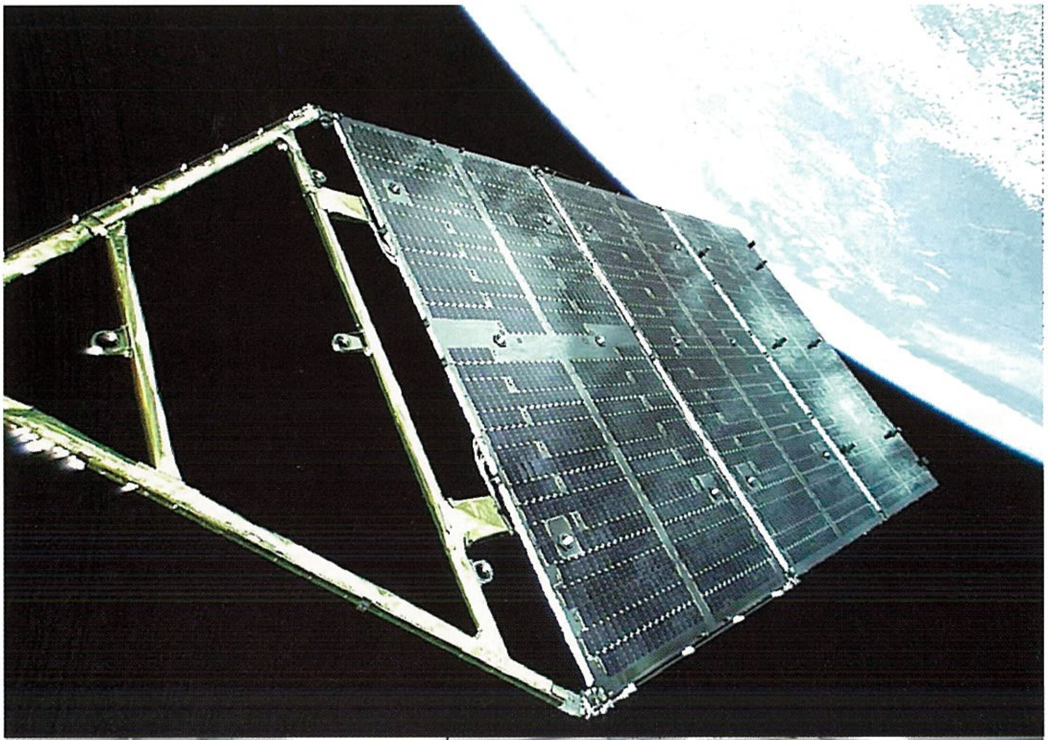
Electrical Insulation News in Asia

No.17 *November 2010*



IEEJ

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PREFACE

Professor Emeritus Masanori Hara

Needs of Society and High Voltage Engineering

I have been involved with research and education regarding high voltage (HV) engineering in Universities and an electric power utility for over 40 years. Our circumstances in the HV engineering field changed drastically during this period.

Around 40 years ago, there was a clear mission of development of an a.c. UHV transmission system in HV engineering in Japan. After the completion of basic research for the design of a.c. UHV transmission lines, the HV section in the manufacturers was rapidly downsized and many engineers and scientists in the field of HV engineering retired without the replacement since we have reached the final transmission levels.

The educational reform was executed at the university under such trend in industry. That is, some universities had dropped their power engineering programs and the number of chairs of professor in the field of power/HV engineering was decreased. Young researchers in the field of HV engineering moved gradually from the power engineering field to the fields of applications of discharge, plasma and high electric stress, such as the development of new materials, industrial processes including material processing, chemical processing, food processing, electronic chip manufacturing, environmental control, bio-medicine and so on.

This tendency should be adopted since we are facing the change from a traditional engineering driven industry to an economical/environmental driven industry and the motivation of young engineers and students reflect the needs of industries, utilities and research concerning HV engineering.

Needless to say, the electric energy is essential for the development of industry and an affluent life, and HV engineering plays an important part in it. Hence, HV engineering must renew its content and methods in consideration of the above-mentioned situation.

The Power Academy covering all Japan was founded to revitalize research and education activity in power engineering under the cooperation between universities, utilities, and manufacturers in 2008. The Power Academy in Kyushu also started operations in the Kyushu region in 2009. This attempt might establish new forms of cooperation between universities and industries in HV engineering in the future.

In the meantime, the EINA magazine had featured mainly result of research activities in the field of HV engineering in Japan in the early stages. Today, it seems that the EINA magazine and its Web site (http://eina.ws) have served as a platform to network all Asian scientists, engineers, and graduate course students. I hope that the EINA contributes much more to building a partnership in the research and education of HV engineering in Asia.

Dr. Masanori Hara
Professor Emeritus of Kyushu University, 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) was set up in 1979 succeeding the Permanent Committee on Electrical Insulating Materials upon the reorganization of IEEJ. The activities of the Committee have been covering mainly solid and composite dielectric materials and their technologies. The important activity of TC-DEI is the annual domestic Symposium on Electrical and Electronic Insulating Materials and Applications in Systems (SEEIMAS), formerly called Symposium on Electrical Insulating Materials. In every 3 years, we hold SEEIMAS as an international one technically cosponsored by IEEE DEIS, namely the International Symposium on Electrical Insulating Materials (ISEIM).

The 41st Symposium on Electrical and Electronic Insulating Materials and Applications in Systems is to be held in Akita city with the General Chair of Prof. M.Nagao on November 15-17, 2010, with technically cosponsored by IEEE DEIS Japan chapter, CIGRE Japanese national Committee and locally arranged by colleagues of Akita 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, outdoor insulations, thin dielectric films and other topics will be discussed.

Next year we will hold the international symposium (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. 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.)).

New materials including nano-materials related

> Nano-Interface Properties of Organic and Composite Thin Films and Device/Sensor Applications (10/2007 - 09/2010, Chairperson: K. Kato (Niigata University)). Next committee is now under consideration.

> Physics of Organic Dielectrics/Semiconductors and Interfacial Design (04/2007 - 03/2010, Chairperson: M. Iwamoto (Tokyo Institute of Technology)). Next committee is now under consideration.

> 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)). Next 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 committee is cosponsored by the TC-DEI and TC of Electrical Discharge and the next one 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: Masayuki Hikita (Kyushu Institute of Technology)
Vice-chairperson: Toshiki Nakano (National Defense Academy)
Secretaries: Fumiyoshi Tochikubo (Tokyo Metropolitan University)
Akiko Kumada (University of Tokyo)
Assistant Secretaries: Yasushi Yamano (Saitama University)
Naohiko 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" 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. The special issue of this symposium will be published in the IEEJ Transactions on Fundamentals and Materials IEE Japan in October of 2010.

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
M. Hikita (Kyushu Institute of Technology)	Measurement of the partial discharges generated by repetitive impulse voltage (established in August 2007)
E. Hotta (Tokyo Institute of Technology)	Generation control and applications of vacuum and low-pressure discharges (established in October 2007)
R. Hanaoka (Kanazawa Institute of Technology)	Discharge phenomena in liquid dielectrics and the technologies of EHD,ER and MR applications (established in December 2007)
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 (Doshisha University)
Secretaries: Hiroshi Akatsuka (Tokyo Institute of Technology)
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 meetings on plasma science and technology in IEE Japan since about 30 years ago. The field of activity includes researches and investigations of various plasmas over wide ranges of their 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 meetings every year. In 2010, four technical meetings were held; in May at Hyogo Prefectural University in Himeji, in August in Honolulu and in Prefectural Culture Center Hall in Gifu, in December at Tokyo Institute of Technology in Tokyo. In 2009 also four technical meetings were held. At each symposium, about 20 or 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 economy improvement of thermonuclear fusion reactors, economic strategy of research and development as well as reactor design have been systematically investigated by the experts of plasma physics and fusion engineering. In the committee of plasma–water applications and their reacting processes involved in liquid interfaces, various types of discharge-plasma applications have been systematically investigated to deepen the understanding of plasma–water interacting phenomena at liquid surface boundaries. In the committee of kinetic description of low-temperature plasmas with applications to modeling and simulation, 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. Finally 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.

Table 1. Investigation Committees in TC-PST

Economy Improvement of Thermonuclear Fusion Reactors	3 years from 2008, Chairperson: Y. Nagayama (National Institute of Fusion Science)
Plasma–Water Applications and their Reacting Processes Involved in Liquid Interfaces	3 years from 2008, Chairperson: K. Yasuoka (Tokyo Institute of Technology)
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)

Electrical Wire and Cables (EWC)

Chairperson: Yasuo Suzuoki (Nagoya University)
Secretary: Akitoshi Watanabe (VISCAS Corporation)
Assistant Secretary: Takashi Kuramochi (Fujikura Limited)
Hitoshi Nojo (J-Power Systems Corporation)

Technical Committee on Electrical Wire and Cables (TC-EWC) is a committee organized to support the IEEJ Power and Energy Society, and comprises members from universities, power utilities, JR Railway Company, Japan Electric Cable Technology Center （JECTEC） and cable manufacturers. The technical committee organizes technical meetings to promote R&D activities in this field and provides an opportunity to present technical achievements. Four technical meetings were so far held in 2010. Two technical meetings on breakdown, deterioration diagnosis and online monitoring system were held as a joint meeting with TC-DEI on January 18 and February 12 in Tokyo. A symposium on technical trends of environmental tests for insulation materials of distribution wires and cables was held on March 17 in Tokyo. A discussion meeting on trends in technologies for wires and cables in various natural conditions was held on September 2 in Kyushu. The technical committee plans to organize 5 more meetings in FY2010.

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

Discussion meeting on trends in technologies for wires and cables in various natural conditions (September 2, 2010, Kyushu)

Pulsed Electromagnetic Energy (PEE)

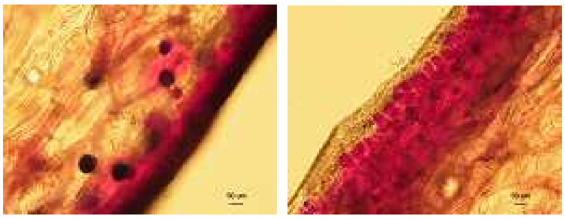
Chairperson:	Eiki Hotta (Tokyo Institute of Technology)
Vice Chairperson:	Koichi Takaki (Iwate University)
Scientific Secretary:	Sunao Katsuki (Kumamoto University)
Scientific Secretary Assistance:	Shinji Ibuka (Tokyo Institute of Technology)

Using pulsed power technology, very high power electromagnetic pulses can be produced, which are used for generating 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 fields; new material development, thin film synthesis or ion implantation technology in industrial field; high speed imaging and intense irradiation by using pulsed x-ray sources, sterilization or medical treatment in biological and medical field; waste treatment or ozone and 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 field of civil engineering and growth promotion of plant in the field of agriculture science. The pulsed power technology thus becomes to be recognized as the basis of many technologies.

Recent topics in field of PEE

Recently, pulsed power applications in industrial fields using biological effects are investigated actively. The applications are roughly categorized as decontamination of air and liquid, crop growth, food processing, and medical treatment. The intense pulsed electric fields (PEFs) with a pulse length of longer than 10 μs are generally used for electroporation because the cell membrane acts as a capacitor and has to be charged to a sufficient voltage to cause membrane defects. Fig. 1 shows microscopic images of the grape peel tissue before (control) and after 30 minutes PEF treatment at 20 kV/cm and 20 pps. The red color is stored in anthocyanoplasts formed by a bilipid membrane inside the cells in the control sample. The red color pigments are extracted from anthocyanoplasts and the red color diffuses into the cells shown in PEF sample. As the results, the polyphenols inside anthocyanoplasts are released from the peel. The application of ns PEFs to biological cells results in intracellular effects with the intense electric field inside the cell seemingly adding a new stress to the internal biological system which will be potentially used for biotechnology, medical treatment and agricultural applications.



(a) Control (b) PFE treatment

Fig. 1 Optical microscopy images of reaction inside the grape peel cell of (a) untreated samples, and (b) PEF treated samples at 20kV and 20 pps.

Recent activities of TC-PEE

The major activity of the Technical Committee on Pulsed Electromagnetic Energy (TC-PEE) is to organize several technical meetings. In 2010, five technical meetings have been held or planned to be held, including the meetings in collaboration with the Technical Committees on Electrical Discharges or Plasma Science and Technology. This year, TC-PEE held the 4th Japan-US Symposium on Pulsed Power and Plasma Applications in Honolulu, Hawaii on August 5-6 (Fig. 2). From two countries, 38 researchers and graduate students have presented 32 scientific papers on topics of pulsed power, plasma, and high-power electromagnetic radiations. This symposium started in 2002 and has been operated by both TC-PEE and TC-PST. Its purpose is to promote scientific collaboration and technical information exchange between Japanese and US scientists working in this field.

Fig. 2 4th Japan-US Symposium on Pulsed Power and Plasma Applications held in Honolulu, Hawaii.

Activity of investigation committee in TC-PEE

TC-PEE is currently running an investigation committee named "biological effects of pulsed electromagnetic energy and their industrial applications". The investigation committee includes 18 members in various fields including electrical, chemical, mechanical engineering, biology and medical science joined from academia and industry. The activity of the committee is to hold the regular meeting and the symposium in addition to the publication of the research report. 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 to biological cells, tissues, organisms and bacteria, and their applications to biotechnology, medical, cosmetic, agricultural and food industries.

(Reported by Eiki Hotta, Koichi Takaki, Sunao Katsuki and Jiang Weihua)

Light Application and Visual Science (LAV)

Chairperson: Hiroyuki Kamei (Tokyo Institute of Technology)
Secretaries: Takeshi Kinoshita (Keio University)
Susumu Kimijima (Covalent Materials Corporation)

Activities of the technical committee on light application and visual science (TC-LAV) have been covering fields of application of optical engineering and visual science for medical science, devices for visual information processing, light sources from far infrared to extreme ultraviolet, advanced lithography, and etc. Three investigation committees: 'Future Technology of Infrared and Terahertz Waves(IC-FTITW)', 'Ultimate Technology for Lithography (IC-UTL)', and 'Technologies for Next Generation Light Source (IC-NGLS)', are affiliated to this TC and are surveying the technology trend of each field.

The special issue of IEEJ Transaction on Fundamentals and Materials entailed by "New trends of light sources and illuminations" is being edited by TC-LAV and IC-NGLS and will be published in May, 2011.

In the field of light sources and illuminations, novel solid-state light sources such as LED and EL have been remarkably developed and are getting rapidly popular in our lives. These light sources have higher luminous efficacy and much longer life time so that these lamps are expected to relieve the environmental problems. On the other hand, the gas discharge light sources have opened new type application like medical/bio processes for disinfection or sterilization, analysis and processing of materials and so on.

Under such situations, the special issue concerned with new type lamps and their application are arranged. The contents are as follows:

(1) Solid-stale light sources,

・LED and Organic EL, progress of phosphors,

・Illumination by solid-state light sources, display application, analysis and processing of materials, medical and bio applications,

(2) Gas discharge light sources,

・Gas discharge development for light sources,

・Gas discharge illumination display, analysis and processing for material, medical and bio applications.

A recent topic of light application, "Novel lithography for helical patterning", is introduced.

Various kinds of micro electro mechanical systems (MEMS) have been developed in these 20 years, and some of them have become indispensable for our daily lives. Lithography is widely used for fabricating various devices of MEMS in addition to the usages for fabricating highly integrated semiconductor devices.

Minimum feature size for advanced semiconductor devices has already reached to less than a half pitch of 45 nm, and devices with half pitches of 32 nm and 22 nm are vigorously researched and developed. However, feature sizes required for MEMS are much larger than these, and typical pattern sizes are in the range of 1-100 μm. On the other hand, customized technological progresses such as special applicability and flexibility for shapes and sizes of objects to be patterned, special thickness or sidewall profile conditions of resist patterns are often required.

Among these requirements, patterning onto fine shafts or pipes is one of the technologies that are strongly requested. Helical patterning is especially useful for fabricating micro-coils that are applicable to springs and inductors.

Laser-scan exposure shown in Fig.1 is one of the most prospective methods for delineating such helical patterns onto fine pipes and wires with

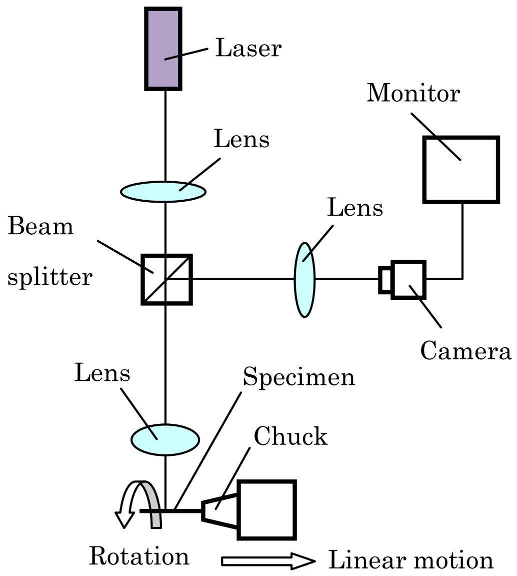


Fig.1 Exposure system for delineating patterns onto fine pipes and wires.

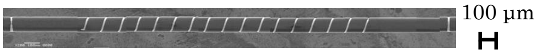


Fig. 2 Helical patterns with width of 11µm and pitch of 120µm pitch delineated on a copper pipe with a diameter of 100 µm.

