Electrical Insulation News in Asia

No.29 *December 2022*

IEEJ

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TECHNOLOGIES FOR TOMORROW

MISCELLANEOUS

PREFACE

Activities of Fundamentals and Materials Society, IEEJ

The Fundamentals and Materials Society (FMS) of the IEEJ covers fundamental fields which are common to applications of electrical engineering, such as electric power and energy, electronics and information and systems, industrial applications, sensors and micromachines. The present activities of FMS, expressed in terms of its 10 technical committees, are Research and Education, Electromagnetic Theory, Electromagnetic Compatibility, Light Application and Visual Science, Instrumentation and Measurement, Dielectrics and Electrical Insulation, Metal and Ceramics, Magnetics, History of Electrical Engineering, and Electrical Discharges, Plasma, and Pulsed Power.

Based on these fields, FMS aims to pioneer new fields and play a leading role in the development of IEEJ, especially by treating new technologies whose applications are still unclear and helping their growth until their applications become well-defined, and also by treating a wide range of fundamental leading technologies. For the activation and development of FMS, it is important to aim for the FMS that is attractive to young people. The FMS has established a “Young Chapter" committee for the purpose of revitalizing the academic activities of young members, developing human resources who will be responsible for the future of science and industrial technology, and building a network of young researchers. I would like to support and promote FMS reforms by young people for young people. In addition, I would like to actively promote initiatives aimed at internationalization, as well as collaboration and cooperation with other societies of IEEJ and other academic societies.

In 2020 and 2021, various activities were restricted due to the COVID-19 pandemic, but various advanced initiatives have been implemented to revitalize activities online. Face-to-face activities have many merits and pleasures, but I believe that hybrid activities that take advantage of the benefits of online activities will be necessary even after the coronavirus crisis subsides. In 2022, many technical meetings were held as a hybrid of face-to-face and online.

The Annual Conference of FMS, which is a major event held every year in the FMS, was also held in Tanegashima, Kagoshima Prefecture from September 13th to 15th, 2022, as a hybrid of face-to-face and online. There were 382 participants in the conference, and 243 papers were presented, and about 70% of the papers were presented face-to-face, making it a very successful conference. The 2023 Annual Conference of FMS will be held at the Jiyugaoka Campus of Aichi AInstitute of Technology, Nagoya from September 7th to 9th, 2023, so please come and join us. Participants from overseas are also welcome. The Annual Conference of FMS has been held since 1999. The 2023 Annual Conference will be the 25th, and I hope that we can plan an attractive commemorative conference for the 25th anniversary.

Dr. Keizo KATO
President, FMS, IEEJ
Professor, Niigata University

EDITORIAL

Message from Chairman

Dear Friends!

EINA Magazine No. 29 (2022) has come out for you Friends. You may look at this newest issue on this Website http://eina.ws.

EINA magazine has been published in printed paper form up to the No. 21 (2014) issue, but from the No. 22 (2015) issue, we decided to publish the magazine mainly in electronic PDF form to reduce the printing and mailing costs. Before this decision, we collected the reader's opinions and the majority were positive. As the chair of the EINA magazine committee, I would like to ask you sincerely to accept our decision. If you feel some inconvenience in the electronic style, please don't hesitate to request us to send the ordinary type EINA magazine. We still continue to print the ordinary type ones for distribution at international conferences to advertise our magazine.

EINA Magazine Committee of IEE of Japan is aiming at interactive communication among R&D people in the field of electrical insulation and high voltage engineering, especially in the Asia-Pacific region. We value this activity because we feel that it would be crucial to building up an interactive channel to promote R&D in this expertise. If you have items for the announcement, why don't you take due advantage of this medium to communicate with your potential friends? Contact eina@eina.ws.

Anyway, Covid 19 has been three years, and many international conferences have been held remotely, which is getting tiresome, but I hope everyone is doing well. I am sure that during Covid 19, you were probably frustrated because your experiments did not go as smoothly as you would have liked. However, it seems that more and more international meetings are being conducted face-to-face these days. For example, in Issue 29, we reported on CMD 2022, and the events conducted face-to-face at the conference like the demonstration of partial discharge diagnostics and the workshop for hands-on experience in fabricating a measurement device for space charge distribution for a cable-shaped sample were very interesting and successful. On the other hand, while experiments could not be conducted, a new field of research in the field of dielectric and insulating materials is also emerging. At CMD 2022 and other international conferences, new "high-voltage fields" without experimental works are emerging that make full use of computers, including materials design using machine learning, new diagnostic methods using machine learning, and advanced simulation analysis. EINA hopes to actively communicate information on these new trends, so please keep an eye on EINA's activities in the future.

I sincerely hope you will join in our EINA activities.

Thank you.

Professor Dr. Yasuhiro TANAKA
Tokyo City University

OUTLINE OF TECHNICAL COMMITTEES IN IEEJ

Dielectrics and Electrical Insulation (DEI)

Chairperson: Toshihiro Takahashi (CRIEPI*)
Secretaries: Yoitsu Sekiguchi (Sumitomo Electric Industries)
Hiroaki Miyake (Tokyo City Univ.)
Assistant Secretaries: Takahiro Umemoto (Mitsubishi Electric)
Norimitsu Takamura (Fukuoka Univ.)
*CRIEPI: Central Research Institute of Electric Power Industry

The Technical Committee on Dielectrics and Electrical Insulation (TC-DEI) has a long history from 1970. The activity of the TC-DEI has been covering mainly solid and composite dielectric materials and their technologies.

The important activity of TC-DEI is the annual domestic Symposium on Electrical and Electronic Insulating Materials and Application in Systems (SEEIMAS). The symposium topics include diagnostic techniques, inverter surge and partial discharge phenomena, functional and new materials and so on. In 2022, the 53rd SEEIMAS was held as a face-to-face conference at Katahira Sakura Hall of Tohoku University, Sendai, on Sept. 5-7, 2022. Since COVID-19 coronavirus pandemic had seemed to be abated, TC-DEI decided to hold the 53rd SEEIMAS in person, however, not to hold a banquet.

In the symposium, 101 persons participated and 73 papers were presented. The COVID-19 coronavirus pandemic prevented us to have a face-to-face meeting since March 2019, i.e. for about three years. Thus, many participants have been thirsty for having physical meetings in order not only to have opportunities for official exchange of technical information but also informal and personal exchange.

TC-DEI awards those who have contributed to the field of dielectrics and electrical insulation technologies as winners of the Ieda and Yahagi Memorial Awards, and let them give their memorial lectures. In 2022, Dr. Yoshiyasu Ehara, Emeritus Prof. of Tokyo City University, the winner of Ieda Memorial Award, gave his Ieda Memorial Lecture entitled with “Insulation Deterioration Diagnosis and Partial Discharge Visualization Technology.” In the lecture, Emeritus Prof. Ehara gave an overview of the mechanism of partial discharge, which is a cause of degradation of electrical insulation performance and a precursor to dielectric breakdown, as well as the permissible values and detection methods in various electric power equipment. He also gave a lecture on the mechanism of partial discharge visualization (optical observation technology) by time-series measurement of electrical tree development and partial discharge occurrence in PMMA. Dr. Shotaro Yoshida, the winner of Yahagi Memorial Awards gave his Yahagi Memorial Lecture entitled with “Development History of Power Cable Technologies and the Research and Development I Worked.” He lectured on the history of power cable development, especially higher voltage and longer length, based on his experience and the compilation of “Study on Systematic Development of Power Cable Technology”, by request from Center for the History of Japanese Industrial Technology, National Museum of Nature and Science, Japan. He also shared his unique experience of making efforts to improve manufacturing technology, which reminded us once again of the depth of power cable technology.

Another important task of TC-DEI is to encourage young researchers and students who involve dielectrics and electrical insulation technologies. MVP (Mutual Visiting type Poster presentation) sessions were held in 53rd SEEIMAS to let them present their research results and discuss among them to develop their presentation and discussion skills. Each session consisted with 5 to 6 presentations. Each presenter presented their results in 5 minutes, followed by 5-minute discussion with other presenters in the same session. The presentations and Q&A sessions were graded by each other, and the MVP award winners were selected by the executive committee of TC-DEI after totaling and evaluating the results. In addition to the presentations and discussions among the groups, time was set aside for discussion with the general participants to deepen the presenters’ study. In addition, the group also had an opportunity to communicate with the presentations of the SS (Sun-Shine) session, which will be described later, to deepen their knowledge of industry trends.

In the SS session, 11 presentations were made by companies related to the field of dielectrics and electrical insulation. Five of these presentations were sponsored by the Technical Committee of Electrical Wire and Cable (TC-EWC). Each company introduced their product development status and application

examples of their products. Some of the presentations exhibited actual measuring devices and cut models of cables and accessories that had been developed. Active discussion could be seen here and there.

Executive committee of TC-DEI would like to express their deepest gratitude to all the participants and presenters, to those who contributed as chairpersons, to those who cooperated in organizing the event. The deepest gratitude is also given to the members of the TC-EWC for their earnest cooperation in the SS session.

The TC-DEI will hold ISEIM 2023 on the year of 2023, on 24-28, September, 2023, at Matsue, Japan. TC-DEI invite all the participants from all over the world. The demo-session and tutorial regarding to assembling PEA measuring sensor will be held in ISEIM 2023. The detail will be able to see on the web site of TC-DEI.

The activity of TC-DEI is not only holding SEEIMS but also holding other technical and administrative meetings. TC-DEI usually holds 7 to 10 technical meetings per year and 4 administrative meetings per year. While keeping a close eye on the situation of COVID-19, TC-DEI is promoting activities through a good combination of face-to-face meetings and virtual meetings.

Additionally, TC-DEI runs Investigation Committees (IC's) in order to encourage the technical information exchange and present status of the related research activities, as shown below:

(1) Advancing Tailor-made Composite Insulation Materials and Their Applications (Jan. 2020- Dec. 2022, Chair: Takahiro Imai, Toshiba ISS)
(2) Advanced Nanomaterials, Organic Device Development and Life Science Application for Supporting Sustainable Growth (Oct. 2020-Sept. 2023, Chair: Keizo Kato, Niigata Univ.)
(3) Precursor Phenomena of Electrical Breakdown in Electrical Power Apparatus and Equipment and Sensing Technologies (Apr. 2021-Mar. 2024, Chair: Takashi Kurihara, CRIEPI)

Their research activities will be published as their technical report or presented in organized sessions in Annual Meetings of IEE Japan or Annual Conferences of Fundamentals and Materials Society, IEE Japan, as well as in organized sessions in ISEIM.

Fig. 1 Dr. Takahashi of CRIEPI, Chair of TC-DEI, giving his opening address.

