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MISCELLANEOUS

PREFACE

Dr. Y. Sekii

Remembrance of an educator involved with insulation technology

Almost 45 years have passed since I started my involvement in research of insulation technology, when I was a student of the graduate school of electrical engineering in college. Under the guidance of my former teacher, I had engaged in an investigation of the deterioration of polyethylene by partial discharge. After graduation, I began work at a cable manufacturing firm, where I worked for 29 years as an XLPE cable engineer, engaging in research and development of medium-voltage and high-voltage XLPE cable systems, including a 500-kV XLPE cable system and a DC cable insulated with XLPE. In 1994, I moved to the Chiba Institute of Technology, where I worked for 13 years as an educator and researcher, engaging in educational work for young students and undertaking many material studies of traditional research subjects related to solid dielectrics. The subjects of investigations were studies of electrical and thermal degradation, including electrical and water treeing, as well as deterioration by partial discharge and studies of space-charge generation in XLPE and EPR. In recent years, I have noticed that the demands for R&D in this field, and technical solutions, have changed appreciably. Many new subjects have emerged, such as condition-monitoring and insulation system diagnosis, asset management of electric apparatus, studies targeting development of cost-saving or environment-friendly technology, and material studies incorporating nanotechnology. In recent years, sessions associated with those subjects are planned at conferences. Those trends can undoubtedly develop a vision for the future in this field.

As an educator at the Chiba Institute of Technology, I strove to give my every effort to convey to students what I have experienced during my work as a cable engineer in cable manufacture. I tried to portray to them the necessity of a challenging spirit, high morale for trying to do their best at those projects for which they are responsible, and a sense of an obedient feeling that can be relished when the projects are achieved. These are the things that I think are necessary for them to become able engineers with responsibility and morals. I feel gratified that many young engineers who have graduated from my laboratory are working actively in public and private sector positions. They are working as engineers at power utility companies, at public transportation corporations, in heavy electric and cable industries, and at installation companies. After retirement, I began to offer my office for young people to study fundamentals of electrical engineering, hoping thereby to supply them a basis for their future activities.

Dr. Yasuo Sekii

Consultant,
Former Professor of Chiba
Institute of Technology, Japan

OUTLINE OF TECHNICAL COMMITTEES IN IEEJ

Dielectrics and Electrical Insulation (DEI)

Chairperson: N. Hozumi (Aichi Institute of Technology)
Secretaries: K. Uchida (Chubu Electric Power Co. Ltd)
Y.Tanaka (Musashi Institute of Technology)
Assistant Secretaries: M. Okashita (Showa Cable Systems Co. Ltd)
H. Takahashi (CRIEPI)

The committee 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 name of the committee changed in 1994 from "TC on Electrical Insulation" to "TC on Electrical and Dielectric Insulation" aiming to expand its activity to the field of electronic and dielectric functional systems.

The important activity of TC-DEI is the annual Symposium of Electrical and Electronic Insulating Materials and Applications in Systems (SEEMAS), formerly called Symposium on Electrical Insulating Materials. In this year's symposium, in addition to regular sessions, we will hold a special session to discuss the problems relating insulation systems subjected to inverter surges. Furthermore, new types of sessions, to promote linkage between industry and the academic world, and to encourage activities of young researchers are being planned. The detail will be reported in advance.

In addition, the committee promotes the International Symposium on Electrical Insulating Materials (ISEIM), which is considered as an international version of the SEEMAS. This symposium is being held every three years. The next ISEIM will be held on September 7-11, 2008 in Yokkaichi City (located near Nagoya City) with Honorary Chair of Dr. T. Okamoto and General Chair of Prof. N. Hozumi. The local arrangement committee is chaired by Prof. S. Nakamura of Mie University. The committee members believe that the symposium will be flooded with friendship and fruitful discussions, and of satisfactory to all the participants.

The TC-DEI is now headed by Naohiro Hozumi of Aichi Institute of Technology. Yasuhiro Tanaka of Musashi Institute of Technology and Katsumi Uchida of Chubu Electric Power Co., Inc. are the secretaries. Minoru Okashita of Showa Cable Systems Co., Ltd. and Toshihiro Takahashi of CRIEPI are contributing the committee as the assistant secretaries.

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

> Environment-friendly materials and systems for electric and electronics application (04/04-03/07, Chairperson: Y.Suzuoki (Nagoya University)). The activity has been finished.

> Economical evaluation of insulation diagnosis (04/04-03/07, Chairperson: N.Hozumi (Aichi Institute of Technology)). The activity has been finished and a new activity is being planned.

New materials including nano-materials related

> Application and improvement of organic molecular films and organic/inorganic composites with controlled nano-structures (04/04-03/07, Chairperson: F.Kaneko (Niigata University)). The activity has been finished, and a new activity will start chaired by K. Kato of Niigata University.

> Physics and interfacial design of organic dielectrics and semiconductors (04/07-03/10, Chairperson: M. Iwamoto (Tokyo Institute of Technology))

> Interfacial phenomena and application of nano-composite dielectric materials (01/06-12/08, Chairperson: T.Tanaka (Waseda University))

Ageing and diagnosis of electric and electronic equipment related

> Degradation diagnostic techniques for power equipment from viewpoints of electrical insulating materials (04/07-03/10, Chairperson: Y. Ehara (Musashi Institute of Technology))

> Partial discharge measurement under repetitive impulse voltage application (08/07-07/10, Chairperson: M.Hikita (Kyushu Institute of Technology)). The committee is being run cosponsored by the TC-DEI and TC of Electrical Discharge.

Basic dielectric and breakdown phenomena related

> Assessment of interaction between polymeric materials and radiation (06/06-05/08, Chairperson: Y. Tanaka (Musashi Institute of Technology)).

> Surface function and long-term performance of outdoor polymer insulation materials (01/06-12/08, Chairperson: H. Homma (CRIEPI)).

Electrical Discharges (ED)

Chairperson:	T. Nakano (National Defense Academy)
Vice-chairperson:	M. Hikita (Kyushu Institute of Technology)
Secretaries:	F. Tochikubo (Tokyo Metropolitan University)
	A. Kumada (University of Tokyo)
Assistant Secretaries:	H. Yasui (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 five investigation committees.

This year, TC-ED has organized four domestic technical meetings on electrical discharges so far. In addition to these, two meetings will be organized to the end of the year 2007. One of the two is the Japan-Korea Joint Symposium on Electrical Discharges and High Voltage Engineering, which will be mentioned later. In these meetings, more than 200 full papers are presented in total from both academic and industrial sides by researchers, engineers, professors and students. Some of these meetings take place jointly with the TC on Plasmas, TC on Dielectrics and Electrical Insulation, the TC on High Voltage Engineering and the TC on Switchgear and Protection, the TC on Pulses Power Technology.

In order to promote the international activities in electrical discharges, the Japan-Korea Joint Symposium on Electrical Discharge and High Voltage Engineering has been organized by the TC-EC. This year, the J-K symposium will be held in November at the Shibaura Institute of Technology, Tokyo. More than 100 papers have been submitted to this symposium. The special issue of the J-K symposium is scheduled to be published in the IEEJ Transactions on Fundamentals and Materials in October, 2008.

The TC-ED also contributes to the organization of the seminar for young researchers 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. The seminar for young researchers in 2007 was successfully held in Noboribetsu, Hokkaido, in last September. Young researchers and engineers participated in the seminar and discussed vigorously the topics related to electrical discharges for two days.

(T. Nakano, tn@nda.ac.jp)

Table 1 Investigation Committees in TC-ED

Chairperson	Research subjects and established time
H. Itoh (Chiba Institute of Technology)	Charged species, excited species, dissociated species, photons and the atomic and molecular dynamics (established in January 2006)
T. Oda (University of Tokyo)	Non-equilibrium, atmospheric pressure plasmas and their applications to environment purification (established in January 2006)
S. Matsumoto (Shibaura Institute of Technology)	Modeling of lightening strokes to structures (established in December 2006)
M. Hikita (Kyushu Institute of Technology)	Measurement of partial discharges generated by repetitive impulse voltage pulses (established in August 2007)
E. Hotta (Tokyo Institute of Technology)	The generation control and applications of vacuum and low-pressure discharges (established in October 2007)

Plasma Science and Technology (PST)

Chairperson: S. Ono (Musashi Institute of Technology)
Vice Chairperson: K. Yukimura (Doshisya University)
Scientific Secretary: Y. Ono (University of Tokyo)
T. Ikehata (Ibaraki University)
Scientific Secretary Assistance: K. Teii (Kyusyu University)

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

The major activity of this committee is to succeed to organize several technical meeting on plasma science and technology every year. For example since January 2006, four technical meeting were held; in January at Ibaraki University, in May at Musashi Institute of Technology in Tokyo, in August at Kauai Island Hawaii, in November at Ehime University in Ehime. In 2007, four times of technical meetings are held. They were held at Kanazawa University in January, at the University of Tokyo in August, at Hokkaido University in September. A technical meeting in the Doshisha University is planned in December. At each symposium, about 20 to 30 presentations are made. Presentations by young researchers in bachelor course and master course are strongly encouraged and appreciated.

Every two years, TC-PST sponsored international symposium APSPT (Asia pacific symposium on plasma technology) had been held in Taiwan in collaboration with domestic societies related to plasma science and technology since 1999. Recently, APSPT-4 was held in YunⅠin Taiwan in December, 2005. Aiming at more flexible management, APSPT-4 became sponsorship by the international organization committee from this time. While many members of TC-PST participate in the international organization committee, TC-PST is continuing playing a role important as a support organization.

APSPT-5 will hold at Cheng Shiu University, Kaohsiung, Taiwan, R.O.C. in December 10-12, 2007. Eight invited lectures, about 120 contribution papers are going to be presented in this symposium.

TC-PST currently runs two investigation committees and a few new will be set up in future. The investigating committees dispersed recently, Plasma ion intensive use process investigation committee and Microwave plasma investigation committee, had published their investigation as hard cover books, and it was useful for these books to systematize the newest technology trends of these field.

Table 1. Investigation Committee in TC-PST

Spherical tokamak	3 years from August 2004, Chairperson: Y. Nagayama (National Institute of Fusion Science)
The advancement of metal sputtering plasma	3 years from January 2006, Chairperson: K. Nakamura (Chubu University)

Pulsed Electromagnetic Energy (PEE)

Chair Person: Kazuhiko Horioka (Tokyo Institute of Technology)
Vice Chair Person: Weihua Jiang (Nagaoka University of Technology)
Secretary: Koichi Takagi (Iwate University)
Assistant Secretary: Hiroyuki Shinkai (Central Research Institute of Electric Power Industry)

Continuous efforts have been made to enhance the activities in pulse power technology and high energy density physics, in the Technical Committee on Pulsed Electromagnetic Energy (TC-PEE). PEE has greatly expanded its regime in technological and application field, based on the state-of-the-art technology of power devices, which shifts the trend from a huge machine to high average power devices. The research field is evolving in the electric power engineering, plasma and discharge engineering, high energy density physics, accelerator engineering and also pulse power device itself. By the modification of pulsed electromagnetic energy, we can make an extremely high energy density (high temperature and/or high density) state with well defined condition, which can be utilized for generations of high power lasers, intense radiation sources, high current particle beams and also for formation of new materials. Among others, pulse-power-driven discharge plasma is expected to be a light source for next generation semiconductor lithography. Recently, application of pulsed high electric field to biological and/or medical field has been proposed. Although interesting, it is still in an infant stage. Then much more efforts are needed for evaluating the usefulness in practical biological fields.

As the field of high energy density plasma has a multi-disciplinary nature, this committee is providing a forum to discuss important technical developments, their applications, increased understandings, new trends, and also future prospects in the interdisciplinary field. In particular, keeping this field attractive for young scientists and motivating them have been of primary concern for all of committee members.

Regularly, Technical Committee Meetings are held four times a year. To provide international forum and promote international collaborations, the meeting is also held once a year. Objective of the conferences is to provide a forum for discussion of the subjects in the field of pulsed electromagnetic energy, mainly in the related countries. However, those meetings including regular technical meeting, are open for persons whoever interested in this field.

There is one investigation committee in the TC-PEE; “Industrial Application of Pulse Power Technology”, which is chaired by Weihua Jiang (Nagaoka University of Technology). In the committee, industrial applications of highly repetitive pulse-power devices based on recently advanced power modulators, are discussed in addition to the conventional pulsed power technology. It is predicted that new technological tools should open an innovative application in wider fields; such as materials, energy, environmental, biochemical, medical sciences and technologies.

Electromagnetic Compatibility (EMC)

Chairperson: Z-I. .Kawasaki (Osaka University)
Secretaries: Y. Mizuno (Nagoya Institute of Technology)
T. Funaki (Kyoto University)
T. Ushio (Osaka University)

The Technical Committee on Electromagnetic Compatibility (EMC) behaves to achieve their own final goals. Those are

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 this purpose the committee pays their attention on 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 three dedicated research sub-committees to realize the effective activity.

1. Investigation Committee on Security Technology for Electromagnetic Wave and Information.
2. Investigation Committee on Evaluation Technologies for Induced Electric Field and Current in a Human Body Caused by Non- uniform and transitional Electromagnetic Fields.
3. Investigation Committee on Earthquake Prediction by Electromagnetic Filed Measurement.

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 "White Paper" named the Report of Investigation Committee.

Electromagnetic environment is the atmosphere in which electromagnetic phenomena exist, and consists of 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. Electromagnetic compatibility (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 Prof. T. Takuma, Prof. O. Fujiwara chaired the committee from 2002, and Prof. Z-I. Kawasaki has succeeded Fujiwara since April, 2005.

The committee organizes technical conferences annually as the Memory of Kobe Earthquake, which occurred on January 17. 1995. The committee holds a few technical conferences, additionally, and those are in June, November, and December for 2005.

1. Investigation Committee on Security Technology for Electromagnetic Wave and Information.

This committee has started its activity in April 2007.

Dr. Shinji Seto of NICT is chairing this committee. The Objectives of the committee activity are followings

1. Surveying the security technology for electromagnetic wave and information, including needs, terminology, and standards,,
2. Surveying the eavesdrop by TEMPEST like technology, including current status, documents, threat, and counter measurement,
3. Surveying the attacking by Intentional-EMI, including current status, documents, threat, and counter measurements.

The committee is focusing on establishing secure and safety world with preparing the adequate (not exceed) counter measurement for the prospective electromagnetic threats in the future.

2. Investigation Committee on Evaluation Technologies for Induced Electric Field and Current in a Human Body Caused by Non-uniform / transient Electromagnetic Fields

This committee was established in July 2006. The mission of the committee is to investigate the methods for calculating the induced electric field and current in a body caused by non-uniform and/or transient electromagnetic fields, and survey articles regarding the related calculation results. This committee also investigates measurement methods, which is indispensable in modeling electromagnetic field source to simulate practical exposure conditions. The committee also performs trend study with focusing on the high resolution electromagnetic field measurement method with compact probes. The following subjects are the items of investigation in this committee:

(1) Investigation of methods for calculating induced electric field and current in an anatomically-based human body model;
(2) Investigation of methods for calculating induced electric field and current in a human body caused by non-uniform and/or transitional electromagnetic field (including

the modeling of source and dosimetry);

(3) Investigation of measurement method for wideband electromagnetic field from extremely low frequency to intermediate frequency. Especially, focused on simplified and rigorous methods;

(4) Investigation of research subjects hereafter;

(5) Preparation of a committee report on the above items.

The committee is just established for taking over from the previous Investigation Committee on Electric Field and Current Induced in a Human Body Exposed to Electromagnetic Fields.

3. Investigation Committee on Earthquake Prediction by Electromagnetic Filed Measurement

This committee has just been established in September 2004. It is chaired by Emeritus Prof. K. Horii of Nagoya University. This committee was located as the succeeding committee for the former "Investigation Committee on Pre-occurrence Phenomena of Earthquakes by the Observation of Environmental Electric Field." According to the previous report, there is large variety of the electromagnetic phenomena related to earthquakes, and a long term universal measurement and research is inevitable to clarify the phenomena. This committee therefore enforced the research activity furthermore and especially focused on the following four subjects:

(1) Analyze various measurement techniques and measurement errors;

(2) Make an inter-comparison and evaluation for measurement results

(3) Analyze the relationship between measured data and earthquakes

(4) Discuss the possibility of establishing a earthquake prediction system

The committee focuses on establishing a highly reliable measurement technology with synthesizing many research results of antecedent electromagnetic phenomena of earthquakes. Periodically research conference is also planned.

Light Application and Visual Science (LAV)

Chairperson: Shinichi Takahashi (Keio University)
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 optical application for medical treatment, media devices for information processing of visual sense, light sources and their measurement, application of infrared light, and advanced lithography.

Miniaturization of semiconductor devices has been strongly progressed without a break, and the key motive force of the technical evolution has always been the improvements in lithography. Requirements indicated by the international technology roadmap for semiconductors (ITRS) are shown in Fig. 1.[1)] In these several years, immersion lithography in water has been quickly developed and eagerly refined. Commercial exposure systems for large volume productions are already available though the systems are quite expensive. At present, it is considered that 193-nm immersion lithography using an ArF excimer laser is the certain favorite for 32-nm half-pitch.

