week. Most of the participants appreciated sufficient preparation by the Local Organizing Committee Japan and their support members. We believe that the Joint Colloquium could provide a precious occasion and very successful fruit for the participants.

Mr. Y. Shirasaka, Chairman of SC A2 of JNC and Local Organizing Committee at Banquet Opening

All guests toasted with Japanese sake after Kagami-wari ceremony at Banquet



Memorial photo of all participants at Doshisha University, Kyoto

Dr. Hiroya Homma
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2011 International Symposium on Electrical Insulating Materials (ISEIM 2011)

The International Symposium on Electrical Insulation Materials (ISEIM) is positioned as the international version of the domestic symposium held every year by the Dielectric and Electrical Insulation Committee of IEE Japan. Continuing a series of conferences that began in 1995, the ISEIM held its 6th conference on September 6-10 2011, in Kanbaikan Hall at Doshisha University, Kyoto, Japan.

The conference covers the nanotechnology, asset management, phenomena under inverter serge as well as several fundamental material researches. There were 128 papers registered for the conference with 60 oral presentations and 68 papers presented in two kinds of poster presentations. These presentations are categorized into 11 kinds of topics, as shown in Fig. 1. More than 140 participants listed in Table 1 from industry, government, research and academic institutions of 15 different countries and areas around the world shared their experience and discussed new progress as well as challenges to be faced in the near future. Fig. 2 shows a group photo of the conference.

The conference started with opening remarks by Prof. M. Nagao of Toyohashi University of Technology, General Chair. Prof. M. Zahn of Massachusetts Institute of Technology delivered the 5th Inuishi Memorial Lecture. The title of his presentation was "Unipolar charge transport in oil-pressboard systems with planar, coaxial cylindrical and concentric spherical electrode geometries", which consisted of research carried out on the theoretical and empirical analyses on charge transport mechanisms. A plenary lecture on DC insulation materials was provided by Dr. P.H.F. Morshuis of Delft University of Technology. To get more attention in the key fields, twelve lectures were provided during the Session. Table 2 lists these lectures with their speakers.

One of our important missions was to encourage young researchers to succeed and expand their activities. From this point of view, we planned a "Mutual Visiting Type Poster Session", called an "MVP session". This session also aims to encourage the presentation and discussion abilities of young researchers by taking sufficient time and space for poster sessions. Presenters were broken into small groups with similar research field and required to give their own poster presentation to the other member in the group. After the short presentation duration, the other group member gave the presenter some question. All other member in the group also gave their

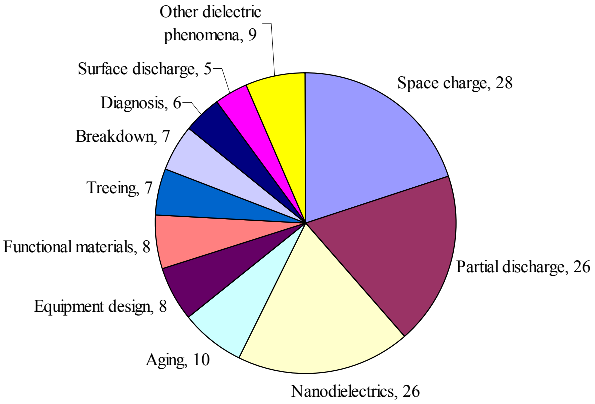

Fig. 1 Constituents of presentations.

Table 1. Number of papers by country.

Country	attendees	Country	attendees
Australia	1	Japan	91
China	33	Korea	1
France	1	Poland	2
Hong Kong	1	Sweden	1
India	1	Thailand	1
Indonesia	2	The Netherlands	1
Italy	2	United Kingdom	2
		United States	1
		Total	141

Fig. 2 Group photo.

Fig. 3 M. Zahn at his Inuishi Memorial Lecture.

Table 2. List of invited lectures.

Speaker	Affiliation	Title
M. Zahn	Massachusetts Institute of Technology, USA	Unipolar charge transport in oil-pressboard systems with planar, coaxial cylindrical and concentric spherical electrode geometries
P.H.F. Morshuis	Delft University of Technology, The Netherlands	Defects and interfaces at DC voltage
G.C. Montanari	University of Bologna, Italy	Supporting the electromechanical nature of ultra fast charge pulses in insulating polymer conduction
S. Li	Xi'an Jiaotong University, China	Dielectric properties of Al-doped $CaCu_3Ti_4O_{12}$ ceramics by coprecipitation method
Y. Yin	Shanghai Jiao Tong University, China	Investigation of space charge at the interface between the insulation of the cable and its accessory
L.A. Dissado	University of Leicester, UK	The effect of ageing upon charge traps in XLPE cable insulation
Z.M. Dang	University of Science and Technology Beijing, China	Mechanism and properties of piezoresistive in rubber-matrix nanocomposites
B.X. Du	Tianjin University, China	Surface charge accumulation and decay of epoxy nanocomposites with TiO_2 particles
K. Wu	Xi'an Jiaotong University, China	Variation of surface charge distribution in the process of PD degradation
Suwarno	Institut Teknologi Bandung, Indonesia	Properties of discharges in liquid and simulation using whitehead equivalent circuits
C. Laurent	University of Toulouse, France	A discussion on the electronic properties of polyethylene interfaces
G. Chen	University of Southampton, UK	Towards understanding of high electric field phenomena in polymeric dielectrics
R. Sarathi	Indian Institute of Technology Madras, India	Understanding partial discharge activity in transformer oil due to particle movement under high frequency ac voltage adopting UHF technique
G.J. Zhang	Xi'an Jiaotong University, China	Temperature effect on frequency domain spectroscopy characteristics of oil impregnated pressboards

presentation in the same way. Using this system, all participants can have deep and fruitful discussion and overcome language barriers. Eleven excellent presenters were presented awards during the conference banquet. Electrical Science and Engineering Promotion Student Paper Awards from The Promotion Foundation for Electrical Science and Engineering were also awarded in the banquet.

The other important mission was to provide chances for encounters with various researchers so as to open up a path to the future. Especially in recent days, linkages among researchers in industry and academia (including students) are becoming more and more important. From this point of view, we planned another special session, named the "Sun-shine Session", to introduce R&D topics in industry to academics. It is believed that the Sun-shine session was helpful for mutual understanding among researchers in industry and academia in the field of electrical insulation materials.

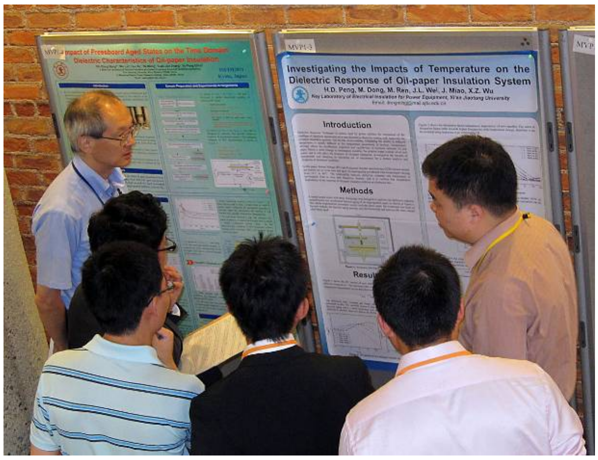

Fig. 3 H. D. Peng at his poster during the MVP session.

Fig. 4 Z. Yue at her poster during the MVP session.

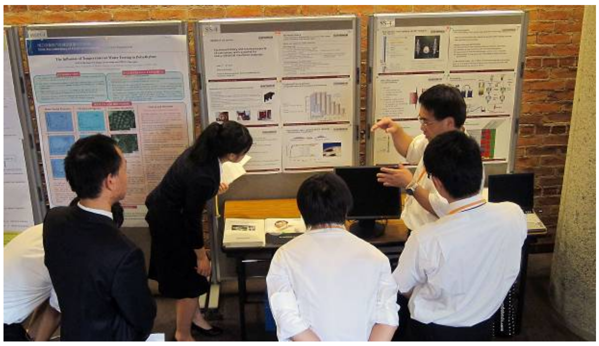

Fig. 5 S. Hishikawa at his poster during the Sun-shine session.

The local organizing committee arranged a technical tour to Shimadzu Co., Sanjo Works. The participants are impressed by several latest instrumental analysis systems such as X-ray devices, spectrum cameras, electron microscopes, and so on. They were also allowed to see the manufacturing processes of gas chromatograph systems, which have been developed and commercialized ahead of other Japanese companies. They also went to Nishiijin Textile Industrial Association and the Temple of the Golden Pavilion, known as Kinkaku-ji, to get in touch with Japanese culture. The local committee also invited all the conference participants to the banquet for a dance show performed by maiko (apprentice geisha).

Fig. 6 L. A. Dissado at his invited lecture.

Fig. 7 K. Wu at his oral presentation.

During the conference, International Advisory Committee of the ISEIM 2011 was held to summarize the status and preparations of the conference. After a successful conversation and discussion, it was eventually decided that the next ISEIM would be held again in Japan in 2014. We hope that all the participants and accompanying families enjoyed a delightful time with full of friendship and kindness. The executive and local committees are proud of providing such events and entertainment.

Finally, we would like to deeply thank all of the participants from all over the world, and members of the organizing committee for their effort to realize this symposium. We also express sincere appreciation to all the supporting members of this symposium for their responsive contributions. We hope that all participants return to Japan in another 3 years.

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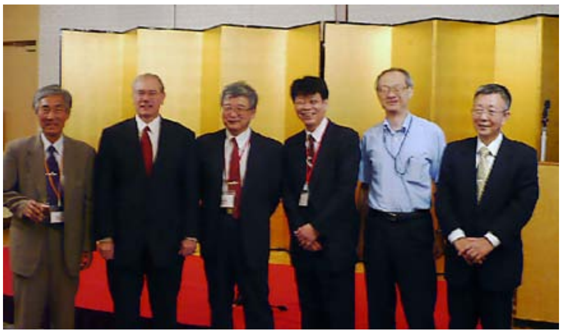

Fig. 8 T. Tanaka of Waseda University, M. Zhan of MIT, M. Nagao of Toyohashi University of Technology (TUT), Y. Tanaka of Tokyo City University, N. Hozumi of TUT, and F. Sugiyama of Promotion Foundation for Electrical Science and Engineering (from left to right).