Fig. 2 Emeritus Prof. Ehara giving his Ieda Memorial Lecture.

Fig. 3 Dr. Yoshida giving his Yahagi Memorial Lecture.

Finally, TC-DEI held 9th International Conference of Condition Monitoring and Diagnosis (CMD 2022) on Nov. 13-18, 2022. The detail can be referred to another report.

Fig. 4 Group photo of attendees.

Electrical Discharges, Plasma and Pulsed Power (EPP)

Chairperson: Hiroki Kojima (Nagoya University)
Vice-Chairperson: Toru Sasaki (Nagaoka University of Technology)
Secretaries: Katsuyuki Takahashi (Iwate University)
Yuki Inada (Saitama University)
Assistant Secretaries: Yusuke Nakagawa (Tokyo Metropolitan University)
Yusuke Nakano (Kanazawa University)

The Technical Committee on Electrical Discharges, Plasma and Pulsed Power (TC-EPP) in the Fundamentals and Materials Society of the Institute of Electrical Engineers of Japan (IEEJ) was founded by integrating former Technical Committee on Electrical Discharge and Technical Committee on Plasma and Pulsed Power in Jan. 1, 2019. The TC-EPP consists of 24 members from various regions involved in discharge, plasma, and pulsed power research and technology from various regions. Discharges, plasma, and pulsed power have long been closely related, and many researchers have been involved in the use of pulsed discharge plasma and pulsed discharge plasma in water for materials, environmental, and biological applications, and the relationship has been growing in recent years in many respects. With the establishment of the TC-EPP, the number of committee members mutually involved in the activity areas of each parent Technical Committee has increased, and it seems that the effect of the integration is becoming apparent. The TC-EPP has been working to promote the importance and attractiveness of this technology through the followings:

(1) Advanced scientific research and systematic investigation of the science and engineering behind discharge, plasma, and pulsed power technology,
(2) Promotion of the search for new science of discharge, plasma, and pulsed power technology, and the development of new applied technology,
(3) Cooperation with other fields and research and investigation from a futuristic and international perspective.

The TC-EPP holds technical meetings four to five times a year. The technical meeting is one of the most important activities in which the integration of technical committees has led to technical exchanges across the former fields. For the past few years, the meeting has been held online due to the influence of COVID-19, but with the social trend toward With-Corona, the meeting is now oriented toward a hybrid meeting, starting with the December 2021 meeting. In 2022, four technical meetings were conducted and organized as hybrid meetings:

(1) Jan. 21–22 at Kitakyushu International Conference Center, Fukuoka, with the TC of Dielectrics and Electrical Insulation (TC-DEI) and of High Voltage Engineering (TC-HVE),
(2) May 18–20 at Machinaka Campus Nagaoka, Niigata,
(3) Jul. 20–21 at Nagoya University, Aichi, with the TC of Stationary Devices (TC-SD) and of Switching and Protecting Engineering (TC-SPE),
(4) Nov. 21–22 as the International Workshop on High Voltage Engineering (IWHV), at Yashiosou, Okinawa, with TC-SPE and TC-HVE.

About one-third to half of the participants in the meetings were on-site, and the total number of participants tends to be higher than that before the COVID-19 pandemic. In addition, some of the meetings were able to hold banquets while taking infection control measures. While maintaining a certain degree of online accessibility, the face-to-face discussions are becoming more in-depth, and we can expect further active technical exchanges in this field. Moreover, the technical meetings held by the TC-EPP will be supported by the IEEE NPSS Japan Chapter (NPS-05) to deepen cooperation with international activities.

Although the management of a hybrid meeting is difficult because the appropriate operation varies depending on the ratio of online participants, fruitful presentations and discussion were held with the cooperation of the committee members who organized each technical meeting. I would like once again to express my deep gratitude to those who worked so hard to organize the technical meetings.

Until last year, the activities of the investigation R&D committees had focused on investigating the applications of electric discharge, plasma, and pulse power technologies, and by last year, the following committees had been established:

(1) Advancing Tailor-made Composite Insulation Materials and Their Applications (Jan./2020-Dec./2022, Chair: Takahiro Imai, Toshiba ISS)
(1) Investigation R&D Committee on the Insulation of Converter-fed Rotating Machines with Expanded Applications (Chair: Akiko Kumada, The University of Tokyo, until Nov. 2021),
(2) Investigation R&D Committee on the Trend of Surface Treatment Technology for Plasma Materials (Chair: Ryuta Ichiki, Oita University, until Dec. 2021),
(3) Investigation R&D Committee on Food Sterilization and Processing Technology by Pulsed

Electric Field (Chair: Yasushi Minamitani, Yamagata University, until Dec. 2021).

At the 2022 Annual Meeting IEEJ, the Investigation R&D Committee on the Insulation of Converter-fed Rotating Machines with Expanded Applications planned and held a symposium titled "Recent Research in Insulation of Converter-fed Rotating Machines", in which a wide range of discussions were held including the fields of dielectric and insulation materials and industrial applications.

While the engineering applications of discharge, plasma, and pulsed power technologies are diverse, with the recent development of the IoT etc., it has become necessary to balance basic engineering education with the increase in the volume of advanced technology education. Especially, technical college students are highly likely to become engineers in the field of application while understanding the safety of electric discharge, plasma, and pulsed power technology, and it is necessary to clarify the current state of these technical education. Against this background, the Investigation Committee on the Technical Education of Discharge, Plasma, and Pulse Power in Technical Colleges (chaired by Tsubasa Nakamura, National Institute of Technology, Oshima College) was established in Apr. 2022 to investigate the current status and trends related to the technical education of discharge, plasma, and pulse power in technical colleges, and to clarify the necessary elements for the technical education related to the technical education of discharge, plasma, and pulse power in technical colleges by referring to the improvement and good practices of the educational methods related to this area in the future. An overview of the education of discharge, plasma, and pulsed power technology in higher education institutions is expected to lead not only to bottom-up of R&D activities in the TC-EPP, to a fundamental understanding of educational methods for training engineers in a wide range of interdisciplinary fields.

The TC-EPP also contributes to organize an annual young researcher seminar in December, in cooperation with the Institute of Engineers on Electrical Discharges in Japan for encouraging the young researchers in the field of electrical discharges, plasma, and pulsed power. In June 25–30, 2023, we host 30th The International Symposium on Discharge and Electrical Insulation in Vacuum (ISDEIV 2023) with technically co-sponsorship of IEEE DEIS in Okinawa. In addition, in March 2024, we are planning to co-host 13th Asia-Pacific International Symposium on the Basics and Applications of Plasma Technology (APSPT-13) with 16th International Symposium on Advanced Plasma Science and its Applications for Nitrides and Nanomaterials (ISPlasma 2024) and 17th International Conference on Plasma-Nano Technology & Science (IC-PLANTS 2024).

Electrical Wire and Cables (EWC)

Chairperson: Naohiro Hozumi (Toyohashi University of Technology)
Secretaries: Kouji Miura (SWCC Showa Cable Systems Co., Ltd.)
Yoshihisa Nagoya (Furukawa Electric Co., Ltd.)
Kenichi Furusawa (Sumitomo Electric Industries, Ltd.)

Technical Committee on Electrical Wire and Cables (TC-EWC) is a committee organized in the IEEJ Power and Energy Society, and is composed of members from cable manufacturers, power utilities, railway companies, universities and related research institutes such as Japan Electric Cable Technology Center (JECTEC) and Central Research Institute of Electric Power Industry (CRIEPI).

The technical committee organizes technical meetings to provide opportunities to present technical achievements and to promote R&D activities in this field. The technical committee so far held technical meeting as a joint meeting of TC-DEI (Technical Committee on Dielectrics and electrical insulation) and TC-EWC, on 'Insulation performance and degradation, characteristics of DEI materials.' As the Covid problem was temporary stabilized in Japan, we were able to hold a joint technical meeting at Akita University on Nov. 15, 2022. The participants met each other at the venue (as well as on-line) and enjoyed the presentations and discussions.

We could also hold SEEMAS (a symposium held by DEI committee cosponsored by TC-EWC) at Tohoku University in Sendai in a hybrid form on Sep. 5-7, 2022. Dr. Shotaro Yoshida, formerly of Fujikura Ltd. received the Yahagi Prize for his work in cable research and development, and gave an impressive lecture.

The technical committee will also hold two more technical meetings, which are jointly organized by TC-DEI and TC-EWC. The topic of the technical meeting will be "Trends in maintenance technologies for wires and cables" and "Technology trends in cable and wire systems (product technology, aging mechanism clarification, diagnostics, evaluation, judgment methods)."

On Nov. 9, 2022, TC-EWC participated the symposium on "Power facilities supporting Japanese lifelines," organized by the TC on Static Apparatus,

and made a presentation on cable technologies. The technical committee is planning to hold a forum on “Latest diagnostic technology for power cables” on Feb. 27, 2023.

In addition to organizing technical meetings, forums and symposia, the technical committee supervises investigation committees dealing with subjects related to electrical wire and cables. Two investigation committees are in active in FY2022 on the following topics, respectively, i.e. “The environment surrounding power equipment and technological trends in environmental measures” (started in May, 2021), and “Advanced maintenance and security of overhead power lines using the latest technology” (started in Oct, 2022)

We are planning to hold a site visit this year at “Spring-8 (synchrotron radiation facility)” in the middle of December. We hope that the Covid conditions will get better and better.

We strongly believe that electric wire and cables occupy an important part of infrastructure that sustains stable supply of electric power. It is thus an important responsibility of us to clarify the social background and development process lead to the establishment of the technologies, and pass these onto the next generation.

Photo: Technical meeting jointed with the DEI committee in

High Voltage Engineering (HV)

Chairperson: Shozo Sekioka (Shonan Institute of Technology)
Secretaries: Takeshi Iwata (Hitachi Corp.)
Yoshiki Nakazawa (Toshiba Energy Systems & Solutions Co.)
Assistant Secretary: Takeo Shiina (CRIEPI*)
*CRIEPI: Central Research Institute of Electric Power Industry

Overview

The Technical Committee (TC) on High Voltage Engineering (HV) in the Power and Energy (P&E) Society of the Institute of Electrical Engineers of Japan (IEEJ) covers the research fields on the high voltage and current. “High voltage” is defined as the voltage to cause phenomena which are not observed when low voltage is applied. Thus, the TC deals with wide areas of electrical engineering. The main purpose of the TC is the promotion and exchange of information and knowledge related to high voltage engineering from international and domestic viewpoints. The major activities of the TC include establishing and discussing Investigating R&D Committees, publishing their IEEJ technical reports and lectures, and organizing Technical Meetings. The COVID-19 pandemic caused serious problems on the activity of the TC and meetings since 2020. The technical meetings were fundamentally held online. Some of the technical meetings were done by hybrid style with online and face-to-face styles in 2022.