However, the favorites for post 193-nm immersion lithography have not been clarified. There are some candidates. One is reflection projection lithography using extreme ultra violet (EUV) exposure lights. From several years ago to 2005, the EUV lithography was considered as a dead certain of the next generation lithography for the 32-nm half pitch. In fact, EUV sources with high powers of more than 50 w at the intermediate focus are under development and near completion.

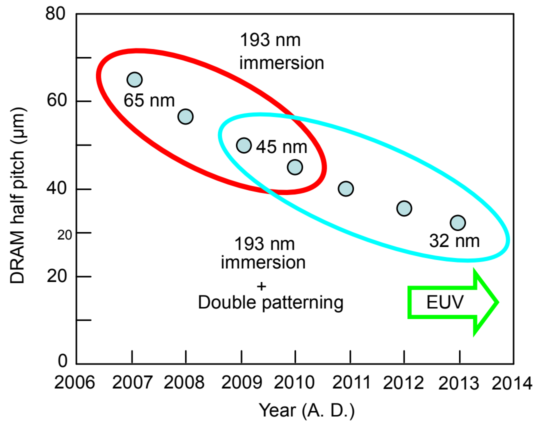


Fig.1 Technology requirements and potential solutions

Miniature exposure tools and full-field α demonstration systems with a numerical aperture of 0.25 has been already available. In addition, mask defects are rapidly decreasing, highly resoluble low molecule resists have been developed, and fine patterns with small line edge roughness are printed. However, all the exposure sources, masks, resists, and optics have not been technically sufficient for the practical use yet.

On the other hand, ArF immersion lithography with some innovative technology is now considered as one of the most prospective candidate for from 32 to 22-nm half-pitch. Double patterning or double exposure enables to print condensed patterns by dividing the patterns into two groups. Immersion lithography using a high refractive-index fluid makes the numerical aperture up to 1.5-1.6. To realize this concept, development of high-index resists and lens materials should be required simultaneously.

Mask less lithography (ML2) using electron beams is still kept as the back-up candidate according to the high resolution performance, though the low throughput is very difficult to be improved.

It will be quite hard to print patterns with a half pitch of less than 22 nm required in the roadmap even though any candidates shown above were applied. However, miniaturization targets have to be cleared overcoming various problems as they were cleared one after another in the past.
(Investigation Committee (TC): Advanced Technology for Lithography)

1) International Technology Roadmap for Semiconductors: ITRS 2006 Update, Lithography, http://www.itrs.net/Links/2006Update/2006UpdateFinal.htm

Electromagnetic wave in the far-infrared or THz frequency from 0.1~10THz attracts attentions in various researches and applications. There are, however, quite few radiation sources in this frequency region. Gyrotron is one of the candidates as a high power radiation source. It has been developed/applied mainly in the microwave or lower frequency. Idehara et al. of Fukui University (FU) have been researching on various kind of gyrotrons including higher frequency over 1 THz.

Gyrotron FU Series has already achieved high frequency operation up to 0.89 THz by using a 17 T magnet and the second harmonic operation. Recently, a gyrotron in FIR FU with a 21 T pulse magnet achieved the breakthrough of 1 THz. In the gyrotron, a demountable gyrotron tube is installed on the center axis of 21 T pulse magnet. In the operation test, a high voltage pulse is applied to electron gun installed in the region of the maximum field intensity B. When B is changed, many cavity modes are excited at the fundamental and second harmonic of electron cyclotron frequency. The second harmonic radiation is separated from the fundamental by using a high pass filter. Observed frequencies are ranged from 395 GHz to 1,005 GHz. The maximum frequency is achieved by the second harmonic operation of $TE_{6,11}$ cavity mode. Corresponding field intensity B is 19.1 T. Now we are trying to increase the frequency by increasing B.[1)]

For convenience of the application, CW gyrotrons (Gyrotron FU CW Series) is being developed. Gyrotron FU CW I has been developed and succeeded in the CW operation at 300 GHz under high power of 1.8 kW. The next gyrotron, Gyrotrons FU CW II and III are being developed. Gyrotron FU CW II with an 8 T liquid He free superconducting magnet, the second gyrotron of the series, has been constructed and the operation test was successfully carried out.[2)] It will be used for enhancing the sensitivity of 600 MHz proton-NMR by use of Dynamic Nuclear Polarization (DNP). The designed operation mode of the gyrotron is $TE_{2,6}$ at the second harmonic. The corresponding frequency is 394.6 GHz. The real operation frequency is 394.3 GHz at TE_{06} mode, because of fabrication error of the diameter of the cavity. The operation is in complete CW at the output power of around 30 W or higher at the TE_{06} cavity mode. There are many other operation modes at the fundamental and the second harmonic. Typical output power of the fundamental and the second harmonic are higher than 100 W and 20 W, respectively. The thirs gyrotron, Gyrotron FU CW III with 20 T superconducting magnet has already been designed and the construction has been almost completed.[3)] The operation test will start soon. (TC: Infrared Application for Safety and Peace)

1) T. Idehara, H. Tsuchiya, O. Watanabe, La Agusu and S. Mitsudo, Int. J. Infrared and Millimeter Waves **27**, 319-331(2006).
2) T. Idehara, I. Ogawa, La Agusu, T. Kanamaki, S. Mitsudo, T. Saito, H. Takahashi, and T. Fujiwara, Int. J. Infrared and Millimeter Waves, **28**, 433-442 (2007)
3) La Agusu, T. Idehara, H. Mori, T. Saito, I. Ogawa, and S. Mitsudo, Int. J. Infrared and Millimeter Waves **28**, 315-328 (2007).

The third topics are light sources. In May 2007 world most authentic symposium series on the light sources “The 11th International Symposium on

Science and Technology of Light Sources" was held in Shanghai. In this symposium, "mercury-free fluorescent lamps", "molecular radiators", "metal-halide lamps" and "solid-sate light sources" were hot-topics. Especially all the oral sessions in one day were fully assigned to solid state lighting. Also the First International Conference on White LEDs and Solid State Lighting will be held in Japan in November 2007. These momentums show the light source researchers and lighting companies are strongly interested in solid state light sources.

In the field of light sources, research on Mercury-free light sources has been most important topics as well as development of high efficacy light sources for these 10 years. In Japan fluorescent lamps has been main target of mercury-free and less mercury movement because fluorescent lamps are most popular lamps for lighting in Japan. To improve the lifetime and efficacy of fluorescent lamps is also important. Misu's group at Kanagawa University reported the electrodes coated by MgO or diamond thin layer. They improve electron emissivity and reduce ignition and operation voltage. Hatta's group reported molecular UV radiators such as OH, NO and CO and conclude they are hopeful as phosphor exciter or UV source for sterilization. Jinno's group at Ehime University reported that almost half energy is lost through stray capacitor in pulsed Xenon fluorescent lamps, however, by using auxiliary external electrode the efficacy is improved 60%.

As new materials for light sources nanocrystalline silicon particles and silicon nanoparticles are reported by Hirakuri's Group at Tokyo Denki University. The nanoscale silicones can emit any color luminescence by controlling the particle size. This technology is expected to open the door to new lighting devices.The third topics is a light sources for lighting.(TC: Technologies for Next Generation Light Sources)

High Voltage Engineering (HV)

Chairperson: S.Yokoyama (Central Research Institute of Electric Power Industry)
Secretaries: I.Aono (Mitsubishi Electric Corp.), K.Hoshina (Toshiba Corp.)
Assistant Secretary: Y.Mizutani (Central Research Institute of Electric Power Industry)

This technical committee (TC) belongs to Power & Energy (P&E) Society of the IEE of Japan, and supervises activity of investigation on technical subjects related to high voltage engineering. Five investigation committees listed in Table 1 are active in August 2006.

The 5th International Workshop on High Voltage Engineering (IWHV 2007) was held in Shizuoka city, following the 1st IWHV at Okinawa in 1999 , 2nd IWHV at Tottori in 2000 , 3rd IWHV at Fukuoka in 2003 and 4th IWHV at Sapporo city in 2004.

The objective of this workshop is to provide a forum to discuss novel findings in field of high voltage engineering, mainly in Asian countries. The workshop will be organized every alternate fiscal year. Selected contributions of the IWHV with original and interesting findings will appear in a special issue of the Transactions of IEE of Japan.

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

The workshop banquet was held also where many participants changed various information of the world wide technology of electric power industries, and the research on electric discharge phenomena while enjoying the food (and history) .Next IWHV will be held in Autumn of 2008. We hope the next IWHV 2008 will also be valuable workshop for exchanging the information related to rapidly moving technology of high voltage engineering.

In November 2006 a Joint Symposium on High Voltage Power Technology with EIT (The Engineering Institute of Thailand under H.M. The King's Patoronage) meeting of IEEJ was held in Bangkok, Thailand. There were several presentations from Japanese engineers and researchers including the member of TC on High Voltage Engineering.

TC on High Voltage Engineering meeting meets four times a year. One of the meetings will be associated with a technical visit to Kobe area.

The members of the committee other than the chairperson of the investigation committees are from universities (4), a research institute (2), electric power utilities (4) and manufacturers (9).

Table 1. Investigation Committees in TC-HV

Research Subject	Chairperson
Manner of Lighting Damages to Wind Power Stations	S.Yokoyama (CRIEPI)
Insulator Coordination (Performance measurement technology)	T.Matsumoto (Shizuoka University)
Mechanism of Lightning Outages on Low-voltage Distribution Systems	K.Michisita (Shizuoka University)
Surge Phenomena on Low-voltage and Control Circuits	T.Funabashi (Meidensha Corp.)
Numerical Electromagnetic Analysis Methods for Surge Problems	A.Ametani (Doushisha University)

Electrical Wire and Cables (EWC)

Chairperson: Takahisa Imajo (Central Research Institute of Electric Power Industry)
Secretary: Shigekazu Yokoyama (Viscas Corporation)
Assistant Secretary: 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 includes members from universities, power utilities, the JR railway company, Japan Electric Cable Technology Center, JECTEC and cable manufacturers. The technical committee holds technical meetings to promote R&D activities in this field and provides an opportunity to present the results of technical achievements. Tree technical meetings was held as the joint meeting with TC-DEI, on February 8, 2007, in Tokyo, and focused on the subject of “Deterioration Diagnosis and Online Monitoring System”. In addition to organizing such technical meetings, the technical committee supervises investigation committee dealing with subjects, which are related to electrical wire and cables.

During the several years of activity, the Investigation Committee for Technology of Wires and Associated Accessories for Overhead Transmission Lines, the Investigation Committee for Computer Software and Its Application for Power Cable Line, and the Investigation Committee for Accessories for 66kV and Higher Voltage XLPE Power Cable were organized. This year, an investigation committee is in action. The name and chairperson of the committee are listed in Table 1.

Occasionally a technical visit by the committee members is made to encourage study on the advanced science and technology. This year, the committee members visited The General Control Center of Shinkansen Transport Department and Electric Power Dispatchers by East Japan Railway Company.

Table 1 Investigation Committee in TC-EWC

Research Subject	**Chairperson**
Technical Trend and Problem for Underground cable Distribution System	J.Motohashi

Instrumentation and Measurement (IM)

Chairperson: Katsunori Shida (Saga University)
Vice- Chairperson: Yoshitaka Sakumoto (Japan Electric Meters Inspection Corporation)
Secretaries: Terumitsu Shirai (Japan Electric Meters Inspection Corporation)

The field of instrumentation and measurement technology is very wide and has a long history. The activity of our committee is always influenced by the technological trend in the era.

The early activities of this committee have mainly focused upon the presentation and discussion of studies and researches in the fields of electrical standards and precise measurement in various electrical fields. It is the reason that our committee is now categorized in the society A (Fundamentals and Materials) of IEEJ. Technological contents in our committee have, however, gradually shifted to various electrical and electronic fields.

Annual activities in the technical committee of instrumentation and measurement have roughly introduced as follows.

i) The general meeting of the committee is held four times every year for discussing the various activities of the committee. 15 members including a chairman, two secretaries and an assistant-secretary constitute the committee.
ii) The meeting by the chairman, the secretary and the assistant-secretary is held four times every year for tentatively planning the activities of the committee.
iii) The workshops for the presentation and discussion of studies and researches are taken place almost every month in principle as a main activity.
iv) The professional research committee for special subject is under consideration.
v) The visit of professional facility is planning to carry out once or twice per year.

The actual subject matters in the workshop are the presentation and the discussion of extensive electronic instrumentation and measurement technologies including;

Ultra-high speed electronic instrumentation
Electro-magnetic measurement related with electrical environment
Optical measurement applied to electronic instrumentation
High precision electronic instrumentation applied to frequencies and time domain
Bio-electronic measurement applicable to the welfare field in society shifted to the aged
Magnetic measurement related to magnetic sensors.

The workshops mainly take place at Tokyo area, and sometimes in Saga (Kyushu Island), in Osaka and in others. The theme of presentation in the workshop is usually focused on the electromagnetic measurement, the remote control instrumentation, the application of optical measurement, the biological electronic measurement, the time and frequency measurement, the application of magnetic measurement and so on, but in several workshops, miscellaneous subjects are acceptable to present and discuss there.

The number of annual presentation in the workshops is around 70 titles. The workshop is supported by IEEE IM and sometimes by other organization.

A professional research committee for special subject is now under consideration.

Our committee website (http://www.im-ieej.com/) also assists to understand our activity.

Written by **Prof. Katsunori Shida**, Chairman (Saga University) e-mail: shida@cc.saga-u.ac.jp

The visit of Shimadzu Museum in Kyoto by the committee members

Metal and Ceramics (MC)

Chairperson: Yasuzo Tanaka (International Superconductivity Technology Center)
Secretary: Masanao Mimura (The Furukawa Electric Co., Ltd.).

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

Mission of TC-MC

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

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

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

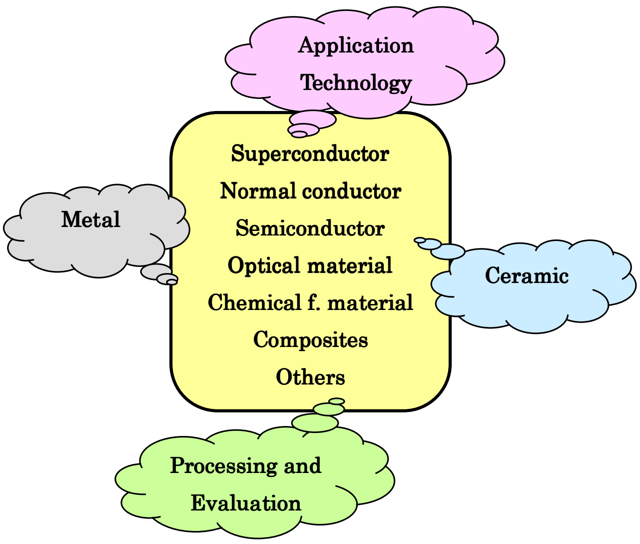


Figure 1 Activity scope of the TC-MC

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 Investigation Committee and the Study Meeting 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. Last three years, we provided new three technologies and related materials such the attractive carbon nano-tube and the functional diamond.

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

Last year, two study meetings were held in TC-MC, in which one meeting held on November 28 was jointed with TC-Magnetics.

Activities of Investigation Committee in TC-MC

As of 2007, there is one investigation committee under TC-MC as shown in Table 3, the name of which is “Fabrication technologies and characterizations of advanced superconducting materials”. The chairperson and secretary are Dr. Hiroaki Kumakura (National Institute for Materials Science, NIMS) and Dr. Takao Takeuchi (NIMS), respectively. Regularly, there are six 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 produce a long-length wire for MgB_2 and Y-based oxide, 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. As an intermediate result, 3-1¥/Am-coated conductors of the Y-based oxide superconductor will be available in the near future.

Table 1 Symposiums in the National Convention of the IEEJ

Theme	Date	Site
Attractive carbon nano-tube as a new electric and electronic material	2004.03.17	Aoyama-Gakuin University
Remarkably advanced diamond for electric and electronic materials	2005.03.17	Tokushima University
Electrode materials for fuel cells and the secondary butteries	2006.03.17	Yokohama National University

Table 2 Study Meetings in TC-MC including a Joint Meeting

Theme	Date	Site
Magnetic materials, general magnetic applications, and nano-scale superconductors*	2006.11.28	Yokohama National University
Advanced electrode materials for fuel cells and a field trip	2006.12.05	Gas-no-Kagakukan in Tokyo Gas Co., Ltd.

Note * This meeting was jointed with Technical Committee on Magnetics in IEEEJ

Table 3 Investigation Committees under the TC-MC

Research Subject	Chairperson (Affiliation)	Period	Remarks
Superconducting materials and electronic devices	Nobuyuki Yoshikawa (Yokohama National University)	1999.10-2002.09	Close
Wire and conductor forming of superconducting materials	Shirabe Akita (CRIEPI)	2001.10-2004.09	Close
Fabrication technologies and characterization of advanced superconducting materials	Hiroaki Kumakura (NIMS)	2004.10-2007.09	Active

(Manuscript received September 28, 2007)

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.)