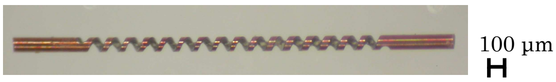


Fig.3 Micro-coil obtained by etching the specimen shown in Fig. 2. It was etched in ferric chloride solution.

diameters less than 100 µm[1,-3)]. Using this system, specimens supported by a chuck was exposed to the laser beam during they were helically moved by the stages. Violet semiconductor laser with a wavelength of 408 nm was used, and the laser beam was focused on the specimen coated with a positive resist film. The beam spot was observed by a camera monitor to check whether the beam spot was correctly scanned on the specimen surfaces or not.

An example of helical resist patterns delineated on a copper pipe with a diameter of 100 µm is shown in Fig.2. The resist thickness was approximately 3 µm, and the mean width of the helical space patterns was approximately 11 µm. The pipe with the helical patterns was etched in ferric chloride solution next. As a result, a fine copper micro-coil was successfully fabricated, as shown in Fig. 3.

This novel lithography method will be much useful for developing advanced MEMS in the near future.

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Authors

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Electro-Magnetic Compatibility (EMC)

Chairperson: Tsuyoshi Funaki (Osaka University)
Secretaries: Ken Kawamata (Hachinohe Institute of Technology),
Tomoo Ushio (Osaka University)
Yoshinori Taka (Nagoya Institute of Technology)

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 noise immunity for

electric and electrical appliances.
2. Investigation committee on EMC technologies for electrostatic discharge (ESD).
3. Investigation committee on technical trends in evaluation of biological protection and compatibility with electromagnetic field.
4. Investigation committee on the analysis technology of electromagnetic filed including human body.

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 Mar. 6th(40th) , Jul 23th(41st), Nov. 27th(42th) for 2009, and Apr.,21th(43th), Jun.18th(44th) for 2010. This year, the committee co-sponsored the 2010, PPEMC (Pan-pacific EMC joint conference), which was held May 27th-28th, 2010 in Sendai.

1. Investigation Committee on Noise Immunity for Electric and Electrical Appliances.

This committee, chaired by Prof. M. Tokuda of Musashi Institute of Technology, was established in Jan. 2008. The mission of this committee is to grasp and analyze the current situation of noise immunity for electric and electronics appliances and to clarify uncertainness of the measurement in immunity test. The investigation subjects are summarized as followings.

1. Standards and regulations on noise immunity for domestic and abroad;
2. Case examples and counter measure to the interference of noise;
3. Techniques for immunity tests;
4. Design and control technology for immunity.

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

2. Investigation Committee on EMC Technologies for ElectroStatic Discharge (ESD).

This committee, chaired by Prof. S. Minegishi of Tohoku-gakuin University, was established in Apr. 2008. The mission of this committee is to study the EMC issues accompanied with electrostatic discharge phenomenon, and clarify the factor for its origination and the mechanisms of the generation of wide band noise. The committee is working on the following subjects.

1. Survey the currently recognized terrors of ESD;
2. Measurement method of wide band current and electric field emitted from ESD;
3. Elucidate the mechanism in the occurrence of ESD, physically;
4. Modeling and simulation of ESD.

This committee envisions inspiring the other EMC engineers to recognize ESD problems as a sort of EMC incident.

3. 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.

4. 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.

Instrumentation and Measurement (IM)

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

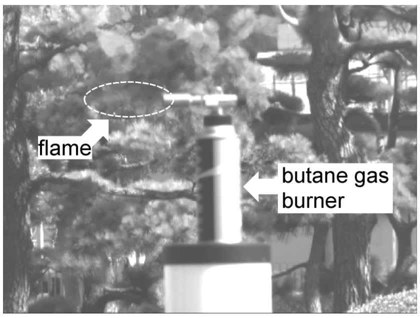
Activities

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

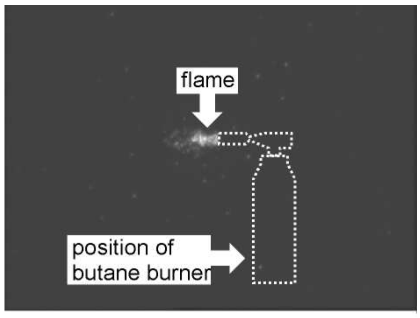
Activities of the technical committee of instrumentation and measurement are as follows.

i) The general meeting of the committee is held four times every year for discussing the various activities of the committee. Fifteen members including chairperson, two secretaries, and an assistant-secretary constitute the committee.
ii) Workshops for the presentation and discussion of studies and researches take place almost every month in principle as a main activity of the committee.
iii) Visit of various professional facilities is planned to carry out once or twice a year.
iv) Special volumes on the transaction of the society A (Fundamentals and Materials) in IEEJ are planned by the committee.

The workshops mainly take place at Tokyo area, and sometimes in Kyushu, Kinki, Shikoku, and other locations. 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 measurement, and so on. In several workshops, miscellaneous subjects are accepted for presentation and discussion. The annual number of presentations in



(a) Visible image of butane burner flame



(b) Image of butane burner flame in the ultraviolet region

Fig. 1. Image of butane flame.

the workshops is around 70 titles. The workshop is supported by IEEE IM and sometimes by other organizations.

The committee planed a special volume on "Measurement Technology for Safety", which included eight papers and was published in August 2009. The three contents, which were also presented in the workshops in the preparatory stage, are roughly introduced in this article.

Topics in special volume

1) Flame Imaging for Safety Surveillance [1]

Flame detection is important for prevention of spreading of accidental fires. When combustible gas is ignited under daylight conditions, the flame is often difficult to detect by conventional imaging because of the high background radiation. The flame can be visualized by selectively detecting the emission of the OH radical, which is present in hydrocarbon or hydrogen flames. By detecting the OH radical emission in the solar blind region of wavelength below 290 nm, the background radiation can be effectively eliminated. In this study, an experimental device for visualization of flame at wavelength 285 nm was constructed. A combination of two narrowband interference filters was found to be sufficient to eliminate background radiation and selectively image the OH emission. Referring to Fig. 1, the device could detect butane burner flame under daylight conditions.

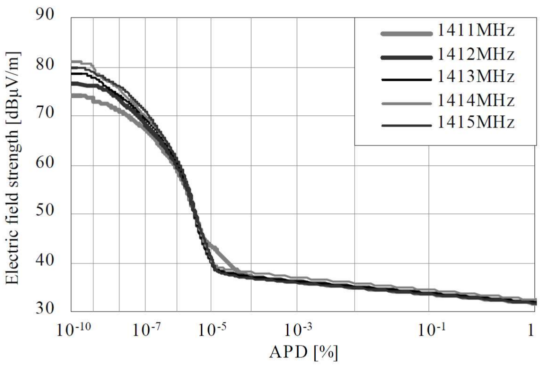
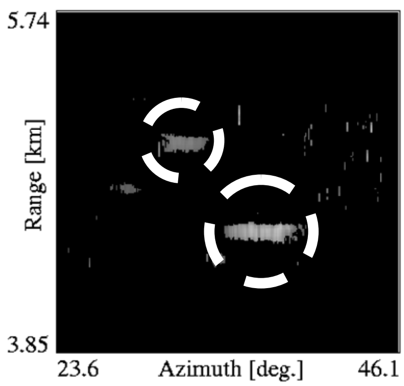


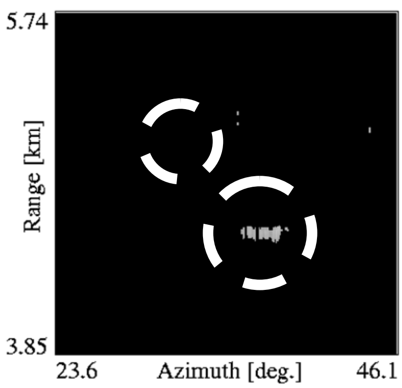
Fig. 2. Measurement results for rarely occurring pulses using APD measuring receiver.

2) Continuous Measurement of Amplitude Probability Distribution and Applications to Pulses of Low Occurrence Frequency [2]

An Amplitude Probability Distribution (APD) measuring receiver that conforms to CISPR16-1-1 2nd edition has been developed. The receiver is installed in a general-purpose spectrum analyzer that has a field programmable gate array (FPGA) for digital signal processing. The evaluation test results for measuring continuity, the results of an examination of the accuracy on the peak measurement of pulses that occur infrequently, and the results of an APD measurement experiment on rarely occurring pulses mainly caused by electrostatic discharge, referring to Fig. 2, were reported.



(a) using the developed CFAR algorithm



(b) using a conventional LOG/CFAR algorithm

Fig. 3. Results using the developed CFAR and a conventional LOG/CFAR algorithm.

3) Suppression of Weather Clutter by a New CFAR Circuit [3]

Various radar clutters obey a Weibull distribution under certain conditions. To suppress such Weibull-distributed clutter, a new adaptive method, in which the parameters of the Weibull distribution and the threshold level for an adaptive Constant False Alarm Rate (CFAR) detector are determined by calculating the variance after passing through a logarithmic amplifier, is proposed. To apply this new method to practical problems observed by an S-band radar, computer simulations were made for a finite number of samples in order to obtain the CFAR maintenance in Weibull radar clutter which included weather clutter. Finally, referring to Fig. 3, two ships (enclosed with circles), which were embedded in weather clutter, were clearly detected using the developed CFAR algorithm, as shown in (a). However, one of two ships was not detected when the conventional LOG/CFAR algorithm was used, as shown in (b). In comparing (a) and (b), the new algorithm resulted in an improvement of 30.82 dB in the target-to-clutter ratio.

WEB site and authors

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

Written by Dr. Kazuo Tanabe (Chairman, Central Research Institute of Electric Power Industry (CRIEPI), e-mail: tanabe@criepi.denken.or.jp), T. Fukuchi, S. Arakawa, and S. Sayama.

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(3) S. Ishii, and S. Sayama : "Suppression of Clutter Near Port by S-Band Radar", IEEJ, Vol.129-A, No.8, pp. 537-542 (2009)

Metal and Ceramics (MC)

Chairperson: Ataru Ichinose (Central Research Institute of Electric Power Industry)
Secretary: Akio Kimura (The Furukawa Electric Co., Ltd.)
Assistant Secretary: Masanao Mimura (International Superconductivity Technology Center)

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

Mission of TC-MC

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

As shown in figure 1, the activities of the TC-MC have been covering mainly electric, electronic and optical materials, and their technologies. Namely their functions are extended such as super-conductivity, normal conductivity, semi-conductivity, mechanical strength, heat transfer, thermoelectric, photo-electricity, optical trans-mission, 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.

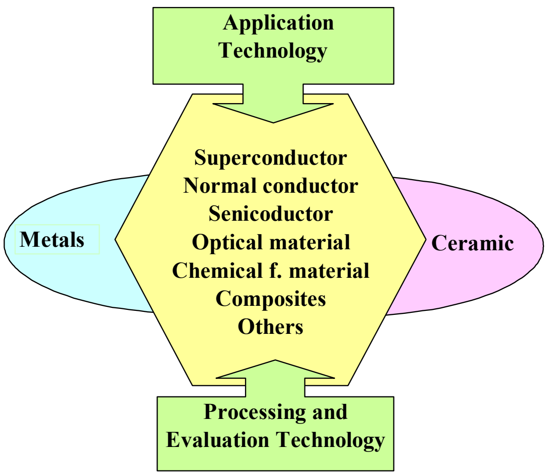

Figure 1 Activity scope of the TC-MC

History of TC-MC

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

Recent activities of TC-MC

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

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

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

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.

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.	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

Table 3 Investigation Committees under the TC-MC

Research Subject	Chairperson (Affiliation)	Period	Remarks
Fabrication technologies and characterization of advanced superconducting materials	Hiroaki Kumakura (NIMS)	2004.10-2007.09	Close
Structure, composition and characterization of advanced superconducting materials	Jyun-ichi Shimoyama (University of Tokyo)	2008.10-2011.09	Open

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.

IEC and CIGRE Japanese National Committees Related to Electrical Insulating Materials

IEC TC15 Japanese National Committee

Chairperson: Yoshiaki Yamano (Chiba University)
Secretary: Yoshio Wakashima (Japan Electrical Safety & Environment Technology Lab.)
Associate Secretary: Akihiro Kawaguchi (Japan Electrical Safety & Environment Technology Lab.)

The task for IEC TC15 is to prepare international standards including specifications for solid electrical insulating materials alone and in simple combinations. This includes coatings which are applied in the liquid state but cure to solids, such as varnishes and coatings.

TC15 establishes definitions, general requirements and specification sheets for individual types of materials. The standards include test methods and guidance where these are required for the specifications. The current activities of TC15 are carried out in 5 working groups (WGs) and 4 maintenance teams (MTs), and more than 160 standards are published. 20 work programs for standardization are in progress this year.

Japanese national committee for TC15C held meetings of three times last year. Over 30 documents for standardization have been circulated from IEC Central Office, including CD, CDV and FDIS, all of which were studied and discussed by the specialists of the Japanese National committee.

To accomplish the tasks of the WGs in TC15, the experts from Japan are active in MT3 (plastic films), WG5 (flexible insulating sleeving), WG7 (resins and varnish) and WG9 (cellulosic materials). They are contributing to accomplish the new work item and revisions of the present standards.

Japanese national committee is participating to the standardization of new and improved insulating materials, such as PEN film and PP film of thin thickness type, in order to offer the appropriate and useful standards for the market.

TC15 meeting has been annually held. The meeting of this year was held on May in Milan. 7 members from Japan worked in MT/WG meetings and the plenary meeting.

CIGRE SC D1 Japanese National Committee (Materials and Emerging Test Techniques)

Chairperson: Naohiro Hozumi (Aichi Institute of Technology)
Secretary: Toshio Shimizu (Toshiba Corporation)
Assistant Secretary: Tsuguhiro Takahashi (CRIEPI)

CIGRE (International Council on Large Electric Systems) has 16 Study Committees (SC) belonging to each of following 4 categories: A (Equipment), B (Subsystems), C (Systems) and D (Horizontal). Among them, our SC D1 has a horizontal character and contributes to other CIGRE SC's. The activity of CIGRE SC's is principally research oriented one, while some of them are closely related to the activities of IEC Committees which publish and maintain the International Standards in the field of the Electrotechnology.

SC D1 has now following 5 Advisory Groups (AG): CSAG (Customer and Strategic related), AG D1.01 (Insulating Liquids), AG D1.02 (High Voltage Testing and Diagnostic), AG D1.03 (Insulating Gases) and AG D1.04 (Insulating Solids). In 2010, SC D1 has started 5 new WG's: WG D1.34 (Diagnosis for OF Cables), WG.D1.37 (PD Detection), WG.D1.38 (Test Techniques for HTS Power Applications), WG.D1.40 (Data Collection and Analysis), WG.D1.41 (Radiation Ageing of Polymeric Insulation).

SC D1 now consists of 5 AG's and 17 WG's: the above new WG's as well as the 12 existed following WG's: WG D1.05 (Capacitors), WG D1.17 (HV Asset Condition Assessment Tools, Data Quality and Expert Systems), WG D1.19 (Solid Insulation Endurance under Repetitive Transient Voltages), JWG B1/D1.20 (Water Tree Detection in XLPE insulation), WG D1.23 (Diagnostics and Accelerated Life Endurance Testing of Polymeric Materials for HVDC

Application), WG D1.24 (Potential of Polymer Nanocomposites as Electrical Insulation for Highly Stressed Insulation Material in AC and DC Application), WG D1.25 (Application Guide for PD Detection in GIS using UHF or Acoustic Methods), WG D1.26 (Basic Principles to Determinate Methane Content of Cross-linked Solid Insulation of MV and HV Cables), WG D1.27 (Material Properties for New and Nonceramic Insulation), WG D1.28 (Optimized Gas-insulated Systems by Advanced Dielectric Coatings and Functionally Graded Materials), WG D1.33 (High Voltage Test and Measuring Techniques), WG D1.29 (PD in Transformers).

The preferential subjects for the 2010 SC D1 Paris group meeting were PS1: New materials for improved efficiency and sustainability of AC & DC power equipment (Nanomaterials, biodegradable materials, New gas compositions, Recyclable materials, Innovative polymers, HTSC), PS2: Challenges for testing and diagnostics (New requirements for ultra high voltage, Interpretation of diagnostic results for condition assessment, New test and monitoring methods), PS3: Endurance of materials especially in harsh electrical and physical environments (Off-shore applications, Repetitive transients, load cycling, thermal overload, nuclear environment). From Japan, following 3 papers were accepted: "Endurance of polymeric insulating materials in nuclear power plants and needs for condition monitoring of electrical cables" by Y. Ohki, et al, "Application of new solid insulating materials and new gas compositions to future advanced gas insulated systems" by H. Hama, et al., "Experimental research on the feasibility of biodegradable polymeric insulating materials" by Y. Ohki, et al. The second paper by Hama et al. was awarded as an excellent Japanese paper for 2010 Paris meeting.

The next 2011 meeting is scheduled to be held at Doshisha University, Kyoto, Japan on September 11-16, 2011, as a Joint Colloquium of A2 (Transformers) and D1. The International Symposium on Electrical Insulation Materials will be held at Doshisha University as well prior to the CIGRE colloquium on September 6-10, 2011. All Japanese colleagues are waiting for your participation.

The Japanese National SC D1 has usually 2 or 3 meetings a year.

International Standardization of 1100 kV UHV Transmission Technologies Originating from Japan

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1. Introduction

A world economy expands over boundaries between countries and regions. In Japan, there are many splendid technologies which the world requires. In order to transfer these technologies to the world, an inter-national standard which includes them as a standard is necessary. An international trade is required to comply with an international standard under the Agreement on Technical Barrier to Trade (TBT) of the World Trade Organization (WTO). The International Electrotechnical Commission (IEC) standard is approved as an international standard in an electrical engineering field. In this situation, it becomes important for Japanese splendid technologies to be utilized in the world market that Japanese technologies are developed by basing on the IEC standard and/or Japanese technologies are reflected in the IEC standard.