This HV TC has dealt with issues related to high voltage and current engineering such as generation, measurement and evaluation of high voltages, high voltage testing, lightning phenomena, lightning protection design, overvoltages, insulation coordination, EMC/EMI/EMF and electromagnetic transient (EMT) analysis. As of Oct. 2022, five investigation committees are active as shown in Table 1.

The HV TC works on finding new themes and carrying out systematically technique succession of conventional technology on HV engineering. Furthermore, the TC established encouragement prize for young scientists, and emphasizes the development of human resources for the young scientists.

Organization

The HV TC consists of Chairperson (1), Secre-

taries (2), Assistant Secretary (1), and members belonging to the following institutes: university (6), research institute (2), electric power utility (5), railway company (1), and manufacturer (7).

Information on IWHV

The HV TC organizes the International Work- shop on High Voltage Engineering (IWHV). One of the major missions of the IWHV is to provide researchers, engineers and students mainly in Asian countries with an opportunity of sharing novel findings in the field of HV engineering. Since IWHV was first held in Okinawa, Japan in 1999, IWHV has been held in various cities in Japan. IWHV is now held once in two years. In every IWHV, participants actively discuss and exchange their knowledge and experience with each other. In addition, contributions with original findings are carefully selected and introduced in a special issue of IEEJ Transactions on Electrical and Electronic Engineering. IWHV2022 was successfully held in Naha, Okinawa Prefecture in hybrid meeting style on 21st and 22nd November. All the papers submitted to IWHV were presented orally. In accordance with the rule of IWHV, presentations and discussions must be done in English. Excellent papers presented in IWHV will be recommended to be submitted to a special issue on IEEJ Transaction.

Table 1. Investigation R&D Committees in the TC on HV.

Investigation R&D Committee	Active period	Chairperson
Investigation R&D Committee on Recent Progress on Characterization of Electric and Magnetic Fields near Electric Power Facilities	3 years from 2022	Kenichi Yamazaki (CRIEPI)
Investigation R&D Committee on Technical Trends of Insulation and Immunity Design against Lightning for Electrical Infrastructure	3 years from 2022	Toshihiro Tsuboi (Tokyo Electric Power Co. Holdings, Inc.)
Investigation R&D Committee on Lightning Protection Issues for Traction Power Supply and Signaling System for Railway	4 years from 2019	Hitoshi Hayashiya (East Japan Railway Co.)
Investigation R& D Committee on Clarification of Lightning Damage Mechanism and Lightning Protection Measures on Power Distribution Lines	4 years from 2019	Tomoyuki Sato (Tohoku Electric Power Network Co., Inc.)
Investigation R&D Committee on Lightning Protection Issues for Offshore Wind Power	3 years from 2020	Koichi Yamabuki (National Institute of Technology, Wakayama College)

Activities of Investigation Committees in the DEI Technical Committee

Advancing Tailor-made Composite Insulation Materials and Their Applications

Chairperson: Takahiro Imai (Toshiba Infrastructure Systems & Solutions Corp.)

Secretaries: Muneaki Kurimoto (Nagoya University)
Hideki Misaka (CRIEPI*)

Assistant Secretaries: Ryotaro Shimada (Hitachi, Ltd.)

*CRIEPI: Central Research Institute of Electric Power Industry

Objective

Tailoring is a keyword in the recent development of polymer composite insulation materials. It enables the composites to have desired material properties based on demands in electric power and industrial sectors. Moreover, the advent of Artificial Intelligence (AI) including Materials Informatics (MI) is just about to accelerate the tailoring of composites. The tailored high-performance and multi-functional polymer composites will contribute to high-efficiency, down-sizing and energy conservation of the electric apparatuses and power devices.

Therefore, our committee started activities in January 2020, and has investigated three main objectives as shown in Figure 1. We believe that our activities toward the objectives play an initiative role in polymer composite insulation material fields.

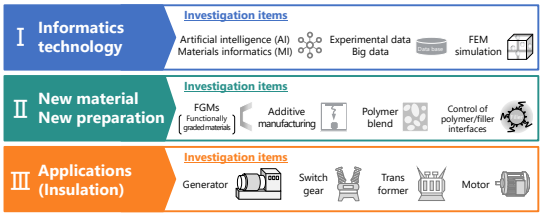
Activities

A. Symposiums on tailoring of polymer composites

Our committee planed and conducted two symposiums in 2022. First symposium entitled “Towards next-generation polymer composite insulation materials” was held in the annual meeting IEEJ in March. Second symposium entitled “Progress in material design and filler dispersion evaluation of polymer composites” was held in the annual conference of fundamentals and materials society IEEJ in September. Both symposiums had many participants, and the related technologies were discussed.

B. IEEJ Technical report

Results of investigation activities are summarized in IEEJ technical report whose contents are shown in Figure 1. Cutting-edge research on tailoring of polymer composites which contains functionally graded composites, additive manufacturing and control of polymer/filler interface is illustrated in the report. Besides, insulation material research based on machine learning and many applications of polymer composites in electric power and industrial sectors are provided in the report.



Contents of IEEJ technical report (tentative)

Chapter 1 : Preface
Chapter 2 : Data-driven approaches in material R&D
Chapter 3 : Insulation material R&D based on machine learning
Chapter 4 : Progress of simulation on polymer composites
Chapter 5 : Evaluation of filler dispersion in polymer composites
Chapter 6 : Sophisticated polymer composites based on new materials and their mechanism
Chapter 7 : Sophisticated polymer composites based on new preparation methods and their mechanism
Chapter 8 : Applications - Inovative polymer composite insulation materials for heavy electric apparatuses -
Chapter 9 : Applications – High-performace polymer composite insulation materials for industrial machineries -
Chapter 10 : Summary and future perspective

Fig. 1. Investigation items in the committee and contents of IEEJ technical report.

Table 1 Members of the committee.

Name	Affiliation
N. Araoka	Fukuoka University
T. Ebina	National Institute of Advanced Industrial Science and Technology
N. Fujimoto	Sumitomo Seika Chemicals Co., Ltd.
M. Fujita	SWCC Showa Cable Systems Co., Ltd.
T. Hasegawa	Fuji Electric Co., Ltd.
N. Hayakawa	Nagoya University
T. Igarashi	Showa Denko K.K.
T. Iizuka	Waseda University
T. Inada	Showa Denko Materials Co., Ltd.
S. Iwata	Osaka Research Institute of Industrial Science and Technology
N. Kasamatsu	Nagase ChemteX Corporation
M. Kozako	Kyusyu Institute of Technology
A. Kumada	The University of Tokyo
N. Kurokawa	(Former) Japan Electrical Insulating and Advanced Performance Materials Industrial Association
T. Mabuchi	Mitsubishi Electric Corporation
K. Miyata	Denka Company Limited
Y. Murakami	Toyohashi University of Technology
M. Nagata	University of Hyogo
Y. Ohki	Waseda University
T. Ohta	Panasonic Corporation
K. Sasaki	Meidensha Corporation
M. Sato	The University of Tokyo
A. Shimozato	Takaoka Toko Co., Ltd.
S. Suzuki	Sumitomo Electric Industries, Ltd.
T. Tanaka	Waseda University
Y. Tanaka	Tokyo City University
K. Tohyama	National Institute of Technology, Numazu College
Y. Yamashita	Toshiba Mitsubishi-Electric Industrial Systems Corporation
T. Yoshimitsu	Nippon Rika Kogyosho Co., Ltd.

Term of Investigation

The term of this committee is three years from January 2020 to December 2022. The final IEEJ technical report will be issued in 2023.

Members of Investigation Committee

Committee members are shown in Table 1. Our committee consists of 28 persons. Ratio of academia including research institute and industry is almost half and half. We believe that it is particularly good balance.

Precursor Phenomena of Electrical Breakdown in Electrical Power Apparatus and Equipment and Sensing Technologies

Chairperson: Takashi Kurihara (CRIEPI*)

Secretary: Hiroaki Cho (Toshiba Infrastructure Systems & Solutions Corp.)

Assistant Secretary: Naoto Shigemori (Furukawa Electric Co., Ltd.)

*CRIEPI: Central Research Institute of Electric Power Industry

Objective

In recent times, with the advent of a global advanced information society, increasingly sophisticated urban functions, and high demand for electric power, highly safe electric power systems are being sought. This includes electric power apparatus and equipment central to maintaining social infrastructure. When accidents occur at such apparatus and equipment and cause power outages, the social impact is substantial, and economic losses become significant. Therefore, the maintenance of electric power apparatus and equipment is extremely important, and diagnostic methods to ascertain deterioration and abnormalities in electric power apparatus and equipment have been utilized for a long time. The Technical Committee on Dielectrics and Electrical Insulating Materials has established investigating R&D committees 10 times since 1980, continuously investigating changes in insulating materials, insulation deterioration diagnostic methods, deterioration assessment criterion, and lifetime estimation methods for cables, transformers, rotating machines, gas-insulated switchgears, and circuit breakers at 3.3–77 kV.

Developments are underway to use nanocomposites, vegetable oils, and alternatives to SF_6 gas as new insulating materials, considering the current global environment. In addition, electric power apparatus and equipment developed overseas are used domestically; thus, insulating materials different from those used in domestically produced electric power apparatus and equipment can be used. As there is a possibility that the demand for developing new insulating materials may increase considering a carbon-free environment, insulating materials and designs will continue to change in the future.

Under such circumstances, insulation deterioration diagnosis is performed for many kinds of electric power apparatus and equipment, e.g., cables, transformers, rotating machines, gas-insulated switchgears, circuit breakers, and disconnectors. However, the precursor phenomena of electrical breakdown and process through which deterioration leads to electrical breakdown differ with changes in insulation design and usage environment of electric power apparatus and equipment. In some electric power apparatus and equipment, e.g., molded transformers, the precursor phenomena of electrical breakdown have not been sufficiently clarified. It is important to discover these precursor phenomena at an early stage, so that insulation deterioration diagnosis is properly carried out.

In addition, with the development of ICT and sensing technologies, online diagnosis in Japan and abroad have been utilized for the insulation deterioration diagnosis of electric power apparatus and equipment. Based on the requirements for early detection of insulation deterioration and labor saving in insulation deterioration diagnosis, the importance of online diagnosis is expected to increase in future. Considering the effective use of online diagnosis, it is important to develop sensing technologies to detect the precursor phenomena of electrical breakdown and ascertain the lead time to electrical breakdown.