Japanese National Committee for TC15 had four meetings in the last year. Nearly 170 standards concerning with specifications for electrical insulating materials are under the responsibility of TC15. TC15 has 5 WGs and 4 MTs, which are concerning with wide range of insulating materials such as inorganic materials, polymeric films and tubes, resins, cellulosic boards, mica papers, etc. Last year, more than 20 drafts for standardization have been received from IEC Central Office, including CD, CDV and FDIS, all of which were circulated in the member of the national committee and discussed in the meetings of the national committee.

To contribute to the activities in TC15, the experts from Japan are participating in WG5, WG7, and WG9.

TC15 plenary meeting has been annually held. This year, the meeting was held during the 3rd week in May in Prague, Czech Republic. More than 25 persons were attended in the meeting.

In the year before last, IEC SC15C was transformed into IEC new TC15 by a decision of IEC SMB, because a new TC112 was constructed merging TC98 into SC15E. The corresponding Japanese National committees were reconstructed according to the IEC new structure. The title of new TC15 is “Solid Insulating Material”. The revised scope of the new TC15 was accepted by the members attended in Prague meeting, which is “To prepare international standards 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.”

CIGRE SC D1 Japanese National Committee (Materials and Emerging Technologies)

Chairperson: M. Nagao (Toyohashi University of Technology)
Secretary: T. Shimizu (Toshiba Corporation)
N.Hozumi (Aichi Institute of Technology)
Assistant Secretary: T. Takahashi (CRIEPI)

CIGRE (International Council on Large Electric Systems) consists of 16 Study Committees (SC) belonging to 4 categories: A (Equipment), B (Subsystems), C (Systems) and D (Horizontal). Among them, our SC D1 "Materials and Emerging Technologies" has a horizontal character which contributes to other CIGRE SC's. The activity of CIGRE SC is research oriented one, although some of them are in conjunction with those of the related IEC Committees.

SC D1 has now following 14 Advisory Groups (AG), Working Groups (WG) and Task Forces (TF); SAG (Strategic AG), CAG (Customer AG), AG D1.01 (Fluid-Impregnated Insulating Systems), AG D1.03 (Insulating Gases), AG D1.05 (Capacitors), AG D1.06 (Solid Insulating Materials), WG D1.07 (Solid Insulating Materials for Rotating Machines), WG D1.14 (Material Properties for Nonceramic Outdoor Insulation), WG D1.15 (HTSC-Material Applications & Cooling), WG D1.16 (High Field Phenomena in Solid Insulation and Interface), WG D1.17 (HV Asset Condition Assessment Tools, Data Quality and Expert Systems), WG D1.18 (Impact of Emerging Generation Technology), AG D1.02 (WG D1.33) (HV Test and Measuring Techniques), SCTF D1.01 (Non-destructive Water Treeing Detection in MV XLPE Cables) and SCTF D1.02 (Solid Insulation Endurance under Transient Voltages).

The preferential subject of 2008 SC D1 Paris

Group meeting are as follows, PS1: Status of emerging technologies for power systems, PS2: Diagnostic of material properties in power equipment (Development and practical experiences), PS3: Challenges for materials in future power systems. From Japan, following 3 papers were submitted and all of them are approved for submission under the severe selection; "Advanced On-site Monitoring and Diagnostics Techniques for Gas Insulated Switchgears" by H.Hama, et al., "Material Challenge of MgO/LDPE Nano-composite for High Field Electrical Insulation" by M.Nagao, et al., "Development of a High-voltage Large-capacity Electric Double-layer Capacitor and Its Application to the Voltage Sag Compensator" by S.Sugimoto, et al.

The next 2007 International SC D1 meeting is scheduled in Gyeongju, Korea in conjunction with SC A1 meeting. The Joint Colloquium on “Insulation systems for electrical machines” is also scheduled on October 24, 2007 during the meeting. The very hot brief report of CIGRE SC D1 Korea meeting and D1/A1 Joint Colloquium is described in the Conference Report part of this magazine.

The Japanese National SC D1 has usually 3 or 4 meetings a year.

RESEARCH ACTIVITIES AND TECHNICAL EXCHANGES IN ASIAN COUNTRIES

Conference Records

IEC WG/MT meetings on rotating machine insulation in Tokyo

From 16th to 20th April, 2007, three IEC WG/MT meetings were held in the Japan Electrical Manufacturers' Association (JEMA) headquarter building shown in Fig.1, Tokyo. The common scope of three meetings is standardization and standard maintenance on rotating machine insulation. Totally 15 members from 10 countries overseas (Austria, Canada, Denmark, France, Germany, Italy, Portugal, Sweden, UK and USA) and Japanese experts joined the meetings to discuss more than 10 IEC documents. IEC WGs consist of experts of the relevant technical fields over the world. Since the members of each meeting were overlapped, plural IEC WG/MT meetings have been held in series at a same place twice a year. The Tokyo meetings followed Jaragua do Sul meeting in Brazil in February 2006 and Berlin meeting in September 2006.

Figure 1 JEMA building in Tokyo

TC 112 WG 3 meeting

On Monday there was IEC/TC112/WG3 meeting on the maintenance of IEC61934TS: Electrical insulating materials and systems - Electrical measurement of partial discharges (PD) under short rise time and repetitive voltage impulses. The IEC Technical Specification (TS) was published on April 2006. The document describes PD measuring methods with repetitive voltage impulses from modern power devices such as IGBT. Main concerns are to detect PD in windings of converter-driven motors. Transient impulse generates due to impedance mismatch between converter, cable and motor winding. The square voltage with overshoot impulse as shown in Fig. 2 causes local impulse voltage at the first turn-to-turn of the stator winding. The influence of the repetitive impulses on insulation system of rotating machine winding has been investigated globally and a number of papers has been reported in IEEE-sponsored meetings. Today, power drive systems (PDS) are and will be applied drastically in number; especially hybrid vehicles (HV) and so on for environmental-friendly vehicles. The document is closely related to IEC60034-18-41 on converter-driven motor discussed in Tuesday. As operating voltage and switching frequency of power devices increase, the peak values of impulses may exceeds to PD inception voltage.

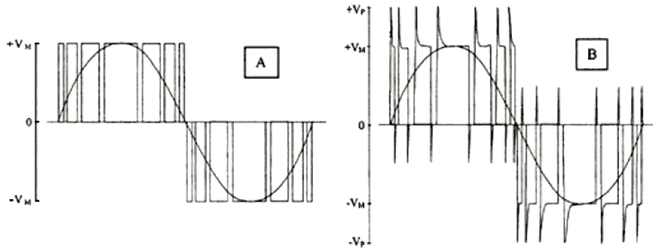


Figure 2 Repetitive impulses on square wave of PWM in converter-driven motor

One of the difficulties of PD detection is that rise time of the impulse voltage is much shorter that a microsecond, or tens nanoseconds in the case of modern IGBT devices. The displacement current due to such a short-rise time impulse has frequency component till tens MHz which cover most of PD pulse current detected with conventional PD monitors. To cope with the problem, PD measuring methods in ultra high frequency (UHF) region may be inevitable. The other problems are from high repetition rate of voltage impulses in kHz from power converters. PD inception or extinction voltages have to be defined and treated as stochastic data treatment.

After Dr. K. Kimura, Project Leader, opened the meeting, Mr. B. Goettert, the Secretary of IECTC112, explained the policy of TC112 organization. Then, recent research review was presented by Prof. M. Hikita from Kyushu Institute of Technology, Japan. PDIV with bipolar repetitive impulses shows unstable behavior, while unipolar repetitive impulses show stable PD inception. The repetitive PDIV/PDEV

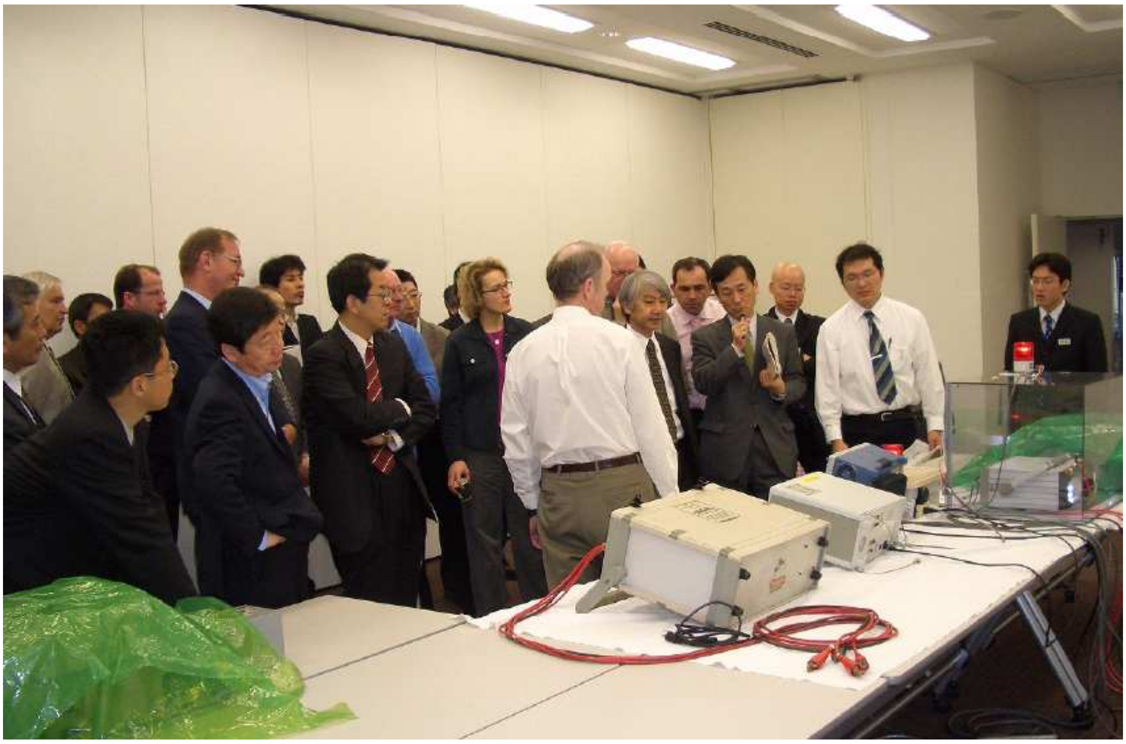


Figure 3. Demonstration of a PD monitor with a repetitive impulse generator.

characteristics were also reported using a sawtooth envelope of bipolar repetitive impulses. The other catalyst for discussion was the demonstration of a PD monitor specially designed for repetitive impulses. Using two impulse generators, twisted-pair and several aged motors, Dr. G. Stone has shown the typical PD pulse waveforms. He also emphasized the necessity of noise reduction from impulse generators. Figure 3 shows heated discussion during the demonstrations. Free discussions continued for the improvement of IEC61934TS Ed1.0 which will be proposed in the coming TC112 meeting in September 2006 in Nagoya, Japan.

TC 2 WG 27 meeting

On Tuesday and Wednesday WG27 meeting was held to discuss Committee Draft (CD) of IEC60034-18-42; Qualification and acceptance tests for Type II electrical insulation systems used in rotating electrical machines fed from voltage converters. Dr. J. Wheeler convened the several-years-long working group. Eleven members and 9 guests joined

A list of comments sent to IEC by National Committees, 2(1419)CD had been circulated before the meeting and formed the basis for the discussions. The 98 formal comments and other informal points were discussed and agreement was reached on the changes required. Many small changes to the text were agreed.

On Wednesday WG27 discussed on the revision of IEC 60034-15: Rotating electrical machines-Part 15: Impulse voltage withstand levels of rotating a. c. machines with form-wound stator coils. National Committee comments on the proposed revisions to this Standard had been circulated to WG Members prior to the meeting. There were several editorial changes which were accepted from amongst the 72 comments.

Figure 4. Word-for-word discussion on a draft in IEC TC2WG27 meeting

TC 2 MT 10 meeting

On Thursday and Friday MT10 meeting convened by Dr. M. Kaufhold was held in the same room. TC2MT10 is responsible for the maintenance of IEC60034-18 series; Rotating electrical machines -Functional evaluation of insulation systems.

At first, the following relevant standards from TC112 (Merge of former SC15E and TC98) were shortly reviewed; duo logo 60727/IEEE930, 60505, 60085 and 60216. Then, the standards of IEC60034-

18 series were reviewed as follows.

1) 60034-18-1
2) 60034-18-21; Test procedures for wire-wound windings – Thermal evaluation and classification
3) 60034-18-22; - Classification of changes and insulation component substitutions
4) 60034-18-31; Test procedures for formed-wound windings – Thermal evaluation and classification of insulation systems used in machines up to and including 50MVA and 15kV
5) 60034-18-32: -Electrical evaluation of insulation systems used in machines up to and including 50MVA and 15kV
6) 60034-18-33; Multifactor functional evaluation - Endurance under combined thermal and electrical stresses of insulation systems used in machines up to and including 50MVA and 15kV
7) 60034-18-34; Evaluation of thermomechanical endurance of insulation systems

The next IEC WG meeting on coil insulation will be held September 24-28, 2007 in Arnhem, Netherlands. TC2WG29 will be conjunct with TC2WG27, TC2MT10 and TC112WG3. Most of members are overlapped in the four meetings. As for the 2008 meetings, Stockholm will be candidate place.

Figure 5 Discussion among motor insulation experts in IEC TC2 MT10 meeting

By Dr. Ken Kimura
Former Visiting Professor of Kyushu Institute of Technology

International Conference on Electrical Engineering 2007 (ICEE 2007)

Dates: July 8-12, 2007
Venue: Hotel Nikko Hong-Kong, Hong-Kong,
Organizer: HKIE
Co-organizers: CSEE, IEEJ, KIEE
Chairperson: Prof. CHAN, Ching Chuen (Hong-Kong)
URL: http://www.icee-hk.org

Purpose and outline:

The International Conference on Electrical Engineering (ICEE) aims to provide a forum for sharing knowledge, experience and creative ideas among worldwide electrical engineers. This is an annual forum for electrical engineers from major players in Japan, Korea, the Mainland China, Hong-Kong and worldwide, to share new ideas, achievements and experiences through presentations and discussions on sustainability and reliability issues. The theme of the ICEE 2007 is "Intelligent, Clean, Efficient Electricity for the 21st Century with focus on sustainability and reliability". A number of panel discussion sessions with invited speakers were organized to address current issues related to Electrical Engineering.

Number of attendees: 438 persons (Japan 149, Korea 92, Hong-Kong 77, China 48, Others 50)

Number of Papers: 340 papers (Japan 114, Korea 104, China 45, Hong-Kong 27, Others 52) Oral 160, Poster 180

Program:

Keynote speeches 6, Oral session 31, Poster session 5, Panel discussion 3

Session theme and number of related papers (Oral/Poster):

Power system & Energy 192(103/89), Fundamental materials and Education 30(6/24), Information & Control system 32(15/17), Electrical machine, Power electronics & Industry applications 47(27/20), Sensors & Micro-machines 18(3/15), Others 22(7/15)

Keynote speeches:

1. High Temperature Superconductivity and Sustainable Economic Development in China
2. Shedding light on blackouts
3. Electric power supply – The engineering challenges
4. Applied Superconducting Power System Apparatuses
5. U-City and IB Certification
6. Current Situation and Prospect of Renewable Power Generation in China

Panel discussions:

1. Photonic Sensors in Electrical Engineering
2. Emerging Technology for Electrical Engineering
3. Electric Power Market and Sustainable Reliability

Opening ceremony

Keynote presentation by Prof. Paul C.W. Chu (China)

Poster session

Conference dinner

(Photos were downloaded from the website of ICEE2007
http://www.icee-hk.org/downloads.htm)

IEC TC112 Nagoya Meeting

TC112 Japanese National Committee

Chair N. SHIMIZU (Meijo University)

1. Introduction

IEC TC 112 meets every year, usually in the full season. This year, the meeting was held in September at the Meijo University in Nagoya, Japan. Including WG meetings, 9 meetings were held from 10th Monday to 14th Friday, September. 42 experts from 10 countries got together in those meetings, a total of 134 people participated. In this report, the outline of IEC TC112 Nagoya Meeting will be described.

2. Framework of TC112

TC 112 was established in 2005 May by a merger of SC 15 E "Insulating Materials - Methods of Test" and "TC 98 Electrical Insulation Systems". The chairman of TC112 is Dr. P.Ronca (Canada) and the secretary is Mr. B.Goettert (Germany) respectively. The title, the scope, the horizontal function and the horizontal safety function at the present time are as follow.

Title: "Evaluation and Qualification of Electrical Insulating Materials and Systems"

Scope: "To prepare International Standards covering methods of evaluation and qualification for electrical and electronic insulating materials and electrical insulation systems"

Horizontal function: "Short term and Endurance tests and qualification for electrical insulating materials and electrical insulation systems"

Horizontal Safety Function: "Test methods for resistance to tracking."

The members of TC112 as of Oct. 2007 are 20 countries as the participant (P) member and 6 countries as observer (O) member. Those countries are shown in Table 1.

TC112 has 8 working groups, of which titles and convenors are shown in Table 2.