On the other hand, the International Council on Large Electric Systems (CIGRE) has taken a role of preparing a pre-document for an IEC standard in the electric power system. It will be important to input Japanese technologies in a CIGRE draft as a pre-standard stage. It might be desired that Japanese splendid technologies are presented at the Institute of Electrical Engineers of Japan (IEEJ) conferences including general meetings and committee meetings, then are summarized in IEEJ's technical reports of sub-committees, are presented at CIGRE conferences and finally are adopted in a draft of an IEC standard.

The 1100 kV (Ultra-High-Voltage, UHV) transmission system technology can be said to be a superior technology, which originated from Japan, since it has been initiated first in the world. The activities of reflecting the UHV technology in the IEC standard have been promoted by a cooperation of related organizations gathered in the International Standardization Committee on UHV System in the IEEJ Electrotechnical Committee[1][2].

In the IEC, the Sector Board 1(SB1), which covers the field of 'electricity transmission and distribution' has recommended the necessity of UHV standardization and the Joint IEC-CIGRE coordination group (JICCG) has been established to coordinate the UHV standardization, and coordinate opinions of countries and regions. In the CIGRE, study committees are initiated to investigate the UHV technologies, and are trying to propose drafts rapidly.

These activities toward the international standardization of UHV system are described in this article.

2. UHV Transmission System in Japan

The Tokyo Electric Power Company, Inc. (TEPCO) has worked to expand the 550 kV network. It was, however, very difficult to secure multiple power transmission routes in Japan. In addition, counter- measures for short circuit capacity problems were required in order to increase the number of 550 kV transmission lines. It was finally decided to construct 1100 kV transmission lines with a capacity 3 to 4 times greater than that of 550 kV transmission lines.

The TEPCO completed the 1100 kV transmission route that links a nuclear power station on the Sea of Japan to the metropolitan region (north-south route) in 1993 and the other route linking power sources on the Pacific Ocean (east-west route) in 1999. These transmission lines are now operated at 550kV and they are expected to be upgraded to 1100 kV in 2010's in order to enhance transmission power from east to west in the control area in terms of transient stability and power flow security.

For UHV transmission system design, a self-supporting double-circuit configuration has been adopted as the first attempt in the world.

For substation design, a gas-insulated switchgear (GIS) has been adopted. Various verification tests have been conducted at UHV equipment test site in Shin-Haruna Substation for unexpected phenomena that had not been revealed in the development stage, and for acquisition of various field data. A photograph of the test site has appeared on the cover of EINA, No. 3, 1996.

3. International Standardization through IEC

(1) Organization of IEC

Fig. 1 shows a schematic diagram of the IEC organization related to the UHV standardization. At the top of the organization there is the general meeting, below which Standardization Management Board (SMB) is located. SMB consists of 15 members of the National Committee representative, and important issues are discussed and decided at the SMB meeting.

Technical Committees (TCs) and Sub-committees (SCs) comprise a major body for drafting a standard. They operate with reporting to and being directed by SMB. Three Sector Boards (SBs) operate under SMB now. SB1, SB3 and SB4 have his own field of focusing. The title name of SB1 is 'Electricity Transmission and Distribution', which means that SB1 is responsible for electric power transmission and distribution network system and equipment.

Members of SBs are nominated by the National Committee and approved by SMB members voting. There are three members including a chair, Prof. H. Ikeda, from Japan. Including two members from both Korea and China, members gather from the world such as USA, Canada, France Germany and South Africa. Related TCs can participate the SB meeting.

The expected function of the SB is: first, to advice on the priority in the sector activities, secondly, to ensure the continuing market relevance of IEC standards, thirdly, to ensure the coherence of standardization activities at the system level.

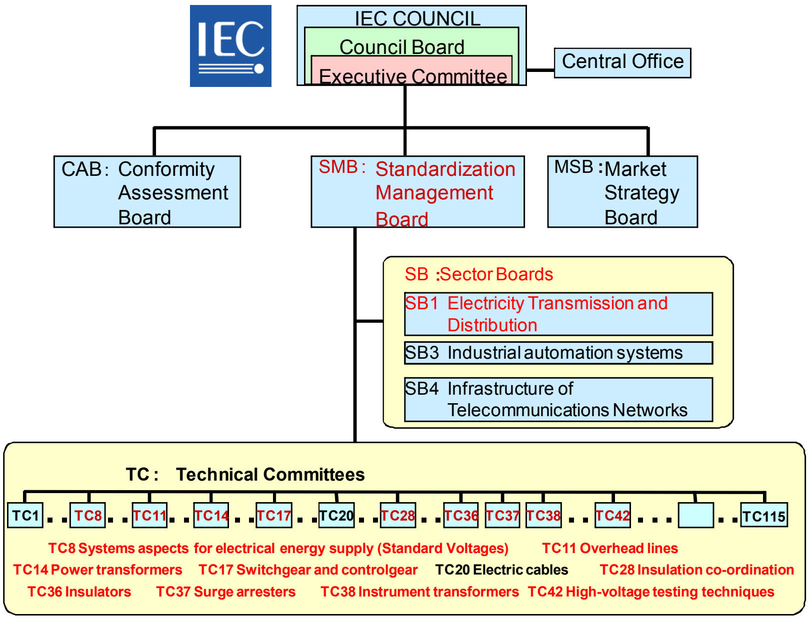


Fig. 1. Schematic IEC organization related to UHV standardization

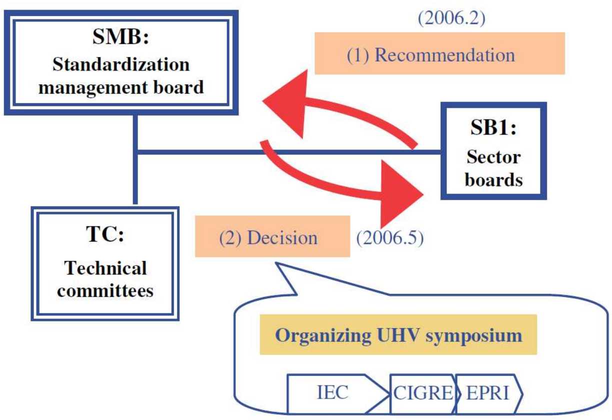
(2) First step of UHV standardization

In 2005, five years ago, it was expected that the pilot project of 1100 kV UHV transmission would operate in China by the end of 2008. UHV engineers and researchers have felt growing requirements for standardization of UHV technologies.

Under the encouragement of such requirements, SB1 held the first SB1 Asian members meeting in November 2005. The IEC standardization of the UHV technology was discussed at the meeting. The SB1 Asian members meeting is generally scheduled midway between two successive SB1 meetings. The reason comes from the fact that Asian members cannot always attend the SB1 meeting although the Asian market, especially the Chinese market, becomes large and important in a transmission and distribution field.

The discussion points of the SB1 Asian members meeting about the UHV standardization were proposed to the SB1 meeting held in February 2006. After discussions the SB1 meeting agreed to send a recommendation of the UHV standardization to the SMB.

In the SMB meeting held in May 2006, the SMB agreed to recognize needs for UHV transmission standards but decided to hold a symposium in order to investigate the present situation. The SMB required the symposium to offer clear answers to questions from the SMB: maturity of UHV technologies and market needs for UHV standards. Those initial processes are shown in Fig. 2.



holding UHV symposium

(3) IEC-CIGRE symposium on UHV

Following the SMB's decision, Chinese delegates promptly proposed to hold the symposium in their country. The IEC central office requested the SB1 to collaborate with CIGRE for the symposium organization. It was agreed that the organizing committee of the symposium should be jointly operated by IEC and CIGRE, China should form a local committee, and the SB1 should promote all preparatory work in IEC. The technical program of the symposium was originally discussed and made at the second SB1 Asian members meeting in June 2006. Then it was sent to both IEC and CIGRE.

To watch these processes and lead the international standardization activities, the Japanese Electrotechnical Committee (JEC) in IEEJ decided to establish a new committee, the International Standardization Committee on UHV System (chair: K. Hidaka), on Dec. 2006. The new committee contributed to make a detailed technical program, whose original program had been proposed by IEC-CIGRE collaboration activity. The program was finally approved and the call for papers was issued based on the program. On the call for papers, there were many papers submitted from around the world.

Almost one year after the SMB's decision, the Beijing UHV symposium took place successfully in July 2007. This symposium confirmed a strong market needs for the UHV standardization and maturity of the UHV technology. And also the symposium declared to give first priority to 1100 kV AC system. Closing remarks of the symposium noted that the joint IEC-CIGRE coordination group should be started as soon as possible by being accepted by the SMB.

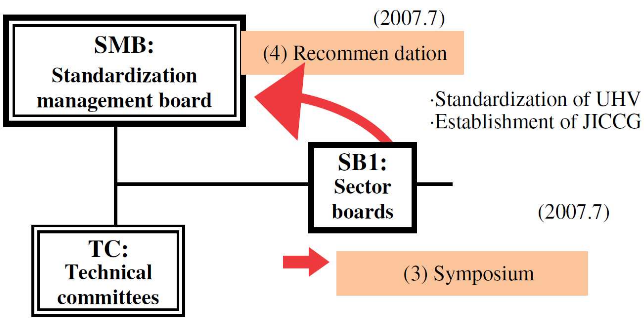


Fig. 3. Process after UHV symposium held in Beijing

The SB1 reported clear answer from the symposium to the SMB. At the same time, the SB1 made a recommendation for the necessity of establishing a joint IEC-CIGRE coordination group (JICCG) for the standardization to the SMB. The SMB approved the recommendation at the meeting in October 2007. At this moment, the UHV standardization was given a 'go' sign. The process is schematically shown in Fig. 3.

(4) Joint IEC-CIGRE coordination group (JICCG)

According to the SMB approval of the SB1 recommendation, the JICCG started in November 2007. The objectives of the JICCG are as follows: First, to determine the domains in UHV technology, both AC and DC, secondly, to make recommendations for what UHV standards the market requires and to develop strategies for international standardization of UHV technologies, thirdly, to prepare a road map of standardization of UHV technologies with full cooperation between CIGRE and IEC.

About 15 members of the JICCG are selected through the IEC and the CIGRE. The road map for the UHV AC standardization was discussed at the JICCG meeting (see Fig. 4). There are three steps. At first, horizontal standard committees such as TC 8 and TC28, start operations. Subsequently, some equipment standard committees such as TC 14 TC 17, and TC 37, begin to make a draft of standard. Finally, other equipment standard committees start.

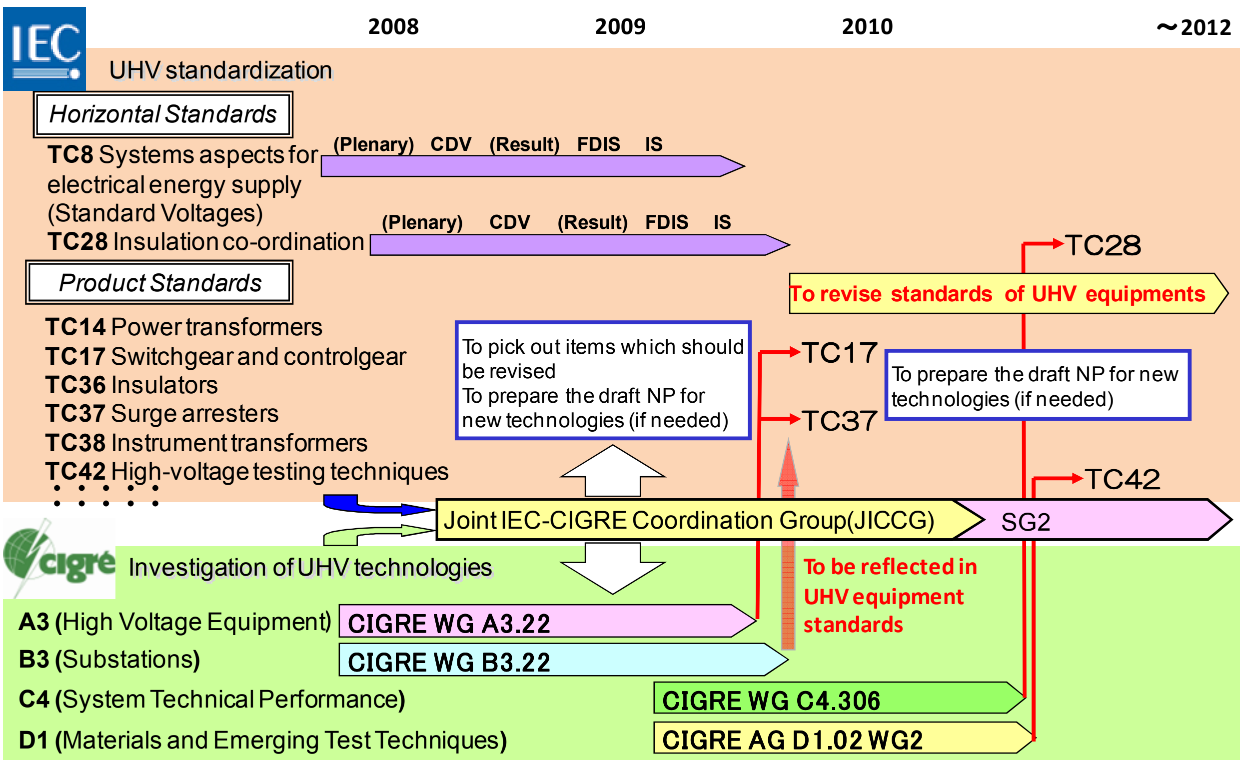


Fig. 4. ROAD MAP of Standardization on UHV AC Technologies

(5) 1100kV UHV as standard voltage

The Committee Draft for Vote (CDV) on the standard voltage compiled by TC 8 was approved in 2008. It was followed by the Final Draft of International Standard (FDIS) whose vote was closed on 22nd of May, 2009. Accord-ing the result of voting, 1100 kV was approved as one of standard voltage values in IEC 60038. Now, 1100 kV is listed in the table of AC three-phase systems having a highest voltage for equipment as shown in Table I.

Table I. AC three-phase systems having a highest voltage for equipment exceeding 245 kV (IEC 60038)

Highest voltage for equipment kV
(300)
362
420
550[b]
800[c]
1 100
1 200

[a] The values indicated in parentheses should be considered as non-preferred values. It is recommended that these values should not be used for new systems to be constructed in future. The values are voltages between phases.

[b] The value 525 kV is also used.

[c] The value 765 kV is also used; the test values for equipment should be the same as defined by the IEC for 765 kV.

IEC 60038

As to the standard rated withstand voltage (the testing voltage) in electrical insulation coordination, the CDV was approved in April 2009 and the FDIS was finally approved on 30th of October, 2009. Table II shows the standard rated withstand voltages for switching and lightning impulse waveforms including the highest voltage of 1100 kV in IEC 60071-1.

A series of activities toward the international standardization have been discussed and carried out by the members of the IEEJ International Standardization Committee on UHV System which is characterized by working horizontally across fields of systems and products.

Table II. Standard insulation levels for equipment exceeding 245 kV (IEC 60071-1)

Highest voltage for equipment U_m kV (r.m.s. value)	Standard rated switching impulse withstand voltage			Standard rated lightning impulse withstand voltage kV (peak value)
	Longitudinal insulation kV (peak value)	Phase-to-earth kV (peak value)	Phase-to-phase (ratio to the phase-to-earth peak value)	
1100	-	1425 (4)	-	1950
				2100
	1425	1550	1,70	2100
				2250
	1550	1675	1,65	2250
				2400
	1675	1800	1.6	2400
				2550
1200 (5)	1550	1675	1,70	2100
				2250
	1675	1800	1,65	2250
				2400
	1800	1950	1,60	2550
				2700

(6) Present and future works

In China, the commercial operation of the UHV transmission system, whose test bases had been completed in 2007[4], started on January 2009.

In 2009, the SMB requested the JICCG to start the following works: first, to carry out 2nd and 3rd steps of UHV AC road map, secondly, to pay special attention for 1200kV, thirdly, to coordinate among TCs for UHV DC.

By the end of 2009, the SMB decided that Strategic Group 2 (SG2), which was newly formed, collaborated in a short term with the JICCG, and later took over the JICCG's works in order to promote the international standardization of UHV technologies.

The equipment standards are being discussed in related TCs in the IEC based on the reports which the CIGRE task groups compiled in 2009.

4. Conclusion

The international standardization activities mentioned in this article depend mainly on the Japanese renowned and advanced 1100 kV UHV technology. This fact would have an influence on future activity in the international standardization.

The author would like to stress again that Japan and East Asia countries should collaborate more and more to transfer their splendid technologies to the world and to take the initiative in setting the international standards on the technologies.

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Conference Records

2009 Korea-Japan Joint Symposium on Electrical Discharge and High Voltage Engineering (KJ2009, Busan, Korea)

Akiko Kumada
The University of Tokyo, Japan

1. Introduction

2009 Korea-Japan Joint Symposium on Electrical Discharge and High Voltage Engineering (KJ2009, Busan) was held at The Paradise Hotel Busan, at Busan in Korea from 5th to 7th November, 2009.