Fig. 9 Snap shot at the banquet - 1

Fig. 10 Snap shot at the banquet - 2

Fig. 11 Maiko dance at the banquet.

International Conferences to be held in Asia

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

Dates: July 24-28, 2012
Venue: Bangalore, India
Chairman: Dr. S. Seetharamu
(Central Power Research Institute)
Sponsored-by: IEEE DEIS

The IEEE 10th International Conference on "Properties and Applications of Dielectric Materials" (ICPADM 2012), is being organized by Central Power Research Institute (CPRI), Bangalore July 24-28, 2012 and supported by Ministry of Power, Government of India. The conference will be sponsored by the IEEE Dielectrics and Electrical Insulation Society (DEIS).

The primary objective of this conference is to provide a platform for researchers, scientists and engineers from all over the world to exchange ideas and hold wide ranging discussions on recent progress and developments in electrical insulation, dielectrics and their innovative practical applications. The Organizing Committee cordially invites you to participate in the conference.

Key dates:

Abstract Submission:	February 10, 2012
Notification of Acceptance:	March 5, 2012
Full Paper Submission:	April 20, 2012
Acceptance Notifications of Paper:	May 18, 2012

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ICEE 2012 (International Conference on Electrical Engineering)

Dates: July 8-12, 2012
Venue: Ishikawa Ongakudo and ANA Crowne Plaza, Kanazawa, Japan
Organized by: IEEJ
Co-organized by: CSEE, HKIE, KIEE
Theme: Renovation and Innovation by Electrical Engineering

The International Conference on Electrical Engineering (ICEE) aims to provide a premium forum for sharing knowledge, experience and creative ideas among electrical engineers around the world. Since 1995, the ICEE has been successfully held once a year. The Institute of Electrical Engineers of Japan (IEEJ) is pleased to announce ICEE 2012 will be held at Kanazawa, Japan from July 8 to 12, 2012. It is a great pleasure for the IEEJ and co-organizers CSEE, HKIE and KIEE to invite potential authors who have significant contributions in electrical engineering fields to submit papers to be referred to the following engineering areas, *Fundamentals, Materials & Education / Power System & Energy / Electronics, Information & Control Systems / Electrical Machines, Power Electronics & Industry Applications / Sensor & Micro-machines / Other Related Areas*.

Key dates:

Abstract Submission:	December 31, 2011
Notification of Acceptance:	February 1, 2012
Full Paper Submission:	April 1, 2012
Acceptance Notifications of Paper:	May 1, 2012

Secretariat:
c/o ICS Convention Design, Inc
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Chiyoda-ku, Tokyo, 101-8449 Japan
Fax: +81-3-3219-3577
E-mail: icee2012@ics-inc.co.jp
URL: http://www.icee2012.org

CMD 2012 (International Conference on Condition Monitoring and Diagnosis)

Dates: September 23-27, 2012
Venue: Grand Bali Beach Hotel, Bali, Indonesia
Chairman: Prof. Swarno (Bandung Inst. of Tech.)
Co-organized by: Bandung Inst. of Tech. and Udayana University, Indonesia
Technically co-sponsored by: IEEE DEIS, CIGRE

CMD2012 will be held in Bali, Indonesia in September 2012. The previous conferences were held in Changwon, Korea (2006), Beijing, China (2008), and Tokyo, Japan 2010. The Organizing Committee of CMD 2012 cordially invites you to participate in the conference. You are invited to submit paper in the following topics but not limited to,

1. Condition monitoring and diagnosis for power equipments and power systems
2. Condition monitoring and diagnosis in power plants
3. Failure phenomena based on electrical, mechanical, chemical and thermal causes
4. Dielectric materials and their aging mechanisms
5. Degradation assessment for power equipment
6. Modern maintenance tools for effective replacement
7. Advanced sensing techniques for condition monitoring and diagnosis
8. Applications of artificial intelligence for data mining and condition assessments
9. Applications of information and communication technologies for condition monitoring and diagnosis
10. Asset management for power equipments
11. Tropical Climate and other Environment related issues including recycling, reuse, mitigation, etc.
12. Strategic planning and management for condition monitoring and diagnosis

Key dates:
Abstract Submission: February 29, 2012
Notification of Acceptance: April 30, 2012
Full Paper Submission: June 30, 2012

Secretariat:
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or suwarno@ieee.org
URL: http://www.cmd2012.org

Joint Conference of IWHV 2012 (International Workshop on High Voltage Engineering) and JK2012 on ED&HVE (2012 Japan-Korea Joint Symposium on Electrical Discharge and High Voltage Engineering)

Dates: November 16-17, 2012
Venue: Kanazawa University, Kanazawa, Japan
Chairman: S. Matsumoto (Shibaura Institute of Technology, Japan)
Co-Chairman: M. Hikita, (Kyushu Institute of Technology, Japan),
J. Y. Koo (Hanyang University, Korea)
Organized by: Technical Committee on High Voltage Engineering, IEE of Japan, Technical Committee on Switchgear and Protection, IEE of Japan and Technical Committee on Electrical Discharge, IEE of Japan
Co-organized by: Kanazawa University and Kanazawa University Research Center for Sustainable Energy and Technology (RSET), Study Committee on High Voltage Engineering and Discharge Application in KIEE
Sponsored by: Japan Chapter of the IEEE Society on Power and Energy Engineering, The Japanese National Committee of CIGRE, The Institute of Engineers on Electrical Discharges of Japan

Joint conference of the eighth International Workshop on High Voltage Engineering (IWHV 2012) and the 2012 Japan-Korea Joint Symposium on Electrical Discharge and High Voltage Engineering provides good opportunity to present and discuss latest findings in the field of high voltage engineering. The IWHV 2012 in Kanazawa will continue along the line of the previous workshops, which were held in Okinawa (1999), Tottori (2000), Fukuoka (2003), Sapporo (2004), Shizuoka (2007), Kyoto (2008) and Kitakyushu (2010). The organizing Committee will recommend excellent contributions to be submitted to the Special Issue of Transactions of IEE of Japan dedicated to IWHV 2012.

The 2012 Japan-Korea Joint Symposium on Electrical Discharge and High Voltage Engineering in Kanazawa, Japan will provide an opportunity for the specialists in the field of fundamentals and applications of electrical discharge and high voltage engineering for exchanging and sharing their research achievements and experiences, and will follow the line of the previous symposium in Busan, Korea, 2009.

Technical Subject Areas:
1. Switchgear, Power apparatus and Industrial applications
2. Lightning, Over-voltages, Fast transients
3. High voltage measurements & testing
4. Insulation materials and systems
   Gas, liquid, solid, vacuum and combined materials, Plasma application
5. Outdoor insulation
6. Fundamental phenomena of electrical discharges, partial discharges and corona discharges
7. Electrical discharge applications including environmental purification and biotechnology
8. Field calculation, measurement & EMC, EMF
9. Nano-dielectric application to HV Power apparatus
10. Environmental effects of HV system

Key dates:
Abstract Submission: June 29, 2012
Notification of Acceptance: August 3, 2012
Manuscripts in PDF: October 5, 2012

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Activities of Laboratories

High Voltage Laboratory at Chulalongkorn University

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1. Introduction

The high voltage laboratory of the Faculty of Engineering, Chulalongkorn University, was established in 1955 for the purpose of education. However, with increased demand of electric power and higher voltage of transmission lines, high voltage test equipment becomes more important for the country. In 1965 and 1980, we received high-voltage test equipment from the Swiss Government for improving the capability of the laboratory both for research and for testing activities.

The objectives of high voltage laboratory are as follows:

1. Education. The laboratory is used for under-graduate study in high voltage engineering in supplementing the lecture courses. We also give educational service to other institutions that still lack in high voltage facilities.

2. Research. The laboratory contributes to various research fields on high voltage engineering, ranging from basic to applied research, which will be described in the following Sections.

3. Service. The laboratory has been appointed by the Thai government to be responsible for testing electrical products for compliance with the Thai Industrial Standards as well as the other standards.

The high voltage laboratory is capable for the test of apparatus used in high voltage systems up to 230 kV. Equipment in the laboratory includes, for example,

- 500 kV, 250 kVA cascaded test transformer
- 1400 kV, 70 kJ, 14-stage impulse voltage generator (see figure 1)
- 400 kV, 8 mA, DC high voltage generator (by means of rectifier circuit)
- 500 kV, 100-200 kHz Tesla transformer

2. Research

The high voltage laboratory deals with both the problem-based and basic researches. Most of the problem-based research topics are from all of the electric utilities in Thailand, i.e. the Electricity Generating Authority of Thailand (EGAT), the Metropolitan Electricity Authority (MEA) and the Provincial Electricity Authority (PEA). For example, the study of contamination on insulators along the coastal area of Thailand, investigation of damages of drop-out fuse in PEA distribution lines, investigation of damages of hot-line clamp in PEA distribution line, development of on line monitoring of lightning arrester in PEA distribution line, etc.

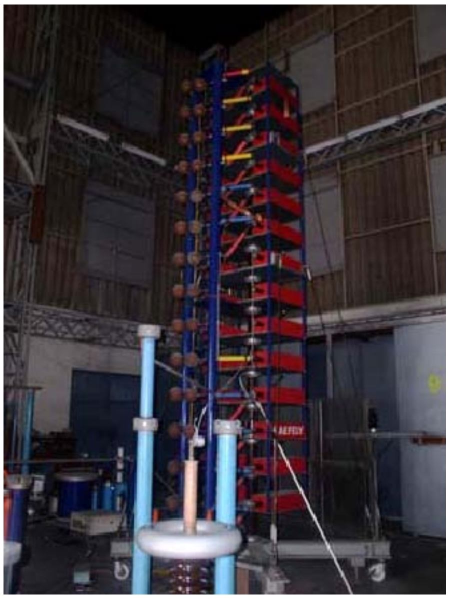

Figure 1: 1400kV impulse voltage generator

2.1 Numerical model of streamer breakdown in air gap at atmospheric pressure

The numerical model of streamer breakdown in air gap at atmospheric pressure is described by the system of equations, including charge continuity equation and Poisson equation. In addition, the photoionization effect is simplified and integrated into the model.