Table 1 TC 112 Membership

Participating Member (20 countries) AUSTRIA (AT) BELGIUM (BE) CANADA (CA) CHINA (CN) CZECH REPUBLIC (CZ) DENMARK (DK) FRANCE (FR) GERMANY (DE) ITALY (IT) JAPAN (JP) NETHERLANDS (NL) POLAND (PL) PORTUGAL (PT) ROMANIA (RO) RUSSIAN FEDERATION (RU) SWEDEN (SE) SWITZERLAND (CH) UKRAINE (UA) UNITED KINGDOM (GB) UNITED STATES OF AMERICA (US)
Observer Member (6 countries) FINLAND (FI) SPAIN (ES) SERBIA AND MONTENEGRO (CS) SLOVAKIA (SK) SOUTH AFRICA (ZA) THAILAND (TH)

Table 2 WGs of TC112 and Convenors

WG.	Title	Convenor
WG 1	Thermal Endurance	Prof. Montanari, IT
WG 2	Radiation	Mr. Dawson, UK
WG 3	Electric Strength	Prof. Stimper, DE
WG 4	Dielectric / Resistive Properties	Mr. Haupt, DE
WG 5	Tracking	Dr. Winter, DE
WG 6	General Methods of Evaluation of Electrical Insulation	Dr. Densley, CA
WG 7	Statistics	Dr. Okamoto, JP
WG 8	Various Material Properties	Prof. Shimizu, JP

3. TC112 Nagoya Meeting

The plenary meeting of TC112 and the meetings of WGs were held at Meijo University from 10th to 14th September this year. 42 experts from 10 countries over the world got together and participated in those meetings as delegates or observers. Table 3 shows the countries and the numbers of the participants.

Table 4 indicates the meetings schedule including the social functions of the banquet and the technical tour. The total number of participants to the meetings was 134, excluding the banquet and the technical tour. Table 4 also shows the number of the participants to the each meeting.

Table 3 Delegates to TC112 Nagoya Meeting

Country	Number of Delegates or Observers
Austria	1
Canada	3
China	3
Denmark	1
Germany	6
Italy	1
Romania	1
U.K.	2
U.S.A.	6
Japan	18
10 countries	42

Table 4 Schedule of TC112 Nagoya Meeting

Date	Meeting	Time	Number of participants
Mon. 10th	WG4	Am (09:00-12:30) & pm (14:00-17:30)	6
	WG7	after WG4	6
Tue. 11th	WG6	Am (09:00-12:30) & pm (14:00-17:30)	18
	WG8	After WG.6	7
Wed. 12th	Advisory Group Meeting	am (09:00-12:00)	7
	Technical Tour	13:50 - 18:00	32
Thu. 13th	WG1	am (09:00-12:30)	27
	WG2	am (09:00-12:30) & pm (14:00-17:30)	6
	WG3	pm (14:00-17:30)	21
	Banquet	(19:00-21:00)	45
Fri. 14th	Plenary Meeting	am (09:00-12:00) & pm (14:00-17:30)	36

The banquet was held in the Hotel Nagoya Garden Palace, at which the most participants stayed. The number of the participants to the banquet are 45, which includes 5 accompanied people and 4 staffs. The technical tour visited to the 2 places; one was the Toyota Commemorative Museum of Industry and Technology and the other was the Noritake Garden. The number of the participants to the technical tour was 32 including 5 accompanied people and 3 staffs.

Fig.1-4 show the photographs taken in the meetings and the banquet.

4. Acknowledgement.

The TC112 Nagoya meeting was supported by over 40 organizations. The IEC TC112 Japanese National Committee expresses its deep thanks to the those organizations.

Fig.1　The plenary meeting.

Fig.2　Coffee break

Fig.3　A table of the banquet.

From left to right;
Mrs. Ronca (CA), Mr.Goettert (Secretary, DE), Mrs. Henriksen (DK), Prof. Henriksen (DK) and Mrs. Densley (CA).

Fig. 4　The participants to the banquet

On the front row sitting, from left to right; Ms.Zhu (CN), Ms.Xu (CN), Ms.Lui (CN), Mrs. Henriksen (DK), Mr.Goettert (Secretary, DE), Dr. Ronca (Chairman, CA), Prof.Shimizu (Chair of Japanese NC, JP), Mrs. Shimizu (JP), Mrs. Ronca (CA) and Mrs. Panteny, and the other 34 people standing.

CIGRE SC A1 and D1 Joint Colloquium and Related Meetings in Korea

CIGRE SC D1 Korean National Committee
Chair JA-YOON KOO (Hanyang University)

CIGRE SC D1 Japanese National Committee
Chair M. NAGAO (Toyohashi University of Technology)

1. Introduction

CIGRE SC A1 & D1 Joint Colloquium & SC related meetings were held at Hilton Hotel in Gyeongju city, Korea, from the 21st to the 26th of October, 2007. This meeting was organized by CIGRE Study Committee A1 & D1 and Korean National Committee of CIGRE in order to discuss and to share the knowledge, experiences and new potential ideas for the future in the field of Rotating Electrical Machines (SC A1) and Materials and Emerging Technologies (SC D1).

2. Summary on CIGRE SC A1 & D1 Joint Colloquium

2007 CIGRE SC A1 & D1 Joint Colloquium was held on 24th of October. There attended more than 200 registered participants from manufactures, utilities, research institutes and universities and from 19 countries, shown in the following table.

Participant's countries and numbers

Country	Number	Country	Number
Korea	100	Israel	2
Japan	19	Spain	2
Germany	15	Sweden	2
Switzerland	8	U.K.	1
Canada	7	Belgium	1
France	6	Brazil	1
Netherlands	5	Hungary	1
USA	5	India	1
Australia	4	Italy	1
Finland	3	Mexico	1
Russia	2	New Zealand	1
Austria	2	Norway	1
Croatia	2	Romania	1
Denmark	2	South Africa	1
Poland	2	**Total**	**201**

In the colloquium, 37 papers on the following 5 technical fields were presented and discussed;

1. Partial Discharge Measures and Diagnostic Technique
2. Electrical Insulation and Dielectric Materials
3. Insulation Application in Electrical Machines
4. New Insulation Development for Electrical Machines
5. Life Assessment Techniques

Most prominent professionals and researchers such as Prof. Ernst Gockenbach, Mr. Gert Coetzee, and Prof. Toshikatsu Tanaka, gave all participants the informative and distinguished lectures as the highlights of the whole occasions. The session titles and the number of papers for both oral and poster presentations are summarized in the next table. If you want to know the title and the authors in each paper, please visit the EINA Magazine Website (http://eina.ws).

Memorial photo of all participants
in 2007 CIGRE SC A1 and D1 Joint Colloquium and Related Meetings in Korea

Session titles and the number of papers

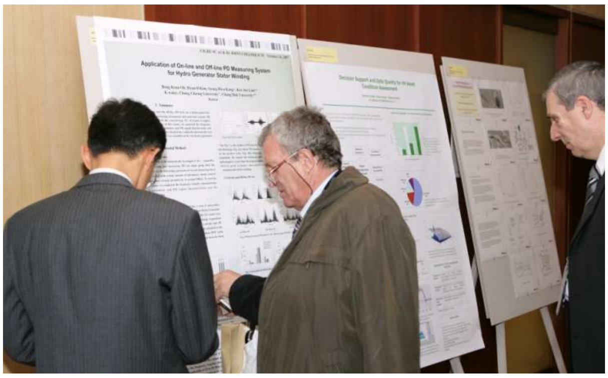
Oral Presentation (18 papers)	
	Insulation Materials for Rotating Machines (3)
	Asset Management for Power Apparatus (2)
	Quality Control Test (3)
	Insulation Test for Rotating Machines (6)
	Field Experiences in Rotating Machines Diagnosis (4)
Poster Presentation (19 papers)	

Mr. G. Coetzee (SC A1 Chairman)

Prof. E. Gockenbach (SC D1 Chairman)

CIGRE SC A1 & D1 Joint Colloquium:
Session Chairs

CIGRE SC A1 & D1 Joint Colloquium:
Oral Presentation



CIGRE SC A1 & D1 Joint Colloquium:
Poster Presentation

3. Summary on CIGRE SC A1 & D1 Related Meetings

During the CIGRE Korea meeting, SC A1 & SC D1 Members had their own study committee meetings, respectively. The schedules are shown in the next tables.

The schedule of CIGRE SC A1 related meetings

Date	Morning	Afternoon	Other activities
10/ 21 (Sun)		WG A1.01 WG A1.06	
10/ 22 (Mon)	WG A1.02 WG A1.05	Technical Visits (Hyundai)	Dinner (Hyundai)
10/ 23 (Tue)	Technical Visits (Hyosung)	Technical Visits (Doosan)	Lunch (Hyosung) Dinner (Doosan)
10/ 24 (Wed)	Joint Colloquium	Joint Colloquium	Banquet (CIGRE Korea)
10/ 25 (Thu)	SC A1 Meeting	SC A1 Meeting	

The schedule of CIGRE SC D1 related meetings

Date	Morning	Afternoon	Other activities
10/ 21 (Sun)		WG D1.07 WG D1.16 AG D1.02	
10/ 22 (Mon)	SC TF 01 WG D1.16 TF D1.03.09 WG D1.17 (TF01&02)	Technical Visits (Hyundai)	Dinner (Hyundai)
10/ 23 (Tue)	Technical Visits (Hyosung) TF D1.33.01 TF D1.33.05	Technical Visits (Doosan) TFD1.33.03 TFD1.33.04	Lunch (Hyosung) Dinner (Doosan)
10/ 24 (Wed)	Joint Colloquium TF D1.03.11	Joint Colloquium AG D1.03	Banquet (CIGRE Korea)
10/ 25 (Thu)	CSAG SCD1 WG D1.14 TF D1.33.01 TF D1.33.05	SCTFD1.02 WG D1.14 AG D1.33 AG D1.04	
10/ 26 (Fri)	SC D1 Meeting	SC D1 Meeting	

4. Summary on Technical Visits and Banquet.

Taking the opportunities it was scheduled to visit 4 leading Korean companies as Technical Tour: Doosan Heavy Industries & Construction, Hyosung Power & Industrial Systems PG, Hyundai Heavy Industries Co., and Korea East-West Power in the afternoon of the 22nd and for full day of 23rd of October. It was really wonderful and informative occasion to see and understand the current situation of Korean Industries' advanced manufacturing technologies for the power apparatus under their warm hospitality.

CIGRE SC A1 & D1 Technical Visit

The Banquet was held in the evening of the 23rd of October, after the Joint Colloquium. It started with the welcome speeches of CIGRE Korean National Committee Chair, Prof. John Koo, SC chairmen and sponsored companies. All the participants really enjoyed the delicious foods and the beautiful and traditional Korean attractions.

CIGRE SC A1 & D1 Joint Colloquium: Banquet

4. Final Remark

The CIGRE SC A1 and D1 Joint Colloquium and the related meetings, Technical Visits and Banquet were really beneficial one for all the participants. They had a memorable time with many new and old friends at the beautiful, cultural and historical city, Gyeongju which was the capital city of Shilla dynasty for about 600 years (354 - 935) with world heritages such as Bulkuksa Temple, Seokguram Grotto, etc.

International Conferences to be held in Asia

CMD 2008 (International Conference on Condition Monitoring and Diagnosis)

Dates: April 21-24, 2008
Venue: Central Garden Hotel, Beijing, China
Chairman: Cheng Rong Li (North China Electric Power Univ. / China)

Insulation condition monitoring and fault diagnosis are extremely important for the reliability and safety of industrial application systems. CMD 2008 will provide a forum for presentations and discussions among engineers and researchers with the view of sharing knowledge, experiences and ideas in this area.
CMD 2008 will be held in Beijing, China, and organized by North China Electric Power University, technically sponsored by CIGRE, IET, IEEE DEIS, NSFC, CSEE and CES. Beijing is the capital of the People's Republic of China. It is not only the nation's political center, but also its cultural, scientific and educational center. Between 1115 and 1911, Beijing served as the capital of the Jin, Yuan, Ming and Qing dynasties, thus becoming a storehouse of Chinese culture, and leaving many superb historical legacies. As the Host City of 2008 Olympic Games, Beijing has become one of the most attractive tourist destinations in the world. So bring your family with you and enjoy the tourist attractions in Beijing.

Key dates:
Abstract Submission October 31, 2007 (Extended from Sep. 30, 2007)
Full Paper Submission January 15, 2008
Secretariat: Mr. Ming Li, Dr. Zhiguo Tang
P.O.Box393#, P.O. Box82#
North China Electric Power University, No.2 Bei Nong Lu, Zhu Xin Zhuang
Chang Ping District, Beijing, 102206, P.R.China
Tel: +86-10-51971630, +86-10-51971617
Fax: +86-10-80795842
Email: secretary@cmd2008.com
URL: http://www.cmd2008.com

ICEE 2008 (International Conference on Electrical Engineering)

Dates: July 6-10, 2008
Venue: Okinawa Convention Center, Okinawa, Japan
Organizer: The Institute of Electrical Engineers of Japan (IEEJ)
Co-organizers:
The Korean institute of Electrical Engineers (KIEE)
The Chinese Society for Electrical Engineering (CSEE)
The Hong Kong Institution of Engineers (HKIE)

The International Conference on Electrical Engineering (ICEE) aims to provide a forum for sharing knowledge, experience and creative ideas among world electrical engineers. Since ICEE the First 1995, it has been successfully held once a year. It is a great pleasure for the IEEJ and co-organizers KIEE, CSEE, and HKIE to invite potential authors who have significant contributions in electrical engineering fields to submit papers.

Key dates:
Abstract Submission December 31, 2007
Full Paper Submission April 1, 2008
Secretariat:
Homat Horizon Bldg. 8FL., 6-2, Gobancho, Chiyoda-ku Tokyo 102-0076, JAPAN
Fax: +81-3-3221-3704
E-mail: icee2008-secre@iee.or.jp
URL: http://www.icee-okinawa.org/

ISEIM2008 (2008 International Symposium on Electrical Insulating Materials)

Dates: September 7-11, 2008
Venue: The Yokkaichi Cultural Hall, Yokkaichi-city, Japan
Chairman: Naohiro Hozumi (Aichi Institute of Technology, Japan)

ISEIM2008 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. ISEIM2008 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.

The conference venue, the city of Yokkaichi, is located near the geographical center of Japan and next to Nagoya. With the Suzuka Mountains to the west and Ise Bay to the east, Yokkaichi enjoys a varied natural environment. It has a rich history of flourishing trade and culture. Modern industry has also taken root in this thriving city, and the Port of Yokkaichi represents the city's gateway to the world. Yokkaichi is clearly a place of a bright future.

Key dates:

Abstract Submission	January 31, 2008
Acceptance Notices	Middle of March, 2008
Manuscript Submission	May 30, 2008

Secretariat: Dr. Toshihiro Takahashi
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Email: iseim2008@freeml.com

URL: http://www2.iee.or.jp/~adei/ISEIM2008/

Laboratory of Advanced Technology of Electrical Engineering & Energy Shenzhen Graduate School, Tsinghua University

Zhidong Jia
Tsinghua University, China

I. Introduction

Laboratory of Advanced Technology of Electrical Engineering & Energy (LATEEE) is part of the **Shenzhen Branch of National Key Laboratory for Power System,** and it is also supported by the **High Voltage Outdoor Insulation Laboratory, Electrical Engineering department, Tsinghua University.** The Laboratory is located in Building L, Graduate School at Shenzhen, Tsinghua University. With an area of 320 square meters of laboratory, 150 square meters of offices and a total investment in equipment of 2 million RMB, the Laboratory of Advanced Technology of Electrical Engineering & Energy ranks at the top level among universities worldwide, ensuring an academic and educational prestige in China.

Fig.1 A view of lab

In the laboratory there are four professors (including an academician of the China National Academy of Engineering), 2 postdoctoral researchers, 19 doctoral students and 21 master students.

II Research Directions

The research directions of this laboratory cover the area from traditional high voltage technology (i.e. high voltage discharge along contaminated surface, high voltage experiment and test, dielectric property of high voltage material, insulation diagnosis, ultra high voltage technology, mechanism of conductor galloping, and so on), to cross-disciplinary high voltage novel technology subjects with material, environmental and biological technology (research on non-biodegradable wastewater treatment by discharge plasma, inactivation of micro-organism and enzyme by Pulsed Electric Field (PEF), electro-spun technique).

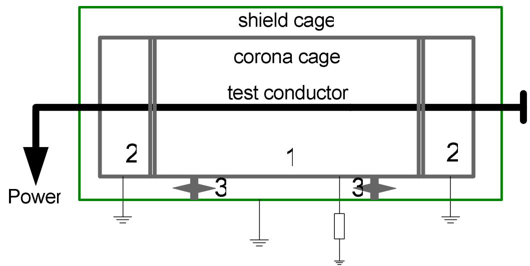
2.1 Traditional high voltage technology

(1) **Investigation on outdoor insulation at high altitudes**

Investigation on the flashover characteristics of porcelain insulator, glass insulators, suspension composite insulator and composite post insulator was carried out in natural high altitude areas (1970 m) by LATEEE. The DC generator provided ±250 kV with fluctuating output voltage changes of less than 1%. The fog chamber was 10 m * 10 m * 10 m. The test used the solid layer method with the 50% flashover voltages (U50%) determined by the Up-and-Down Method. The arcing behavior on natural polluted insulator surfaces was studied using a PCI-2000 S high-speed camera at a speed of 250 fps. Test results can be used as a reference for ±800 kV UHVDC transmission project at high altitudes.