In order to promote the international activities in electrical discharges, "Japan-Korea Joint Symposium on Electrical Discharge and High Voltage Engineering" has been organized in collaborative with the Technical Committee of Electrical Discharge in IEEJ and Electrical Discharge & High Voltage Engineering Society of KIEE, and has been held every two years since the first symposium was held at LG Cable & Machinery Co. Ltd. In 1996. KJ2009 Busan is the 11th conference followed by the one at Shibaura Institute of Technology, Tokyo in 2007 (JK2007). KJ2009 is mainly organized by KIEE Electrophysics and Applications Society in collaborative with Technical Committee of echnical Committee of Electrical Discharge in IEEJ and co-organized by Research Group of High voltage and Discharge in KIEE and Dong-A University.

Table 1 lists the number of presented papers of KJ2009 compared with that of JK2007, and Table 2 lists the number of participants. The numbers of presented paper and participants have remained stable at around 100.

Eighty-one full papers were presented in total from not only academic but also industrial sides by researchers, professors, and students. This symposium aimed to offer the graduate students opportunities of making presentation in English, and following to this intension, more than half papers were presented by graduate students.

2. Outline of Symposium

2.1 Timetable

Table 3 indicates the symposium schedule including the social events of the banquet and the technical tour. The program committee assigned each paper to each session, in other words, presenters could not decide the presentation way. Each session has not been classified to any specific theme.

Table 1. Number of participants of KJ2009 symposium based on preliminary count in the evening of the first day.

	JK2007	KJ2009	
		Regular	Student
Participants	136	56	38
		94	

Table 2. Number of presented papers in KJ2009 symposium.

	JK2007	KJ2009	
		Japan	Korea
Oral	58	11	11
Poster	42	28	31
Total	100	81	

Table 3. Schedule.

Date		Schedule	
Nov.05	12:00-18:00	Registration	
	13:00-13:15	Opening Ceremony	
	13:15-14:45	Invited Lectures (3 papers)	
	15:00-16:40	Oral A (5 papers)	Oral B (5 papers)
	17:00-18:10	Poster I (26 papers)	
	18:30-20:30	Banquet	
Nov. 06	8:40-10:00	Poster II (40 papers)	
	10:20-12:00	Oral C (5 papers)	Oral D (5 papers)
	12:00-12:30	Closing Remark	
	14:00-18:00	Technical Tour (Korea Electrotechnology Research Institute)	

2.2 Invited Lecture

The following three invited lectures were given by the guest speakers from China, Japan, and Korea.

A) "Research of outdoor insulation of EHV and UHV transmission line in China," Prof. Zhicheng Guan (Tsinghua University, China)
B) "University Activities in Power Apparatus Technology," Prof. Hiroaki Toda (Kyushu Institute of Technology, Japan)
C) "Experience of R&D on the 765kV Double Circuit Transmission System," Prof. Jeong-Boo Kim (Joongbu University, Korea)

2.3 BPPA

In JK symposium, Best Presentation Paper Award (BPPA) is presented to the author of a high-quality paper written primarily by a young researcher including a student. The following 9 papers were awarded in KJ2009.

(1) “Surface Discharge Characteristics in Different Media,” by Eun-Hyeok Choi (Kwang Sik Lee Lab., Yeungnam Univ., Korea)
(2) “Development of the On-line iPDM System for the PD Diagnosis for 25.8 kV C-GIS,” by Taesuj Choi (Hyosung Corporation, Korea)
(3) “Development and Type Tests of HVDC +-250kV MI Submarine Cable System,” by Tae-ho Lee (LS Cable Ltd., Korea)
(4) “Discharge Characteristics of AC PDP with Cross-bar Electrode in High Xe Partial Pressure,” by Hyung-Woo Nam (Chung-Hoo Park Lab., Pusan National Univ., Korea)
(5) “Discharge Propagation on Barrier in Dry Air” by Y. Oida (Hidaka Lab., The Univ. of Tokyo, Japan)
(6) “Location of Partial Discharge at Joint Section of CV Cable Using Acoustic Emission Technique”, by K. Sakamoto (Otsubo Lab., Miyazaki Univ., Japan)
(7) “Corona Inception Electric Field of Arcing Horn Model by Electric Field Calculation Based on 2D and 3D Models,” by H. Shirai (Hikita Lab., Kyushu Institute of Technology, Japan)
(8) “Breakdown Characteristics of CF3I on Dielectric Surface,” by T. Takeda (Hidaka Lab., The Univ. of Tokyo, Japan)
(9) “Preparation and Fundamental Investigation of characteristics of Silicon Rubber Nano-composite of Outdoor Insulation,” by M. Higashikoji (Hikita Lab., Kyushu Institute of Technology, Japan)

2.4 Summary

This symposium is intended to encourage the young researchers in the field of electrical discharges by providing opportunities to make presentations. Not a few participants made their first presentation in English, and seemed to get valuable experiences.

Figure 1. Prof. Toda at the invited lecture.

Figure 2. Participants in oral session.

Figure 3. Best paper presentation announced in closing ceremony.

By **Dr. Akiko Kumada**
The University of Tokyo, Japan

International Conference on Electrical Engineering (ICEE 2010 Busan, Korea)

Prof. Seung-Jae Lee, Myongji University, Korea

1. Preface

The 16th International Conference on Electrical Engineering (ICEE 2010) was successfully held from July 11th to 14th at the Paradise Hotel in Busan, the city of international tourism in Korea.

Since its 1st conference was held in Korea in 1995, ICEE has been hosted by Korea, Hong Kong, Japan and China in turns on annual basis, and has steadily expanded. ICEE2010, under the main theme of "The Smart & The Green in Electrical Engineering", was constituted with a welcoming reception, an opening ceremony, keynote speeches, technical sessions, a tour and a banquet in turns. At the conference, around 500 researchers from 10 countries participated and 419 outstanding research results were presented. The Organizing Committee of ICEE 2010 provided an opportunity to share each others' knowledge and experiences through the keynote speeches by representatives of 4 countries. The committee also hosted the Industry Special Session for the first time to promote active participation of the industry. During the history session, the participants could look back ICEE's history and development during the last 16 years and shared a meaningful time to discuss directions for the future. In addition, the represent- atives came to an agreement to publish ICEE Journals from 2011 at the representative meeting, which made this ICEE into a landmark in the 16 years history of ICEE. Thanks to the agreement, ICEE could step forward to be the ICEE of Asia, just like IEEE in North America and CIGRE in Europe.

2. ICEE2010's Statistics and Programs

Please see the tables shown below.

1) Full Paper Submission Status

Country	No. of Papers	Country	No. of Papers
Australia	2	Japan	155
China	32	Korea	194
Germany	1	Taiwan	1
Hong Kong	12	Thailand	11
India	3	United Kingdom	2
Iran	6	Vietnam	1
419 Papers from 12 Countries			

2) Registration Status

Country	No. of Participants	Country	No. of Participants
Australia	1	Japan	201
China	36	Korea	234
Germany	1	Taiwan	1
Hong Kong	14	Thailand	10
India	3	United Kingdom	2
Iran	3		
506 Participants from 11 Countries			

3) Welcoming Reception

The welcoming reception, commenced on July 10th (Sun) at 6 p.m., was the beginning of ICEE 2010. Mr. Jong-Keun Park, the chairman of the conference, started the reception with his welcoming speech. Experts from around the world congratulated the successful hosting of ICEE 2010 and enjoyed their first encounters and reunions.

4) Opening Ceremony

The opening ceremony was commenced on July 12th (Mon) at 9 a.m. under the presiding of Mr. Seung-Jae Lee. Representatives of each country (KIEE: President Jong-Keun Park, IEEJ: President Takashi Fujimoto, CSEE: President Yanchang Lu, HKIE: Vice President Fuk Cheung Chan) gave welcoming speeches. In addition, an appreciation plaque ceremony was held to show appreciation for the founders of ICEE (Mr. Fumio Arakawa, Mr. Hasegawa Jun, Mr. Otto Poon, Mr. Jae Pong Jeon)

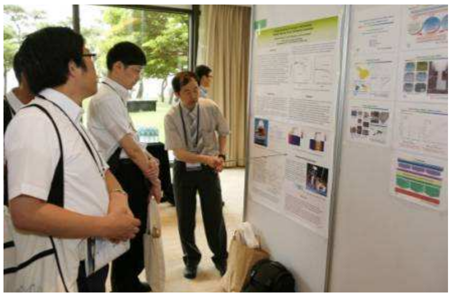
5) Keynote Speeches

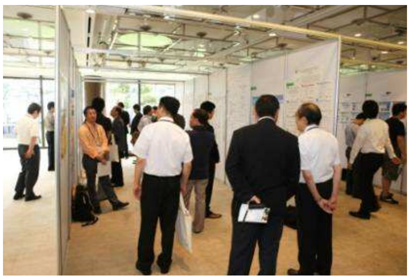
Renowned experts representing IEE of each county were invited to the keynote speeches. The experts gave representative lectures to grasp the latest research trends and to contribute for the future strategy regarding new technologies and industry creation.

Speaker	Speech Title
Mr. Moon-Duk Kim	Green Growth in Electricity
Dr. Shunji Yamamoto	Continuing Progress Our Electric Power Machinery Toward a Next Generation and the Enlarged Application
Prof. Jianhua Wang	The Intelligent Electrical Equipment for Smart Grid
Prof. C. C. Chan	Electric Vehicles and Smart Grid Development Roadmap

6) Technical Sessions

The presentation, commenced on July 12th at 1:30 p.m., was constituted with 3 special sessions, 35 oral sessions and 6 poster sessions; in overall, 167 oral presentations and 252 poster presentations. During the history session, held as the special session, participants enjoyed a chance to look back the history of ICEE and to discuss the development directions for the future. Thanks to the great interest of the participants, the smart grid and EMTP special sessions were successfully held and numerous questions and discussions were made under each theme.




7) Technical Tour

It was planned to visit Kori Nuclear Power Plant and Haedong Yongkung Temple on July 13th in the afternoon with all participants wearing souvenir T-shirt. However the participants made a trip only to Kori Nuclear Power Plant due to rain. The participants felt sorry, but it was a meaningful tour that introduced the current status and future of the nuclear energy.

8) Banquet

The banquet was held on July 14th at 6 p.m. at the Grand Ballroom of Paradise Busan with 300 participants all wearing souvenir T-shirts. The representatives of each country and Mr. Ja-Hong Koo, the president of the LS Group also gave congratulatory speeches to celebrate the successful hosting of ICEE 2010. At the dinner, the organizing committee of ICEE 2010 announced the plan of ICEE Journal publication and asked for interest and participation. In addition, a promotional event was prepared to promote the upcoming ICEE 2011 in Hong Kong, and Mr. Jong-Keun Park, the president of KIEE, handed over the flag to the vice president of HKIE. After the dinner, a B-boy performance, which made the night unforgettable with the dynamic moves and strong beat.

9) Representative Meeting

The representative meeting was held on July 12th at 5 p.m. at Nurimaru Conference Room to discuss sustainable and systematic development of ICEE 2010. At the meeting, the representatives agreed to publish ICEE Journal from January 2011 onwards which turned the meeting into a historical moment and made the future of ICEE 2010 more concrete. The venue Nurimaru on the scenic island Dongbaik enabled the representatives to enjoy nice photo time and to socialize in amicable atmosphere.

Reported by: **Prof. Seung-Jae Lee (Chairman of the Organizing Committee)**
Myongji University, Korea

International Conference on Condition Monitoring and Diagnosis 2010 (CMD2010)

Toshihiro Takahashi
Central Research Institute of Electric Power Industry, Japan

The Institute of Electrical Engineers of Japan (IEEJ) has successfully held the International Conference on Condition Monitoring and Diagnosis 2010 (CMD2010) on September 6 - 11 in Toyosu campus of Shibaura Institute of Technology, Tokyo, Japan with 374 participants from 31 countries and areas and 308 papers including plenary lectures. The conference was technically co-sponsored by IEEE-DEIS, CIGRE, CES, KIEE, and KIEEME.

The CMD2010 covered many issues surrounding the electric power apparatus, such as condition monitoring and diagnosis, failure phenomena based on physical and chemical aspects, material sciences, financial and economic aspects like asset management techniques, and degradation by radiation, sun shine, and salty wind. Therefore, not only the researchers in universities and companies related to these fields but also the person related to operation of the power apparatus were welcome to attend and contribute the conference.

After the opening address by Prof. Hitoshi Okubo of Nagoya University, chair of the organizing committee of CMD2010, on Sep. 7, three plenary lectures were followed. Firstly, Prof. Ernst Gockenbach of Leibniz Universität Hannover, Germany, gave his plenary lecture entitled with “Condition Monitoring and Diagnosis for Reliable Power Transmission and Distribution”, having state-of-the-art information around the CMD technology. Then, Dr. Ashok Sundaram of EPRI, USA, talked about “Enabling Asset Management with the Smart Grid” instead of Mr. Mark McGranaghan of EPRI. The lecture was filled with the latest information of the smart grid technology mainly in USA. Finally, Mr. Hiroshi Yamaguchi of The Tokyo Electric Power Co., Inc., Japan, made his plenary talk about “Condition Monitoring and Diagnosis for Aged Power Apparatus in Japan” with the CMD technology in Japan where the electricity plays quite important role in human activity. All the plenary lectures gathered attendees’ interest, thus the lecture hall was full of the audience. After the plenary talks, Prof. Dae-Hee Park of Wonkwang University, Korea, delivered his talk entitled with “Recent Activities Related to CMD in Korea and the Contribution of the late Prof. Kyu-Bock Cho” as a memorial lecture honoring Prof. Kyu-Bock Cho who was the chair of the first CMD held on 2006 in Changwon, Korea.

The plenary talks were followed by 24 oral sessions and 2 poster sessions. 143 and 161 papers were listed on the oral and poster sessions, respectively. The detail of the paper number per objective power apparatus is shown in Table 1. As can be seen in Table 1, nearly one third of the papers were related to transformers, which can be said that issues around transformers are the most interested subject of recent years. 3 oral sessions were held parallel, and the two poster sessions were held in the evening of Sep. 7 and 8, respectively, independent from any oral sessions. All the oral sessions were filled with many audience and hot discussions even on the last day. Both poster sessions also gathered many audience and discussions in every parts of the session site.

On ahead of the opening of CMD2010, tutorials were held on Sep. 6 with 8 courses, having their themes of GIS, transformers, cables, and rotating machines, each of them with English and Japanese. More than 240 persons had hung on the words of lecturers who were specialists of the respective fields.

23 companies related to the CMD technology had made their exhibition booths on the conference. All the companies exhibited their state-of-the-art CMD apparatus, techniques and so on with real apparatus by their specialists. All the attendees had been fascinated with their technology.

Short tours were held on Sep. 7 AM and PM, for the Shin-Toyosu underground substation, which is the world first 500 kV underground substation located near from the conference venue. All the attendees for the short tours were fascinated with the sophisticated underground substation.

Two technical tours were held on Sep. 9 PM. One course was for the Electric Power Historical Museum & Asakusa Kannon Temple, the other was for the Yokohama Thermal Power Station & Asakusa Kannon Temple. Attendees of the both technical tours had interested in the historical and the state-of-the-art power apparatus and Japanese historical culture with one of the oldest temple “Senso-Ji” and its surrounding town having many souvenirs, Japanese fast food, and so forth.

The banquet following the two technical tours was held at Meguro Gajoen, having some gorgeous Japanese gardens and precious artistic handicraft articles. Meguro Gajoen is one of the traditional hotels in Tokyo, established in 1930’s. Its interior is full of arts, its walls and ceilings are tastefully decorated with beautiful pictures of flowers and birds, which impressed all the attendees and invited the some courtly time.

Finally, we would like to deeply thank all of the participants from all over the world, and members of the organizing committee and the sub-committees for their effort to realize this symposium. We also express sincere appreciation to all the supporting members of this symposium for their tremendous contributions, and financial support by Commemorative Organization for the Japan World Exposition '70.

The next CMD will be held in Bali, Indonesia, in 2012. We wish not only all the participants but also the researchers who could not attend this CMD will come to Bali with the harvest of coming two years.

Dr. Toshihiro Takahashi
(Assistant Secretary of CMD 2010)
E-mail: tosihiro@criepi.denken.or.jp

Participants in CMD2010

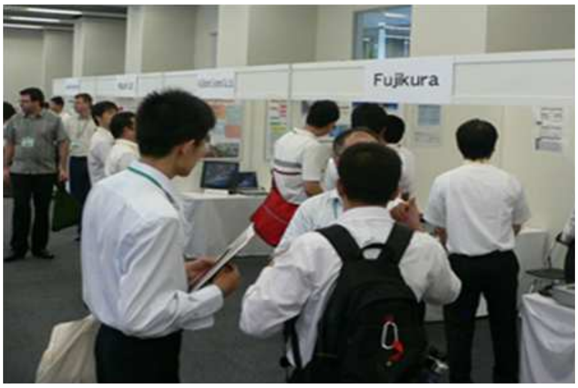
Prof. Hitoshi Okubo
at the opening address

Prof. Ernst Gockenbach
at his plenary talk

Dr. Ashok Sundaram
at his plenary talk

Mr. Hiroshi Yamaguchi
at his plenary talk

Prof. Dae-Hee Park
at a memorial lecture honoring
Prof. Kyu-Bock Cho



Information exchange at the exhibition

Discussion at a poster session

Presentation at an oral session

"Kagami-wari", traditional ceremony of opening of the banquet

Number of attendees by country

Country	attendees	Country	attendees
Japan	205	Russian Federation	3
Korea	29	Singapore	3
China	25	United States	3
Germany	17	Egypt	2
Canada	14	Hong Kong	2
Indonesia	8	India	2
Australia	7	Romania	2
Austria	7	United Kingdom	2
France	7	Greece	1
Netherlands	6	Hungary	1
Sweden	5	Iran	1
Italy	4	Malaysia	1
Switzerland	4	New Zealand	1
Thailand	4	Slovenia	1
Brazil	3	Taiwan	1
Czech Republic	3	Total	374

Number of papers by object apparatus

Object apparatus	Paper number
Transformer	112
Cable	50
Switchgears	31
Rotating machines	24
Overhead transmission lines	17
Common techniques	17
Optical sensor	12
Outdoor insulation	11
Arresters/Power capacitors/Others	9
New developments in asset management	8
Insulating materials	7
PD diagnostic methods	6
Total	304

International Conferences to be held in Asia

ISEIM 2011 (International Symposium on Electrical Insulating Materials)

Dates: September 6-11, 2011
Venue: Kanbaikan, Doshisha Univ., Kyoto, Japan
Chairman: Prof. Masayuki Nagao
(Toyohashi University of Technology)

ISEIM2011 targets issues on the physical, chemical and practical aspects on the dielectrics, electrical conduction and breakdown in dielectrics, not only in solid dielectrics but also liquid and gas dielectrics. ISEIM2011 will provide you an important chance to discuss above topics with a lot of researchers gathering from all around the world. It is sponsored by Technical Committee on Dielectrics and Electrical Insulation, IEEJ and technically co-sponsored by IEEE Dielectrics and Electrical Insulation Society and CIGRE SCs D1 and A2.