Figure 2 show the propagation of streamer and the electric field distribution at various times between the sphere gap. From the model, the rate of increase of discharge current is c.a. 1.4 A/ns, when positive streamer approached the cathod. This is quite close to the value of 1.44 A/ns obtained from the experiment.

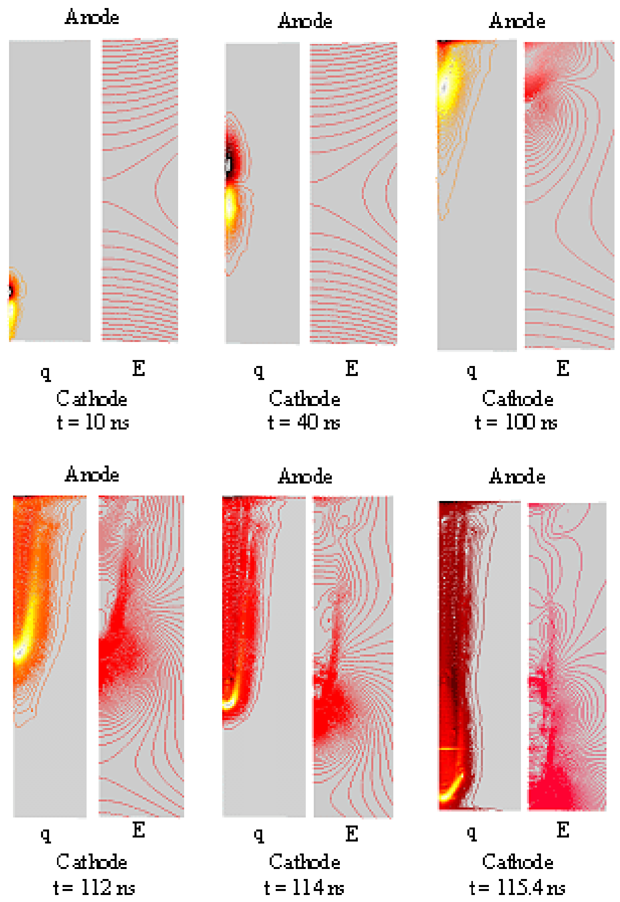

Figure 2: Propagation of streamer (q) and electric field distribution (E) at various times between the sphere gap

2.2 Condition assessment of surge arresters in distribution systems

Surge arresters are key components for the protection of power systems against transient overvoltages. It is known from experience that current-voltage characteristics and insulation properties of surge arresters become degraded due to the continuous application of system voltages, transient overvoltages and chemical reactions with the surrounding atmosphere. It is more economic to replace the degraded arrester before it fails than to deal with damage to expensive equipment and interruptions of electrical energy supply. Therefore, it is necessary to have an effective field inspection method to assess the conditions of in-service surge arresters. For this purpose, a number of polymer housed surge arresters with different locations and years in service were randomly collected from distribution lines, including service-aged surge arresters searched using an infrared thermography camera. These samples are subjected to laboratory tests, i.e. measurements of resistive leakage current, power losses, dielectric dissipation factor, insulation resistance, polarization index, reference voltage, residual voltage, return voltage and infrared thermography. The test results are compared and analyzed. The appropriate method in the evaluation of distribution surge arrester condition will be discussed with the criterions and recommend procedures for diagnosis of surge arresters.

2.3 Field analysis in system of covered conductor

Overhead distribution systems in Thailand widely utilize covered conductors, called "space aerial cable (SAC)", in many areas for improving reliability of the systems. The SAC consists of aluminum as the main conductor, semiconductive shield, XLPE as the main insulation, and the cable jacket. For mechanical and electrical separation, cable supporters, such as spacers and post-type insulators, are required in the overhead-line systems.

A number of problems have occurred in the systems of SAC overhead lines after a period of service. The deterioration of the cable insulation was found at the contact position between the cable and spacer, in particular where the porcelain spacers are used. For this reason, we have analyzed the electric field intensification at the contact point between a covered conductor and a spacer (See Figure 3). Some techniques for mitigating the electric field at the contact point have been investigated.

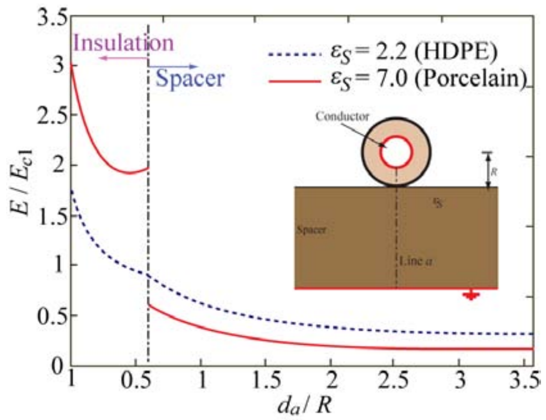

Figure 3: Field distribution in configuration of a covered conductor on a spacer for different spacer materials

Acknowledgment

We would like to thank Dr. Masahiro Kozako, Kyushu Institute of Technology, for the opportunity to introduce our laboratory in the EINA magazine.

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Research in High Voltage and Electrical Insulation Laboratory at Shanghai Jiao Tong University

Yi Yin

Shanghai Jiao Tong University, China

Prof. Yi Yin
Shanghai Jiao Tong Univ.

1. Introduction

High voltage and electrical insulation laboratory (HVEIL) at Shanghai Jiao Tong University was found to teach college students of electrical engineering knowledge on high voltage and electrical insulation technology, and serves as a test center for postgraduate students and researchers to do deep study on insulating materials and power equipments. The lab also provides testing system to companies, research institutes, and laboratories in other universities.

At present, our lab has a full professor and four associate professors. Two Ph. D. candidates and ten postgraduate students are pursuing their degrees here (Fig. 1). Although our team is very young, we are full of passion and motivation in this area. With the active work of Prof. Yin and our staffs, we have done outstanding achievements in several fields, including fundamental studies on insulating materials, such as space charge behavior, high field conduction and thermally stimulated current, monitoring and diagnosis for power equipment, such as diagnosis for cable life, online monitoring system for dissolved gas in transformer. Based on the fruitful research we have done, over 200 scientific papers have been published both at home and abroad, and over 2 million RMB financial supports are attracted every year from Chinese government, the Ministry of Education and companies.

Figure1. A whole-family photo of HVEIL

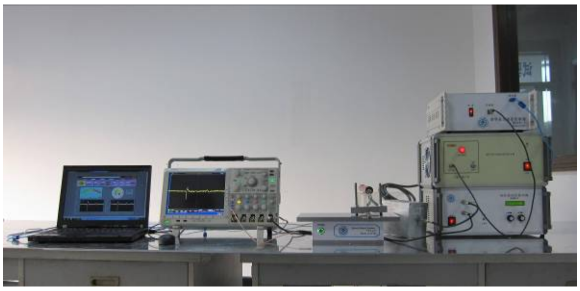
2. Research Activities

Recently, our research mainly focuses on two aspects: fundamental studies on insulating materials and condition monitoring and diagnosis for HV equipments. A brief introduction will be shown below.

A. Fundamental studies on Insulating Materials

Along with the wider use of polymer insulating materials in electrical and electronic industry, its micromorphology and dielectric properties have attracted lots of researchers' attention. One of the most important issues in solid insulating material aging is space charge behavior. Space charge accumulation inside the material will distort local electrical field and may finally lead to insulation failure. In order to study space charge behavior in various solid insulating materials, space charge measurement systems for flat sample and cable sample based on pulsed electro-acoustic (PEA) method were developed, respectively (Fig. 2).

a) flat sample



b) cable sample

Figure 2. PEA measurement systems for flat sample and cable sample, developed by HVIEL

The spatial resolution of the system is down to 10 μm, and the testing temperature is up to 363K (Fig. 3). The entire testing progress is completely programmable. Data gained from the system has helped us develop several insulating materials and has been published in more than 60 articles (Fig. 4). We have provided the system to Harbin University of Science and Technology and Beijing University of Chemical Technology for research. And the system is also provided to Shanghai Electric Cable Research Institute (SECRI) to test insulating materials and extruded HVDC cables.

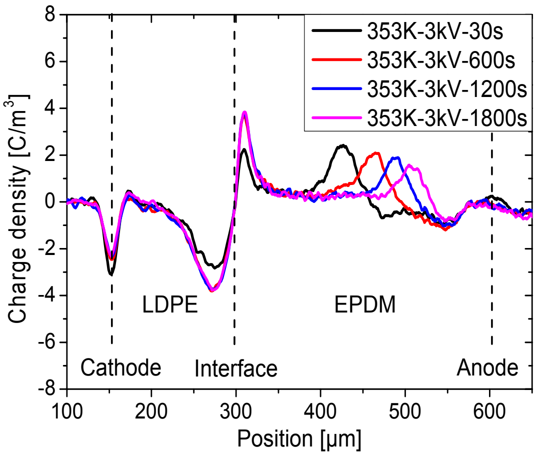


Figure 3. Space charge at the interface between the insulation of cable and its accessory

Figure 4. Extruded HVDC cable connector, developed by HVEIL

Figure 5. TSC measurement system

Another field we are interested in is the thermally stimulated current (TSC) measurement. TSC measurement is an effective method to study trap density and distribution of trap level in polymer insulating materials. However, there is always a bottleneck that how to improve the measurement accuracy. Fortunately, our lab has taken a large step in this aspect (Fig. 5). The TSC measurement system we developed originally has expanded the current measurement range down to a level of 0.1pA.

The fundamental studies presented above are financially supported by National Science Foundation of China.