(2) **Technology of corona cage, corona characteristics and electrical-magnetic environment of overhead transmission line.**

Corona cage is used to study the corona characteristics and electrical-magnetic environment of the VHV or UHV overhead transmission line, such as radio interference, audible noise and corona loss.
The corona cage consists of a single test conductor or conductor bundle placed concentrically inside a metallic cylinder with a much larger radius.
Figure 2 presents the structure of the small corona cage used in our laboratory, and figure 3 is its general view. The total length of this cage is 4m and the cross section varies from 1.6*1.6m to 2*2m.



1—Central Section, 2—Guard Section, 3—Post Insulator

Fig.2 Structure of Corona Cage

Fig.3 Corona cage used in the experiment

(3) **Research on dynamic characteristics of the conductors and mechanical characteristics of composite insulators in overhead transmission line**

The advanced 4DOF (degree of freedom) uniform model for overhead transmission line, with the analysis capabilities of multi-span, split-phase conductor and insulator strings, is built for the dynamic problem of the lines, such as wind vibration, ice shedding, galloping and so on, which is crucial in determining the alignment of the conductors, the type of towers and the configurations of spans. The laboratory leads the way in the fields of the structural optimization of V-type and the configuration optimization of interphase spacers, based on the large deflection theory of composite insulators. Our research is widely applied in 220kV, 500kV, 750kV and 1000kV power transmission lines.

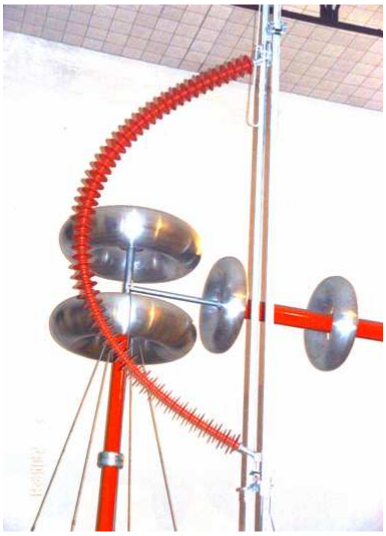


Fig.4 Inter-phase spacers

(4) **Research on discharge along contaminated surface and Technique of Room Temperature Vulcanized (RTV) silicone rubber**

Room Temperature Vulcanized (RTV) silicone rubber is a good insulation material and is widely used to improve contamination performance. The laboratory has been researching RTV silicone rubber since 1986, and its production technique has been adopted by several companies. Discharge along contaminated hydrophobic and hydrophilic surface has been experimented. The laboratory is currently working on semi-conducting RTV silicone rubber to solve the problems caused by ice build-up on insulators and power lines.

Fig.5 Hydrophobicity Test of RTV

(5) **Diagnosis and evaluation of outdoor insulation status of power transmission system**

This research investigates the method to evaluate the external insulation state of power system, and then predict the possible pollution flashover accidents. The evaluation is based on the online monitored leakage current and the environmental condition in the field. In addition, the group also is developing the online leakage current monitoring system and the external insulation evaluation system.

(6) **Corona Discharge Remote Monitoring Technology on Outdoor Insulation**

Monitoring Technology bases on a device consists of a well designed optical receiver and locator, a PMT (Photo Multiplier), a preamplifier and additional signal conditioning circuit, which locates, captures and amplifies tiny invisible light signals of corona discharge on the surface of objects from a certain distance. An oscilloscope or a computer mounted with a data acquisition card can be connected to the output

Fig.6 Monitoring Facility

of the device to view or record waveforms, which will be applied with additional analysis to extract useful information for further research.

2.2 High voltage novel technology

(1) Research on atmospheric pressure glow discharge technique

Owing to their suitability for industrial process, especially the possibility of usage for on-line treatment, One Atmosphere Pressure Glow Discharge Plasma (OAUGDP) treatments are widely used for industrial purposes such as modifying the wettability or the adhesion of polymers.

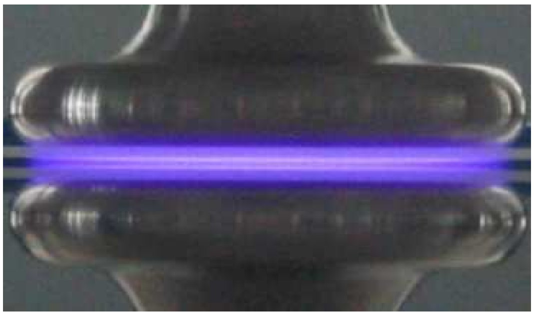


Fig.7 OAUGDP in a 1mm air gap at 11.93kHz 1762.5V

The method of OAUGDP has been researched: OAUGDP is obtained when the dielectric barrier-controlled discharge is turned on following a slow increase in the densities of ions and electrons in all of the gas due to the occurrence of a lot of small avalanches under a low field. Fig8 shows an OAUGDP in a 1mm air gap at 11.93 kHz 1762.5V

(2) Research on non-biodegradable waste water treatment by discharge plasma

Water treatment by the direct electrical discharge in aqueous solutions is an innovative advanced oxidation technology. Non-thermal plasma is produced during the discharge processes where a large amount of high energy electrons and active species (such as active radicals and molecules etc) are generated. These active species directly react with organic molecules dissolved in water and either oxidize them or even get them completely mineralized. UV-visible spectrophotometer is used to analyze the treated water. This technology has advantages such as high removal efficiency, non-selective, no secondary pollution, etc., and exhibits promising application potential.

(3) Pulsed electric field (PEF) processing of liquid food

Pulsed electric field (PEF) processing is a non-thermal method of food preservation that uses short bursts of electricity for microbial inactivation and causes minimal or no detrimental effect on food quality attributes. PEF can be used for processing liquid and semi-liquid food products. This technology offers high quality fresh-like liquid foods with excellent flavor, nutritional value, and shelf-life. PEF is considered to be the most potential non-thermal processing technique to replace conventional thermal-processing. Fig 8 shows the S. Cerevisiae before treated (left) and treated (right).

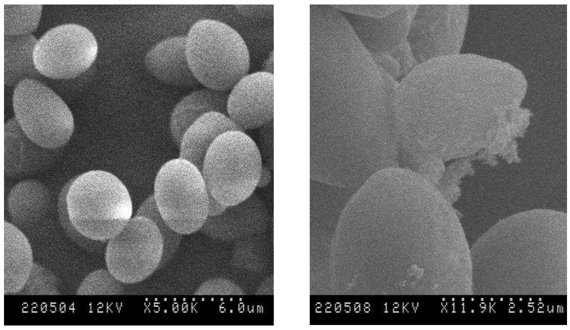


Fig.8 The S. Cerevisiae before treated (left) and treated (right)

(4) Research on electro-spinning technology

Electro-spinning is a simple and straightforward process by which continuous polymer fibers, with diameter ranging from a few nanometers to microns, can be produced. In the present contribution, ultrafine fibers were spun from polyethylene oxide (PEO)/water solution using a homemade electro-spinning set-up. The effects of the spinning voltage in DC, the collection distance and the electro conductivity on the formation of the as-spun PEO fibers have been investigated. Poly vinylidene fluoride (PVDF)/ Dimethyl Formamide (DMF) and PVDF/PEO/DMF solution to produce a hydrophobic surface were also used. The electro-spun products obtained a better hydrophobicity than ordinary casting films.

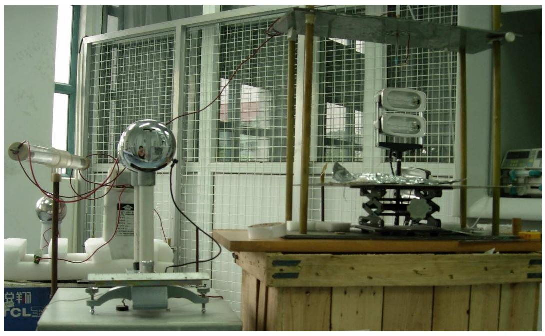


Fig.9 Experiment circuit of electro-spinning

(5) Treatment of Vehicle exhaust gas with high-voltage pulse discharge

High-voltage pulse discharge is considered to be an efficient approach to dispose exhaust gas both at home and abroad. The instrument will be utilized to study the treatment of vehicle exhaust gas. Results are available to control and reduce air pollution in big cities.

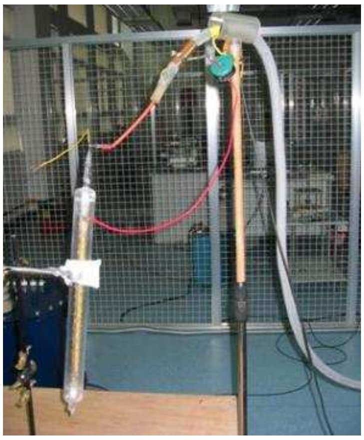


Fig.10 Reactor of Vehicle exhaust gas treatment

(6) Research of effects of pulsed magnetic fields on osteoporosis

In this research, a therapy system has been developed for osteoporosis, which is a systemic skeletal disease characterized by low bone mass and micro-architectural deterioration of bone tissue, with a subsequent increase in bone fragility and a susceptibility to fracture. Fig 11 shows the interface of this system.

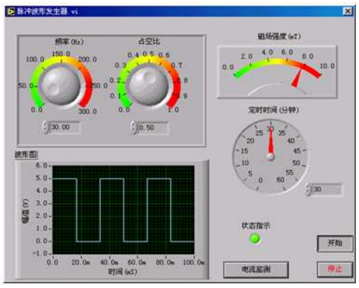


Fig.11 Interface of therapy system

III Papers and achievements

With advanced instruments, facilities, test-bed, power resource and the support of more than 10 million yuan research funds, LATEEE has completed more than 50 enterprise-funded horizontal subjects and government-funded longitudinal subjects. Focusing on the international frontier technology and its application, and the key problems in national economy, the laboratory has taken several projects from **National Natural Science Foundation** and projects at **provincial or ministerial level**, such as outdoor insulation performance and insulator selection for 750KV transmission line in high altitude areas, research on key technology of 110KV transmission line in high altitude areas along Qinghai-Tibet railway, design and feasibility research of southern power grid ultra high voltage test base, ±800kV outdoor insulation of contaminated insulators of high altitude areas in Yunnan and Gui zhou province.

In the last four years, 5 invention patents have been claimed, and more than 100 papers have been published, including 11 papers in SCI, 7 in ISTP, and more than 30 in EI. The laboratory aims to become the South China centre and base of high voltage research, academic communion, and novel technology application. With the support of Shenzhen government and Tsinghua University, it will continue its contribution to electrical power development in China.

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Activities of High Voltage Research Laboratory at Democritus University of Thrace – Xanthi, Greece

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The High Voltage Laboratory of Democritus University of Thrace, Xanthi, Greece, is part of the Power Systems Laboratory. Its activities started in 1993. Since then it has grown to the current state of research activities.

The following facilities are available in the High Voltage Laboratory:

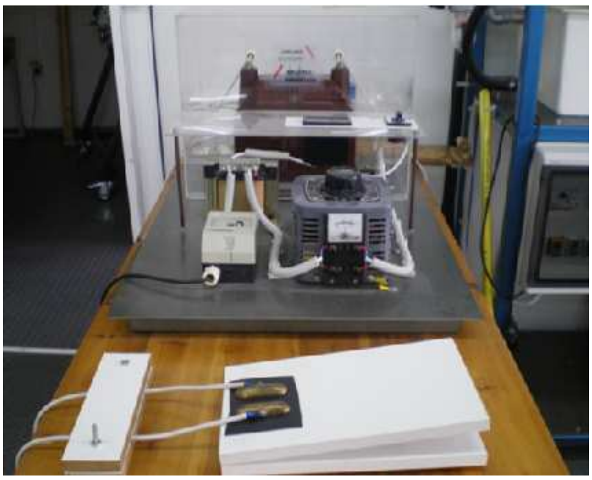
(i) Test Cell for Air/Gas Breakdown

The laboratory is equipped with a test cell for discharges research with air and gases both at low and high pressures. The test cell containing the electrodes is more than 2 cm thick so that the test cell can withstand extremes of pressures (either very high or very low). Special windows have been constructed in the test cell, so that the activity, taking place in the electrode gap, can be observed with special optical means.

Test Cell for Air/Gas Breakdown

(ii) Test Arrangement for the Study of the Behaviour of Water Droplets Under Electric Fields

A uniform electrode arrangement together with the appropriate power supply is available for the study of water droplets on polymeric surfaces under the influence of electric fields. The whole arrangement was constructed so that it contains the uniform electrodes, the polymeric material and the water droplets on it. Various conductivities of water, surface roughness of the polymeric surfaces, droplet volume as well as the positioning of droplets w.r.t. the electrodes and their effect on the flashover voltage was investigated in numerous experiments. Both horizontal and inclined electrode arrangements were used. The angle used for the inclined arrangement is similar to those of real insulators.



Test Arrangement for the Study of the Behaviour of Water Droplets Under Electric Fields

The most remarkable conclusion from all the experiments, apart from the strong influence of the aforementioned parameters on the flashover voltage, was that the positioning of the water droplets w.r.t. the electrodes plays sometimes a more dominant role than the droplet volume. The effect of the positioning of water droplets on the flashover voltage is evident for both horizontal and inclined electrode arrangements.

(iii) Electrode Arrangement for the Study of Discharges in Air

A point-plane electrode arrangement is used to study discharge behaviour in air at or even below the so-called inception voltage. The whole approach is based on the work performed by Bruning and co-workers (of Lectromechanical Design Co.), who indicated that the damage caused in a solid dielectric material above inception voltage is qualitatively similar to the damage caused at voltages below inception. In our laboratory, this idea is followed by having a constant voltage applied to the point-plane gap, finding the inception value, and then increasing the gap up to the point of only intermittent discharges. What we find is that there are sporadic discharges even below the so-called inception voltage, something which implies that there are similar phenomena appearing in solid dielectrics and in air. The whole approach of the very small discharges, an idea elaborated for a number of years by Prof. Toshikatsu Tanaka of Waseda University and other researchers, and their role in insulation deterioration, is a subject worth of further research. It goes without say that the industrial importance of such studies is not to be neglected, since the influence of very small partial discharges might be taken into account also in formulating ageing insulation models .

Electrode Arrangement for the Study of Discharges in Air

(iv) Dielectric Strength of Transformer Oil Samples (Project in Cooperation with the Public Electricity Corporation (PPC))

Since 1994 there is a cooperation with the Public Electricity Corporation (PPC) of Greece regarding the study of samples taken from distribution transformers of 15-20 kV. The purpose of this work is to measure the dielectric strength of the samples with a Foster Test Cell and then try to correlate it with the previous history of the transformers (lightning overvoltages, switching overvoltages, etc.). Transformer oil samples were taken from distribution transformers from a large area of Northern Greece.

(v) Test Cell and Filtration System of Transformer Oil

A plexiglass test cell was constructed with its filter system in order to study the influence of the filter particles and filtering cycles on the transformer oil dielectric strength. The filter system does not allow particles larger than 5 μm to go through it. The purpose of this project is to study the influence of filters of various sizes on the dielectric strength of transformer oil. The increasing number of filtering cycles was found to have a positive influence on the dielectric strength of transformer oil.

Filtration System of Transformer Oil

(vi) Simulation of Electrical Treeing Propagation in Solid Dielectrics

Electrical tree simulation is studied with the aid of MATLAB and TOOLBOX programmes. Particular importance was paid in the simulations on the local variation – even slight – of the dielectric constant. This idea was refined and was introduced as dielectric inhomogeneity factor in subsequent work. This was a contribution of our research group in comparison to other previous simulations performed by other researchers. Various aspects of tree simulation were studied, e.g. , the simple case of point-plane electrode arrangement, and the case where enclosed cavities and/or particles (insulting and/or conducting) exist in the insulating material. Moreover, tests carried out with plexiglass samples of various thicknesses showed that the observed trees were similar in shape with those obtained from simulation.

The idea of the aforementioned inhomogeneity factor is used now in order to study electrical tree simulations in composite insulating systems, such as machine insulation.

(vii) Devices of the High Voltage Laboratory

Our laboratory has a Tettex PD detector, oscilloscopes to register waveforms of various frequencies (up to 100 MHz), a sphere gap, power supplies for d.c. voltages, microscope facilities to observe damaged areas of insulating materials and small house models for student demonstrations of the protection against lightning.

Sphere gap

(viii) International Cooperation

Our laboratory has a cooperation with Helsinki University of Technology (HUT), Helsinki, Finland, on neural networks and partial discharges. This cooperation came about after my intellectually stimulating staying at HUT during the summer of 2002 as invited professor. Since 2000 there was an interesting exchange of ideas with Prof. R. Sarathi of the Indian Institute of Technology (IIT) Madras, India, on the subject of electrical tree simulation. This cooperation materialized in publishing common research papers on other subjects as well.