The conference venue, Kyoto-city, is located mid-west of Japan, well-known as an ancient Japanese capital city with a 1200-year history. Since its open in AD 794, Kyoto has been always one of the centers of Japanese politics and culture. Thus, Kyoto has been maintaining historical architecture such as shrines and Buddhist temples, gardens, town and natural scenery, and so forth. All of you will feel heartwarming hospitality and the real Japan.

Key dates:
Abstract Submission: January 31, 2011
Acceptance Notification of Abstract: Middle of March, 2011
Manuscript Submission: May 30, 2011

Secretariat:
Dr. Toshihiro Takahashi and Dr. Norikazu Fuse
C/o Electric Power Engineering Research Laboratory,
Central Institute of Electric Power Industry (CRIEPI)
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Email: iseim2011@freeml.com
URL: http://www2.iee.or.jp/~adei/ISEIM2011/

ICEE 2011 (International Conference on Electrical Engineering)

Dates: July 10-14, 2011
Venue: Harbour Grand Kowloon, Hong Kong
Organized by HKIE
Co-organized by CSEE, IEEJ, KIEE

The International Conference on Electrical Engineering (ICEE) aims to be a premium forum for sharing information, creative ideas, expert knowledge and experience among electrical engineers of the world. Since 1995, ICEE has been successfully held once a year. The Hong Kong Institution of Engineers (HKIE) is pleased to announce ICEE 2011 will be held at the Harbour Grand Kowloon Hotel from 10 to 14 July 2011. The theme of the ICEE 2011 is "Towards Smart & Low-Carbon Electrical Engineering". It is a great pleasure for the HKIE, together with co-organisers, The Chinese Society of Electrical Engineering (CSEE), The Institute of Electrical Engineers of Japan (IEEJ) and The Korean Institute of Electrical Engineers (KIEE), to invite potential authors to submit quality papers to be referred in the following areas: power systems, energy and environment, electric traction systems, power electronics, motor drives & industrial applications, fundamentals, materials & education and other related areas.

Key dates:
Abstract Submission: December 31, 2010
Acceptance Notification of Abstract: February 1, 2011
Full Paper Submission: April 1, 2011
Acceptance Notifications of paper: May 3, 2011

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E-mail: conf3@hkie.org.hk
URL: www.icee-con.org

CMD2012 (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.)
Organized by ?
Co-organized by Bandung Inst. of Tech. and Udayana University, Bali

Key dates:
Abstract Submission: February, 2012
Acceptance Notification of Abstract: April, 2012
Manuscript Submission: June, 2012

Activities of Laboratories

Research in High Voltage and Electrical Insulation Laboratory at Tianjin University

B.X. Du, Y. Gao and Y. Liu

High Voltage and Electrical Insulation Laboratory

School of Electrical Engineering and Automation, Tianjin University, Tianjin, 300072, China

1. Introduction

High Voltage and Electrical Insulation Laboratory (HVEIL) at Tianjin University was founded originally to serve as a test site for college students of the department of electrical engineering who wanted to learn knowledge about high voltage test skills for power equipment. In 1990s', the HVEIL was open to scientific research and some of the hot topics, such as partial discharge measurement for high voltage transformer, were immediately involved at that time. The development of the HVEIL became even faster after the year 2002 in which Prof. Du joined in the laboratory and served as a leader. With the active work of Prof. Du and our staffs, we have developed scientific researches in many fields, including tracking behavior of polymer insulating materials, condition monitoring and diagnosis for power equipment, plasma discharge and its application, etc. Our work covers the fundamental study for insulating material and also the industry application to local power system in China. Over 220 scientific papers have been published by our staffs both in Journals and Conference Proceedings, which earns us a worldwide academic reputation and encourages us to further discover the unknown firmly.

At present, we have one full professor, one associate professor, two lecturers and three engineers in the HVEIL. Three Ph. D. candidates and eighteen postgraduate students are pursuing their degrees here, and more than twenty undergraduate students work in the laboratory for their Bachelor Degree Thesis every year. Our research projects have attracted over 2 million RMB as financial support from Chinese government, ministry of education and companies, and we would like to show the research activities in the HVEIL in the following sections.

Figure 1: A picture from Prof. Du's Laboratory

2. Research Activities in the HVEIL

In the HVEIL, two main issues are currently performed, namely tracking behavior of polymer insulating material and condition monitoring and diagnosis for power equipment. A brief introduction of the research progress will be shown below in detail.

A. Tracking Behavior of Polymer Insulating Materials

Polymer insulating materials have been widely used in electrical and electronic industry for over 50 years. The safe use of the material is very important for the reliability of the electrical and electronic devices. One particular phenomenon that occurs on the surface of polymer is tracking failure. The tracking is essentially a surface breakdown phenomenon which is characterized by the formation of carbonized conductive path that bridges the electrodes. This is considered as an important reason for short-circuit and even fire of the polymers. With the purpose of understanding the tracking behavior clearly, systematic works have been carried out since 1990s'. The influence of concerned factors, such as ambient temperature, pressure, additives, waveform of applied voltage and frequency, on the tracking behavior has been investigated, and the results obtained containing valuable information for understanding the nature of

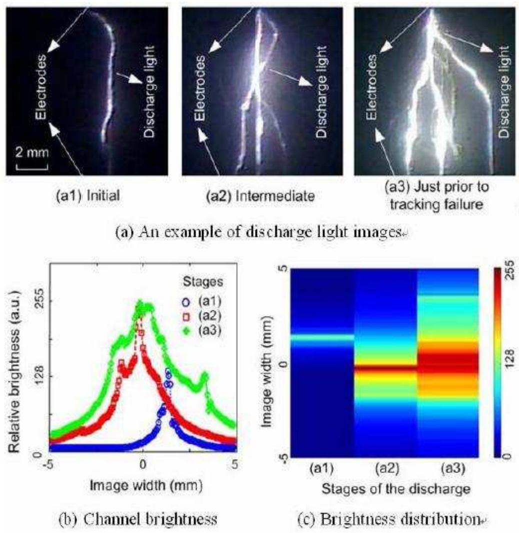

Figure 2: A discharge light distribution based method to feature the tracking failure

tracking phenomenon have been published both in IEEE Transactions and Conference Proceedings.

Recently, we start to focus on the radiation effect on the tracking behavior of polymers. Radiation environment can be found in nuclear power stations, space equipment and scientific facility. A highly energetic radiation ray, for example gamma-ray, can have a significant influence on the ageing process of insulating material, and thereby influence the safe use of the equipment. We have set up a test system to investigate the tracking behavior of gamma-ray irradiated polymers, including polyethylene, epoxy resin and polybutylene polymers. It has been preliminarily concluded that a cross-linking type material is more sustained in the resistance to tracking than a degradation type material after gamma-ray irradiation. This information may help to choose the proper material used as insulation in radioactive environment. Moreover, we currently adopt epoxy based nano-composite as test sample to study the tracking behavior so as to find a new way to improve the resistance to tracking for polymer by nano-particle doping.

Besides the tracking phenomenon, we are also interested in another attractive and important phenomenon-surface charging and charge decay. The surface charge accumulation has been found a critical problem that rules the withstand voltage of the insulation surface. A considerable number of researchers have engaged in the work of clarifying the mechanisms of surface charging and charge decay, and it is generally established that surface charge dynamics is deeply related to the characteristics of localized surface states and is influenced by surface property, permittivity, surface as well as bulk resistivity, temperature, relative humidity and so on. The very issue we concerned is the radiation effect on surface charge dynamics of insulating polymers, and we have found that the charge behavior for both polyethylene and epoxy resin is evidently changed as the material is exposed to gamma-ray irradiation. We are now trying to reveal the mechanism for the results obtained, and such information will be helpful in determining the safe use of polymer in radiation environment.

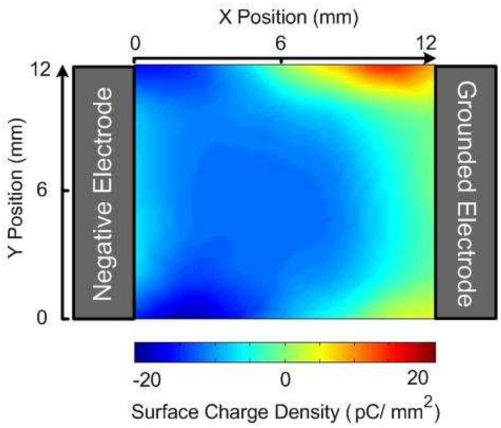

Figure 3: Surface charge image of polyethylene after charging by negative bias voltage (obtained in the HVEIL by using a self-designed electrostatic probe).

Those works introduced in this section is financially supported by National Nature Science Foundation of China, Doctoral Fund of Ministry of Education of China and Young Scholar Foundation of Tianjin University.

B. Condition Monitoring and Diagnosis for Power Equipment

Ageing of insulating material acts as a decisive factor that influences the life-time of power equipment. Knowing the insulation status is a key point for understanding how risky the equipment is. A traditional method for getting insulation status of power equipment is often off-line and periodical test based. Such method is likely to send information deficient to make a decision that if the insulation is in danger or not, because the information is of course less accurate comparing with that obtained from on-line test which can reflect the real manner of insulation when it is in real operation. On-line measurement of insulation status then becomes the state of the art and condition monitoring and diagnosis (CMD) is likely to play a dominant role in power management system in the future.

Figure 4: Devices for research of partial discharge measurement for XLPE power cable.

We noticed that the CMD would facilitate to know insulation status of power equipment in early 1990s', and the interesting topic we concerned was partial discharge detection. By developing very high frequency sensors, ultra-acoustic sensor and optical sensor, we successfully captured partial discharge signal in the HVEIL by employing insulation models that are extracted from high voltage transformer and XLPE cable. We also make efforts to develop new methods based on wavelet analysis to separate the real partial discharge signal from the data measured. Currently, we are trying to put the above ideas into real industry application. For instance, with the help of Tianjin Electric Power Corporation, we are establishing an on-line partial discharge monitoring system for a 220 kV XLPE cable route located in Tianjin Binhai New Area by using both high frequency current transformer and capacitive coupler sensor assembled at the cable accessories. Such a monitoring system may benefit from the sensor arrangement so that the location of partial discharge is feasible.

For supporting the CMD research work, we have carried out a series of fundamental investigations in order to gain a good understanding of the ageing mechanism of

Figure 5: PD detecting sensor assembling and laboratory PD test for 110 kV XLPE cable (supported by Tianjin Electric Power Corporation).

polymer insulating materials. What we have concerned with includes electrical treeing as well as water treeing phenomenon, space charge measurement technique and its application in detecting space charge within real XLPE cable, interface breakdown behavior occurred at cable joint between XLPE and silicone rubber, effect of cross-linking byproducts on the insulation performance of XLPE.

Furthermore, we engage in the work of leakage current measurement and analysis by using a novel data processing method called “recurrent plot”. This method is proved to be available for identifying the process of surface discharge on outdoor insulator. It will provide useful information for estimating the insulation status of outdoor SIR insulator.

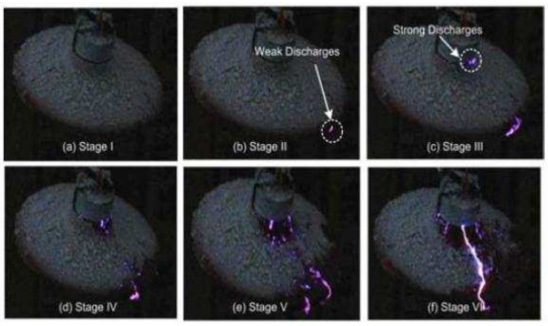

Figure 6: Monitoring on process of rime-ice flashover of outdoor SIR insulator.

The researches presented in this section are mainly supported in finance by local electric power corporation in China, and we find that such cooperation between the HVEIL and the company can benefit both the participants.

3. Academic Exchange and Cooperation

With the financial support of the HVEIL, we have frequent international academic exchanges and cooperation. We have sent our staffs to attend international conference and symposiums, such as CEIDP, ICSD, CMD, ICPADM, etc. We have also invited active researchers to visit us and make academic exchange. We are pleased to share the experience and facility in the HVEIL with researchers in the community of electrical engineering, high voltage/electrical insulation and applied physics, and we sincerely invite specialists from all over the world to visit the HVEIL and make cooperation together.

4. Acknowledgement

The authors wish to thank Prof. Toshikatsu Tanaka, Waseda University, for kindly offering the opportunity to us to introduce the research progress in the HVEIL at Tianjin University.

5. Biography

Prof. B. X. Du received the M.E. degree in electrical engineering from Ibaraki University in 1993 and Ph.D. degree from Tokyo University of Agriculture and Technology in 1996. He was with Niigata College of Technology, Japan and was an Associated Professor. Now, he is a Professor at the Department of Electrical Engineering, School of Electrical Engineering and Automation, Tianjin University, China. His main research interests are dielectric failure mechanisms of polymer insulating materials, electrical insulation technology and partial discharge measurements. He is a member of IEEJ, senior member of IEEE and CSEE.

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China Corner

Recent Progress in Electrical Insulation of Wind Generator in China

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1. Overall

1.1 Development and Forecast of Wind Power in China

Wind energy, as an alternative to fossil fuels, is plentiful, renewable, widely distributed, clean, and pro-duces no greenhouse gas emissions during operation. The abundant inland and offshore wind energy resources provide China with potential for large-capacity, in-grid wind farms. Large-scale wind farms are connected to the electric power transmission network; smaller facilities are used to provide electricity to isolated locations [1].

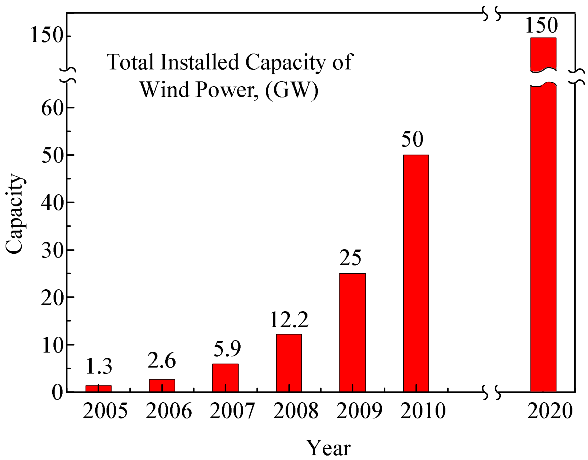

Fig. 1 Total installed capacity of wind power in China from 2005 to 2009, and the predicted total installed capacity in 2010 and 2020 are 30 GW and 150 GW, respectively.

As shown in Fig. 1, wind power in China develops very fast from 2005, and the total installed capacity has reached 25 GW in 2009. It is predicted that the total installed capacity will be 30 GW in 2010 and 150 GW in 2020, which would complete the plan that raise the total installed capacity of wind power to 30 GW, which is set by National Development and Reform Commission in "Medium and Long-Term Development Plan for Renewable Energy in China" [2-4].

Table 1. Energy Structure of China in 2009

Energy Category	New Installed Capacity of 2009 (GW)	Total Installed Capacity Until 2009 (GW)	Total Generating Capacity of 2009 (billion kWh)
Thermal Power	60.76	652.05	2986.7
Hydropower	19.89	196.79	512.7
Wind Power	8.97	16.13	26.9
Nuclear Power	--	9.08	70.0
Total	89.70	874.07	3596.5

The data in table 1 refer to the Grid-connected installed capacity. Although the wind power develops very fast, there is a big gap between the current status and the target that raise the share of renewable energy in total primary energy consumption to 15 percent in 2020.

1.2 Wind Power Demonstration Project

Shanghai Donghai Bridge offshore wind power demonstration project was completed on July 6, 2010, and started to supply clean energy to Shanghai city [5, 6].

As shown in Table 2, the wind farm established 34 homemade 3 MW wind turbines, with a total installed capacity of 102,000 kW, the annual power generation capacity of 267 GWh, which is the first time to install independent research and development of 3 MW offshore-type units that marks the high-power wind turbine equipment of China among the world's most advanced manufacturing.

Furthermore, the East China Sea Bridge wind farm Phase II (100,000 kilowatts level) preliminary work has been approved by the relevant departments.