B. Monitoring and Diagnosis for HV equipment

Safety and stability is the most crucial task for power grid. Although the traditional off-line and periodic preventive test can prevent power equipment fault to some extent, it is less accurate and economical. Thus, on-line and undamaged diagnosis becomes a new star in this area. In order to find a balance between safety and economic efficiency, the residual life of HV equipment needs to be known. Our lab has developed a diagnosis system for XLPE cable and motor bar, based on Isothermal Relaxation Current (IRC) Method (Fig. 6 and Fig. 7). This system combines measurement and analysis in a whole. Therefore, users can get aging condition of the tested sample directly. Now, the diagnosis system has been improved to the 3rd generation, and has already been provided to Hebei Electric Power Design Institute and SECRI.

Figure 6. Diagnosis of XLPE cable using IRC 3.0 system

Figure 7. Diagnosis of motor bar using IRC 3.0 system

Furthermore, our lab also focuses on condition monitoring for power transformer. In oil-immersed power transformer which has faults in it, gases will produce from the oil and organic insulating materials.

By analyzing the content of dissolved gas, the faults' type, even position, can be known. This method is one of the most effective ways to find early failures inside the transformer. Our team has developed an on-line monitoring system for dissolved gas based on photo-acoustic and spectroscopic technique, which is unique in China and even world leading. Eight kinds of gases can be detected including H_2, C_2H_2, C_2H_4, C_2H_6, CH_4, CO, CO_2 and H_2O. And the accuracy for some kinds of gases can even reach 0.1 ppm. The system has been provided to Shanghai Electric Power Corporation and now well services in a substation (Fig. 8).

Figure 8. On-line monitoring system for transformer oil dissolved gas (supported by Shanghai Electric Power Corporation)

The researches presented in this section are mainly supported by local electric power corporations and institutes in China.

3. Academic Exchange and Cooperation

Our lab is always active in making frequent academic exchange with other universities and research institutes both at home and abroad. In the past three years, we have sent one lecturer and one Ph. D. candidate to Prof. Toshikatsu Tanaka's lab in Waseda University. And every year, we sent our staffs to attend international conferences and symposiums, such as ISEIM, CEIDP, ICPADM, ICSD, CMD, etc. We are very pleased to share the experience and facility in our lab with researchers in the field of high voltage and insulation technology, material science and applied physics. We sincerely invite researchers all over the world to visit our lab and make cooperation together.

4. Acknowledgement

The authors wish to thank Prof. Nagao, for kindly offering us the opportunity to introduce the research progress in HVEIL at Shanghai Jiao Tong University. We also wish to thank Prof. Toshikatsu Tanaka, for offering us the opportunity of academic exchange with Waseda University.

5. Biography

Prof. Yi Yin was born in Jiangsu Province, China. He received the M. E. degree and Ph. D. degree in Electrical Engineering from Xi'an Jiao Tong University, in 1997 and 2000 respectively. After that, he worked as a post-doctoral researcher in Shanghai Jiao Tong University from 2000 to 2002. Now, he is a professor at the Department of Electrical Engineering, School of Electronic Information and Electrical Engineering, Shanghai Jiao Tong University. His main research interests are dielectric properties of polymer composites, high voltage technology, condition monitoring and diagnosis of HV equipment, etc. He is an international advisory committee member of 2008 and 2011 International Symposium on Electrical Insulating Materials, committee member of Specialization Committee on Engineering Dielectrics of China Electrotechnical Society, Committee member of Specialization Committee on Electric Materials of Shanghai Society for Electric Engineering.

Associate Prof. Xuguang Li was born in Henan Province, China. He received the M. E. degree in Electrical Engineering from Xi'an Jiao Tong University in 1999 and Ph. D. degree from Shanghai Jiao Tong University in 2003. After that, he worked as a post-doctoral researcher in Shanghai Jiao Tong University from 2003 to 2005. Now, he is an associate professor at the Department of Electrical Engineering, School of Electronic Information and Electrical Engineering, Shanghai Jiao Tong University. His main research interests are Electromagnetic field numerical calculation and dielectric properties of polymer composites,

Dr. Zhe Li was born in Guangxi Province, China, in 1978. He received the M.E. degree and Ph. D. degree in High Voltage and Insulation Technology from Shanghai Jiao Tong University, China, in 2005 and 2007, respectively. After that, he joined HVEIL in the Department of Electrical Engineering at the same school. And he was invited to Waseda University, Japan as a visiting researcher from Apr. 2008 to Mar. 2010. His interest is dielectric properties of polymer nano-composite and electrical insulation.

Professor Yi Yin

High Voltage and Electrical Insulation Laboratory

The Department of Electrical Engineering, Shanghai Jiao Tong University, Shanghai, 200240, China

China Corner

Development on Insulating Materials for Inverter-fed Motors in China

Prof. Shengtao Li
Xi'an Jiaotong Univ.,
Xi'an, China

1. Overall

The carrier frequency of inverter-fed motor has been developed from a few kHz to more than 10 kHz currently since pulse width modulation (PWM) control mode is widely adopted in inverter-fed motor. Consequently, the stator winding of electric motor is able to withstand a higher change rate of voltage (d*U*/d*t*) and the turn-to-turn insulation of electric motor could also withstand a greater electric stress. Under variable-frequency voltage, the turn-to-turn insulation is subjected to a voltage dozens of times higher than that under sinusoidal voltage waveform. In this case, the partial discharge would generate in the interior of materials, which is the main reason for premature failure of insulation material in inverter-fed motor [1-2]. In addition, although the low-order harmonic components are greatly reduced due to PMW, there are very high harmonic components caused by PWM in the output voltage waveform of inverter-fed motor. These high harmonic components become particularly critical in the condition of low-voltage output. Their amplitudes can even be approximate to fundamental waveform. Their existence causes an increase in the resistance of the conductors of stator and rotor, resulting in a temperature rise of about 10%-20% [3-5]. Therefore, thermal loss is one of reasons for accelerating the aging of insulating materials. The effect of space charge, the electromagnetic excitation, vibration, etc can also accelerate the aging process of insulation materials. These factors greatly affect the performance of insulation materials in the inverter-fed motor. This article focuses on the research and application progress in corona-resistance wire enamel, corona-resistant film and silicone impregnating varnish in China.

2. Corona-resistance wire enamel

Before 1990's, Chinese researchers who were major in insulation material used the method of adding inorganic fillers into the polymer to improve the corona-resistance performance of the corona-resistance wire enamel. However, the production technology of the inorganic fillers in the early stage only reached micron size or submicron size. As a result, the surface of the enameled wire using the enamel which was filled by this kind of fillers was too rough to meet the technology requirements. After 1990's, as the production technology of the nano-particles was becoming more and more mature, people began to have the nano-particles filled into the wire enamel to form higher heat-resistances wire enamel. In recent years, China has been launching great number of research works in the field of the application of the corona-resistance wire enamel for variable frequency motor. Researchers from Harbin University of Science and Technology, Xi'an Jiaotong University, Shanghai Electric Research Institute and Shanghai Electric Cable Research Institute, etc have done related research works in different aspects [6, 7] and have achieved great progress. The results of the researches prove that the compound corona-resistance wire enamel that consists of nano-particles can result in the improvement of the corona-resistance performance up to 5~100 times [8, 9]. Furthermore, some achievements have been transferring into industrial applications. For example, the research conducted by Shanghai Electric Research Institute and Shanghai Electric Cable Research Institute is now being transferred into a small-scale production in Chang Shu Weifu Company [10].

3. Polyimide film

Polyimide (PI) film is widely used as insulation material in motor due to its excellent thermal, mechanical and electrical properties. Thus, it plays a significant role in extending the service life of motor through improving the corona resistance performance of PI film. According to the Twelfth Five-Year Plan, there will be a leapfrog development on high-speed rail in China during this period, for which the traction motor with high power is the key equipment. Therefore, how to improve the breakdown performance and the corona resistance property of PI film is now one of the key issues Chinese researchers have to deal with.

On one hand, China chose to introduce foreign high performance PI film. Chinese engineers have worked on the manufacturing technology of motor insulation using these PI films. For example, CSR Zhuzhou Electric Co., Ltd and Chang Shu Weifu Company have achieved what Kapton CR PI film has successfully applied to JD150S high-speed hybrid (power 1020kW, voltage 1950kV, rotating speed 4000r/min) as turn-to-turn insulation through winding and sintering on copper wires. After a few year exploration practices, the manufacturing technology of PI film insulation in China has been gradually put into use in industry.

On the other hand, researchers have been developing new PI film through incorporating nanoparticle into PI matrix. Researchers in Xi'an Jiaotong University, Harbin University of Science and Technology, Shanghai Jiaotong University and Tongji University, etc, have done some works on the corona resistance, breakdown performance, space charge and thermal property of PI nanocomposite [11-14]. Some advantageous results have been obtained. For example, the corona resistance property of PI nanocomposite film has a great improvement [14-15].

4. Impregnation paint of organic silicon

Impregnation paint of organic silicon has wide application in special motor such as traction electric machine. This kind of paint can meet the requirement of high heat resistance and high reliability of the insulation system of the variable-frequency traction motor. At present, China is in the process of gradually digesting and absorbing "C-level system of insulation structure” from foreign countries, and, at the same time, designing and applying the impregnation resin of organic silicon that has better performance in corona resistance. For example, CSR Zhuzhou Electric Co., Ltd has employed 3551 solvent-free organic resin and H62A/B organic resin produced by Wacker Chemie AG on KZ4A and DJ4 traction electrical machine. Moreover, after several years of technological advancement, Zhuzhou Times New Materials Technology Co., Ltd has achieved great breakthrough on the technology of production and application of the impregnation paint of organic silicon. Machinery Industry Electric Material Product Quality Supervision and Inspection Center of China has verified that its products have the same performance as similar products from overseas.

5. Others

Researchers and engineers in Xi’an Jiaotong University, Harbin University of Science and Technology, Shanghai Jiaotong University, CSR Zhuzhou Electric Co., Ltd and so on have investigated the aging and breakdown mechanism of insulation materials under nonsinusoidal applied field. In the early researches, Chinese researchers mainly focused on the origin of ageing and breakdown of insulation materials, such as the effect of thermal, space charge, vibration, etc, on the ageing and breakdown. Based on these researches, Chinese researchers and engineers proposed that adding micro inorganic filler into polymer was likely to improve the ageing property of turn-to-turn insulation material. With the development of nanotechnology, Chinese researchers gradually pay more and more attention on the effect of nanopaticles on the ageing and breakdown of insulation material in recent years [11, 12, 16, 17]. For example, Liu had proposed that nano TiO_2 can optimize the distribution of bulk electric field in TiO_2/PI composite [11]. After corona discharge, nmTiO_2 deposited on the surface of composite and formed an electron shielding layer. This layer can capture charge carriers. The captured charge carriers transport around the surface of composite due to the higher conductivity of nmTiO_2, which is advantageous to reduce the accumulation of charges. In addition, nmTiO_2 can absorb the ultraviolet rays caused by corona discharge, reducing the degradation of polymeric matrix [11].