Against this background, the objective of this committee is to investigate the precursor phenomena of electrical breakdown and the process through which deterioration leads to electrical breakdown, according to changes in the insulation design of electric power apparatus and equipment and usage environments. The other objective is to investigate the latest sensing technologies to detect such changes.

Investigative Matters

The committee will investigate the following items for 3.3-77-kV cables, transformers, rotating machines, gas-insulated switchgears, circuit breakers, and disconnectors:

(1) Changes in insulation design and usage environments
(2) Precursor phenomena of electrical breakdown and process through which deterioration leads to electrical breakdown
(3) Latest sensing technologies to detect the precursor

phenomena of electrical breakdown

Term of Investigation

The term of this committee is three years from April 2021 to March 2024.

Activities

We held four meetings in 2021 and five meetings in 2022, and discussed the aforementioned items. We also held seminars on deterioration mechanisms and deterioration diagnostic technologies of insulating materials in electric power apparatus and equipment as a forum of the Fundamentals and Materials Society (FMS) on July 2, 2021, at Tokyo Branch of IEEJ on November 26, 2021, and at Tokai Branch of IEEJ on March 4, 2022. Furthermore, we held special topic sessions on the same theme in the Annual Conference of FMS on September 2, 2021, and on September 15, 2022.

Advanced Nanomaterials, Organic Device Development, and Life Science Application for Supporting Sustainable Growth

Chairperson: Keizo Kato (Niigata University)
Secretaries: Shin-ichro Nakajima (Japan Aviation Electronics Industry, Ltd.)
Yusuke Aoki (Mie University)
Assistant Secretary: Akira Baba (Niigata University)

Research on organic electronics such as research on the electronic and optical functions of nanomaterials and thin films and the development of devices and sensors using organic materials, has been making great progress. Research on flexible electronics, printed electronics, bioelectronics, etc. has also been very active. In the near future, innovative devices using organic materials will be developed. In addition, research related to organic devices could be applied to life sciences. Nanomaterials and nanostructure control technology are considered crucial for the development of organic devices and their applications in life sciences, and various kind of attempts and research and development are being made to this end. Thus, research on nanomaterials, organic device development and life science application that create a new society and support sustainable growth is required.

From these points of view, this investigating R&D committee has been established to investigate and examine the most advanced nanomaterials, nanostructure control technology, evaluation techniques, high-performance/high-function organic device development and life science application. The purpose of this investigating R&D committee is to contribute to the sustainable growth of society based on the development of new electronic devices and electrical equipment and industries such as energy, environment, and biotechnology.

The R&D committee was established in October 2020, with the term of three years. The investigation has focused attention on the nanomaterials and structure control for high-performance organic devices and life science related to:

(1) Advanced nanomaterials and nanostructure control technologies
(2) Surface and interface properties and evaluation techniques for nanomaterials and devices
(3) Electronic and optical functions of nanomaterials, organic thin films, and composite films
(4) Organic device development and life science application

6 meetings had been held by November 2022. Lectures related to the above subjects were given by the committee members and non-member researchers. Recent research topics and trends were also introduced by the committee members, and earnest discussions were done. The 6th meeting was held on November 18, 2022 at the FREA (Fukushima Renewable Energy Institute, AIST (National Institute of Advanced Industrial Science and Technology)) in Koriyama City, Fukushima Prefecture. A tour of various research facilities of the FREA was also conducted. Fig. 1 shows a group photo at that time.

Fig. 1. Group photo in Japan's largest electromagnetic anechoic chamber during the FREA research facility tour on November 18, 2022.

The Technical Meeting on "Dielectrics and Electrical Insulation" were also held online on March 1-2, 2021 and on February 10, 2022, and Karuizawa, Nagano Prefecture (and online), July 18-19, 2022 in cooperation with this investigating R&D committee.

Research on advanced technologies such as nanomaterials, nanostructure control, nanointerface property evaluation, and device and sensor applications, will link nanomaterials, organic thin films, and composite films to the development of high-performance, high-function organic devices, and it is also possible to expand to life science. Moreover, it is expected to develop new functions to nanomaterials and nanostructure control technology for organic thin and composite films. The development innovative electronic devices and electrical equipment, and expansion into industries such as energy, environment, and biotechnology, and life science application are highly expected. Therefore, it is believed that this committee will significantly contribute to the development of electrical and electronic materials and devices in Japan and overseas and the sustainable growth of society.

The members of this investigating R&D committee are as follows: Takeshi Asami (Denka), Masayuki Chikamatsu (AIST), Eiji Ito (Shinshu Univ.), Satoru Iwamori (Tokai Univ.), Tomio Iwasaki (Hitachi, Ltd.), Sachiko Jonai (Niigata Univ.), Hirotake Kajii (Osaka Univ.), Takaaki Manaka (Tokyo Tech), Tatsunosuke Matsui (Mie Univ.), Yasuhiro Miura (Hamamatsu Univ. School of Medicine), Tatsuo Mori (Aichi Inst. of Tech.), Tetsushi Okamoto (TMEIC), Mitsuyoshi Onoda (Himeji City Fire Department), Hitoshi Ohnuki (Tokyo Univ. of Marine Sci. and Tech.), Takashi Ota (Panasonic), Masafumi Takesue (Kao), Rumiko Yamaguchi (Akita Univ.), Hiroshi Yamamoto (Nihon Univ.), Hiroshi Yamauchi (Tokyo Denki Univ.), Norimitsu Yoshida (Gifu Univ.).

EINA Magazine Publication

Chairperson: Yasuhiro Tanaka (Tokyo City University)
Secretaries: Masahiro Kozako (Kyushu Institute of Technology)
Norikazu Fuse (CRIEPI*)
*CRIEPI: Central Research Institute of Electric Power Industry

Objective

The EINA Committee, which publishes the magazine "Electrical Insulation News in Asia", aims to construct an international interactive channel for information exchange in the field of dielectrics and electrical insulation in the Pan Pacific region. We are currently providing an annual issue of EINA magazine as well as making it available on the EINA Website.

Chronicle of the Committee

The Committee, with the official title "the Cooperative Research Committee (CRC) of Asian Interlink of Dielectrics and Electrical Insulation", was established by the late Professor M. Ieda in 1991. It played the leading role in the initiation of this kind of work from Jan. 1991 to Dec. 1992. The committee reviewed the present status of scientific and technological cooperation in the field of dielectrics and electrical insulation in Asian countries and sought appropriate ways to promote informative interaction among the countries.

On the basis of the former activities, the CRC of "Electrical Insulation News in Asia" was founded by Professor H. Yamashita, Keio University in April 1994. One of its key activities was the publication of the "Electrical Insulation News in Asia (EINA)" from No. 1 (Sept. 1994) up to No. 6 (Sept. 1999). This dedication contributed greatly to a mutual understanding of electrical insulation activities in Asia.

Professor T. Tanaka of Waseda University took over this role in 2000 and expanded its role to accommodate

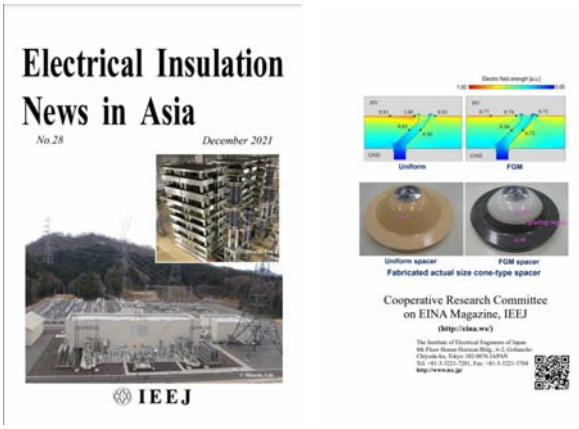


Fig. 1. Front and rear covers of the latest issue of EINA magazine (EINA No. 28, Dec. 2021).

information flow among Asian countries and to facilitate a more timely flow of information through its Website. Three international technical exchange sessions were held in ICPADM 2000 (Xian Jiatong University, China), ISEIM 2005 (the Kitakyushu Intern'l Conf. Center, Japan), and ISEIM 2008 (Yokkaichi Cultural Hall, Japan) for the promotion of information exchange and human contact among researchers of Pan-Pacific region in the field.

Professor M. Nagao of Toyohashi University of Technology) chaired the committee from 2009 to 2021. After that, Professor Y. Tanaka of Tokyo City University succeeded to the chair of the committee. In the past, the EINA magazine had been published both

sending by mail as well as through the website. In 2015 we sent out questionnaires on the way to the publication to readers. As the collected answers coincided with our intention, we decided to publish the magazine mainly in electronic PDF form through the website. However, we still continue to send printed booklets for those requesting and authors of articles in the issue. They are also distributed at related international conferences.

Activities

Our present committee consists of 8 key members listed in the right of this page and 20 other members listed in the last page of the magazine. One annual general meeting and also secretariat meetings as needed are held to plan, carry out and review its activities. The EINA Magazine No. 28 was published in electronic form in December 2021 as shown in Fig.1 and was also uploaded to our website http://eina.ws/.

Please visit the website. It may be of interest to you.

The Committee has been financially supported by IEEJ as well as by voluntary contributions from Japanese enterprises.

Term of Investigation

The term of this committee is from September 2021 to March 2023. Thereafter a succeeding committee will be set up every two years.

The web site of the committee

http://eina.ws/ where you can browse the EINA magazines.

Activities of Other Committees Related to Electrical Insulating Materials

IEC TC 15 Japanese National Committee

Chairperson: A. Kawaguchi (JET*)
Secretary: C. Kondo (DuPont Nippon Paper Papylia)
*JET: Japan Electrical Safety & Environment Technology Laboratory

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

TC15 establishes definitions, general requirements and specification sheets for individual types of materials. The standards include test methods and guidance where these are required for the specifications".

Although TC15 Japanese National Committee (TC 15 of JNC) has certainly the same scope as that for IEC TC15, its mission is accomplished by consulting with Japanese industrial situations and market in the world.

As shown in Table 1, the current activities of TC15 are carried out by 3 working groups (WGs) and 6 maintenance teams (MTs). IEC TC15 publishes now more than 160 standards.

The major topic in 2022 is the retirement of Mr. John Gauthier, long-time secretary, and the appointment of Mr. Solomon Chiang as secretary. Mr. Bernhard Klaussner, chair of TC15 has not changed.

Mr. Solomon Chiang is participating in TC15 for the first time, but he has some basic knowledge on the principles and mechanisms of standard development and maintenance through his activities in IEEE and other organizations.