Table 2. Relevant parameters of the East China Sea Bridge wind farm

Total number of wind turbine generators	34
Total Capacity (MW)	102
Electricity generation hours per year (h)	2624
Electricity provided to the grid per year (GWh)	267

1.3 Three National Research and Design (R&D) Centers of Wind Power

China's National Energy Administration has formally approved 38 energy R&D centers in the last two years, in which have 5 R&D centers on wind power that are National Energy Offshore Wind Power Technology and Equipment R&D Center, National Energy Large-scale wind power Grid Connected System R&D Center, National Energy Research and Development (experimental) Center of Wind Turbine Blades, National Energy Wind turbine R&D center, and National Energy R&D center of Wind Power Operations [7, 8].

These R&D centers are of great significance in establishing China's energy and technology support system, meeting national and strategic needs for innovative energy structure optimization and upgrading and satisfying market demand for energy technology and equipment.

2. Developments of Electrical Insulation Technology of Wind Generator

Wind turbines are used to tap the potential of wind energy, which is available in millions of MW. Reliability of wind turbine is critical to extract this maximum amount of energy from the wind. Considering the complex and diverse operating conditions in China, such as very low or high temperatures, alternating hot and cold temperatures, high humidity, salt spray, dust, high altitude, low wind speed and coastal areas, we need to design and produce a broad range of wind generators which can be installed in diverse climates and work efficiently in operating conditions. These harsh environments require high reliable wind generators, which put forward very strict requirements for the insulation systems [9], such as the insulation of stator windings, collecting ring and brush unit, and cable. The strategic points of the insulation systems are able to work at the harsh environments.

The towers of the wind generators are very high, some of which are more than 100 m, and are usually the highest object in its area, so it is very easier for them to be stroke by the lighting. Therefore, much more attentions should be paid to the lighting stroke and overvoltage protection.

2.1 Stator Windings

The wind turbines operate at the special geographic environments, such as, Gobi, grassland, and seaside, which have special requirements on insulation system and materials. A lot of research and design have been done on this field.

Firstly, the wind turbine insulation system consisted of solvent-free polyesterimide impregnating resin, mica tape with polyester and molten polyimide lapped magnetic wire was studied and the results showed that the insulation system had lower dielectric dissipation factor (better than the excellence goods performance indicators), good salt spray resistance and high and low temperature insulation performance (reach the excellent level), high breakdown voltage (average voltage, 24.4 kV). It was said that the insulation system was one of the best insulation systems with excellent insulation properties [10-12].

Secondly, a kind of surface insulating coating with a base material of high molecular weight epoxy resin used in wind turbine generators was developed, which demonstrated that the coating exhibited better electrical insulation properties when certain high molecular weight epoxy resin was used as the base material. Its volume resistivity achieved 9.6×10^{13} Ω·m, electric strength was 67 MV/ m and arc- resistance was 127 s. The salt spray resistance was improved to 1000 h when using mica powder and aluminum triphosphate as pigments and fillers, and the wear resistance could reach 0.037 g when choosing an elastic curing agent modified by polyether, which meant that the surface insulating coating reached the same level of international product [13].

Thirdly, a kind of heat temperature epoxy resin glass fiber cloth laminated sheet was manufactured, and it had excellent high thermal endurance, machine performance and electrical properties, which reached the same level of class H epoxy resin glass fiber laminated sheet that is manufactured by an Europe company [14].

2.2 Collecting Ring and Brush Unit

Insulation is the key technology of collecting ring and brush unit, which need the properties of high dielectric performance, low leakage current, good corona resistance at high voltage, stand high and low temperature, and enough mechanical strength and so forth according to the harsh operating environment of wind turbine generators [15-18].

However, the insulation materials of the original collecting ring and brush unit in the wind generators produced by Chinese factories are phenolic pressure plastic, epoxy fabric laminates, or film mica plate, and the fit between conducting rod and conducting ring is clearance fit, which have a lot of shortcomings, such as, partial discharges, even arcs in the contact gap that lead to the aging or breakdown of the insulation materials, toner scattered and deposited on the insulation among the phases, causing short circuit of wind generators.

Table 4. Comparisons of the original collecting ring and brush unit and the improved collecting ring and brush unit in China

	Original collecting ring and brush unit	Improved collecting ring and brush unit
Insulation structure	Clearance fit between conducting rod and conducting ring	Slip fit between conducting rod and conducting ring, adding insulation sleeve
Insulation material	Phenolic pressure plastic, epoxy fabric laminates, film mica plate	Composite insulation of mica tape and glass cloth

As shown in table 4, plenty of researches have been done to improve the performance of collecting ring and brush unit, for example, composite insulation of mica tape and glass cloth was used to increase the dielectric properties and reduce the costs, clearance fit was changed to slip fit by coated the relevant components with dielectric materials or added insulation sleeve inside the collecting ring. Therefore, the improved collecting ring and brush unit are suitable for high speed and long life wind generators and can be used in the harsh environment with high humidity, very high or low temperature and lighting, etc.

2.3 Power Cable

The original wind turbine generator power cables are composed of single hard thick copper wire and traditional rubber-like insulation and sheath, which have a good heat resisting property. As the diameter of the copper conductor is very large, it is difficult to bend and install the cable, and the mechanical and tearing strength of the traditional rubber-like materials are very low, so the insulation and sheath layer are easy to crack.

The improved cables adopt the soft brass wires or soft tinning brass wires with the diameter of 0.15~0.5 mm intertwisted with each other in the same direction as the conductors, and thermoplastic vulcanizate, silane cross-linking ethylene/propylene rubber, high tear resistant silicone rubber compounds, polyvinyl chloride as the insulation materials, and vulcanizate elastomer, PUR-elastomer compound, polyurethane as the sheath materials. Moreover, many of the improved cables add some new layers, such as strengthening cladding layer and flame retardant layer, to improve the performance that are anti radiation, stand abrasion, seawater corrosion

Table 5. Comparisons of the original cables and the improved cables in China

Components	Original Cable	Improved Cable
Conducting wire	Single hard thick copper wire	Many soft brass wires with the diameter of 0.15~0.5 mm intertwist with each other in the same direction
Insulation layer	Traditional rubber-like materials	Thermoplastic vulcanizate, silane cross-linking ethylene/propylene rubber, high tear resistant silicone rubber compounds, polyvinyl chloride
Sheath layer	Traditional rubber-like materials	Vulcanizate elastomer, PUR-elastomer compound, polyurethane
The others		Strengthening cladding layer, flame retardant layer

resistance, and so on. Besides the general properties of the power cables, such as good high/low temperature resistance, good oil resistant, good corrosion resistance, etc., the improved cables have better mechanical property than the original ones, and they are softer, which make them easier to bend, distort and install, shown in table 5 [19-22].

2.4 Lighting Stroke and Overvoltage Protection

With the increase of the capacity of wind turbines, towers are heightened to obtain more wind energy, which causes the increase of the lightning stroke risk. Wind turbines being repeatedly struck by lightning will increase generator stator insulation deterioration, eventually may cause insulation breakdown incidents [23-26].

Lightning surge on the stator windings of megawatt direct-driven wind turbine generators was analyzed with the surge arresters installed on the terminal of generator and two sides of transformer, which show that the coil-to-core voltage raise when lightning spread to the generators, the voltage distribution along the windings is non-uniform initially, and the highest voltage appears near the neutral. The surge arresters can effectively restrain the lightning overvoltage.

It is more difficult to protect the doubly fed induction wind generators from lighting stroke and overvoltage, for the doubly fed induction wind generators is easier inflected by the induced voltage from lighting stroke. Therefore, a new protection system was developed whose structure was that a surge arrestor and fuse grounded to the earth was connected in series with the stator, and a surge arrestor and fuse linked with a grounded gap arrestor was connected in series with rotor.

In conclusion, although we have made some progress on the technology of insulation in wind turbine generators, we should accelerate our pace to localize at least 70% of the wind turbine generators in the newly-built wind farms [2].

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Korea Corner

765kV Transmission Technology Development in Korea

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1. Introduction

The historic 765kV age began in Korea on May 8, 2003, when operation of 765kV double-circuit transmission lines, the highest voltage in Asia, was started for the first time in the world from Dangjin to Shinansung, 115 years after the first electrical bulb was lit in Korea Kyongbok palace in Seoul.

The opening of the era of 765kV Extra-High Voltage (EHV), which we refer to as the power transmission highway, was a significant event for the Korean power industry in that it represented a major upgrade in technology.

Due to economic development and improvement in living standards around 2003, Korea was showed an annual increase in the demand for electricity of around 8%. Just as highways need to be built for smooth traffic flow, in a small-sized and densely populated country like Korea, the construction of 765kV transmission lines to transmit power from generation plants to end users was imperative.

2. Current Status of 765kV Facilities

2.1 Worldwide 765kV Facilities

Power transmission at the 700kV level began in 1965 when Hydro-Quebec of Canada transmitted 500MW of power generated at the Churchill Falls Hydro Plant to Montreal using a nominal voltage of 735kV and a maximum voltage of 765kV. American Electric Power started transmitting power at a nominal voltage of 765kV and a maximum voltage of 800kV in 1969. Since then, 765kV transmission lines of nominal voltage have been introduced in other areas such as New York (by NYPA), Brazil, Venezuela, and South Africa. In Eastern Europe, Poland and Hungary started to operate of 750kV transmission lines of nominal voltage in the 1970s in order to receive power from the former Union. Recently, China and India also developed 765 kV and 1,000kV transmission lines.

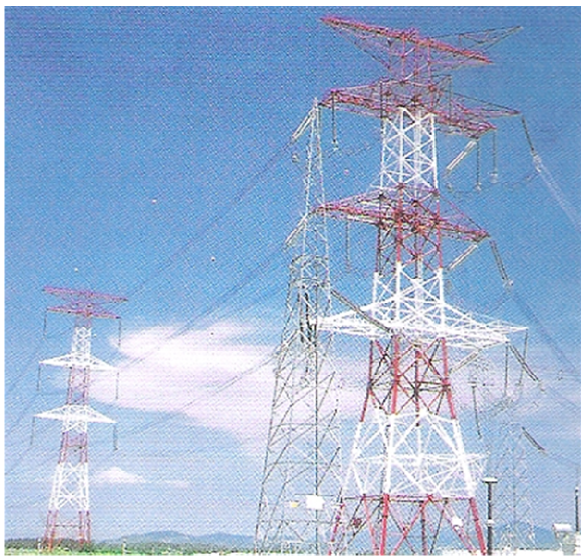
▸Worldwide 765kV Power Transmission

Country	Enhanced voltage (kV)	Year	Transmission Distance(km)
USA	345→765	1969	300
Russia	750→1,150	1985	2,000
Canada	315→735	1965	600
Japan	500→1,000	2000	250
Brazil	375→750	1982	900
South Africa	400→765	1988	440
India	400→765	2000	450
Venezuela	400→765	1984	650
Poland/ Hungary	400→765	1986	114
China	500→750→1,000	2009	640

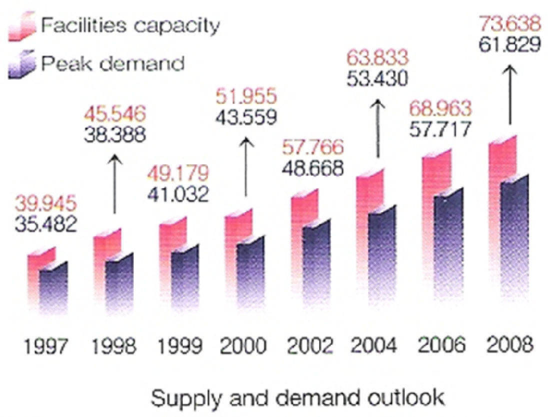
2.2 Reasons for Introducing 765kV Facilities to Korea

Owing to the rapid economic development of Korea, there was a significant yearly increase in the demand for electricity of around 8%. Energy consumption per person was also rised steeply on an annual basis. In Korea, the area with the largest increase in electricity demand is concentrated in the Seoul-Gyeonggi Province region. However, it is difficult to construct a new power plant in this densely populated area. Therefore, bulk transmission lines are required to transport power from Central Korea or Kangwon Province, where large-scale power plants are located, to the Seoul-Gyeonggi area. Accordingly, Korea commenced preparations to upgrade the voltage class to 765kV in 1979, and research and development for 765kV began in 1983. In October 1997 the first 345kV line was energized with 765kV. On May 8, 2003, history was made when 765kV power transmission commenced. 765kV transmission lines in Korea are the first in the world to use vertical double circuit tower types, which have twice the transmission capacity of the horizontal one-circuit types used in other countries.

Around 2003, 765kV transmission lines extending 340km, from Dangjin Thermal Power Plant through Shinseosan to Shinansung (178km), and from Shintaeback to Shingapyung(162km), were completed; and currently, there are plants build more transmission lines,

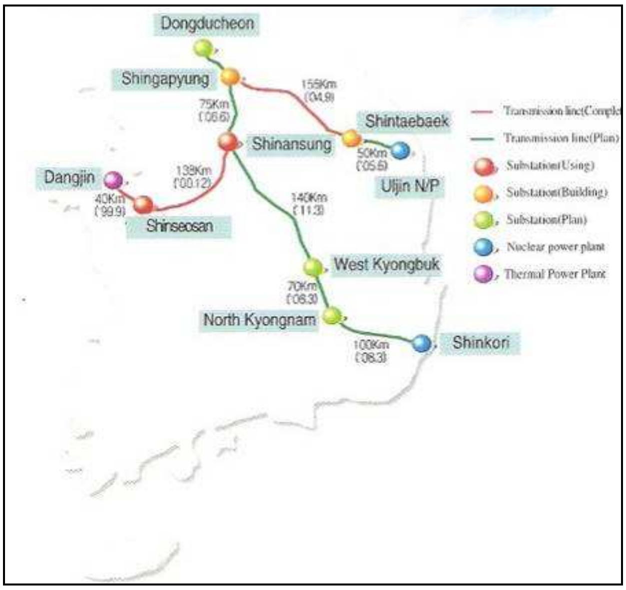


▸765kV Test Line in Gochang KEPCO PT Center



▸**Power demand in Korea**

including a transmission line extending from Shinansung-West Kyongbuk-North Kyongnam-Shinkori Nuclear Plant. Also 765kV single circuit line was completed on July, 2010.



▸**Route of 765kV lines**

2.3 Effects of Upgrading the Voltage of Transmission Lines

- Solves misdistribution problems in the Seoul-Gyeonggi area
- Minimizes land required to build transmission facilities and substations
- Reduce electricity losses
  - Enhances the stability of the power network
- Improves international competitiveness by improving technology in the power industry

3. Advantage of 765kV Transmission System

3.1 Effects of Upgrading the Voltage of Transmission Lines

765kV transmission lines have 5 times the transmission capacity of 345kV lines. This is of great advantage for effectively utilizing land, as it decreases sites for transmission towers and right-of-way.

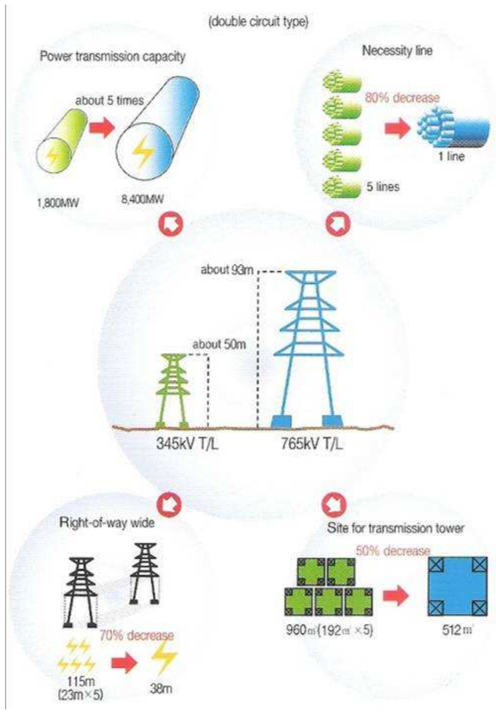
3.2 Minimizes Loss of Power during Transmission

Loss of power during transmission is inversely proportional to the square of the voltage, hence if voltage is raised from 345kV to 765kV, loss of power decrease 20%.

3.3 Saves Constructional Cost

If transmission capacity is taken into consideration, 765kV transmission lines save construction costs per KW by 74% compared to 345kV lines.

Division		**154kV T/L**	**345kV T/L**	**765kV T/L**	
		Double circuit	**Double circuit**	**Double circuit**	**Double circuit**
Transmission capacity		480 MW	1,800 MW	8,400 MW	4,200 MW
Losses		1.2%	0.26%	0.05 %	0.05 %
In terms of Capacity	Number of lines	18	5	1	2
	Site area (m^2)	2,304	960	512	760
Construction cost in terms of transmission capacity			650₩/kW	480₩/kW	



▸**Advantages of 765kV Transmission System**

3.4 Environmental Friendly Design

765kV transmission lines were designed and constructed to be environmentally friendly after extensive experiments, including assessments of audible noise from corona, radio, noise, electric field, magnetic field, and Aeolian noise, using full-size test lines. The Gmax of KEPCO 765kV transmission lines with that of 500kV and 765kV lines of other countries. Gmax functions are an important factor in environmental problems, the lower the Gmax, the less the electrical environment is affected.

4. Facilities for 765kV Transmission

4.1 Conductor

The Power line is the medium that actually transmits electric power. It must have high conductivity, great mechanical strength, low density, and durability. Bare wires are used in 765kV lines because heat is generated, and ACSR (Aluminum Cable Steel Reinforced) is the most commonly used conductor type. ACSR is made by twisting hard-drawn aluminum wires, which have relatively high conductivity (about 61%), around galvanized steel wires, which have high ultimate tensile strength ($125kg/mm^2$). Most electricity flows through the aluminum core and the cross section and resistance of the stranded wire is calculated for the aluminum part only. Compared with hard drawn copper stranded conductors with the same resistance, the outer diameter of the conductor is larger, and is more effective in preventing corona, making ACSR advantageous for high-voltage transmission lines.