These investigations are beneficial for the understanding on the ageing mechanism of PI film in inverter-fed motors, so that the design of the structure of turn-to-turn insulation [18] and inverter-fed motor has been improved. The traditional inverter-fed motor has been changed to baseband system inverter-fed motor. For example, the VFG series products of variable frequency motors manufactured by Shanghai Fukuda Motor Co., Ltd are the baseband system inverter-fed motors. They have been widely used as infinitely variable speed electric drive, such as in pump station and mechanical engineering.

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Korea Corner

Development of ±250kV HVDC Submarine Cable in Korea

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1. Introduction

Recently, DC Cables have widely used for the power transmission from islands to mainland as well as between islands. The use of DC cables has also expanded for connecting power networks with different frequencies. In Korea, these needs for DC transmission were highly increased since the first HVDC transmission cable was commercialized in 1998. The main technologies of HVDC submarine cable are cable design technology and manufacturing one which can make cables as long as possible.

In this review, the HVDC cable design technologies as well as mass impregnation technologies during development of ±250kV HVDC submarine cable for the 2nd Jeju and Jindo interconnection project done by LS Cable and System in Korea is described. The electrical and mechanical performances of the developed HVDC cables and their joint which were fully evaluated in accordance to the Electra 171 and 189 of the GIGRE are briefly mentioned.

2. Design

2.1 Target Performance

The values to design the cable which meet the target performance are summarized in the table 1. The expectancy of life is set as 30 years. The calculated target Vdc is 550kV and Vimp is 1,050kV

Table 1. Design of factors for target performance

Factor	Description	Value
U_0	DC operating voltages(kV)	250
K_1	Degradation coefficient for 30 years	1.93
N	Life exponent of V-t characteristics	19
K_2	Temperature coefficient	1.0
K_3	Safety factor	1.1

2.2 Insulating paper and compounds

Recently, the kraft paper has widely been used instead of Manila pulp or Manila-wood pulp mixture. Generally the unbleached duplex calendared kraft paper is applied to the HVDC cable and the table 2 lists the properties of kraft paper for this project.

The DC insulation paper is used with insulation compound under the impregnated state during the service, so that the insulating compound has a lot of influence to the electrical characteristics of the manufactured cable. The impregnation is the process by which the air in the paper fiber is replaced into the substance with higher electrical strength.

Generally the high viscosity compounds are used for MI cable such as

- Mineral oil: paraffin, naphtenic, etc.
- Synthetic oil: polybutene, alkylbenxene, etc.

Table 3 shows the insulation compound used in this project.

Table 2. Properties of kraft paper for this project

Item		Unit	Value
Thickness		μm	98
Gurley		S/100ml	9000
Elongation	C	%	8.9
	M		4.8
Moisture	C	7.0	1.8
	%		7.0
Ash content		%	0.27
Conductivity (of water extract)		mS/m	0.6

Table 3. Performance of compound for this project

Item		Unit	Value
Density @ 20℃		g/cm^3	0.925
Mean coefficient of expansion per ℃		-	0.0007
Viscosity	60	-	1200
	100		200
	120		120
Total acid number		mg KOH/g	0.01
Corrosity sulfur		-	Non
Dielectric loss @ 100℃		-	0.002
Relative permittivity @ 60℃		-	2.25

3. Evaluation and Results

The developed HVDC cable was evaluated in accordance to the Electra 171 and 189 of the GIGRE In electrical evaluation, test voltage of 800kV has been applied because the maximum operating voltage increased. Figure 1 is the procedure of the type test for the cable.

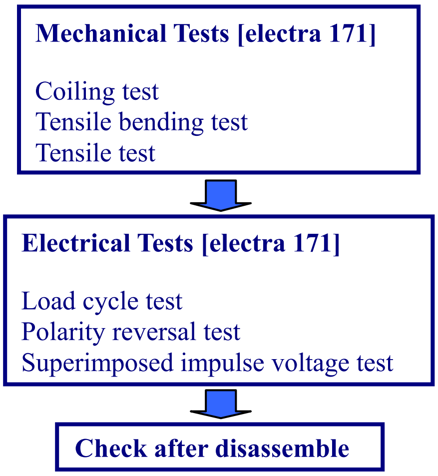

Fig. 1 Procedure of type test used in this project

Among the test items in figure 1, the polarity reversal test and superimposed impulse voltage test are the most important for HVDC cable performance evaluation. The permanent deformation of conductor, armour, joints and terminal joints has been checked by visual inspection and the no deformation has been found.

The table 4 is the result of type test of 250kV HVDC submarine cable.

Table 4. Result of 250kV HVDC submarine cable type test

Item	Requirements	Results
Coiling test	No mechanical breakdown by visual check	PASS
Tensile bending test	No damage for MI paper No deformation for conductor and amour	PASS
Tensile test	No considerable difference between measured data and calculated ones	PASS
Load cycle test	No breakdown and no damage by visual check after disassemble	PASS
Polarity reversal test		PASS
Superimposed impulse voltage test		PASS

4. Conclusion

In Korea, ±250kV HVDC submarine cable for the 2nd Jeju and Jindo interconnection project has been developed by LS Cable and System and is now installing. The HVDC cable has been evaluated in accordance to CIGRE recommendation and successfully met the requirement. Throughout this project, the cable industry in Korea could establish their own technologies and know-how necessary from design to installation of HVDC submarine cable.

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Indonesia Corner

Mitigation of Ceramic Outdoor Insulator Failures in Indonesia

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1. Introduction.

Indonesia is a tropical country which is situated around the equator. The sun is overhead in the country throughout the year. Temperature in Indonesia is usually high. Maximum temperatures are 30-34^{o}C at sea level and 27-31^{o}C at 500 m. The typical minimum temperatures are 20 to 25 ^{o}C at sea level and 17 to 22 ^{o}C at 500 m[1]

There are 2 seasons, rainy season and dry season. During rainy season, the rainfall usually high and during dry season low. Irian Jaya is the highest rainfall area with mean annual rainfall of up to 3185 mm. Java and Madura as the most populous area have mean annual rainfall of 2571 mm. Due to high rainfall, the relative humidity (RH) in most of Indonesian parts is high. During night and early morning, the RH is as high as 95 %. The high values of rainfall and humidity easily cause corrosion.

Since the sunshine is bright throughout the year, the solar radiation is high in Indonesia. The typical value of the solar radiation is 1.250 W/m2. This high solar radiation contributes to the acceleration of aging of electrical apparatuses especially outdoor high voltage equipments.

In Indonesian electric power lines 500 kV, 275 kV, 150 kV and 70 kV voltage levels are being used in transmission lines while 20 kV and 220/380 V are used in distribution lines. 500 kV EHV lines are being used as the back bone of electric power transmission in Java Island which is at present composed of 15 EHV substation and 1,565 kmc EHV transmission lines. The 275 kV networks are being used in Sumatra. In the near future, the 275 kV lines will be expanded in Sumatra and 500 kV transmissions will also be introduced[2]. System failure due to insulator problems is high in Indonesia. To keep the systems in good operational condition, reliability of outdoor insulators is important.

2. Outdoor Insulator Failure

Outdoor insulators are exposed to environmental climate such as high temperature and humidity as well as pollution from coast and industries. As the result, leakage current may flow on the insulator surface and may degrade the insulator surface[3]. Under particular condition, dry band arcing may take place on the insulator surface leading to the failure of the insulators[4]. There are 2 kinds of failure modes widely found in Indonesia. They are flash over due to lack of ability of the insulator surface to withstand the applied voltage and mechanical failure due to corrosion. Corona generates UV light, heat, electromagnetic radiation and gaseous by products such as ozone and nitrogen oxides. The last gas may be converted to nitric acid under a particular circumstances which may corrode the pin part of an outdoor insulator.

Examples of the two failures are shown in figure 1. Figure 2 shown a large number of fail insulators taken from services.

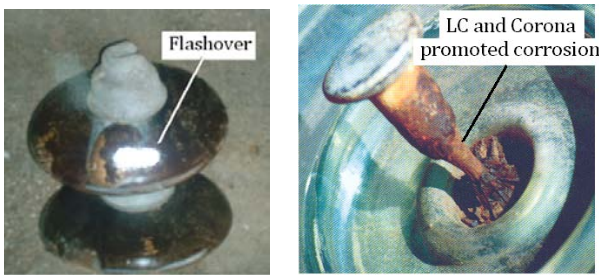


Figure 1 Insulator failure
(a) flash over (b) mechanical failure

Figure 2 Corroded insulators taken from lines

3. Efforts to mitigate insulator failures in Indonesia

There are three solutions introduced to solve the environmental problem on the insulator surface. They are improvement of insulator design, periodic washing, and coating with water-repellent agents or other surface treatments.

3.1 Application of fog type insulators and increasing the number of insulator string

It is common in Indonesia to use fog type insulators or additional insulator string in highly polluted areas.

3.2 Periodical insulator washing.

This method mainly applied for substation located at heavily polluted areas. This method is effective to mitigate insulator failures, however costly and labour ineffective.

3.3 Application Semiconducting Glazed Insulator (SCG)

Figure 3 Washing car stand by in a Substation

In 2004 more than 40.000 pieces of semi-conducting Glazed (SCG) insulators were installed to over-come high insulator failure rate at 150 kV lines in Southern Coastal area of East Java Island such as Jember, Banyuwangi, Lumajang. The insulators were also installed in Bali Island such in Kapal, Gianyar, Sanur, Nusa Dua, Gilimanuk and Pesanggaran. The semicocting glazure used was tin-oxide. At the beginning of the operation, the insulators performed very well. The failure rate decreased drastically. However, after 3 years of operation many failures took place. Large number of insulator string were broken, damages and flashover as shown in figure 4. Finally, in 2007 all the SCG insulators were removed from system (figure 5) and replaced by conventional ceramic insulators. It was concluded that application of SCG in Indonesian coastal area like East Java and Bali is not suitable[5].