Perhaps due to the change of secretary, no IEC TC 15 meeting was held in 2022, and the next meetings has not yet been determined. Therefore, JNC meetings are usually held three times a year, but only once in 2022.

For a time, TC15 activities did not progress, but since the end of 2022, discussions on TC15 Working Documents have been restarted and new activities are expected under the new structure.

As described in Table 1, IEC TC15 has 3 WGs and 6 MTs which deal with the individual solid insulating materials for electrical and electronics applications. The kind of insulating materials concerned with TC 15 are classified by fundamental and basic category. Member of TC15 of JNC are encouraged to activate the domestic and global markets through their technologies of high levels. TC15 of JNC is contributing to the standardization works in WGs and MTs as the conveners and experts of the WGs and MTs, which are WG5 WG7 MT3, MT10, MT14, MT15 and MT16. Especially, MT3 and MT16 are managed by Japanese conveners.

Table 1. Working Groups and Maintenance Teams in TC 15

Working Groups in active		
WG No.	Title	Number of JP expert
5	Flexible insulating sleeving for electrical purposes	1
6	Rigid fibrous reinforced laminates for electrical purposes	0
7	Resins and varnishes	1
Maintenance Teams in active		
MT No.	Title	Number of JP expert
3	Plastic films	3
10	Combined flexible materials	1
11	Mica products	0
14	Pressboard and related material	1
15	Cellulosic paper products	1
16	Miscellaneous	2

IEC TC 112 Japanese National Committee

Chairperson: Hiroya Homma (CRIEPI*)
Secretary: Takashi Kurihara (CRIEPI*)
Associate Secretary: Kenichi Yamazaki (Toshiba Infrastructure Systems & Solutions Corporation)
*CRIEPI: Central Research Institute of Electric Power Industry

IEC TC 112 deals with many international standards and specifications on "Evaluation and qualification of electrical insulating materials and systems". TC 112 was established in 2005 based on TC 98 and the related sub-group in TC 15, which were disbanded after the establishment of TC 112. TC 112 Japanese

National Committee (JNC) was also established in 2005 to correspond to the activities in TC 112 and to concern with related Japanese standards.

TC 112 involves eight working groups (WG) and dealing with more than 50 standards. TC 112 JNC includes eight corresponding WGs and one more WG that relates with the Japanese Industrial Standards (JIS). The WG structure of TC 112 JNC is shown in Table 1. 28 JNC expert members are registered to the eight international WGs and the convener of WG8 is now taken by Prof. Yasuhiro Tanaka. In this reason, Japanese members are very active in this standard region.

Table 1. WG structure of TC 112 JNC

WG	Subject
1	Thermal endurance
2	Radiation
3	Electrical strength
4	Dielectric/resistive properties
5	Tracking
6	General methods of evaluation of electrical insulation
7	Statistics
8	Various material properties
9	Japanese Industrial Standards (JNC only)

From September 19 to 23, 2022, IEC TC 112 Meeting was held in Kista, Sweden and via Zoom, and the Plenary, Advisory group and WGs meetings were scheduled during the week as shown in Fig.1. Nine experts from JNC remotely participated in them. The next meetings of TC112 will be held in Sharm-El-Sheikh, Egypt, from October 16 to 20, 2023.

Recent standards discussed in TC112 are partly listed:

A. WG1

- IEC 60216-1: Electrical insulating materials - Thermal endurance properties - Part 1: Ageing procedures and evaluation of test results.
- IEC 60216-4-1: Electrical insulating materials - Thermal endurance properties - Part 4-1: Ageing ovens - Single-chamber ovens.
- IEC 60216-4-2: Electrical insulating materials - Thermal endurance properties - Part 4-2: Ageing ovens - Precision ovens for use up to 300 °C.
- IEC 60216-4-3: Electrical insulating materials - Thermal endurance properties - Part 4-3: Ageing ovens - Multi-chamber ovens.
- IEC 60216-5: Electrical insulating materials - Thermal endurance properties - Part 5: Determination of relative thermal endurance index (RTI) of an insulating material.
- IEC 60216-6: Electrical insulating materials - Thermal endurance properties - Part 6: Determination of thermal endurance indices (TI and RTE) of an insulating material using the fixed time frame method.
- IEC TS 60216-7-1: Electrical insulation materials - Thermal endurance properties - Part 7-1: Accelerated determination of relative thermal endurance using analytical test methods (RTEA) - Instructions for calculations based on activation energy (PL: Jun Haruhara).
- IEC TR 60216-7-2: Electrical insulating materials - Thermal endurance properties - Part 7-2: Results of the round robin tests to validate procedures of IEC TS 60216-7-1 by non-isothermal kinetic analysis of thermogravimetric data (PL: Jun Haruhara).
- IEC 60216-2/AMD1: Electrical insulating materials - Thermal endurance properties - Part 2: Determination of thermal endurance properties of electrical insulating materials - Choice of test criteria.

Fig. 1. A snapshot of the Plenary meeting of TC 112 held in Kista, Sweden and via Zoom on September 23, 2022.

B. WG2

- IEC 60544-5: Electrical insulating materials - Determination of the effects of ionizing radiation - Part 5: Procedures for assessment of ageing in service.

C. WG3

- IEC 60243-2: Electric strength of insulating materials - Test methods - Part 2: Additional requirements for tests using direct voltage.
- IEC TS 61934: Electrical insulating materials and systems - Electrical measurement of partial discharges (PD) under short rise time and repetitive voltage impulses.
- NWIP IEC/TS 61251-2: Electrical insulating materials and systems - DC voltage endurance evaluation.

D. WG4

- IEC 62631-1: Dielectric and resistive properties of solid insulating materials - Part 1: General.
- IEC 62631-2-1: Dielectric and resistive properties of solid insulating materials - Part 2-1: Relative permittivity and dissipation factor - Technical Frequencies (0,1 Hz - 10 MHz) - AC Methods.
- IEC 62631-2-3: Dielectric and resistive properties of solid insulating materials – Part 2-3: Determination of relative permittivity and dielectric dissipation factor (AC methods) – Contact electrode method for insulating films.
- IEC 62631-3-1: Dielectric and resistive properties

of solid insulating materials Part 3-1: Determination of resistive properties (DC methods) – Volume resistance and volume resistivity, general method (PL: Jun Haruhara).
- IEC 62631-3-2: Dielectric and resistive properties of solid insulating materials Part 3-2: Determination of resistive properties (DC methods) – Volume resistance and volume resistivity, Surface resistance and surface resistivity.
- IEC 62631-3-12: Dielectric and resistive properties of solid insulating materials – Part 3-12: Determination of resistive properties (DC Methods) – Volume resistance and volume resistivity, method for casting resins.
- NWIP IEC 62631-2-3: Test methods for Relative Permittivity and Dissipation Factor of insulating films with very thin thickness.

E. WG5
- IEC 60587: Electrical insulating materials used under severe ambient conditions - Test methods for evaluating resistance to tracking and erosion.
- IEC TR 62039: Selection guide for polymeric materials for outdoor use under HV stress.

F. WG6
- IEC 61857-33: Electrical insulation systems - Procedures for thermal evaluation - Multifactor evaluation with increased factors at elevated temperature.
- IEC 61857-42: Electrical insulation systems - Procedures for thermal evaluation - Part 42: Specific requirements for evaluation of an electrical insulation system (EIS) used for road transportation applications.
- IEC 63177: Test method for compatibility of construction materials with electrical insulating liquids.

G. WG8
- IEC 62836: Measurement of internal electric field in insulating materials - Pressure wave propagation method.
- NWIP IEC TS 62758-2: Calibration of space charge measuring equipment based on the pulsed electroacoustic (PEA) measurement principle (PL: Yasuhiro Tanaka).

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

Chairperson: Akiko KUMADA (The University of Tokyo)
Secretary: Hideki MISAKA (CRIEPI*)
Secretary: Makoto MIYASHITA (Mitsubishi Electric Co. Ltd.)
*CRIEPI: Central Research Institute of Electric Power Industry

CIGRE (International Council on Large Electric Systems) has 16 Study Committees (SC) belonging to each of following 4 categories: A (Equipment), B (Subsystems), C (Systems) and D (Horizontal). Among them, our SC D1 has a horizontal character and contributes to other CIGRE SC's. The activity of CIGRE SC's is principally research oriented one.

SC D1 has now following 6 Advisory Groups (AG): Strategic and Customer AG, Tutorial AG, AG D1.01 (Liquid and liquid impregnated insulation systems), AG D1.02 (High voltage and current testing and diagnostic), AG D1.03 (Solid materials) and AG D1.04 (Gases). D1 consists of these AGs and following 24 WGs listed as follows.

D1/B1.49 Harmonised test for the measurement of residual inflammable gases in insulating materias by gas chromatography, D1.50 Atmospheric and altitude correction factors for air gaps and clean insulators, D1. 54 Basic principles and practical methods to measure the AC and DC resistance of conductors of power cables and overhead lines, D1/B3.57 Dielectric Testing of gas-insulated HVDC Systems, A2/D1.51 Improvement to Partial Discharge Measurements for Factory and Site Acceptance Tests of Power Transformers, D1.58 Evaluation of dynamic hydrophobicity of polymeric insulating materials under AC and DC voltage stress, D1.60 Traceable measurement techniques for very fast transients, D1.61 Optical corona detection and measurement, D1.62 Surface Degradation of Polymeric Insulating Materials for Outdoor Applications, D1. 63 Partial Discharge Detection under DC voltage stress, D1.64 Electrical insulation systems at cryogenic temperatures, D1.65 Mechanical properties of insulating materials and insulated conductors for oil insulated power transformers, D1.66 Requirements for partial discharge monitoring systems for gas insulated systems, D1.67 Dielectric performance of new non-SF6 gases and gas mixtures for gas-insulated systems, D1.68 Natural and synthetic esters - Evaluation of the performance under fire and the impact on environment, D1.69 Guidelines for test techniques of High Temperature Superconducting (HTS) systems, D1.70 Functional Properties of modern insulating liquids, D1.72 Test of material resistance against surface arcing under DC, D1.73 Nanostructured dielectrics: Multi-functionality at the service of the electric power industry, D1.74 PD measurement on insulation systems stressed from HV

power electronics, B1/B3/D1.79 Recommendations for dielectric testing of HVDC gas insulated system cable sealing ends, B1/D1.75 Interaction between cable and accessory materials in HVAC and HVDC applications, D1/B1.75 Strategies and tools for corrosion prevention for cable systems, D1/A2.77 Liquid Tests for Electrical Equipment.