After a comprehensive review of RI/TVI, corona noise, transmission capacity, and maintenance of appropriate height level, ACSR $480mm^2$ Cardinal 6 conductor bundle, which is stronger than ACSR $480mm^2$ Rail generally used in 345kV transmission lines, was chosen for the 765kV transmission lines. ACSR/AW conductor was chosen for the Dangjin Thermal Plant, which is closed to the coastline, to prevent wires from corrosion.

Kinds of Conductor	ACSR $480mm^2$ (Cardinal)	ACSR/AW $480mm^2$ (Cardinal)
Composition of conductors	Al 54/3.38 St 7/3.38	Al 54/3.38 St 7/3.38
Calculated diameter	Al 484.53 St 62.81	Al 484.53 St 62.81
Tensile load (kg)	15.300	15.300
Outer diameter (mm)	30.42	30.42
Weight(kg·km)	1.836	1.760
Modulus of elasticity	7.987	7.565
Coefficient of linear expansion($10^6/^oC$)	19.53	20.5

4.2 Insulator

Insulators are used to support insulation between power cables and towers, and it also used to insulate them electrically. An insulator is used outdoors and hence it must have good electrical and mechanical qualities under unfavorable weather conditions such as wind, rain, salt, dust, and snow. It must also have sufficient electric surface resistance while leakage current must be sufficiently low.

Corona discharge should not occur at rated voltage, and insulators must not be damaged or destroyed if arc or corona discharge occurs on the surface.

There are many different types of insulators, such as porcelain, glass and composite. The 765kV transmission lines use porcelain insulators.

4.3 Spacer Damper

765kV lines use multiple sub-conductor types, which have the characteristics of corona reduction and are better for improving line constants. 6 conductor bundle types are used in KEPCO 765kV. In such cases, spacer damper is used to prevent conflict between sub-conductor, maintain distance between sub-conductors, and prevent damage that might be caused to wires by oscillations due to wind and electromagnetic force. Spacer dampers used in 765kV transmission lines were developed in Korea and they are used on all lines.

4.4 Steel Tower

A 765kV steel tower weights over 200 tons and their height ranges from 80 to 150m. If angle type tower is applied to such huge structures, complex components must be used, which is very difficult to construct and repair. Therefore, steel pipe members, which can be applied as a single member, were used as the main member and diagonal member. Angle components were used in only tower arm parts. For the foundations, which must be constructed in rugged mountain areas, reliable deep foundations were used.

4. Researches on 765kV Transmission System

4.1 Air Insulation Test

Air insulation tests were conducted using 4MV outdoor impulse voltage generators to test full size suspension insulators. The results of the tests were used when designing the 765kV steel towers, for determining how many insulators to use and for designing air insulation clearance. They were also used when deciding the design levels of various 765kV devices, such as BIL (Basic Impulse Level) and BSL (Basic Switching Level) of the transformers; the TRV (transient recovery voltage) of HSGS (High Speed Ground Switch), circuit breakers and the rating of the lightning arresters.

4.2 Transmission Line Oscillation Test

Full size transmission line oscillation test facilities are used to test the oscillation of overhead transmission liens. They are also used in assessing the oscillation of the 6-conductor bundle type and to test methods of applying spacer dampers for overhead transmission lines.

Oscillation Test Facilities

- -3 arch type steel towers, CCTV set for oscillation observation
- -Equipment for recording and analyzing oscillation data
- -Tension measurement system and load cell
- -Meteorological observation equipment, such as anemoscopes, anemometers, and thermometers
- -Sensors for oscillation measurement

4.3 Electrical Environmental Simulation Tests using Corona Cage

A corona cage was used to conduct simulation tests for evaluation of the environmental effects of 765kV transmission lines and for choosing candidate conductor types. Many types of tests can be conducted efficiently and economically with a corona cage, because the conductor used in the test and applied voltage can be altered easily, and because the conductor surface voltage gradient can be increased with low voltage increments.

The corona cage is used for studies on phenomena such as corona noise and radio wave interference, which are the most important factors when designing the conductor for 765kV transmission lines.

4.4 Leakage Current Measurement System : LCMS

Experimental outdoor stations for long term testing of EHV (Extra High Voltage) insulators were constructed. LCMS which can measure and acquire the tendency data of leakage current of EHV insulators in real time was developed and used for research. EHV insulator experimental facilities have been utilized for long term reliability assessment of EHV insulators through leakage current tendency analysis which considered environmental factors and different characteristic of EHV insulators.

4.5 TV Wave Interference of 765kV Transmission Lines

When incoming TV waves occur in large scale transmission lines such as a 765kV 6-conductor bundle transmission line, TV waves are usually reflected or shielded by the conductors and consequently TV wave interference occurs.

TV wave interference is a problem that directly affects residents near transmission lines. Therefore TV wave reception before and after the lines were built was measured and compared to check whether the transmission lines have caused additional interference. Appropriate measures for each region are then recommended. Technical support has been offered to solve potential civil petitions under construction of transmission line.

5. Conclusion

KEPCO have been operating single circuit 765kV and Double circuit 765kV transmission Lines for the first time in the world since 2010 by more than 15 years development research. This KEPCO 765kV double circuit technology is very economic and useful for transmission utility. Therefore the KEPCO 765kV electromagnetic interference technology was selected as a standard of IEC TR CISPR 18 on June, 2010. KEPCO will continue to develop more effective and safe maintenance technology for 765kV system and also to develop +/- 500kV Class HVDC transmission technology.

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India Corner

Activities at High Voltage Laboratory, National Institute of Technology, Durgapur-India

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NIT, Durgapur, India

The High Voltage Laboratory at National Institute of Technology (NIT), Durgapur was established in the year 2008 with the prime objective of promoting research in the field of high voltage engineering and to familiarize the students, utilities and industries with high voltage power apparatus in traditional laboratory as well as through distance learning with the aid of information and communication technology(ICT). At present more than three thousand institutes provide engineering education in India and among them approximately half of them offer undergraduate programs in Electrical and Electronics engineering that includes High Voltage (HV) Engineering. Also it is mandatory as per the guidelines of All India Council for Technical Education (AICTE) that the laboratory facilities are to be provided for all the programs which are offered by the institutes. However, very few institutes have High Voltage Laboratory facilities due to involvement of huge costs and availability of specialized faculty members and skilled staffs in the field of High Voltage Engineering. It leads to develop a ICT enabled High Voltage Laboratory in eastern region to facilitate the remote facilities to the institute as well as utilities.

Availability of High speed internet facility in most of the institutes/colleges are the prime advantage to formulate a network for digital e-learning environment for recently developed remotely operated High Voltage Laboratory at NIT, Durgapur. It is an unique facility for remote operation and first in world which can be augmented to provide the remote facilities of digital e learning with the inclusion of ICT enabled technology in India and abroad.

Important features of the ICT enabled High Voltage Laboratory (ICTRHVL), at NIT ,Durgapur are the followings:-

1. ICT enabled High Voltage Laboratory, NIT Durgapur, first of its kind in world can be accessed with proper authentication from anywhere in the world by 24×7.
2. Provides an economical means of learning high voltage engineering for institutes offering Electrical and Electronic programs at undergraduate and postgraduate level.
3. Enhance hands on experience of conducting real time laboratory experiment for the HV courses among the students all over the world at anywhere and anytime.
4. The ICTRHVL at NIT Durgapur also provides facilities to the industries as well as the utilities for online testing of HV power apparatus and on line test report generation.
5. ICT enabled HV laboratory culminates the "access to all" opportunity to every incumbent to build the trust between industries, government agencies and individual which is a powerful tool for the development of underdeveloped and developing countries.

Laboratory Infrastructure

High Voltage Laboratory at NIT, Durgapur is equipped with the following traditional laboratory equipments.

- Impulse Voltage Generator
- 500mm sphere gap for HV measurement
- Impulse voltage divider (damped capacitive type)-800kV
- Digital Impulse oscilloscope with software.
- AC Power frequency HV testing transformer 300 kV , 0.5 A
- AC Divider (300 kV)
- Partial Discharge measuring system upto 300 kV
- Coupling capacitor
- Capacitance and Tan delta measurement (LV & HV)

Figure 1: HV Laboratory at NIT, Durgapur

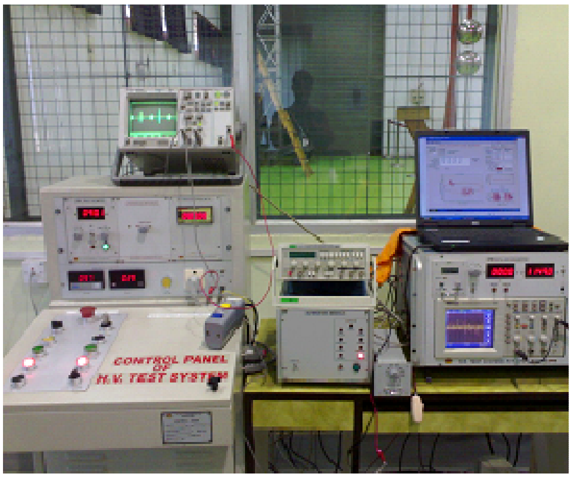

Figure 2 ICT enabled operation of HV Laboratory experiments

- Resistivity meter
- Leakage current tester
- Limited remote facility of impulse and AC high voltage systems

The traditional laboratories have some limitations associated with them in achieving their objectives efficiently and economically as to develop and maintain, it needs costly infrastructure, skill technicians and efficient faculty members. The AC High Voltage and impulse High voltage test system are capable to operate remotely through ICT enabled operation. The laboratory is also equipped with high resolution video camera for better realization of the experimental setup, arcing phenomenon and activities during the testing and experiments in high voltage power apparatus.

Ongoing research projects at HV laboratory, NIT Durgapur

On-line monitoring of partial discharges in high voltage power apparatus using optoelectronic method

Recent development in the field of high voltage engineering, automation technology and information communication technology are showing a significant boost in up gradation of power system. As insulation of any electrical equipment is a sensitive zone of failure in the power system, utmost care should be taken by power engineers. The insulation of high voltage (HV) equipment gradually degrades due to the cumulative effects of electrical, chemical and mechanical stresses caused by the partial discharges (PD). Partial discharges are small local electrical discharges that occur within electric insulation of HV equipment such as switchgear, cables, transformers, windings in large motors and generators. In addition, Partial discharges occur at voids, contamination, poor conductor profiles and floating metal-work in the high voltage equipment. Therefore it is very essential to detect, measure and also localization of partial discharge within the HV equipment for prediction of insulation life, replacement time and early indication of outages during their period of service. The optical technique that has been introduced in this work is sensitive for PD measurements inside the HV equipment compared to other technique such as electric detection, chemical detection and acoustic detection methods. In this work, the optical PD detection technique is used to measure the PD in the model transformer by two alternative procedures, firstly the detector collected the signal of PD, when the

Figure. 4 A photograph of the schematic experimental setup of partial discharge measurement

Figure 3: ICT enabled operation of AC & Impulse High volatge test system

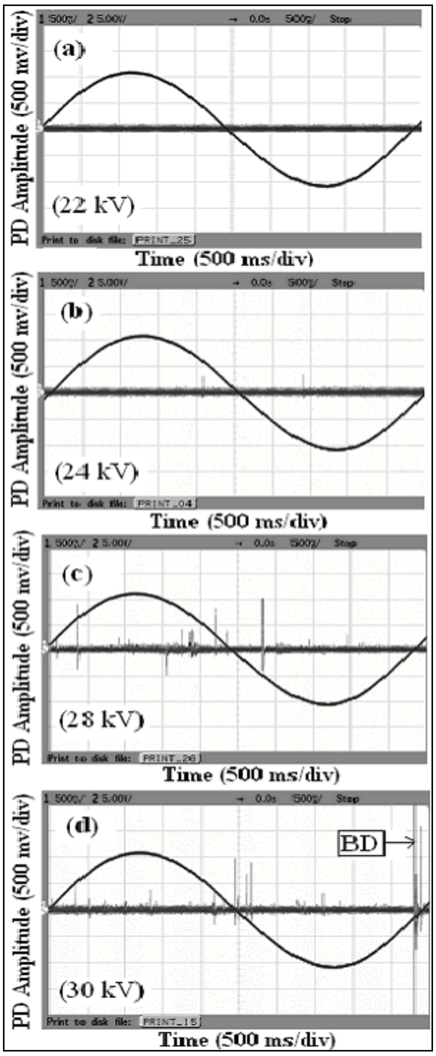

Figure. 5. PD signal observed when the optical sensor is placed at the centre axis of the two electrodes,
(a) applied high voltage of 22kV,
(b) applied high voltage of 24 kV,
(c) applied high voltage of 28 kV,
(d) applied high voltage of 30 kV till the break-down occurs

direct laser beam passes through the centre axis of the electrode arrangement of the transformer model, and secondly the laser beam passes through the fiber optic cable, attached with an optical sensor for acquiring the acoustic signal is placed in the centre axis of the electrode arrangement of the transformer model as well as in different location of the transformer model. Finally, the measured values of PDs are compared for both the ways. The proposed method has several advantages over the conventional PD detection method such as electrical detection, chemical detection, and acoustic detection .

Study on the application of wavelet analysis method for denoising the partial discharge signal

Partial Discharges being a major source of insulation failure in power system ,detecting it accurately is a critical need for power companies to improve personnel safety and decrease the potential for loss of service. To achieve this, the suppression of noise is crucial priority to any partial discharge (PD) data analysis in on-line PD measurement. Therefore the study on the application of wavelet analysis method for denoising the partial discharge signal is being performed to achieve good effect in noise rejection in online PD detection by the method of Wavelet Transform (WT).

Development of a model for On-line Fault Diagnosis in the Transformer oil by Dissolve Gas Analysis (DGA)

In any electrical power system, transformers constitute one of the largest investments in a utility's system. For this reason, transformer condition assessment and management is a high priority. If a transformer fails, it would have a significant negative impact on revenue and service reliability. Hence monitoring the state of health of power transformers, a key component in the path of reliable power, is very essential. The model will help to increase the self life of the transformers by predicting the need for filtration and thus making the overall power system more efficient and reliable.

Remote operation of High Voltage 100kV AC test set with Labview

Using NI Labview, the automation of 100kV AC test system is being studied for enhancing the ICT facilities of the laboratory. With proper authentication, anybody from anywhere can access this facility all 24x7 hours through the web. The software implementation is done through proper coding in NI Labview.

In addition to the above projects , High Voltage Laboratory NIT Durgapur obtained several sponsored projects from the following government funding agencies :-

1. Ministry of Human Resources and Development (MHRD), Govt of India
2. Department of Science & Technology, Govt of India
3. National project Implementation Unit(NPIU), Technical Education Quality Improvement Programme (TEQIP), World Bank
4. National ICT Mission , Govt of India

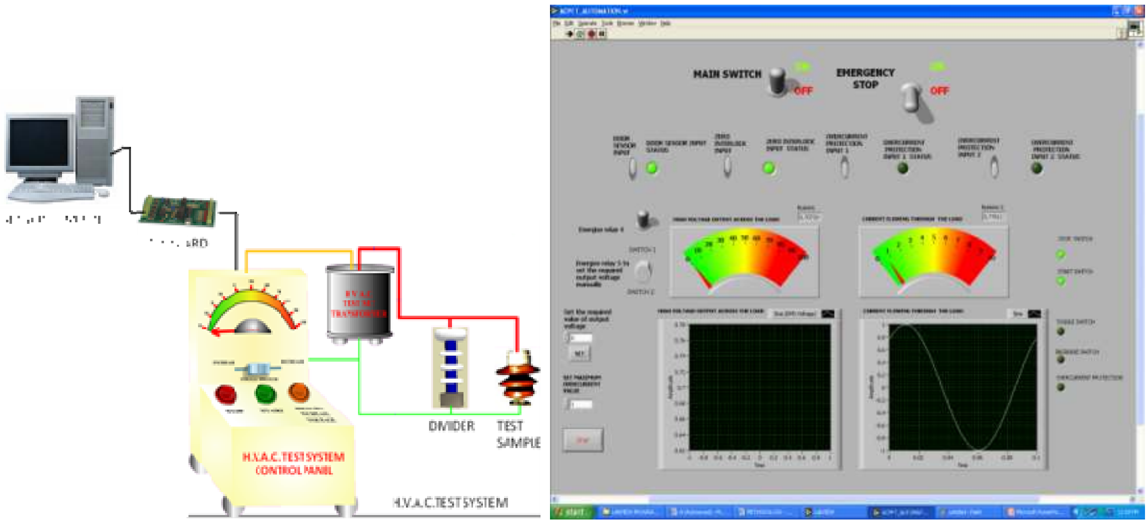

Figure 6: Schematic diagram for automation of H.V.A.C. Test set and Front Panel view for online access of H.V.A.C. Test set.

Conclusion

High Voltage Laboratory at NIT, Durgapur maintains a close association with professors at various institute in India and abroad. As the coordinator and developer of the HV laboratory, NIT, Durgapur, I am happy to disseminate the innovative ideas for continuous development of the laboratory and research in the field of High voltage engineering. To work in the new research areas of high voltage engineering, we are eagerly looking forward to enhance the scientific collaboration between NIT Durgapur and various research institutes in India and abroad. It has the opportunity to support all the learning objectives of the traditional high voltage laboratory in a remote setup. To the authors' knowledge, the laboratory is the first remote educational high voltage laboratory in the world. It is foreseen that it will be part of an e-learning network nationally and internationally, similar to that being developed in LabShare – a project that has been funded by the Australian Government's Department of Education, Employment and Workplace Relations, through the Diversity and Structural Adjustment Fund.