Figure 4 Broken string SCG insulator

Figure 5 Large number of SCG Insulators removed from system

3.4 Silicone coating

In effort to mitigate insulator failures, silicone coating application was considered. There were 3 kinds of insulators used in the experiment. The first insulator was 20 kV class pin-post type ceramic insulators. The insulators are widely used in Indonesian State Electricity Corporation (PT. PLN) network. The second insulator was suspension type with creepage distance of 315 mm. The insulators are widely used for 500 kV transmission line insulator strings. The typical silicone coated insulators are shown in figure 6. The trial application of these type silicone coated insulators were conducted at Pangandaran substation which is located at coastal area about 500 m from Indonesian Ocean southern of Java Island.

Figure 6 Silicone coated insulator
(a) post pin type (b) suspension type

Figure 7 Silicone-coated insulators at Pangandaran substation testing site

The last sample was rod type insulator used at 150 kV transmission as shown in figure 8. The rod type insulators were installed in 150 kV transmission lines

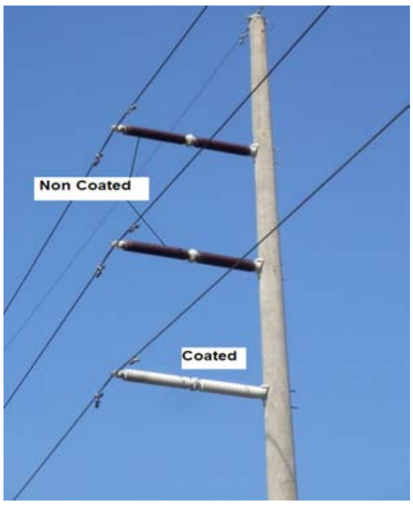


Figure 8 Rod type insulator samples at Ketewel, Bali

at Ketewel coastal area in Bali Island[6]. This area is a heavily coastal polluted and many insulator flashovers are found.

The silicone coated rood type insulator was installed in 2009 and so far performing very well.

Corona suppression

The corona intensity measured by using a UV camera Daycor II SN 169 from coated insulator was as low as 10 % of uncoated insulator as shown in figure 9.

(a) (b) (c)

Figure 9 Corona intensity at uncoated (a), (b) and coated (c) insulators measured using UV Camera

The application of silicone coating also reduced the insulator temperature. Figure 10 shows the thermal image of uncoated and coated insulators taken using FLIR IR camera.

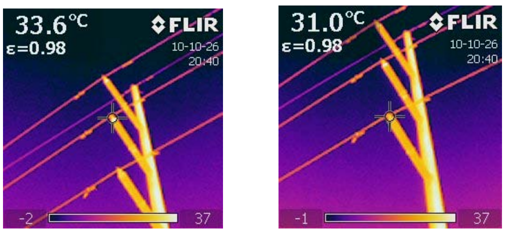


Figure 10 Thermal image of insulator
(a) phase S (uncoated) and (b) phase T (coated)

Leakage current suppression and flashover voltage increase

The leakage current flowed on the insulator surface was measured by measuring the voltage across a series resistance using a Digital Oscilloscope with digitizer of 8 bit, bandwidth of 100 MHz, and the maximum sampling rate of 1 GS/s.

Table 1 shows the typical leakage current on non coated and RTV coated suspension insulators as function of applied voltage under kaolin salt pollution at 40 mS/cm. The table indicates that RTV coating reduces the leakage current significantly. The table also shows that non coated insulator flashover at applied voltage of 35 kV. However, no flashover was observed for RTV coated insulators even at applied voltage of 45 kV. The leakage current was also as low as 0.8 mA at this voltage level. The facts indicates that RTV coating on insulator surface greatly increases the flashover voltage. Therefore, mitigation of insulator flashovers can be done using RTV coating.

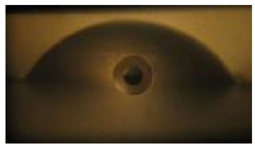
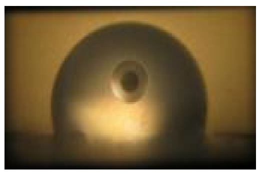
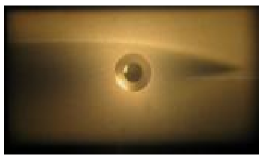
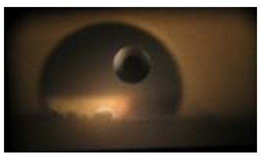
Table 1 Leakage current and flashover behaviour for non-coated and coated insulators with kaolin-salt pollution at 40 ms/cm

Voltage (kV)	Leakage Current (mA) Non-coated	Leakage Current (mA) RTV Coated
5	0,226	0,073
10	0,358	0,151
15	0,371	0,224
20	0,695	0,305
25	1,601	0,394
30	-	0,478
35	Flash Over	0,580
40		0,705
45		0,811

Hydrophobicity Improvement

Good outdoor insulators have a strong ability to repel water and pollution from their surfaces. This property is called as Hydrophobicity. Hydrophobicity is indicated by its contact angle. The silicone coated insulators are more hydrophobic as shown in table 2.

Table 2 Contact angle for coated and uncoated insulators

No	Water Droplet Profile	Contact angle (deg.)
1	 New-non coated clean insulator- non coated	45 - 55
2	 New- coated clean insulator	100 - 110
3	 New-non coated kaolin-salt polluted	10-20
4	 New-coated kaolin-salt polluted	95 - 110

The table clearly indicates that RTV coating improves the hydrophobicity of new clean insulators significantly from contact angle of 45^o-55^o to 100^o-110^o. This changes the surface from hydrophilic to hydrophobic. Similarly, RTV silicone rubber coating maintains the hydrophobicity at kaolin-salt pollution with contact angle of 95^o-110^o which is almost the same value as at clean condition. However, contact angle for non coated insulator drops drastically to is 10^o-20^o which is a strong hydrophilic surface.

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Life Assessment for Aged XLPE Cables

1 Introduction

XLPE cables as solid insulation have been widely adopted in the underground transmission lines. We have many such transmission facilities built in the late 1980's and they are reached to designed life (30 years). It is difficult to replace all of the XLPE cable used for 30 years as the matter of manpower shortage and lack of funds. To replace more deteriorated XLPE cable preferentially, the amount of replacing work and budget can be equalized.

We use the techniques and facilities to investigate the value of breakdown voltage of aged cables and to assess the life of them. These techniques are also applied to investigate the cause of fault.

This article explains our method for life assessment to aged XLPE cable.

2 The Water-tree degradation and diagnosis

XLPE cables are mainly degraded by water-tree. Water-tree reduces effective thickness of the insulation layer according to the growth, and this causes the decrease of the breakdown voltage. Abnormal voltage (lightning surge or single line to ground fault) will cause partial discharge (PD) at the tip of the progressed water-tree, and PD will result in breakdown. Even the operating voltage, PD will occur under heavy condition of the water-tree degradation.

So, the life of aged XLPE cable can be assessed to investigate both of the length of water-tree or the decrease of breakdown voltage and the operating time.

3 The method for life assessment

To assess the life of aged XLPE cables, samples of XLPE cable lines laid under the various conditions are used. The following breakdown voltage test is applied to these samples, and the value of the breakdown voltage and the length of water-tree are investigated.

3-1 Pre-interruption breakdown test

The value of the breakdown voltage of XLPE cable is measured by the breakdown voltage test as shown in Fig.1-(i). PD will primarily occur at the weakest point of an insulation layer containing the maximum length of water-tree, contaminants or void. By the detecting of the initiation location of PD, maximum water-tree may be able to be found. In the case of the normal breakdown voltage test, the water-tree in the weakest point may be burned by heat of the breakdown. So, the maximum length of the water-tree will be not able to be investigated. Moreover there is no method to detect the location of water-tree in insulation layer from the outside. So, "pre-interruption breakdown test" is carried out to measure the pre-breakdown voltage and to detect the maximum water-tree simultaneously.

Pre-interruption breakdown test is the method to interrupt the power supply immediately before breakdown by detection of PD signal as pre-breakdown. At first, the shielding layer is divided by four. Voltage is applied to testing cable, and rises in step-like. PD signal can be detected from shielding

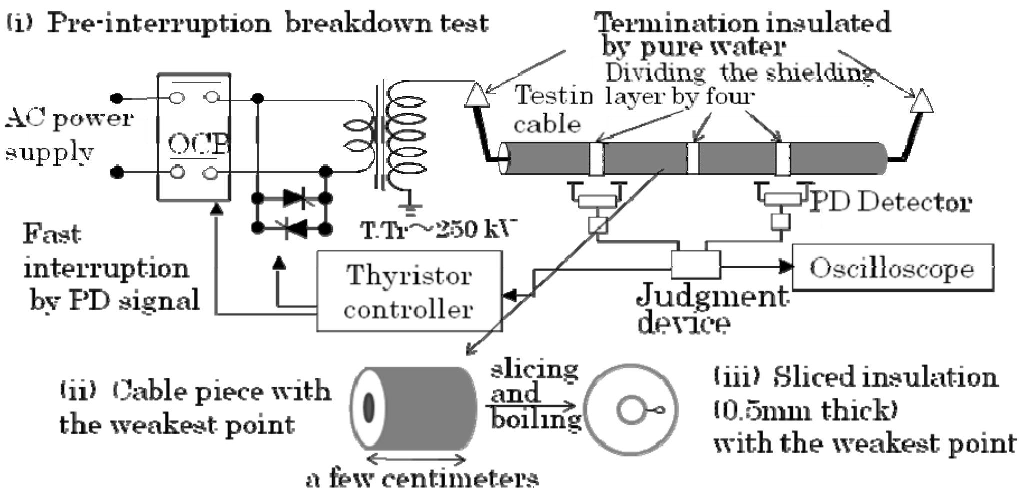

Fig. 1 Pre-interruption breakdown test and investigation of the water-tree

layer of XLPE cable with PD detectors in breakdown voltage test. So, PD signal will be detected at one of divided shielding layers. Next, the shielding layer that generates the PD signal is divided by two, and the voltage is applied to testing cable. PD signal will be detected at one of narrower divided shielding layers. To repeat the same test, the location of PD signal can be narrowed. Finally, the PD signal can be detected at the range of a few centimeters. By this method, the location of maximum water-tree can be found not to burn the insulation. Additionally, the breakdown voltage is measured.