A further cooperation takes place with the National Technical University of Athens (NTUA), Athens, Greece, with Associate Professor F. Topalis on subjects such as barrier effect and neural networks in GIS.

Needless to say that the cooperation with Dr. A. M. Bruning and his co-workers (of Lectro-mechanical Design Co., Virginia, USA) on the very small partial discharges and their effects on polymeric materials continues.

Conclusions

As a head of the High Voltage Laboratory of Democritus University of Thrace, I am pleased to say that we made certain advancements in various fields of high voltage research. Research also means interaction with other scientists from other institutions and, possibly, from other countries. That is why I invite professors from all over the world to visit our facilities and to enhance scientific cooperation with us. In today's antagonistic world, it is only through cooperation and dialogue that science and engineering can flourish for the benefit of all of us.

Acknowledgments

I, as the author of this short report wish to sincerely thank Dr. Yoshiyuki Inoue, of Functional Materials Technology R & D Department, Toshiba Co., Yokohama, Japan, for giving me the opportunity to write about the high voltage research in our laboratory. I also thank Mr. E. Sarkavos for his technical help.

China Corner

Lecture series for graduate students
------- Insulating materials and their applications

by Prof. Shengtao Li
Xi'an Jiaotong University, China

Lecture series for graduate students “Insulating materials and their applications” was held in Xi’an Jiaotong University from August 11 to 19, 2007. The lecture was sponsored by Degree Committee and Education Offices of Shaanxi Province, and Xi’an Jiaotong University, organized by School of Electrical Engineering and State Key Laboratory of Electrical Insulation and Power Equipment, Xi’an Jiaotong University. 15 famous professors and experts (13 persons from outside China) were invited to give their lectures. The topics and lecturers are given in Table 1. About 300 participants from universities and colleges, institutes and companies attended the lecture.

Table 1 the topics and lecturers of lecture series “Insulating materials and their applications”

Topics	Lecturers
Part I: Theory of dielectric materials under high electric field	
Electrical conduction under high filed in dielectric materials	Prof. Teruyoshi Mizutani Aichi Inst. Tech. & Nagoya University, Japan
Electrical aging and breakdown in insulating materials	Prof. L. A. Dissado University of Leicester, UK
Space charge and electroluminescence in insulating polymers	Prof. Christian Laurent National Center for Scientific Research and Toulouse University
Computer simulation in the theory studies on electrical aging and breakdown	Prof. Kai Wu Xi’an Jiaotong University, China
Part II: Insulation aging and fault diagnosis in power equipment	
The aging and tests of composite insulators	Prof. Xidong Liang Qinghua University, China
Insulation breakdown and diagnosis in power transformers	Dr. Tsuneharu Teranishi Toshiba Corporation, Japan
Breakdown and degradation of ZnO varistor blocks	Prof. Shengtao Li Xi’an Jiaotong University, China
Rotating machine insulation: Failure processes and diagnosis	Prof. Greg Stone Iris power, Canada
Partial discharge diagnosis of high voltage insulation systems	Prof. Gian Carlo Montanari University of Bologna, Italy
Condition based monitoring and asset management of electrical infrastructures	Prof. Johan J. Smit Delft University of Technology, The Netherlands
Space charge phenomena, aging and diagnosis in cables	Prof. G. Chen University of Southampton, UK
Applications of nonlinear analysis in power engineering	Prof. Steven Boggs University of Connecticut, USA
Part III: New techniques of insulation	
Environmental-friendly materials and systems for electric and electronic application	Prof. Yasuo Suzuoki Nagoya Univeristy, Japan
Interfacial phenomena and nanocomposites	Prof. J. K. Nelson Rensselaer Polytechnic Institute, USA
Superconducting power applications and their cryogenic electrical insulation techniques	Prof. Hitoshi Okubo Nagoya University, Japan

Workshop on Dielectric Materials and Electrical Insulation for Power Equipment

This workshop was sponsored by State Key Laboratory of Electrical Insulation and Power Equipment, Xi'an Jiaotong University, and Engineering Dielectrics Committee of China Electro- technical Society. The workshop was held in Xi'an Jiaotong University in August 12 and 17, 2007, respectively. Prof. S. A. Boggs, Prof. T. Mizutani, Prof. L. A. Dissado, Prof. G. Chen, Prof. J. K. Nelson, Prof. C. Laurent, Prof. Y. Suzuoki were invited to attend the workshop. The topics and speakers are given in Table 2. About 50 participants from universities and colleges, institutes and companies attended the workshop.

Table 2 the topics and speakers of the workshop

Topics	**Speakers**
Session 1	
Reliability problems in UHV power equipment	Prof. Kai Wu Xi'an Jiaotong University, China
Specific issues related to surface and interface phenomena of insulating materials under high electric filed	Prof. G. J. Zhang Xi'an Jiaotong University, China
High voltage research in Tianjin Univeristy	Dr. Y. Gao Tianjin University, China
Discussion on high voltage vacuum circuit breakers	Dr. Z. Y. Liu Xi'an Jiaotong University, China
Session 2	
Some research work on functional dielectrics	Dr. J. Y. Li Xi'an Jiaotong University, China
Polymer dielectric nanocomposite - development and the problems	Dr. Y. Yin Shanghai Jiaotong University, China
Preparation and properties of PLS nano-composites	Prof. X. H. Zhang Harbin Technology University, China
What we do about UHV DC/AC project in China	Dr. P. Liu Xi'an Jiaotong University, China

Fig. 1 the picture of lecture series

Fig. 2 the picture of the workshop

TECHNOLOGIES FOR TOMORROW

Development of New-Type Outdoor Termination for XLPE Using Composite Insulator with SF_6 Gas

1. Introduction

Porcelain insulators have been widely used for outdoor terminations. However, in recent years, so-called composite insulators (also called polymeric insulators), which consist of the FRP cylinder and silicone rubber, have increasingly employed because of their ease of handling.

We have developed a new type of termination for a XLPE cable that further reduces weight and allows for horizontal use by using a composite insulator, a cold shrinkable rubber unit and SF_6 gas [(1)]. This paper describes the design and performance of both 77kV and 154kV new type outdoor termination, and the follow-up survey of 77kV outdoor termination in the commercial power transmission line.

2. Demand of New-Type Termination

As can be seen in Figure 1, in 77kV transmission lines outdoor termination which connects overhead line and XLPE cable is usually installed on the tower, on the other hand, in 154kV transmission lines outdoor termination is set up on the ground. In order to convert a tower that was used for only overhead line to a terminal tower connecting the overhead and underground transmission lines by the use of conventional termination, the reconstruction or reinforcement is needed to keep the enough clearance and to support the weight of termination. As a result, the tower must be substantially improved or rebuilt. As can be seen in Figure 2, if the termination can be set up horizontally, the problem of the clearance around the termination can be resolved without remodeling the tower, as a result, substantial cost reductions can be expected.

Moreover, the conventional method of constructing the 154kV overhead lines and XLPE cables requires the large area for build the outdoor termination on the ground; approx.600m^2. Therefore, if XLPE cables can be connected on the tower, cost can be reduced and the variety of installation can be increased.

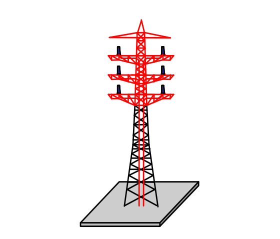
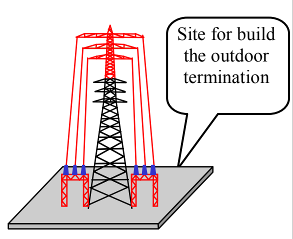
	
For 77kV XLPE cable (connected on the tower)	For 154kV XLPE cable (connected on the ground)

Fig.1 Towers connecting overhead line and underground line

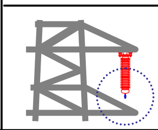
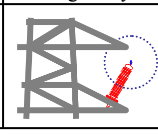
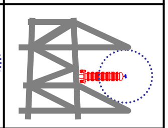
	Downward	Diagonally	Horizontally
Installation layout			
Results	Required space around the outdoor termination is insufficient		Required space can be obtained
	×	×	○

Fig.2 Case study of installation layout of outdoor termination on tower

3. Structure and Features of Termination

3.1 Structure of Conventional Termination

Figure 3 shows the basic structure of the conventional termination for a 77 kV and 154kV XLPE cable.

A porcelain insulator is used, and a rubber pre-molded insulator is pushed into the epoxy resin insulator using a spring unit in the internal insulator. Silicon oil is used to fill the porcelain insulator. The airspace which absorbs the change of silicon oil volume due to the seasonal and daily variation of temperature is placed above silicon oil where the electric field is weak. Consequently, the variation of installation is limited to being vertical or diagonal (with limits on the angle).

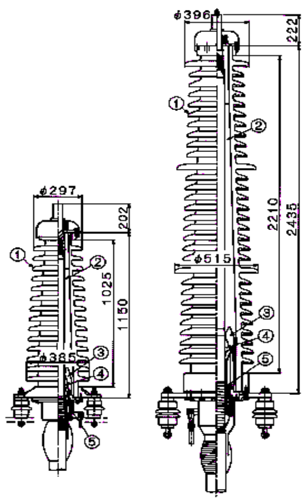
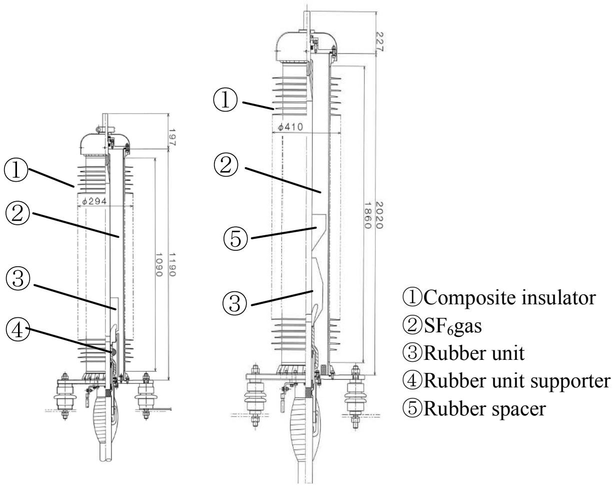


Fig.3 77/154kV outdoor termination (Porcelain insulator type)

3.2 Structure of New-Type Termination

Figure 4 shows the basic structure of the new termination for a XLPE cable. This termination has the following three features.

(1) By using a composite insulator instead of a conventional porcelain insulator, weight can be reduced substantially.
(2) By using a simple structure that uses a rubber unit only for the internal insulation and does not require a compression unit and epoxy resin insulator weight reduction and ease of installation can be made.
(3) By using SF_6 gas instead of silicon oil in the insulator, the termination can be set up horizontally.



	Composite insulator type (New type)	Porcelain insulator type (For reference)
77kV	Approx.100kg	Approx.200kg
154kV	Approx.200kg	Approx.450kg

Fig.4 77kV/154kV outdoor termination (Composite insulator type)

The termination is designed to have sufficient insulation strength even if SF_6 gas pressure downs to 0MPaG (atmosphere pressure), in order to lighten the maintenance work. Note that SF_6 gas pressure is set to 0.1 MPaG so as to prevent the internal pressure from becoming negative during use.

4. SF_6 Gas Leakage Characteristics from a Composite Insulator

The gas leakage characteristics of SF_6 gas were studied in order to use SF_6 gas in the new composite insulator termination. We first examined the degree of gas leakage factors that can be conceived of, and estimated the long-term variation of gas pressure and gas component in the composite insulator, then evaluated the validity of the result through the comparison with experimental result in real lines.

4.1 Gas Leaking Factor by Vibration

We verified the airtight performance for the newly developed 77 kV termination through the vibration tests. Table 4 shows the results. In the sequence of vibration tests which simulate the real vibration on the tower and the vibration at the resonance frequency of new termination (22.5 Hz or 83.3 Hz), no SF_6 gas leak was measured in any case, and that good airtight performance with respect to the vibration was confirmed.

Table 1 Result of vibration test

No	Test condition				Result
	Frequency (Hz)	Vibration Acceleration (G)	Duration	Basis	
1	7.5	0.72	7 hours	Estimated frequency on the tower	Good
2	100	0.72	7 hours 4 times	Vibration 10^7 times in non-resonant frequency	Good
3	22.5	0.3	Sine-wave 3 cycles	Resonance frequency ※	Good
4	83.3	0.3	Sine-wave 3 cycles		Good
5	22.5	0.3	3 hours	Resonant frequency	Good

※ In conformity to the standard test for earthquake resistance design

4.2 Simulation of Gas component changes in the Composite Insulator

The SF_6 gas in the composite insulator slightly diffuses to the exterior through the composite insulator and the cable insulator, while the air slightly penetrates into the composite insulator, as can be seen in Figure 5. As a result, the component of the gas in the insulator is to be changed. These changes were estimated through successive approximations in a cylindrical model. The coefficients of SF_6 gas permeability for each material used in the calculations were measured using a gas permeability measurement device [5]. For oxygen and nitrogen, the gas permeability coefficients described in the references [3]-[6] were used.

Figure 6 shows the results of calculations for the gas component changes in the insulator at the temperature of 23º C. The initial conditions for the calculations were as same as the real use, after vacuuming the inside of a composite insulator, SF_6 gas was filled at the absolute pressure of 0.2MPa (gas pressure gauge reading of 0.1 MPaG). The penetration rates of nitrogen and oxygen are higher than the diffusion rate of SF_6 gas, and so the pressure in the composite insulator rises slightly over 30 years.

The estimated density of the SF_6 gas after 30 years is about 0.19 MPa. Therefore, good electric performance can be expected even after 30 years, because termination is designed to have sufficient electrical performance even with the SF_6 gas pressure of 0.1MPa (absolute pressure).

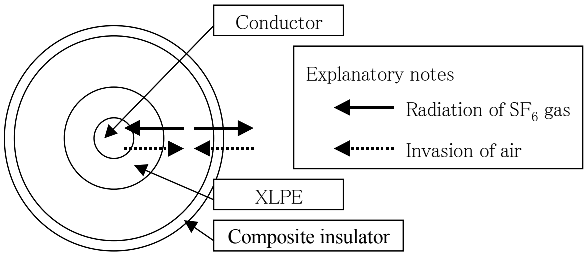


Fig.5 Gas flow between inner space and outer space of composite insulator

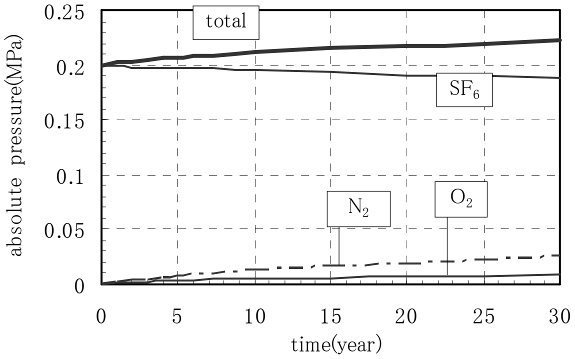


Fig.6 Calculated formation of gases in composite insulator

5. Conclusion

We have described the design and development of new type outdoor termination using a combination of a composite insulator, a rubber unit, and SF_6 gas.

Both of new type termination for 77kV and 154kV has been into commercial lines. Since then, the following results have been obtained.

(1) Costs and construction time can be reduced because of the unnecessary of temporary steel tower.

(2) When we divide the power from existing overhead line to under ground cable with the conventional constructing method, the construction site is restricted where the site for the temporary tower is procured. This restriction disappears when new construction method is used. As a result, the connection point of line and underground cable can be selected where the length of underground cable is the shortest.

(3) Line reliability is improved due to shortening the outage time for construction by eliminating the move to a temporary route and back from it.

To apply the new type outdoor termination to the ultra-high voltage lines is difficult due to the weight of cable and its termination. However, at ultra-high voltage class, the composite insulator has the great advantage of material cost than porcelain insulator. As the experiences of using the composite insulator in 77 kV- or 154 kV-class cables accumulate, greater use of the composite insulator in ultra-high voltage lines can be expected, although ultra-high composite terminations might be installed on the ground.

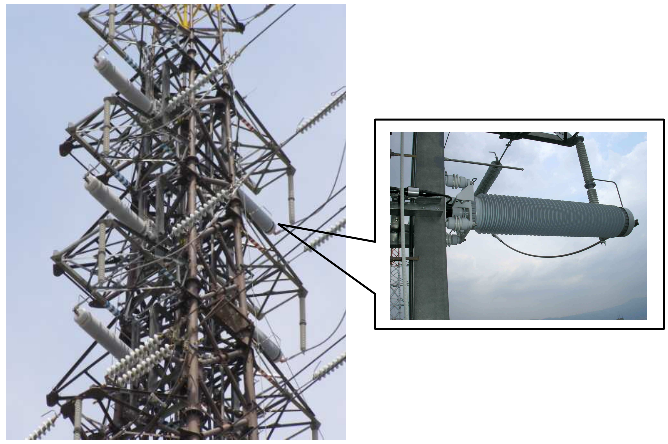


Fig.7 Installed 154kV new termination

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Development of 72 kV Class Environmentally-Benign CO_2 Gas Circuit Breaker Model

1. Introduction

SF_6 gas has widely been used for high-voltage and large-capacity electric power equipment such as gas insulated switchgears (GIS) and gas circuit breakers (GCB) due to its excellent insulating and arc-quenching capability. Although SF_6 gas strongly contributes to achieve compactness and high reliability of the equipment, it has been recognized as one of the potent greenhouse gases and was designated to reduce the emissions at COP3 at Kyoto in 1997. At present, strategic effort to reduce the emissions is being made, which actually pan out. Over the long term, however, it is certainly preferable to reduce the consumption itself, because its atmospheric life time is observed to be quite long, thus the amount of SF_6 gas on the earth will inevitably get increasing in the future unless artificial destruction.