In the CIGRE Paris Session 2022, the SC D1 Tutorial (Electric performance of new non-SF6 gases and gas mixtures for gas-insulated systems) was held on 1st Sep., Poster Session on 2nd Sep., and Group Discussion on 3rd Sep. The Tutorial was based on the results of WG D1.67 (TB849 published) and introduced the latest trend of SF6 alternative gases, new proposed test methods, electrical insulation performance of gas mixtures, analytical methods for gas mixtures, etc. The Group Discussion In the meeting, there were 19 presentations on PS1 (testing, monitoring, diagnostics), 19 presentations on PS2 (Material for electro technical purposes), 3 presentations on PS3 (Simulation tools with measurement techniques), and 3 presentations on PS4 (Simulation tools with measurement techniques). The number of papers for each PS was 22, and the number of papers for each PS was 3. The number of papers for each PS was 22, 27, and 4, respectively, and the number of papers for PS1, which has the same agenda as before, was the same as before. PS3 is a new viewpoint topic, and although the number of papers is small, the evaluation of deterioration using an aging deterioration model for transformers and simulation tools for the construction of a digital twin were discussed. Japan contributed two papers to PS1 (technology for detecting corrosion under steel coatings and flow charging evaluation of oil-filled transformers) and three to PS2 (development and application of functional insulating materials using nanofillers), with six contributions including the author of each paper.

The next regular meeting and group discussion meeting of SC D1 will be scheduled during Cairns Symposium held in September 2023.

Hybrid Dialogue-style Lecture for Young Researchers in Annual Conference of FMS in IEEJ

Chairperson: Yusuke Nakano (Kanazawa University)

The Young Chapter Planning Committee on in the Fundamentals and Materials Society (FMS) of the Institute of Electrical Engineers of Japan (IEEJ) was newly founded in September 2019. This committee was expected to revitalize the FMS by organizing events of young researchers, by young researchers, for young researchers. The formation of networks among young researchers would be important for promoting cross-disciplinary research activities and enhancing research collaboration between industry, academia and public institutions in future activities.

So far, several online networking events were held due to the COVID-19, but it was attempted to conduct face-to-face. Compared to face-to-face communication, online communication seems to be less effective because the amount of information was limited. Under these circumstances, as one of special sessions at the annual conference of FMS held in a hybrid style on September 13th–15th 2022 in Tanegashima, the young chapter planning committee also tried to hold a dialogue-style lecture. The session consisted of two parts, the first half being a lecture and the second half being a place for exchange and discussion among participants.

Theme of the lecture was “Creation of research themes,” which seemed to be attractive to young researchers and engineers. The committee invited two lecturers, Yuki Inada (Saitama University) and Wataru Ohnishi (the University of Tokyo), involved in following theme: “Development of a compact, inexpensive, versatile current limiting circuit breaker” in program of unexplored challenge 2050 supported by New Energy and Industrial Technology Development Organization (NEDO) (https://research-er.jp/projects/view/1165148). The members of this project consist of young researchers in different specialized fields, e.g. electrical insulation, circuit breaker phenomena, plasma analysis, power semi-conductor, precision positioning. Such cross-disciplinary project was of great interest to participants of students and young researchers, and was also well suited to the

Fig. 1. Special topic session of a dialogue-style lecture for young researchers and students in annual conference of FMS of IEEJ. (Tamegashima Development Center (Firearm Museum))

committee's purpose.

In the lecture, an organizer asked them to talk about how they came to carry out above project and how they met with fellow researchers, rather than project details (Fig. 1). Questions from the audience were also flexibly received, and delved into the more interesting contents so that the audience can actively participate the session. In the latter part, participants were divided into 4 groups (4~5 persons/group) and freely communicate each other and discuss their interests, problems, unique measuring method etc. in their own research.

From the questionnaire to participants after the session, it seems to be fruitful for them. A few of their opinions as follows:

- This is the first time to participate in the face-to-face conference. Compared to the online conference, it was good opportunity freely to discuss with students from other universities and professors, who were usually difficult to talk to.
- I learned a lot by hearing about the creation of research themes and the approach of new measurement methods.
- I was able to expand my research community.

The above comments are exactly in line with the intentions of the committee, and would indicate the importance of social gatherings at academic societies, especially for students and young researchers.

On the other hand, half of the participants in the FMS conference did not know about this session. Although this session was named for young researchers, it is still a problem that professors and senior researchers, who are in a position to mediate and lead young researchers, do not know about the existence of events for young researchers.

Finally, the committee can gradually be providing a forum for discussion for young researchers in IEEJ community. The challenges are to disseminate the activities of our committee, to increase the number of participants, and to enhance the content of the activities.

RESEARCH ACTIVITIES AND TECHNICAL EXCHANGES IN ASIAN COUNTRIES

Conference Records

The 8th IEEE International Conference on High Voltage Engineering and Applications (ICHVE 2022)

Fig. 1. General Chair of ICHVE 2022, Prof. Feipeng Wang from Chongqing University, China.

The 8th IEEE International Conference on High Voltage Engineering and Applications (ICHVE 2022) was held from September 25 to 29, 2022, jointly organized by IEEE Dielectric and Electrical Insulation Society, Chongqing University, Xi'an Jiao tong University, University of Connecticut, Chongqing Electric Power Research Institute of State Grid Corporation, and CSEE High Voltage Professional Committee. As shown in Fig. 1, the General Chair of ICHVE 2022 was Prof. Feipeng Wang from Chongqing University. Due to the impact of the COVID-19 coronavirus, the ICHVE 2022 organizing committee decided that this conference would be conducted in a combined online and offline mode. The conference was held successfully, bringing together more than 400 domestic and international university faculty, students, and engineers online and offline. Prof. Brian Stewart (Fig. 2), President of the IEEE DEIS Society, delivered a welcome speech at the opening ceremony as shown in Table 1. The conference invited 12 internationally famous high voltage engineering scholars to give keynote speeches and carried out 32 oral and 7 poster sessions, with rich contents and various forms.

ICHVE 2022 covers research topics such as electromagnetic field calculation and measurement, online monitoring and fault diagnosis, external insulation, new insulation materials, grounding systems, transformer, and motor insulation, aging, and space charge, electrical insulation for special environments, industrial applications, and high-voltage engineering education. As shown in Table 2, as of September 25, 2022, ICHVE 2022 has accepted

Fig. 2. Welcome speech by Professor Brian Stewart, President of the IEEE DEIS Society

621 abstracts, and finally, the ICHVE 2022 organizing committee accepted 578 papers from 18 countries.

ICHVE2022 adopted a hybrid online and offline model and organized Zoom's real-time events.

A. Real-time Events

The following 6 real-time events were organized (all times are listed in China Standard Time):

(1) Welcome Reception (September 25, 18:30-21:00)
(2) Opening Ceremony and Award Speech (September 26, 8:00-10:00)
(3) Keynote Speech (September 26, 10:30-15:30; September 27-28, 8:00-9:30)
(4) Oral and Poster Sessions (September 26- 28, 10:00-17:45; September 29, 10:00-15:45)
(5) Technical Tour (September 28, 14:00-17:30)
(6) Student Award Announcement & Closing Ceremony (September 29, 16:15-16:45)

Professor Jinliang He of Tsinghua University gave a keynote presentation titled "Grafted Polypropylene Insulation Materials for Next-Generation High Voltage Cables." As shown in Fig. 3, more than 400 people attended his presentation through online and offline methods. In the report, he pointed out that with the development of renewable energy, especially offshore wind power, cable transmission has become very important. The traditional cross-linked polyethylene cable insulation can no longer meet the requirements of environmental protection and sustainable development. The development of environmental protection,

Table 1. Country-wise distribution of participants (626 persons from 18 countries)

Country	Number of attendee	Country2	Number of attendee2
China	578	Singapore	2
Germany	9	UK	7
Sweden	2	Turkey	3
Japan	3	US	1
France	1	Others	8
Greece	18		

Table 2. Country-wise distribution of papers (626 papers from 18 countries)

Country	Abstract submission	Final paper submission
China	621	578
Germany	12	9
Sweden	2	2
Japan	3	3
France	1	1
Turkey	4	3
Greece	20	18
Singapore	2	2
UK	8	7
US	1	1
Others	8	8

low-carbon power equipment requirements, and electrical products in the design, manufacture, use, recycling, and other aspects will produce new changes. Different technical routes to tailor the performance of polypropylene-based cable insulation are presented and compared, including blends with other elastomers, copolymers, addition of nanoparticles, and grafting of polar groups.

Prof. Shengtao Li (Fig. 4) from Xi'an Jiao Tong University gave a keynote presentation titled "Synergic Effect of Adsorbed Gas and Charging on Surface Flashover in Compressed Gas." More than 400 people attended his presentation through online and offline methods. In the report, he pointed out that surface flashover is a discharge phenomenon that occurs at the gas-solid interface, especially in high-pressure engineering. It is important to elucidate the microscopic processes along the interface to improve the flashover performance. However, the underlying gas-solid interaction physical processes of surface flashover in compressed gas are still unclear. Here, the synergistic effects of adsorbed gas and charge on surface flashover are considered and explored in depth. The qualitative relationship between gas adsorption and surface flashover is carefully explored. Gas adsorption raises the surface flashover voltage by preventing the electron collision ionization process in the compressed gas.

Zhongdong Wang from the University of Exeter,

Fig. 3. Offline attendees listen to the presentation

Fig. 4. Keynote presentation by Prof. Shengtao Li

Fig. 5. Keynote presentation by Prof. William Chisholm

UK, gave a keynote presentation titled "High Temperature Insulation Systems, Dynamic Thermal Rating of Power System Plant and Its Relevance to Net-Zero." During the presentation she pointed out that as new insulation materials are developed in the context of Net Zero, increased functions can be considered and designed into new insulation materials or systems. Power system equipment needs to operate under a combination of electrical, thermal, mechanical, and sometimes Physico-chemical reaction stresses.

Professor William Chisholm (Fig. 5) of the University of Toronto, Canada, gave a keynote presentation via the ZOOM platform. The keynote presentations of other professors in the conference are not

listed, and each real-time activity of this conference was recorded until the end of the conference on September 29. Each presentation was followed by a live discussion and answers by the speaker.

B. On-demand Events

In on-demand events, speakers have uploaded their presentation files to the ZOOM platform prior to their presentations along with audio and/or movies in pptx or peps format. Attendees can enjoy each presentation and ask questions to the speaker through the ZOOM platform. Presenters are required to respond to the questions. The conference team is responsible for coordinating the discussion on the conference floor.