At the pre-interruption breakdown test, the facilities that rating voltage is 250kV of AC (150 kVA) and the termination insulated by pure water that reduces the noise by the corona discharge from the termination is used.

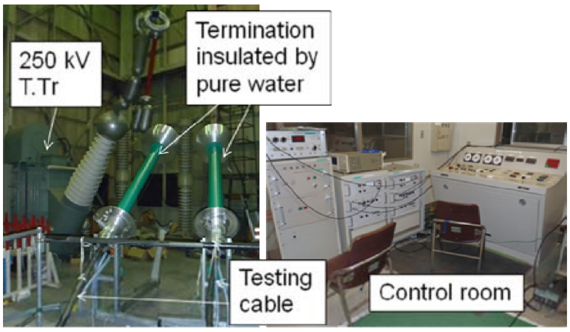

Fig.2 Facilities of pre-interruption breakdown test

3-2 Investigation of the water-tree

By the pre-interruption breakdown test, a few centimeters piece of XLPE cable containing the pre-breakdown point can be obtained as shown in Fig.1-(ii). Next, insulation is sliced 0.5 mm thick. After boiling the sliced insulation, water-tree can get visible by magnifying glass (Fig.1-(iii), Fig.3 and Fig.4).

Fig.3 Sliced insulation and magnifying glass

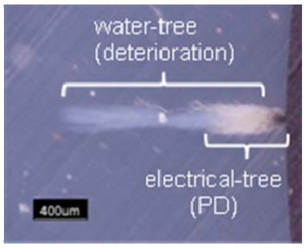

Fig.4 Water-tree and electrical-tree

4 Life assessment

By the data of above test (the value of breakdown voltage and the maximum length of water-tree), the life of aged XLPE cable is assessed.

At first, the testing data is plotted; vertical axis (log) is for pre-breakdown voltage [kV] or electric stress [kV/mm], horizontal axis is for operating time [years]. Next, the average μ and standard deviation σ is calculated, and the line of μ-3σ (the range from μ+3σ to μ-3σ contains 99.7% of testing data) is drawn. The replacing time for aged XLPE cable is estimated at the intersection point of μ-3σ and phase to phase voltage that is applied to the insulation by a single line to ground fault (Fig.5).

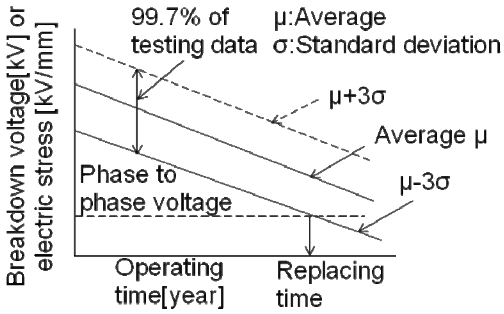

Fig.5 Life assessment method

5 Conclusion

We explained the life assessment method and facilities for test. Based on this method, we will plan for replacing aged XLPE cable.

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Compact Mounting Structure for 500kV Transmission Line Arresters

1. Introduction

Transmission line arresters have been installed mainly in 66/77 to 154kV transmission lines to prevent line faults (voltage dips or supply outage) caused by lightning strokes. However, the transmission line arresters in 275 and 500kV transmission lines are used in the limited areas because of higher implementation cost related to material, construction and design.

Thus, compact mounting structure for 275kV transmission line arresters have been developed to reduce the above implementation cost [1]. Based on these technologies, we developed and evaluated compact mounting structure for 500kV transmission line arresters.

2. Compact Mounting Structure

Fig. 1 shows a previous and a newly developed transmission line arresters for 500kV transmission lines. The previous design is mounted vertically with an additional metallic support, and often requires modification of the tower arm or jumper conductor. On the other hand, the newly developed transmission line arrester is installed by replacing the existing arcing horns of the insulator assembly. Therefore,additional modification as mentioned the above can be eliminated. Table 1 shows the specification for 500kV transmission line arrester.

Previous transmission line arrester	Newly developed transmission line arrester
	

Fig. 1 500kV Transmission Line Arresters

Table 1 Specification for 500kV Transmission Line Arresters

Items	Requirements
Rated voltage	394kV
Nominal discharge current	20kA (2/20μs)
High current impulse	35kA (2/20μs)
Reference voltage	558kV or more at 1A
Residual voltage	1100kV or less at 35kA
Short circuit current	63kA, 0.1s
Contamination level	0.35mg/cm^2
Mechanical strength	1960N, 1min (tension & bending)

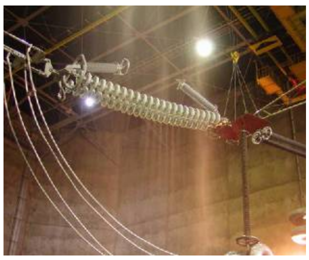
3. Verification of Newly Developed Transmission Line Arresters

3.1 Electrical Characteristics

Considering physical arrangement of arrester units compared to the previous transmission line arresters, insulation coordination test, follow current interruption test, switching impulse withstand voltage test, and corona characteristics test were carried out. Table 2 shows the test results, which indicates that the newly developed transmission line arresters have the equivalent performance compared to the previous one. Fig. 2 shows typical test situation of electrical tests.

Table 2 Results of Electrical Tests

Items	Results
Insulation coordination	All spark-over occurred in series gap of the transmission line arrester, not in the arcing horn gap of the insulator assembly under the following conditions: Rise time: 1500kV/μs Series gap length: 1950mm Arcing horn gap length: 3800 mm
Follow current interruption	Series gap interrupted follow current within 1/2 cycle under ESDD of 0.35mg/cm^2.
Switching impulse withstand voltage	• more than 943kV (2.00pu) with sound arrester • more than 868kV (1.84pu) with failed arrester
Corona characteristics	• No visible corona at 364kV • RIV: less than 60dB at 364kV (dry) less than 90dB at 303kV (wet)

Insulation coordination, corona characteristics)

Fig. 2 Test Situation of Electrical Tests

3.2 Mechanical Characteristics

As the arrester units of the newly developed transmission line arresters are installed by replacing the arcing horns of the insulator assembly, change of series gap length during conductor swing, and also mechanical stress on the transmission line arresters and the disc type insulator units caused by dynamic load such as aeolian vibration and galloping were investigated.

(1) Conductor Swing

The insulator assembly can swing transversely by strong wind. Simulating conductor swing under wind velocity of 25m/s, the insulator assembly with the arrester units was subjected to conductor swing at the traverse angle of approximately 50 degree. Fig. 3 shows the test situation.

Maximum change of series gap length during the test was +103mm, which was within the tolerance. And maximum mechanical stress on the disc type insulator units was almost same as that of the insulator assembly without the transmission line arresters.

Fig. 3 Test Situation in Conductor Swing

(2) Aeolian Vibration

A continuous vibration of power conductor by wind may cause fatigue problem on the pin of the disc type insulator units. Then, the insulator assembly with the transmission line arrester was subjected to continuous vibration up to 1 million times at the resonance frequency. As a result, maximum mechanical stress on the pin of the disc type insulator units was lower than the fatigue limit of the ferrous material.

(3) Galloping

Since many 500kV transmission lines in Japan locate in heavy snow and strong wind areas, the insulator assembly with the transmission line arresters may be subjected to severe dynamic stresses caused by galloping. Thus, we carried out artificial galloping test using full-scale test specimen in 500kV Yamazaki Test Line operated by Kansai Electric Power Company.

The test specimen were installed in suspension and tension towers, and conductors were swung vertically at five kind of vibration modes by the artificial vibration machine. Table 3 and Fig. 4 show the conditions of the test and the test situation.

Table 3 Test Conditions for Galloping Simulation Test

Items	Description
Line length	0.8km
No. of towers	4 towers
Type of conductors	TACSR 810mm^2 × 4 bundles
Type of insulator assembly	
Suspension	330kN (23) disc type insulator units, 1string
Tension	330kN (23) disc type insulator 3units, 2strings
Tension load	120kN (=60kN/string)
Example of dynamic load applied	1st loop Frequency: 0.47Hz Swing angle: 9 degree$_{p\text{-}p}$ Acceleration: 1.7G$_{p\text{-}p}$

Fig. 4 Test Situation of Galloping Simulation Test

Maximum mechanical stress at the hardware of transmission line arresters was only some 5% of fatigue limit. And Fig. 5 shows stress on the pin of the disc insulator units during the galloping simulation test. The ratio of bending to tension stress in case with transmission line arrester is almost equivalent to that without transmission line arresters.

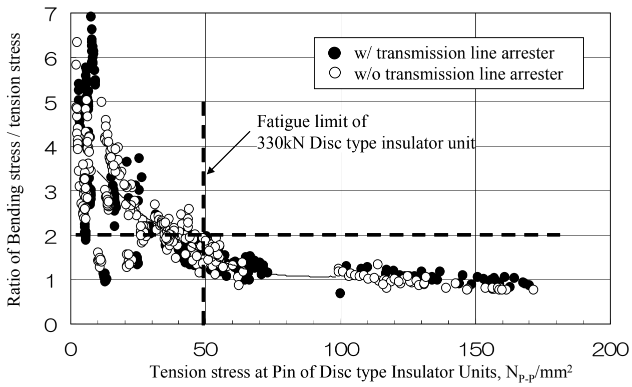


Fig. 5 Stress on Pin of Disc type Insulator Units

4. Conclusion

A compact mounting structure for 500kV transmission line arresters satisfied electrical and mechanical requirements. And material, construction and design cost were about 40% lower than those for the previous transmission line arresters. Therefore, the newly developed transmission line arresters contribute to cost effective implementation for 500kV transmission lines.