With the above background, a 72.5 kV-31.5 kA class CO_2 gas circuit breaker (hereinafter called CO_2-GCB) model, which contains neither SF_6 nor Freon at all, was designed and produced. As a result of current interruption and insulation tests, the CO_2-GCB model achieved satisfactory performance.

2. Why CO_2 Gas?

The gases that are applicable to an environmentally-benign electric power equipment are required to have no or minimal toxicity, global warming effect and ozone depletion effect, and should remain gaseous at low temperatures, for example, around -30 °C. When selecting the alternative gases widely from the above viewpoints, the possible candidates are narrowed down to air, N_2, O_2, H_2, CO_2, rare gases (He, Ar, etc), and their mixtures. In practice, they are also required to have adequate insulating and arc-quenching capability, chemical stability, and have no flammability and explosiveness. Eventually, the possible candidates which can be applied as single gas or main gas of mixture could be limited only to N_2 and CO_2. (Here, air is regarded as an N_2-based mixture.)

Table 1 shows the comparison of fundamental gas properties of SF_6, CO_2 and N_2. As shown in Table 1, CO_2 meets the basic requirements for application to an environmentally-benign electric power equipment. In addition, CO_2 has a lower boiling temperature than SF_6, and it is known that CO_2 remains gaseous at low temperature ranges down to -40 °C even at a high gas pressure of 1.0 MPa-abs.

As for insulating capability, as also shown in Table 1, CO_2 is naturally lower than SF_6, but its 50% breakdown voltage is about 35% higher than that of N_2 at a high gas pressure of 0.9 MPa-abs.

In Table 1, arc-quenching capability is evaluated by arcing time constant as an index for the thermally interrupting capability of a gas. Qualitatively, smaller arcing time constant suggests better thermal interrupting capability. Table 1 shows that the arcing time constant of CO_2 is higher than that of SF_6, but is below one tenth of that of N_2.

In short, although CO_2 gas is inferior to SF_6 gas in insulating and arc-quenching capabilities, it surpasses N_2 gas which is regarded as a representative alternative gas in many previous works, particularly in arc-quenching capability. This suggests that CO_2 gas is a promising alternative gas, particularly for switching apparatus such as a GCB.

Table 1. Comparison of fundamental gas properties between SF_6, CO_2 and N_2.

Gas	SF_6	CO_2	N_2
Molecular mass	146.06	44.01	28.01
Density (kg/m^3)*1	5.9	1.8	1.1
GWP*2	23,900	1	~0
ODP*3	–	–	–
Toxicity*4	–	–	–
Chemical stability	Stable	Stable	Stable
Flammability / Explosibility	–	–	–
Boiling temperature (°C)*5	–51	–78	–198
Dielectric strength (%)*6	100 (–)	34 (–)	25 (+)
Arcing time constant (μs)*7	0.8	15	220

*1 At 300 K, 1 MPa-abs
*2 Global Warming Potential, Integrated period 100 years (IPCC, 1995)
*3 Ozone Depletion Potential
*4 As pure gas (Note that arced gas could be different)
*5 At 1 MPa-abs
*6 50% breakdown voltage measured by a full-scale coaxial cylindrical electrode (The weak polarity value is shown), Lightning impulse, At 0.9 MPa-abs
*7 Measured for a free-burning arc at 1 MPa-abs

3 Basic Concept and Technologies

As described above, CO_2 gas meets the basic requirements for application to an environmentally-benign power equipment and surpasses N_2 gas in terms of insulating and arc-quenching properties. However, when simply replacing SF_6 gas with CO_2 gas based on an existing SF_6 gas equipment, it must cause reduction of performance or increase in the size of the equipment. To avoid this as much as possible, it is necessary (1) to understand the fundamental properties of CO_2 gas as an insulating and arc-quenching medium to draw its full potential, and (2) to develop new breakthrough technologies to compensate the performance gap between SF_6 and CO_2.

As one strategy for the above, a Hybrid-puffer™ type interrupter specially designed for CO_2 gas has been investigated. As known generally, the higher puffer pressure at current zero leads the higher thermal interruption performance. A Hybrid-puffer™ is one of the techniques enhancing the puffer pressure by utilizing arc energy effectively during a current interruption.[1] Fig. 1 shows the analytical result of puffer pressure at current zero, compared between a conventional double-flow-type interrupter and Hybrid-puffer™-type for both CO_2 and SF_6. As noted in Fig. 1, Hybrid-puffer™ technique is more effective for CO_2 than SF_6, which is because gas density and heat capacity of CO_2 are smaller than SF_6 and, in addition, arc voltage in CO_2 is larger than SF_6.

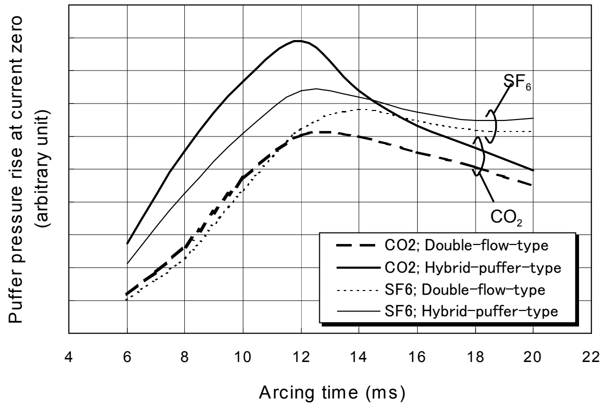

Fig. 1. Comparison of puffer pressure enhancing effect by Hybrid-puffer™ technique between SF_6 and CO_2.

4. Development of 72 kV CO_2-GCB Model

Based on the basic investigations of CO_2 properties, a 72 kV-31.5 kA class CO_2-GCB model, shown in Fig. 2, was designed and produced. The specifications of the model are shown in Table 2. The filling gas pressure is 0.8 MPa-abs, which is a little higher than that of a usual SF_6-GCB. In practical use of a CO_2-GCB, however, the filling gas pressure could be higher, for example 1.0MPa-abs, in consideration of gas liquefaction, safety, and related regulations. In the CO_2-GCB model, a Hybrid -puffer™-type interrupter specially designed for CO_2 gas was adopted. Furthermore, all the dimensions of the GCB components were determined based on fundamental dielectric data of CO_2 gas with sufficient margin. The tank diameter is about 1.7 times as large as that of the latest SF_6-GCB in the same rating.

Current interruption and insulation tests of the CO_2-GCB model were carried out based on the standard of IEC 62271-100. As a result, the CO_2-GCB model achieved satisfactory performance for major test-duties; namely, capacitive current switching, short-line fault 90%, terminal fault 100% (symmetrical and asymmetrical) interruption, power-frequency and lightning impulse insulation.

Decomposed products and gases after current interruptions are also one of the fundamental issues from the practical viewpoint. It was observed that no harmful arced gas which cannot be absorbed by Zeolite and that no controversial decomposed product for the practical use were detected even after more than 10 times large current interruptions.

Fig. 2. View of the 72 kV-class CO_2-GCB model (for single phase).

Table 2. Specifications of the CO_2-GCB model.

Items	Value
Filling gas	CO_2 100%
Filling gas pressure	0.8 MPa-abs
Rated voltage	72 kV
Rated interrupting current	31.5 kA
Power frequency	50 Hz
Rated ACWV	140 kV_{rms}
Rated LIWV	350 kV

5. Conclusion

Based on the fundamental investigations of CO_2 properties as an insulating and arc-quenching medium, a 72.5 kV-31.5 kA-class CO_2-GCB model was designed and produced. As a result of interruption and insulation tests, the model achieved satisfactory performance for major test-duties. This could be the first step toward a practical SF_6-free high-voltage power equipment in the future.

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Development of dry outdoor termination for XLPE cable

Introduction

Outdoor termination for XLPE cable is generally composed of porcelain bushing enclosed oil or gas insulation and insulating part. (1)(2) Recently customer requirement increasingly tends to be environmental-friendly composite, reduction of the risk of both harming people and severe destructions caused by breakdown. We have been developing dry outdoor termination to cope with such needs.

This paper reports the development for 110kV synthetic type termination. (3) This synthetic termination consists of only rubber bushing. Its feature is lighter than that of the existing termination and simple structure to minimize the number of parts. The all rubber shed is molded at one time without separate area, therefore the bending performance is excellent electrically when the termination is set on the utility pole etc. and also long term characteristic for interfacial electrical strength was confirmed by imitating dry interfacial condition.

As several qualification test was conducted for the termination to evaluate its performance, the results are presented the below.

Structure and feature

Figure 1 shows the structure of the dry outdoor termination for 110kV class cable, which has the following features.

1. Completely dry-type solid insulation structure
2. Easy handling and lightweight (about 40kg)
3. Free installation angle and environment-friendly
4. No need for special tools or skills

Figure 1 110kV synthetic termination

Electrical design

The insulation of the outdoor termination was designed in accordance with JEC3408 for 77kV XLPE cable and IEC60840 for 110kV XLPE cable. The electric field control mechanism was optimized by the electric field design in the deformation of expanding rubber bushing on the cable. Main portions in this design are style of semi-conductive stress cone and the area of air on the surface of rubber casing. The relationship between the shape of silicone rubber sheds and electrical strength is important to control the flash over phenomenon. We carried out many impulse voltage tests by using porcelain or polymeric bushing to study the electrical stress on the bushing surface so that the permissible electrical strength was acquired. Our experience gives better course to get the best design.

The creepage distance is approximately 4200mm long. It is longer than distance of very heavy condition in IEC pollution 138kV level.

Assembly procedures

The procedure for assembling the dry outdoor termination is the follows as;

1. Cable bending (annealing)
2. Cable screen removing
3. Compression of connecting rod
4. Wrapping insulating tape
5. Applying lubricant on cable surface and rubber inside
6. Inserting rubber casing
7. Forming Water proof layer

The inserting force is about 160kg so that jointer can slide on cable by proper lubricant.

The testing sample pulled up is shown in Figure 1.

This type termination can be incomplete to stand straight longitudinally. Therefore, we have to check the bending and electrical performance to verify satisfactory property in actual use.

Electrical performance test (Initial performance)

At first stage, we conducted several initial performance tests by using prototype rubber casing. This termination is made of silicone rubber and consists of an insulated part with a high resistance to tracking, vulcanized to a semi-conducting part which forms the field controlling stress cone. One of the performance test was conducted with approximately 45 degree by mechanical bending as shown in Figure 2.

Break down phenomenon was not occurred in the insulating material. The flash over at Impulse 700kV was appeared on the rubber casing.

Table 1 Results of initial performance test

Requirement	Bending
AC160kV 30min PD96kVNo detection for 110kV class	45deg.5cycles 133kVPD No detection
±550kV 10 shots for 110kV class	Good

The starting point in which the flash over occurred was at the position of maximum electrical strength on the surface of the rubber casing. The calculated peak stress was nearly equal to the break down stress of air. Therefore, the design method was verified to be reliable.

Figure 2 Impulse voltage test for prototype 110kV synthetic termination

The other sample of the termination was tested to check its initial electrical performance based on JEC3408 and IEC60840. The outdoor termination was connected with the 800mm^2 XLPE cable. Table 1 shows the test results. The result of the initial characteristics test was excellent in terms of the performance required of IEC 110kV class and JEC 77kV class terminations.

Table 2 Result of initial characteristics tests

Items	Condition	Results
AC withstand voltage test	150kV/1hr (JEC3408)	Good
	160kV/30minutes (IEC60840)	Good
AC breakdown Voltage test		250kV OK
Lightning impulse withstand voltage test	±550kV/3-shots (JEC3408)	Good
	±550kV/10-shots (IEC60840)	Good
Lightning impulse breakdown voltage test		±650kVOK

(Long-term performance)

A long-term loading cycle test was carried out during 20 days applying 128kV based on IEC60840 to confirm the long-term stability. Two outdoor terminations were arranged in the long-term test circuit. The loading condition was controlled at the conductor temperature of a dummy XLPE cable. Long-term test for 110kV class was successful in accordance with IEC 60840.

Table 3 Conditions for long-term test for 110kV class

Items	Condition
Applied voltage	128kVAC
Applied current cycle condition	Conductor temperature 95–100°C×20 cycles
Loading cycle	20 cycles

Conclusion

The authors developed dry outdoor termination for 110kV XLPE cable, in which no porcelain bushing or insulating oil is used. The electrical and mechanical test was conducted for 110kV synthetic termination. Its performance was excellent to use in actual setting situation and satisfactory according to IEC 60840. .
The electrical and heat cycling performance was verified to be steady and have enough margin for power transmission.
The authors can respond on customer requirement with enough satisfaction because we have appropriate solution with dry outdoor termination.

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Advanced Materials for Composite Insulators

1. Introduction

For outdoor applications there are ceramic insulators (glass and porcelain) and polymeric insulators. Polymeric insulators can be subdivided into monolithic insulators, which are predominately made of cycloaliphatic epoxies, and composite insulators consisting of a FRP core for load bearing and a flexible housing material as shed.

For both, monolithic insulators and composite insulators epoxy resins are the materials of choice and have a long tradition.

Electrical industry is quite conservative concerning material selection. Today there are still epoxy resins in use that have been developed more than half a decade ago.

Cycloaliphatic epoxy-based electrical insulation materials for outdoor monolithic insulators have been used for over 40 years with big success.

Based on the more than 30 years of experience with named CEP (=conventional cyclo epoxies), a further advanced material named HCEP (=hydrophobic cyclo epoxy) was developed and launched in 1999, which combines the many advantages of cyclo epoxies over silicones and ceramics with certain hydrophobic properties similar to that known from silicones.

The features of HCEP have already been the subject of several publications. In order to complete the picture the main ones are mentioned in the following:

- Very good hydrophobicity transfer effect
- Very good hydrophobicity recovery effect
- Improved tracking and erosion stability in several tracking tests.
- Significantly lower leakage currents observed in several salt fog tests
- Better thermal cycle resistance compared to CEP system

HCEP systems have been introduced and applied outdoor monolithic insulators successfully in the world since 7 years.

Huntsman Advanced Materials (Switzerland) has recently developed and introduced 'Advanced materials for composite insulators'. The followings is to show up the advanced material developments for 'New epoxy-based housing materials' for composite insulators.

2. Development of New Housing Material for Composite Insulators

At the INMR conference 2001 a feasibility study was presented, which announced the development of a flexibilized version of HCEP as a cost efficient alternative to liquid silicone rubber (LSR) as housing material for composite insulators. Unmodified HCEP would not be suited for that purpose due to its high stiffness.

The development of an epoxy-based shed-material is still an ongoing project. The basic target is not to flexibilise HCEP to the same flexibility of silicone but only to a degree that is sufficient to take up the stresses that occur in composite insulator applications and to pass the sudden load release test. Further side targets are to adjust the system to a mixing ratio of 1 to 1 by volume in order to make it applicable with existing LSR-equipments. This is a huge difference to standard epoxy application as components are not being stirred up and no degassing or pre-heating is applied. Of cource the electrical properties should be adequate for the targeted applications.

Aside the lower material cost compared to LSR a further advantage would be that no primer-treatment of the rod would be necessary, as epoxy adheres well to the epoxy rods.

Table 1 Development targets for SHCEP

• Price level:	Lower than LSR
• Hydrophobicity concept:	Same as HCEP
• Flexibility:	As much as necessary
• Electrical properties:	Suited for IEC 61109
• Processing:	Similar to LSR, but no primer

In order to achieve higher water diffusion break down strength a fundamental reformulation was done. This lead to a new system, which is referred in the following to SHCEP (=Shed-HCEP).

Table 2 Property overview of SHCEP

Designation	LMB 5829/30
Mixing ratio (by volume)	1 : 1
Filler load	50%
Density A-component / g/ml	1.1
Density B-component / g/ml	2.0
Density cured state / g/ml	1.6
Viscosity resin @ 23°C / Pas	2.0
Viscosity hardener @ 23 °C / mPas	35
Mix-Viscosity @ 23°C / Pas	2.0
gel. time @ 110 °C (gel norm)	8'
Tg / °C (by DSC)	ca. 20
Tensile strength @ 23°C / MPa (ISO 527)	10 - 15
Elongation at break @ 23°C / % (ISO 527)	30 - 50
Modulus @ 23°C / MPa (ISO 527)	ca. 250
Water uptake 10 d 23°C / % (ISO 62-80)	1.0 - 1.5
HV-Tracking and erosion resistance (IEC 60587)	1B4.5
BDV / kV/mm (IEC 60243-1)	19 - 24
Arcing resistance / s (ASTM D495)	>190
Diffusion break down strength (DIN VDE 0441-1)	HD-2

The latest version of this material named LMB5829 /LMB5830 is slightly less flexible but shows a good tracking and erosion resistance and a good water diffusion break down strength. Table.2 gives an overview on some key properties of the new system.