The following 5 on- demand events were organized:

(1) Keynote Speech (12 papers)

Keynote Speech were planned on the recent topics by 4 coordinators, one of which was arranged as the real-time event above and the other 3 sessions were organized as the on-demand sessions as follows:

(a) Grafted Polypropylene Insulation Materials for Next-Generation High Voltage Cables
(b) Synergic Effect of Adsorbed Gas and Charging on Surface Flashover in Compressed Gas
(c) Liquid Metal Battery for Large-scale Energy Storage: from Materials to Devices
(d) Novel Intelligent Sensing Technology for Transmission and Substation Equipment
(e) High Temperature Insulation Systems, Dynamic Thermal Rating of Power System Plant and Its Relevance to Net-Zero
(f) Research Progress of Pulsed Power Supply Technology in Electromagnetic Launch System
(g) Trends in Power Transformer Diagnostic and Monitoring Techniques
(h) Energy Conversion for Sensing: Practice from Materials
(i) Prospects of New Electrical Materials and Sensing Technologies in Future Power Grids
(j) Analysis of Measured Lightning-induced Voltages on a Matched Overhead Line
(k) Space Charge Behavior and Numerical Simulation of Oil Impregnated Paper Insulation under DC Superimposed Sinusoidal AC Electric Field with Different Frequencies
(l) Application of Terahertz Time-domain Spectroscopy in Nondestructive Testing of Oil Paper Insulation

(2) Oral and Poster Sessions (11 sessions, 605 papers)

In the Oral Sessions, the pptx or ppsx presentations within 15 minutes were organized in the following 4 sessions. Note that numerals in parentheses represent the number of papers.

Oral A Sessions (27)
- (A) Electromagnetic fields: computation, measurement (6)
- (B) High voltage insulation system: Liquid, solid dielectrics (7)
- (C) Online condition monitoring, fault diagnosis (7)
- (D) Transients and EMC: lightning, switching, repetitive transients (7)

Oral B Sessions (30)
- (A) High voltage measurement techniques and instrumentation (8)
- (B) High voltage insulation system: Air, gas, vacuum dielectrics (8)
- (C) I: High voltage apparatus: Reliability and maintenance II: Aging, space charge, and industrial applications (7)
- (D) I: New features and special interests in high voltage engineering. II: High electrical stress insulation system for electronic devices (7)

Oral C Sessions (27 papers)
- (A) I: Outdoor insulation: Insulator, environmental effects. II: High voltage insulation for UHV AC and DC system (6)
- (B) I: New insulation materials II: Smart materials and applications in high voltage engineering (7)
- (C) I: High voltage insulation for UHV AC and DC system. II: High voltage applications in smart grid (7)
- (D) Aging, space charge, and industrial applications (7)

Oral D Sessions (28)
- (A) Grounding systems (7)
- (B) High voltage cable insulation (7)
- (C) Online condition monitoring, fault diagnosis (7)
- (D) Insulation of high voltage transformer and machine (7)

Oral E Sessions (28)
- (A) I: Electromagnetic fields: Computation, measurement. II: Online condition monitoring, fault diagnosis (7)
- (B) High voltage insulation system: Liquid, solid dielectrics (7)
- (C) Online condition monitoring, fault diagnosis (7)
- (D) I: New insulation materials. II: High voltage insulation system: Liquid, solid dielectrics. III: smart materials and applications in high voltage engineering (7)

Oral F Sessions (27)
- (A) High voltage apparatus: Reliability and maintenance (6)
- (B) I: High voltage insulation system: Air, gas, vacuum dielectrics. II: Online condition monitoring, fault diagnosis (7)
- (C) New features and special interests in high voltage engineering (7)
- (D) High voltage insulation system: Liquid, solid dielectrics (7)

Oral G Sessions (27)
- (A) Transients and EMC: Lightning, switching, repetitive transients (7)
- (B) High voltage cable insulation (7)
- (C) Online condition monitoring, fault diagnosis (6)
- (D) I: High voltage insulation for UHV AC and DC system. II: High voltage applications in smart grid (7)

(a)

(b)

(c)

(d)

Fig. 6. Gala Dinner Spectacular. (a) Speech by conference chairman Feipeng Wang. (b) The dinner guests chatted freely. (c) Dinner Singing Performance. (d) Guzheng playing for the dinner party.

Oral H Sessions (24)

(A) High voltage measurement techniques and Instrumentation (6)
(B) High voltage cable insulation (7)
(C) Online condition monitoring, fault diagnosis (5)
(D) High voltage insulation system: liquid, solid dielectrics (6)

In the Poster Sessions, the posters will be placed in the Jingwei Foyer, 1F, for offline attendees to visit.

Poster A Sessions (58)

(A) Electromagnetic fields: computation, measurement
(B) Transients and EMC: Lightning, switching, repetitive transients
(C) High voltage insulation system: Liquid, solid dielectrics
(D) Online condition monitoring, fault diagnosis

Poster B Sessions (58)

(A) High electrical stress insulation system for electronic devices
(B) High voltage apparatus: reliability and maintenance
(C) New features and special interests in high voltage engineering
(D) High voltage insulation system: Air, gas, vacuum dielectrics

Poster C Sessions (59)

(A) Outdoor insulation: Insulator, environmental effects
(B) High voltage insulation for UHV AC and DC system
(C) New insulation materials
(D) Aging, space charge, and industrial applications
(E) Smart materials and applications in high voltage engineering

Poster D Sessions (57)

(A) Online condition monitoring, fault diagnosis
(B) High voltage cable insulation
(C) Insulation of high voltage transformer and machine
(D) Grounding systems

Poster E Sessions (57)

(A) Electromagnetic fields: computation, measurement
(B) New insulation materials
(C) Online condition monitoring, fault diagnosis
(D) Smart materials and applications in high voltage engineering
(E) High voltage insulation system: Liquid, solid dielectrics

Poster F Sessions (60)

(A) High voltage insulation for UHV AC and DC system
(B) High voltage apparatus: Reliability and maintenance
(C) Online condition monitoring, fault diagnosis
(D) High voltage applications in smart grid
(E) High voltage cable insulation

Poster G Sessions (58)

(A) Online condition monitoring, fault diagnosis
(B) High voltage engineering education
(C) High voltage measurement techniques and instrumentation
(D) High voltage insulation system: Liquid, solid dielectrics
(E) High voltage cable insulation

C. Administration of ICHVE 2022

On July 8th, 2022, the organizing committee discussed and decided to hold the ICHVE 2022 conference in a combined online and offline format. Since then, the ICHVE 2022 organizing committee has accelerated its hard work on the conference in terms of technical and financial issues.

Fig. 7. Group photo of offline participants.

To promote ICHVE 2022 as much as possible, the organizing committee prepared ICHVE 2022 with a mixture of online and offline activities. Online participation, we live-streamed through the ZOOM platform and with the cooperation of domestic and foreign counterparts, the network system was built, tested, and modified several times and the offline conference venue is set at Radisson Blu Hotel, Chongqing, China.

The session also discussed paper submission, the review process, presentation style, and publication requirements. The presentation and discussion styles are described in the previous sections. Papers that meet the following 3 requirements will be published in IEEE Xplore after the conclusion of ICHVE 2022:

(1) Submission of final full paper after review
(2) Submission of presentation electronic file
(3) Payment of registration fee

As for the registration fees, the early bird fees for ICHVE 2022 are 4550 CNY(Chinese Yuan) for IEEJ, IEEE, CIGRE, CES, KIEEME members, 4875 CNY for non-members, 3250 CNY for IEEE student members, 3575 CNY for non-member students, and 2925 CNY for online attendees. The regular attendance fee is 4875 CNY for IEEJ, IEEE, CIGRE, CES, KIEEME members, 5200 CNY for non-members, 3575 CNY for IEEE student members, 3900 CNY for non-member students, and 3250 CNY for online attendees: workshop tickets are an additional 130 CNY. The printed proceedings are not published, and attendees can download the proceedings data from the web-based system.

As shown in Fig. 6, during the ICHVE 2022 conference, the organizing committee prepared a dinner at the Radisson Blu Hotel Chongqing on the 1st floor of the Meridian Hall for offline participants as well as organized a technical tour of ABB Transformer Chongqing Ltd. and the ultra-high voltage branch of the State Grid Chongqing Electric Power Company.

As shown in Fig. 7, more than 400 people participated in the conference online and offline. As the general chair of the ICHVE 2022 organizing committee, I sincerely thank all committee members for their tremendous efforts to make this international meeting possible in the context of the COVID-19 coronavirus epidemic. I am confident that the ICHVE 2023 International Conference in 2023 will again be a great success!

Feipeng Wang
Chongqing University, Chongqing China
General Chair
ICHVE 2022 Organizing Committee

9th International Conference on Condition Monitoring and Diagnosis (CMD2022)

The 9th International Conference on Condition Monitoring and Diagnosis (CMD2022) was held on November 13-18, 2022, at Kitakyushu International Conference Center, Fukuoka. CMD provides a platform for academia, industry, technology providers, consultants, and experts in power engineering to discuss and share ideas, results, experiences and to talk over future trends and technologies in the field of

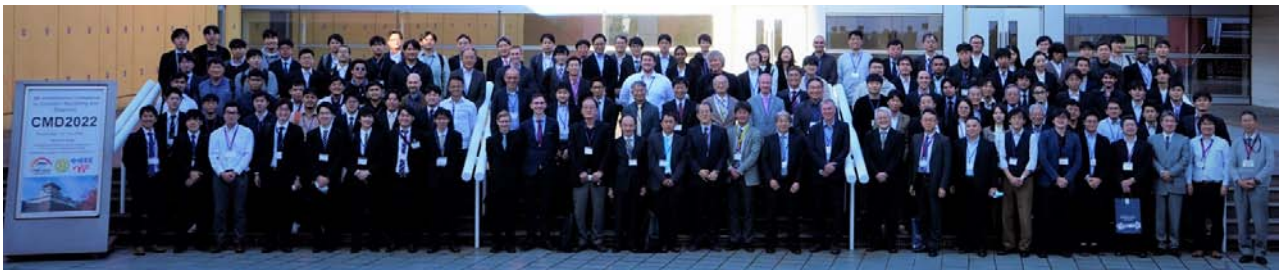


Fig. 1. Group photo.

electric power apparatus monitoring, fault diagnosis, and asset management. CMD has been held every 2 years since 2006 in Asian and Oceanian countries. Figure 1 and Table 1 show the participants in CMD2022 with the total 272 participants from 23 countries. Table 2 shows the number of papers with the total 178 papers, which is larger than those in CMD2018 and CMD2020 as shown in Figure 2.