This product was jointly developed by Kansai Electric Power Company and NGK Insulators, Ltd. in Japan.

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[1] K. Tsuge et al., "Application Technology of Lightning Arrester for 275kV Transmission Lines", 28th International Conference on Lightning Protection, Kanazawa, VI-43, 2006

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TECHNOLOGIES ALERT

Development of Lignocellulosic Bioplastics for Insulating Materials

In recent years, the use of biomass resources attracts much attention from the viewpoint of the prevention of increasing in atmospheric concentration of CO_2 and the building of the sustainable society. In particular, the study of the biomass-based plastics (bioplastics) made from the renewable resource is positively conducted.

Japan BioPlastics Association (JBPA) defines bio-mass-based plastics as polymer materials that are produced by synthesizing, either chemically or biologically, materials which contain renewable organic materials (1). The bioplastics have already been used some products such as packing materials and parts of home electric appliance in Japan. Therefore, the widespread application of the bioplastics is expected in the near future.

Insulating materials take important roles of in the electric power industry. In the electric apparatuses, the amount use of the insulating material is so much. Therefore, we develop the epoxy-based lignocellulosic bioplastics which have same characteristic compared to the conventional insulating materials.

The lignocellulose was obtained as by-product from sugar-making process. The lignocellulose was introduced into neat epoxy resin, and was cured with acid anhydride. This epoxy-based lignocellulose derivative, which is categorized into the bioplastics, has insulation breakdown strength and flexural strength comparable to those of neat epoxy resin. Moreover, we tried to make the polymer insulator with the lignocellulosic bioplastics as shown in Figure. The insulator passed the standard test of 6.6 kV voltage rating (AC : 16 kV, Imp : ±45 kV).

Furthermore, we presently focus on the characteristics of the lignocellulose derivative as a phenolic hardener and a cross-linking agent. The lignocelluloses derivative contains a lot of phenol group which can make cross-link network with epoxy group. Hence, this approach is effective to increase ratio of biomass resources in lignocellulosic bioplastics, and enables the lignocellulosic bioplastics to become more environmentally-friendly material.

References

(1) Web-site of Japan BioPlastics Association(JBPA)
http://www.jbpaweb.net/english/english.htm

Figure The lignocellulose powder, polymer insulator (left) and appearance of examination (right).

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Developing the world's highest voltage 275kV superconducting power cable

As a high-Tc superconducting power cable (HTS cable) is capable of carrying massive amounts of electricity with low loss, it is expected to making a contribution to energy savings and the reduction of CO_2 emissions. Particularly, we expect that coated conductors as typified by an YBCO wire will be applied for HTS cables, because these will be achieved lowest cost and lowest loss in HTS wires. Furukawa Electric has developed a 275kV HTS cable constructed from YBCO wires, which was important technical issues associated with "Technology development project of the Yttrium-based superconducting power device" commissioned by NEDO. The most common backbone transmission line is 275kV in Japan. However, the voltage class of the superconducting power cables that had been developed so far was 66kV in Japan and a maximum of 138kV overseas, so it was imperative to develop a HTS cable that could withstand high voltages. We have succeeded in raising the voltage of a superconducting power cable and in developing an outdoor termination, and the termination and the superconducting cable have passed an AC voltage test of 400 kV and an impulse voltage test of 1155 kV, and have proven tolerance to constant AC current loading of 3 kA.

Fig. 275kV HTS power cable cut model and outdoor termination.

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MISCELLANEOUS

Photos on Front and Rear Covers

Front Cover

Sakai Solar Power Generation Plant in Full Commercial Operation

Sakai Solar Power Generation Plant has been constructed by the City of Sakai (in Osaka Prefecture) and the Kansai Electric Power Co., Inc. (KEPCO) as their joint project. The solar power plant in Sakai has started its partial operation in October 2010 (3MW), and its full-capacity commercial operation in September 2011 (10MW). This plant is the largest solar power generation plant in Japan. The upper photo of the front cover shows solar panel arrays and the lower is an aerial photo of the plant.

KEPCO plans to share the information obtained through the power plant construction and its operation widely, and it will aim to improve further electric supply reliability of the power system. KEPCO will continue to contribute to the widespread use of solar power generation in the future.

<Summary of Sakai Solar Power Generation Plant>

Structure:	The joint enterprise of Kansai Electric Power Company and the City of Sakai
Address:	4-5-6 Chikkou, Nishi-ku, Sakai City
Site area:	about 21 ha
Output:	10,000 kW
Generated Energy Output:	About 11 M kWh/year (Equivalent of electricity for about 3,000 average households)
CO_2 Reduction:	About 4,000 t/year

Takashi Ochi
(Sakai Solar Power Generation Plant,
Kansai Electric Power Company, Osaka, Japan)

Rear Cover

High Performance Field Emission from Carbon Nanowalls and Carbon Nanowall/Nanocrystalline Diamond Composites

Nanostructured carbon materials such as carbon nanotubes, nanofibers, nanodiamond, and graphene have gained heightened interests. Carbon nanowalls (CNWs) belong to this category of functional materials and consist of two-dimensional networks of almost vertically-aligned graphitic walls. The width of the walls is typically a few to some tens of nanometers. The walls consist of stacks of nanographite domains, interconnected with amorphous carbon. Due to the high aspect ratio, high surface area, and high in-plane conti-nuity of the unique wall structures, CNWs are expected as the potential candidate for large-area field emitters free from Joule heating, templates for fabricating other nanostructured materials, and electrodes for fuel cells and lithium-ion batteries.

In general, field emission from a surface is facilitated by increasing a local electric field E_{local}, which is related to the macroscopic field E_{macro} applied between the surface (cathode) and the anode by $E_{local} = \beta E_{macro}$, where β is the field enhancement factor. The emission turn-on field of CNWs at room temperature is normally below 3 V/μm, which is as low as that of carbon nanotubes. However, the local field onto sharp edges of the walls is not well enhanced due to *electric field screening* between the densely grown walls. The field screening is suppressed if we could increase the wall spacing. The mechanism of spontaneous alignment of the walls has not been under-stood yet. A possible explanation is the crowding effect; the dense wall growth forces the walls to align vertically.

CNWs are deposited on various substrates typically by plasma-enhanced chemical vapor deposition. With a substrate scratching pretreatment, CNW/nanocrystal-line diamond (NCD) composites can be deposited. The upper four figures show top-view and cross-sectional images of CNWs and a CNW/NCD composite. For CNWs, the space between the walls ranges from tens to a few hundreds of nanometers. For a CNW/NCD com-posite, the underlying NCD regions cover the space between the walls and, hence, the overall wall spacing is favorably increased by interception of the lateral wall continuity. The NCD regions seemingly reinforce the walls to align vertically.

The lower figure shows field emission characteristics of CNWs and a CNW/NCD composite deposited on non-scratched and scratched silicon substrates, respectively. For CNWs, the emission turn-on field reaches a minimum of 2-3 V/μm. For a CNW/NCD composite, the emission turn-on field decreases down to around 1 V/μm and the emission current increases significantly. The enhanced emission performance of a CNW/NCD composite is attributed to suppression of the field screening as confirmed by a large increase in the field enhancement factor β .

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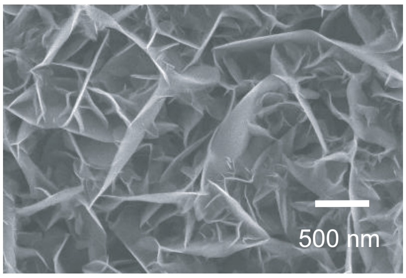
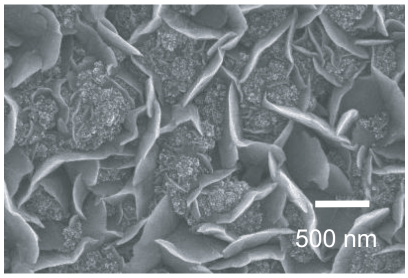
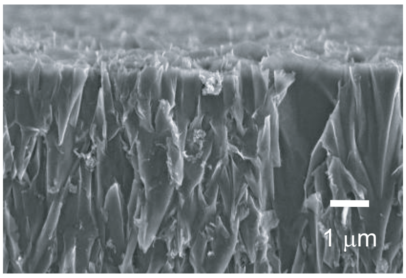


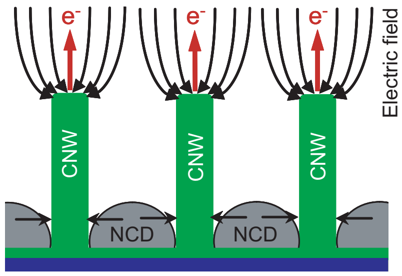
Carbon nanowalls (CNWs)



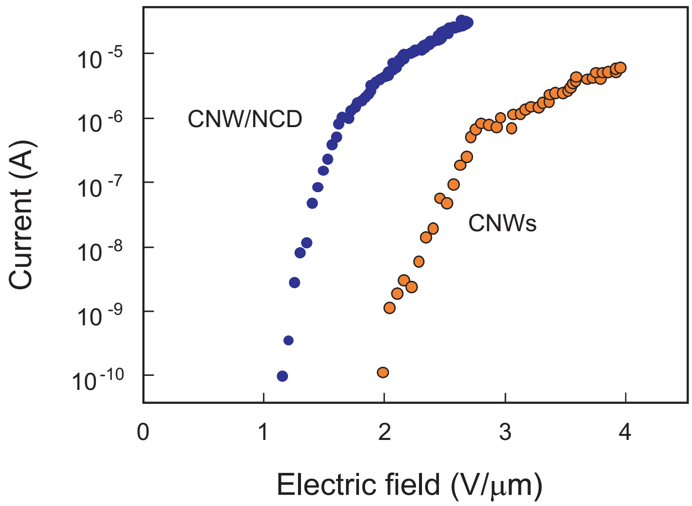
CNW/Nanocrystalline diamond (NCD)



Cross section of CNWs



Schematic of CNW/NCD emitter



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