Fig.1 displays the behavior water droplets set on a cut surface of SHCEP, demonstrating the intrinsic hydrophobicity independent from any casting skin or mold release effect.

Fig.1 Water droplets set on a cut surface of SHCEP

Fig.2 and 3 show the behavior of SHCEP in a plasma-test, which proves the hydrophobicity recovery behavior after a forced loss. This experiment was carried out on test specimens made using a non-silicone mold release agent, which was carefully removed with iso-propanol prior to the test (in order to prevent any potential hydrophobicity effects from the mold release agent).

Fig.2 Spray test before (left) and immediate after (right) plasma-treatment shows that the plasma is effective to destroy hydrophobicity (fully wetted surface)

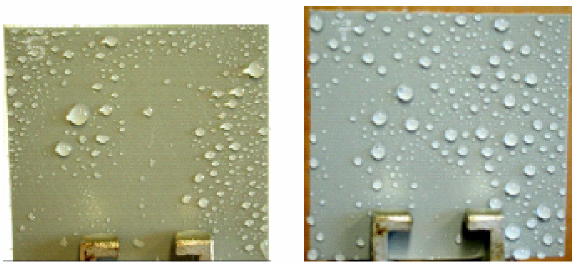

Fig.3 Spray test one day (left) and three days (right) after plasma-treatment shows hydrophobicity recovery after forced loss

The test shows, that the plasma was effective to fully destroy the original hydrophobicity. Already one day after the treatment the hydrophobicity has fully recovered.

Fig.4 shows an example of a typical processing equipment. Like LSR the epoxy product can be pumped out of the container in equal volumes of component A and B through a static mixer into the hot mold.

Fig.5 shows a composite prototype insulator made with SHCEP in this process.

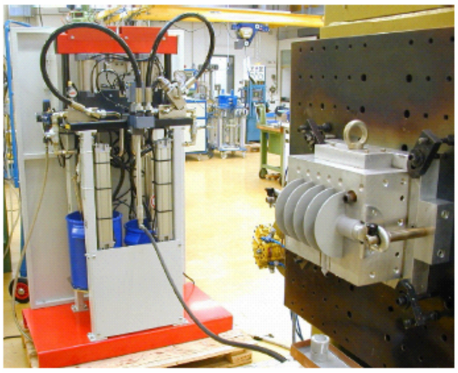

Fig.4 Processing equipment for SHCEP

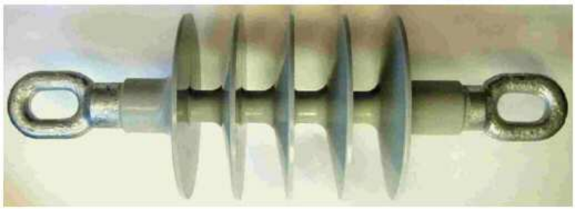

Fig.5 Composite insulator made with SHCEP

3. Conclusion

Based on the success of Araldite® HCEP system, Araldite® SHCEP is a new semi-flexible material that has been developed for composite insulators. SHCEP is an insulating outdoor system that can be used as housing material for the FRP core of composite insulators. It delivers intrinsic hydro- phobicity, hydrophobicity transfer and recovery effects similar to HCEP.

As SHCEP system is semi-flexible it is expected to be able to absorb the stresses that occur in composite insulator applications. The system has a mix ratio of 1:1 by volume making it suitable for the same meter mix equipment as used for LSR This is a significant advantage over standard epoxy applications as no stirring; degassing or pre-heating is required, making processing easy with only the simplest equipment. No primer treatment of the rod is necessary either as the epoxy adheres well to this.

The special formulation of SHCEP system also has good tracking and erosion resistance as well as good water diffusion break down strength.

(References: Beisele, C. : Advanced Materials for Outdoor Applications, May 2007)

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Development of 3D Temperature Imaging system with micro-encapsulated thermo-chromic liquid crystal for high-energy electron beam irradiation

1. Introduction

Insulating materials used in spacecrafts are exposed to high-energy particles, such as electrons, protons, and neutrons, which are accelerated on the surface of the sun. When the materials are irradiated by high-energy charged particles, the particles dump their kinetic energy into the target materials as thermal energy, and the space charges accumulate in the materials. In case of the irradiation with a large amount of the charged particles, the materials may sometimes melt and it gives a serious damage to the spacecraft. Hence, it is important to investigate the behavior of high-energy charged particle injected into high-polymer insulation materials.

Recently, we have developed new technique to image 3D energy absorption as temperature elevation within transparency materials by using micro- encapsulated thermo-chromic liquid crystals (MTLCs)[1]. This technique is useful to estimate the distribution of energy dumping caused by high-energy particles inside of the high-polymer transparency materials.

2. Principle of Temperature Distribution Imaging

In this study, we introduce new technique to measure three dimensional temperature distributions. MTLCs, which is produced by Japan Capsular Products, are used as a temperature sensor. The diameter of MTLC is about 20 to 30 micrometers. The cholesteric liquid crystal, which has suitable nature of high resolution and high sensitivity to the changes of temperature[2], is encapsulated within urea resin or gelatin capsule. Wavelength of scattered light from MTLC is changes as the environmental temperature surrounding MTLCs. Therefore temperature distribution is observed by the color image.

Figure 1 shows the example of correlation of the color with the temperature. This correlation is obtained by suspending MTLC within transparency materials. Scattered light is measured with CCD camera. The wavelength of the scattered light becomes shorter with the increase of temperature. In other words, the scattered light changes in its color from red to violet with the increase of temperature.

Schematic view of the measurement system for temperature distribution under the high-energy electron beam irradiation is shown in Fig. 2. Incident light emitted from LED (light-emitting diode) through a slit of 5 mm-wide is illuminated to a sample through a lead glass, which is put to protect the light source from the irradiation of high-energy electron beam or X-ray. The specimen is irradiated by the electron beam from upper side of it. The color distribution toned by MTLCs in the bulk of the specimen where the light is illuminated is observed using a CCD camera, which is put in front of the sample as shown in Fig.2. The change of the color tone distribution during the electron beam irradiation is recorded by digital color image. If the position of the incident slit light is moved, 2D temperature distribution on other cross-section is visualized. We can reconstruct 3D temperature distribution by sweeping the slit light source.

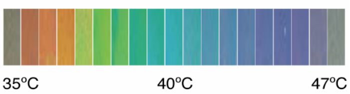

Fig.1 Example of correlation of the scattered light color with the substrate temperature.

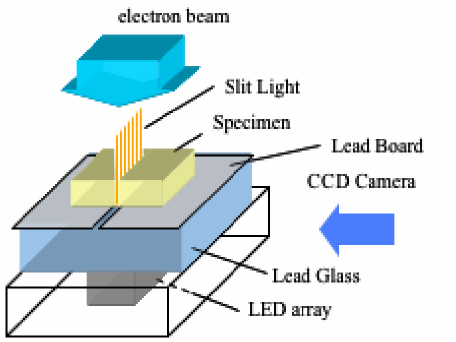

Fig. 2 Schematic view of the temperature measurement system with MTLC method for high-energy electron beam irradiation.

3. High-Energy Electron Beam Injection Experiment

High transparency epoxy resin is employed as the target material for electron beam injection in this investigation. The procedure of making specimen is as follows. Epoxy resin of liquid state with low viscosity is prepared. After dispersing particles of MTLC homogeneously into liquid state epoxy resin, it is cured by catalyzing agent. Dimensions of epoxy resin specimen is 30mm x 30mm x 10mm. The volume ratio of MTLCs dispersed in this specimen is 0.1%. In this experiment, MTLC colors from 40ºC (red) to 50ºC (violet) are employed.

Electron beam irradiation is performed using the electron acceleration system #1 (Cockcroft-Walton type) at Takasaki Advanced Radiation Research Institute, Japan Atomic Energy Agency (JAEA).

4. Imaging of Temperature Distribution due to High-Energy Electron Beam

Figures 3 show the captured images of temperature distributions within the specimen irradiated by high-energy electron beam. The condition of electron beam irradiation is as follows. Electron beam irradiation is carried out in air atmosphere at 19 ˚C. The electron acceleration energy is 1 MeV. The current density of the electron beam is approximately 130 nA/cm^2.

As shown in Fig. 3 at 180 s after the beginning of irradiation, rainbow colors are observed below the area of Cherenkov radiation. Here, Cherenkov radiation denotes blue area around the top of the specimen, that is observed all over the time during the high-energy electron beam irradiation. The order of color tones from the top to the bottom direction in the specimen is violet, blue green, orange, yellow and red. During the irradiation, it is found that the gradation of the color tones gradually shifted towards the bottom side with keeping that order. It means that the heat source caused by kinetic energy dumping for injected electrons is localized within the upper area of the specimen. The physical process of electron injection into high-polymer is clearly visualized with this technique. After the end of the irradiation, the circles of the colors appeared in the middle of the sample. It means that the temperature decreases from the peripheral area of the specimen. Since the heat flux is emitted from the surface of the sample, the result seems to be reasonable.

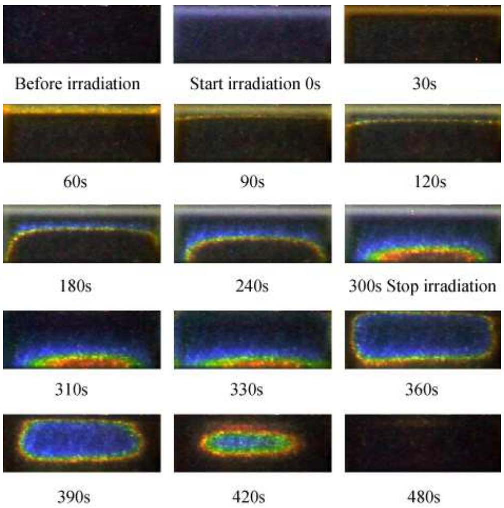

Fig.3 Time sequential images for color change inside specimen irradiated by electron beam with 1MeV, 130nA/cm^2.

5. Quantitation of Temperature Distribution by the Image Processing

These 'raw' images as shown in Figs. 3 are shown with low brightness and low contrast. Furthermore, since the color data of the 'raw' images have no linearity with temperature, it is difficult to understand the temperature distribution.

To show the temperature distribution clearly, the image processing technique with color coordinate transformation[3] is performed. Figures 4 are digitally processed images on Figs. 3. In these images, areas over and below the measurement temperature are described as white (over 40 ˚C) and black (below 30 ˚C) colors, respectively. We can show the capability to quantitate temperature distributions inside the specimen with non-destructive way.

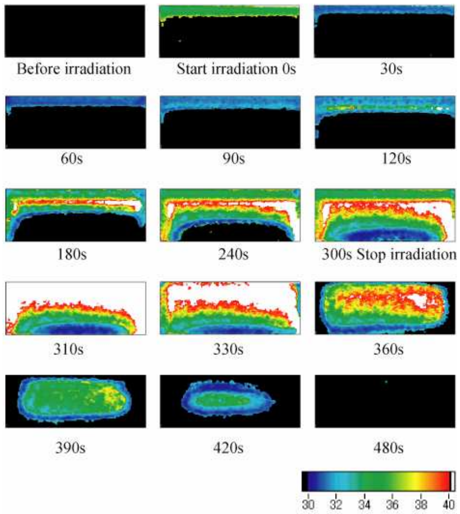

Fig.4 Quantitation of temperature distributions for color images shown in Fig. 3.

5. Conclusion

We propose the new technique to estimate temperature distributions inside materials with MTLCs. This method has capability to scan 3D temperature distribution inside target materials, and advantage in the real time temperature measurement with nondestructive way. This method is applied to high-energy electron beam irradiation into high-polymer materials. The result of experiment shows energy absorption distributions caused by electron beam injection are clearly visualized. Temperature distributions are estimated from captured images by the image processing technique with color coordinate transformation.

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MISCELLANEOUS

Photos on Front and Rear Covers

Front Cover:

New High-Performance Wind Turbine

(Yokohama, Japan)

Wind power generation has come to be used widely in the world as a key role for preventing global warming. Accordingly, the wind turbines are getting larger rapidly and higher in performance. Mitsubishi Heavy Industries, Ltd.(MHI) has developed the new high-performance wind turbine MWT92/2.4. The rated output is 2400kW with diameter of 92m. Here we present the several new technologies applied for MWT92/2.4, which are effective to reduce the load exerted on the large wind turbines. The first MWT92/2.4 turbine starts in operation on 17th January in 2006. The operation experience and verification results will be described also.

Masayuki Mukai
Mitsubishi Heavy Industries
Yokohama, Japan

Rear Cover:

Three-dimensional (3D) View of Electric Potential Well Distribution caused by Electrical Induced Dipole of Nanoparticle for Trapping Charge Carriers.

The figure represents a calculated three-dimensional (3D) view of the electric potential well distribution for trapping charge carriers of hole and electron. The potential well is generated by the electric dipole moment of nanoparticle which is induced under applied electric field. The potential well has a deep trapping depth (1.5 to 5.0 eV) and is a large capturing area (100 nm in diameter) for carriers. The background of this research work to calculate the potential well is shown in followings.

Space charge formation in low-density polyethylene film containing a small amount of MgO nanoparticle (LDPE/MgO nano-composite film) subjected to a high electric field greater than 100 kV/mm has been studied using a pulsed electro-acoustic (PEA) method. No marked space charge formation was observed in LDPE/MgO nano-composite films. To discuss the mechanism of no space charge accumulation in LDPE/MgO nono-composite film, we assumed that both electric potential wells produced by a permanent dipole moment such as that of a carbonyl radical (C=O) and an electrical induced dipole consisting of nanoparticle (spherical dielectrics and high permittivity) under a high electric field to create a trapping site for electric charge carriers. The trapping depth created by the permanent dipole moment such as that of the carbonyl radical (C=O) of chemical impurity defects is about 0.45 eV. However, that induced by high-permittivity dielectric nanoparticle (MgO) is about 1.5 to 5.0 eV, which is much deeper than that of chemical impurity defects. The suppression of space charge formation is explained using the potential well model consisting of a dipole induced by a high-permittivity dielectric nanoparticle.

Tatsuo Takada, Yuji Hayase, Yasuhiro Tanaka (Musashi Institute of Technology, Japan) and **Tatsuki Okamoto** (Central Research Institute of Electric Power Industry, Japan)

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Vol. 127-A No. 5 (May 2007)	Special Issue on Organic Molecular Electronics in 21st Century
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By Masahiro Kozako (Kagoshima National College of Technology, Japan)

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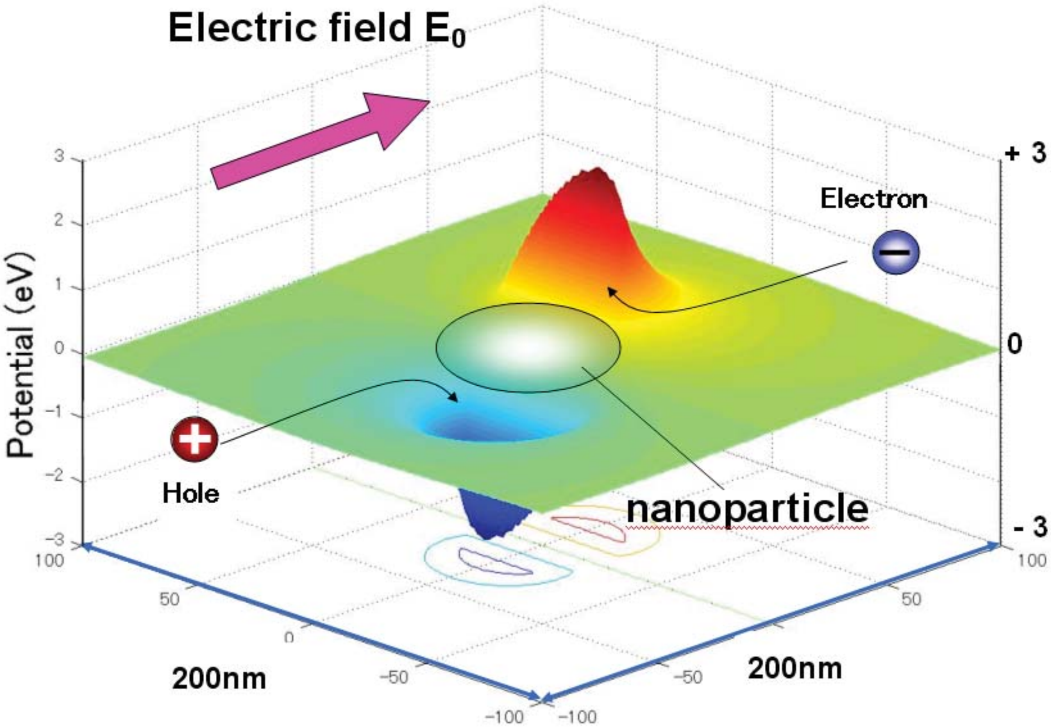

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