I personally invite the researchers to pay a visit to our high voltage laboratory, NIT, Durgapur so as to strengthen our scientific collaboration and ICT enabled activities in the field of High Voltage engineering.

Acknowledgement

The author wishes to thank Ramanujam Satrathi, Department of Electrical Engineering, Indian Institute of Technology, Madras, India for giving an opportunity to write about the High Voltage Laboratory activities at NIT, Durgapur India.

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TECHNOLOGIES FOR TOMORROW

12kV/50A Enclosed Cylindrical Type Fuse Cut-out

1. Introduction

In recent years, the insulation covering of energized parts has been improved in both reliability and safety for use on distribution lines. Currently cut-outs with exposed energized parts are still used as protective devices for transformers, resulting in problems such as electric shock by accidental contact of energized parts. In addition there is the potential for earth faults and short circuits through contact with trees and wild animals, as well as causing corrosion of the exposed energized parts etc.

To overcome this, we have developed the 12kV/50A enclosed cylindrical type fuse cut-out applicable for the 10kV distribution system as used by the SHANGHAI MUNICIPAL ELECTRIC POWER COMPANY of China.

Our device offers excellent insulation and anti-pollution performance by covering the energized parts for increased reliability and safety of the distribution line.

2. Construction and Characteristics

Our developed product satisfied the Standard requirements in China. To achieve its insulating properties it adopts the cylindrical porcelain concept with its excellent and well proven insulating properties, to provide safety and pollution withstand performance for its energized parts making it particularly suitable for the 10 kV distribution system in Shanghai.

(1)In the design and construction particular attention has been given to reduce any electrical potential stress concentrations through:
- Selection of materials and their shape to achieve electric field relaxation.

(2)In the insulation and pollution design particular attention has been given to achieve requirements for a 10 kV distribution system through:
- Selection of the structure to ensure the withstand voltage performance.
- Selection of the structure to ensure the necessary creepage distance.

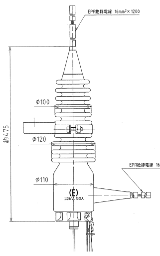
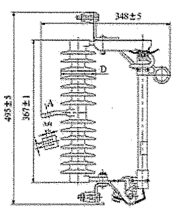
(3)Additionally sufficient breaking capacity is achieved through:
- Selection of the materials and construction to withstand inner gas pressure forces during the interruption process.
- Selection of the materials and construction to achieve excellent arc suppression performance during the interruption performance.

2-1. Comparison between Developed Product and Existing Product.

Table 1 shows the construction and characteristics of our developed product and the existing product.

The existing cut-out with its exposed energized parts has the disadvantage to be affected by rain, dust and pollution. On the other hand, our developed product with its covered construction is quite excellent where safety, reliability and pollution withstand performance of the energized parts are concerned.

Table 1 Construction and characteristics

Item	Our developed product	Existing product (open cut-out)
Construction	 Enclosed type	 Open type
Characteristics		
Safety	○	×
Reliability	○	×
Pollution performance	○	×

○:Good ×:No good

3. Specifications

Table 2 shows the basic performance of the enclosed cylindrical type fuse cut-out .

Table 2 Basic performance

Item		Specifications
Rated voltage / current		12 kV / 50A
Rated breaking current		Sym 8 kA rms
Min. creepage distance		350 mm
Withstand voltage (kV)	Power frequency	To earth: Dry/Wet : 42 /30
		Across isolating distance: Dry 48 (without fuse tube)
	Lightning impulse	To earth：Dry 75
		Across isolating distance: Dry 85 (without fuse tube)
Max. temperature rise		35 ℃
Breaking test	Rated breaking current : Sym 8kA rms	
	Min.breaking current : 175A	
Switching Test	Load current switching : 50A	
	Excitation current switching : 3A	
	Charging current switching : 1A	
Mechanical endurance test		300 times
Short Time Current		1000A 1 sec

4. Main performance evaluation

The following are the main performance evaluation results.

4-1. Interruption performance

At the start of the project, the effective breaking value was 4 kA at a test voltage of 12 kV(originally designed for 7.2 kV as used in Japan). After adopting improvement of materials and construction for arc suppression performance, we could secure 8 kA breaking performance for the first time at 12 kV for the cylindrical enclosed type cut-out. Photo 1 shows the test situation with test voltage 12 kV / breaking current 8 kA at SHANGHAI ELECTRIC POWER TRANSMISSION & DISTRIBUTION TESTING CENTRE CO.,LTD..

Photo 1. breaking test situation

4-2. Safety performance

We also confirmed that no flashover would occur at a power frequency voltage 18 kV for 1 min between inside energized parts and a conducting sheet covering adhesive part of top mold cone and bottom open end. Photo 2 shows the safety test situation.

Photo 2. Safety test situation

4-3. Corona

We carried out electric field analysis, and confirmed that there were no structural problems such as radio influence by corona. Figure 1 shows the result of electric field analysis.

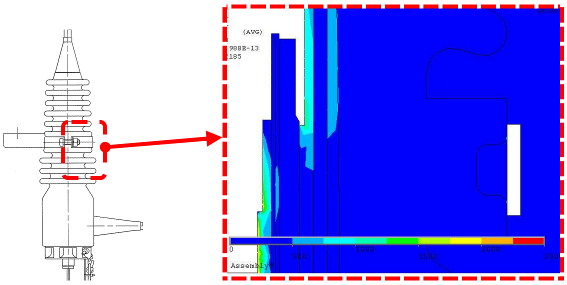


Figure 1. Result of electric field analysis

5. Field test

We have checked the performance by field test on a distribution line by Shanghai Power from July 2008 to the present date. Since then, there aren't any problems and filed test is continuing. Photo 3 shows the field test situation.

Photo 3. Field test situation

6. Conclusion

Our developed product offers increased reliability, safety and anti-pollution performance over the existing product, and will contribute to overall power service performance by improving the reliability and safety of distribution lines to service current social needs.

Currently we are engaged in further improving our new product by increase its breaking performance from the existing 8 kA to 12.5 kA to expand its range of application.

This product was jointly developed by the following companies, according to the request from SHANHAI MUNICIPAL ELECTRIC POWER COMPANY.
This article was prepared by NGK Insulators, Ltd. which is an affiliated company of ENERGY SUPPORT CORPORATION.

- -SHANGHAI MUNICIPAL ELECTRIC POWER COMPANY
- -SHANGHAI ELECTRIC POWER LIVE WORKING COMPANY, LTD
- -SHANGHAI FUJIKURA CHENGLONG CABLE ACCESSORY CO.,LTD
- -ENERGY SUPPORT CORPORATION

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TECHNOLOGIES ALERT

Development of the Large-sized 154kV XLPE triplex cable

Recently, there was a large-scale plan of uprating of underground transmission cables for thermal power plant enhancement in Tokyo Bay area.

But large space for snaking installation was needed for usual single core XLPE cable laying in tunnel for absorbing the thermal expansion. With the triplex cable, however, such expansion can be absorbed by change in the triplex cable diameter. This twisted flexure saves expansion space, and, also allows for more efficient use of underground space

Therefore TEPCO developed the large-sized (800-1000mm^2) 154kV XLPE triplex cable.

By applying this new cable at first in Japan, we could use existing tunnels and saved the construction cost and the term drastically by avoiding large-scale civil engineering work for tunnel.

We mainly conducted the following mechanical characteristic experiments for development.

1. We implemented the bending test, and checked that there was no disarray of the inner cable structure.
2. By measuring the Young's modulus, we found the difference of the thermal-mechanical characteristic between the usual single core cable and the triplex cable. So we can estimate the axial force of the triplex cable, therefore we are able to save the number of cable cleat and assess the thermal expansion of the cable.
3. We conducted the full scale experiment of tunnel installation of the cable, and made sure the self-absorbing characteristic of thermal expansion even in the large-sized triplex cable.

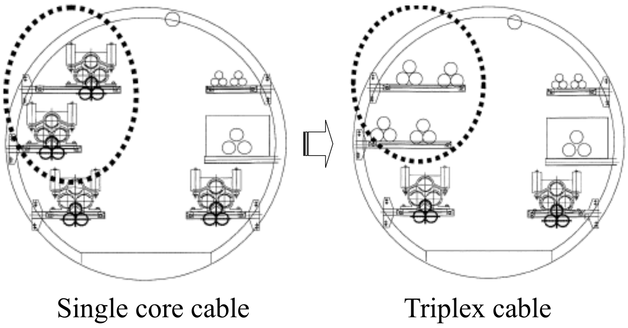

Fig.1 The comparison of cable space in cross section of tunnel

By **Yasuhiko Aihara**

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http://www.tepco.co.jp

MISCELLANEOUS

Photos on Front and Rear Covers

Front Cover

Electrostatic Discharge Tests of Satellite Solar Panel

Greenhouse Gases Observing Satellite (GOSAT, "Ibuki") Solar Array Paddle Deployment
Courtesy of JAXA (Japan Aerospace Exploration Agency)

Although space is generally regarded as vacuum, it is filled with plasma. In terms of electrical insulation, being in space does not guarantee better situation than on the Earth. The plasma charges satellite surface as well as its interior. When a satellite encounters energetic electrons in orbit, the satellite body that can be regarded as a floating conductor in space is charged to a highly negative potential with respect to the plasma. The charging of the satellite body leads to build up of potential difference among various parts on a satellite, especially between surface insulator and the satellite chassis. As the differential voltage exceeds a certain threshold, electrostatic discharge (ESD) occurs at the edge of conductor and insulator exposed to space. The threshold differential voltage for ESD inception can be as low as one hundred volts.

Among the satellite components, solar panels are the most vulnerable to ESD. The conventionally designed solar panels are composed of many metallic parts exposed to space, such as solar cell electrodes, and a large area of insulator, such as coverglass. In the worst case, one ESD pulse may lead to catastrophic failure of the satellite power system as the pulse makes transition to an arc discharge in the solar array circuit resulting in the short-circuit of the power system.

Since the middle of 1990s, many satellite failures whose cause was identified to be ESD have been reported as the satellite power level increased to deal with the demand of more communication channels or diversified satellite missions. In Japan, the complete loss of ADEOS-II Earth observation satellite in 2003 due to arcing in the power system changed how satellite solar panels are designed and tested in Japan. Nowadays, it is a common practice not only in Japan but also in US and Europe, to test a solar panel design against ESD before its launch.

The purpose of the test is to investigate whether a given design of solar panel can withstand many numbers of ESD events expected in orbit. The test is done using a so-called solar array coupon shown in the bottom right of the front cover. The coupon is made of exactly the same material and procedures as the flight solar panel. The coupon is put in a vacuum chamber. Its surface is charged by an electron beam of several keV simulating the energetic electrons in orbit, such as aurora or substorm, or by a plasma simulating the ionospheric plasma. The coupon is connected to an external circuit simulating the satellite power system under power generation. The test investigates whether a pulse of ESD leads to the arc discharge or not.

The ESD tests of satellite solar panel in Japan has been carried out at Laboratory of Spacecraft Environment Interaction Engineering (LaSEINE), Kyushu Institute of Technology located in city of Kitakyushu. GOSAT (Ibuki) launched in 2009 was also tested at LaSEINE and its solar panel is working fine in orbit as shown in the top picture. LaSEINE is a world-leading institution in the field of spacecraft charging. Based on the test methods carried out at LaSEINE, a new ISO standard, ISO-11221, on ESD test methods of satellite solar panel has been established in 2010. Nowadays, LaSEINE carries out ESD tests for not only Japanese satellites, but also for satellites of other countries, such as USA, China and India.

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(Laboratory of Spacecraft Environment Interaction Engineering,
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804-8550 Japan)

Rear Cover

Space Charge Formation by Irradiation of Visible Light in Polyimide under DC Electric Stress

Space charge distribution formed in polyimide (PI) film (Kapton®) under dc electric field is strongly affected by visible light illumination. The space charge formation in Kapton® film is investigated using a modified PEA (Pulsed Electro-Acoustic) system for measuring space charge distribution under various visible lights illuminations from LED. As shown in the upper figures, the space charge formations are clearly observed in the film under dc electric field (20 kV/mm) with visible lights illuminations, while it is not observed in it without light illumination. Furthermore, it is obviously found that the charge accumulation pattern in the film strongly depends on the wavelength of illuminated light. In the case of red light illumination, a small amount of hetero charges are observed in bulk of film near anode and cathode electrodes. In the case of green light illumination, only negative hetero charge near anode side is observed. On the other hand, the blue or violet light illumination makes homo space charge formation near cathode. It means that the relatively lower energy light illumination by red or green LED dominantly make a hetero charges while the higher energy light illumination by blue or violet LED seems to enhance charge injection from illuminated electrode. This phenomenon is also observed in opposite polarity of dc voltage application. Lower figures show the results obtained by green and blue lights illuminations from anode side. It is found that the positive hetero charge near cathode side is quickly formed with green light illumination, while the injected positive homo charge near anode side is gradually formed with blue light illumination from anode side. These results suggest that the visible light illumination must enhance the electric field in the bulk, and consequently it makes the breakdown strength lower than that without the illumination.

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T. Maeno (National Institute of Information and Communications Technology)
Japan

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Six kinds of transactions are published. Five kinds of transactions are edited by five societies* in IEEJ. The other one (IEEJ Transactions on Electrical and Electronic Engineering) is bimonthly published in English, which is mentioned in a later section.

(*) Five societies in IEEJ are as follows:

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B: Power and Energy Society
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(Themes of the recent issues published in English)

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Vol. 129-A No. 12(Dec. 2009) Electromagnetic Technologies for Forecasting and Monitoring Natural Hazards
Special Issue on Technology 2009 : Reviews & Forecasts
Vol. 130-A No. 11(Nov. 2010) 2009 Korea-Japan Joint Symposium on Electrical Discharge and High Voltage Engineering

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No.	Title	Pub. date
1169	New Generation Electric and Magnetic Actuators	2009/9/10
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1171	The present conditions and the future prospects investigation of the simulation technology in water supply and sewer system	2009/12/1
1172	Clarification of lightning damage mechanism on power distribution lines and upgrade of forecast technique of damage rate	2009/11/5
1173	Lightning, Surge Arresters, and Insulation Co-ordination for High Voltage Power Systems	2009/11/25
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1185	Advanced Discharge Applications and Fundamental Discharge Parameters	2010/4/5
1186	A Technology of Constant Determination and Performance Calculation for Permanent Magnet Synchronous Machines	2010/4/20
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1195	Elemental technology use for industrial linear electromagnetic drive systems and their ap-	2010/6/30

	plications	
1196	Technical Report of Diagnostic Technology for Induction Machines	2010/7/5
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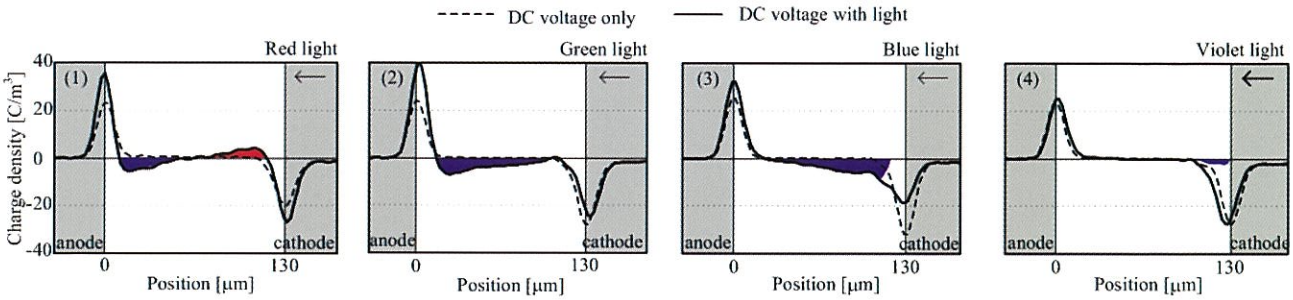
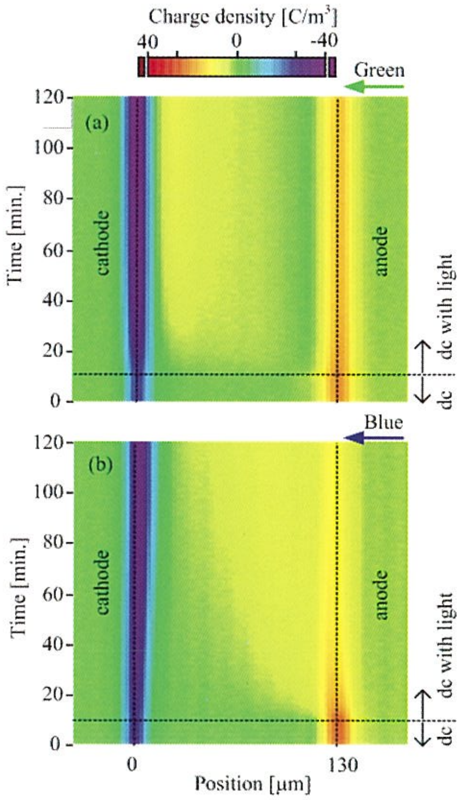


Space charge distribution in Polyimide film with irradiation of various lights (under DC stress of -20 kV/mm).



Time dependent space charge behavior in PI film under (a) green and (b) blue lights irradiation

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