Table 3 shows the time schedule of CMD2022. To prevent the COVID-19 infection, CMD2022 was held in the hybrid-style. In consideration of the world time difference, the main sessions were arranged in the evening of each day in Japan for on-line participants from overseas (noon in Europe, morning in America). Both on-site and on-line participants in CMD2022 would have spent their fruitful time for presentation, discussion and information exchange on condition monitoring and diagnosis of electric power apparatus in the following events:

Table 1 Number of participants

	On-site	On-line	Total
Japan	115	7	122
Korea	53	5	58
China	5	28	33
Asia	18	9	27
Europe	18	7	25
Middle East+Africa	2	2	4
North America	1	2	3
Total	212	60	272

Table 2 Number of papers

	On-site	On-line	Total
Japan	56	7	63
Korea	35	4	39
China	1	24	25
Asia	17	6	23
Europe	15	5	20
Middle East+Africa	1	3	4
North America	3	1	4
Total	128	50	178

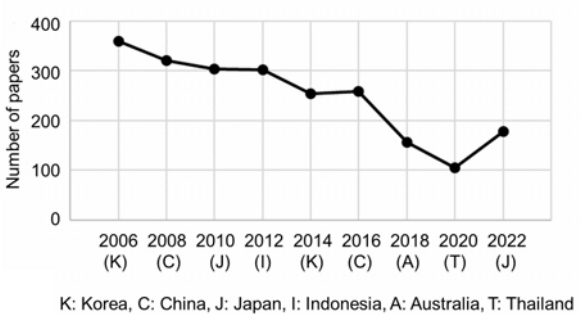


Fig. 2. Number of papers (2006-2022)

A. Tutorial

A tutorial titled “Assembly of space charge equipment for full-size HVDC insulation systems” was held in the morning and early afternoon on the first day of CMD2022. The concept of this tutorial was not only to learn the necessity and the principle of space charge measurement, but also to assemble a measurement sensor by participants themselves and take it their home. Two courses were conducted, one in the morning for the cable-shaped samples and the other in the afternoon for block-shaped samples. The courses consisted of a lecture on space charge measurement, assembling the sensor, and confirmation of its operation. The tutorial course was opened with the lecture given by Dr. P. H. F. Morshuis (Solid Dielectric Solutions, The Netherlands, Fig. 3). Then, the participants were given a precious opportunity to assemble the sensor for a space charge measurement. The fabricated sensor was the state-of-the-art measurement configuration, which is the highest measurement accuracy of a space charge measurement for a thick insulation system such as a DC extruded cable. The assembly of the sensor was supervised by Professor Naohiro Hozumi of Toyohashi University of Technology (Fig. 4) and Professor Hiroaki Miyake of Tokyo City University. Moreover, some university students engaged with the research on space charge measurement helped the participants to assemble their own sensors as student staffs (Fig. 5). In order to smoothly conduct the fabrication of the measurement sensor in the tutorial, the parts to be used were well prepared in advance, for example, the housing of the sensor was drilled and machined.

A total of 18 participants joined in this tutorial. All participants were able to complete their assembling and operation checks, although they struggled with the small parts for assembling. Some participants attended both the morning and afternoon lectures and engaged in lively discussions with the lecturers. They discussed the measurement principle with the lecturers in front of the output waveforms of the sensors they assembled.

The atmosphere was friendly throughout the tutorial. Every time one could confirm the sound operation of

Table 3 Time schedule

	AM		PM1		PM2		PM3
	09:00-12:00 (JST)		13:00-15:30 (JST)		16:00-18:00 (JST)		19:30-21:30 (JST)
Nov. 13 (Sun.)					Welcome party		
Nov. 14 (Mon.)	Tutorial	Lunch (Not provided)	Tutorial	Coffee break	Workshop-1	dinner (Not provided)	Opening & Plenary session-1
Nov. 15 (Tue.)			Poster session-1/ Demo event-1		Poster session-2/ Demo event-2		Oral session-1
Nov. 16 (Wed.)			Workshop-2		Oral session-2		Banquet
Nov. 17 (Thu.)			Poster session-3/ Demo event-3		Poster session-4/ Demo event-4		Plenary session-2 & Closing
Nov. 18 (Fri.)	Technical tour/Excursion						

Fig. 3. Dr. P. H. F. Morshuis at his lecture.

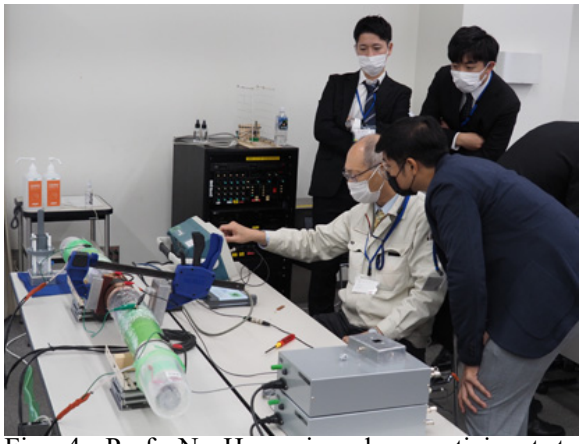


Fig. 4. Prof. N. Hozumi and a participant to confirm the operation soundness of the assembled sensor.


Fig. 5. A participant assembling her sensor, helped by a student staff.

his/her assembled sensor, there was a round of applause. Since the operation of the sensors was confirmed using AC XLPE cables with insulation thicknesses of more than 20 mm, it was a good opportunity for participants to deepen understanding of the size and scale of full-size electric power equipment.

B. Exhibition and Demo sessions

Recently, not a few companies have been involving technologies of the monitoring and diagnosis for electric power apparatus. Some exhibition deals such technologies, but they can only let the companies allow just displaying monitoring and diagnosis devices themselves. At most, participants can see its operating status in demonstration mode. No demonstration has ever been made to actually generate PDs and measure the PDs. However, it is important to measure actual PDs in order to understand the capability of the measurement device and its operating conditions.

Therefore, the organizing committee of CMD2022 decided not only to exhibit various PD measurement devices, but also to provide an opportunity for participants to actually measure the PDs that were actually generated by these measurement devices and see how they operated. A needle-plane electrode system, an epoxy-molded void-embedded electrode and a defective 6 kV XLPE cable were prepared to ignite actual PD by energizing them by a portable AC high voltage testing transformer of 50 kVrms of its rated voltage. Figure 6 shows the testing transformer and a PD source. Figure 7 shows the overall situation of the test in which PDs are actually generated. Figure 8 shows some of the PD sources used in the demo-session. A large screen was placed at the front of the testing area to show the PD current pulse measured by an HFCT or a shunt resistor placed at the grounding wire of the PD source. This was effective because all the exhibitors and participants could recognize whether the PD occurred or not at the time the exhibitors perform their PD measurement.

Of the 12 companies and 1 university laboratory that exhibited, 11 companies brought in equipment related to PD measurement and measured actual PDs. As

Fig. 6. Testing transformer and PD source in demo-session.

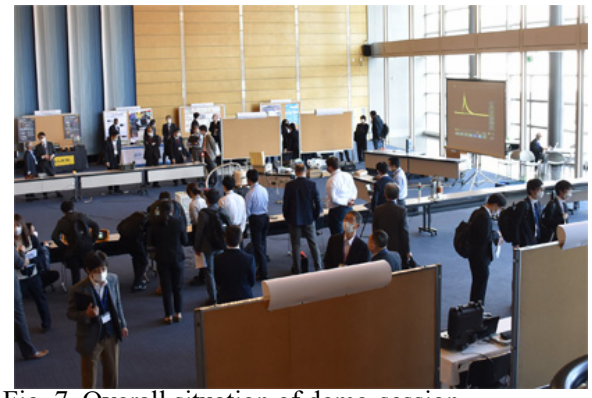
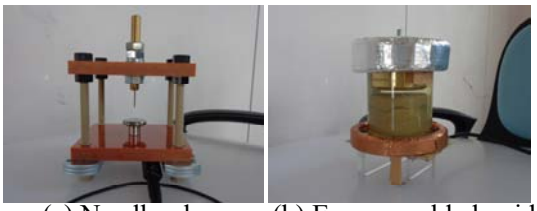


Fig. 7. Overall situation of demo-session.



(a) Needle-plane electrode (b) Epoxy-molded void embedded electrode

Fig. 8. Some of the electrode system for PD source.

shown in Fig. 7, many participants came to see how PD was actually measured by the measurement devices of each company in real time. Many participants commented that it was good to be able to see the operation of the PD measurement devices of each company in detail. Exhibitors also commented that it was good that participants could see the actual operating conditions. Some exhibitors were able to exchange opinions that led to concrete business negotiations. The demo-session was different from those held by exhibition companies, and was highly evaluated by both participants and exhibitors.

The Technical Committee on Dielectrics and Electrical Insulation, IEEJ, which played a major part in organization of CMD2022, intends to continue holding such demo-sessions at various events in the future.

C. Oral & Poster sessions

Six oral sessions on cable, rotating machines, insulation materials, transformer, diagnosis techniques

Fig. 9. Poster session.

Fig. 10. Digital signage system.

(GIS etc.), diagnosis and asset management were held with 37 (26 on-site, 11 on-line) presentations.

Four poster sessions were held and 131 (95 on-site, 36 on-line) presentations were made (Fig. 9). The poster session of CMD2022 was initially considered to be held only on-site, but it was conducted as a hybrid-style including some online presentations by advance declaration in consideration of the Japan's border situation against COVID-19.

In recent years, many IEEE conferences have used web-based presentation system using the "Gather□," and poster sessions are often carried out completely online. However, this conference was designed to provide an opportunity to implement a new presentation style, assuming that many on-site presentations will also be made.

Specifically, the "digital signage" systems (Fig. 10) consisted of monitor, speaker, and webcam were prepared as local equipment, and remote participants connected to the local equipment using Zoom® on their own PCs to share their own posters, which were displayed on the local monitors for presentation.

The on-line participants could confirm the visitor of their own prestation and atmosphere of the on-site situation. It was designed as truly a realistic virtual presentation.

Although there were some problems with the sound, such as difficulty in hearing the presentations due to the output sound (on-line presenter's voice) from the monitors. It was the problem that the non-dedicated equipment which does not have a directivity sound system was used. However, the local attendees commented that it was a good way to listen to the online presenters' presentations at the local poster

location and to feel a sense of unity. The organizers believe that the hybrid-style cannot be ruled out in the future for conference operation, and that improvements should be continued to be made to the hybrid poster session format without being restricted by conventional operation method.

Among the oral and poster presentations by students, best student paper award was selected based on the paper quality and their presentation. Five students were celebrated in the closing session (Fig. 11).

D. Workshops

Two workshops were held as follows:

(1) "Advanced Maintenance Strategies and Asset Management for the Substation Equipment in Japan" by 4 Japanese utilities (Kyushu, Tokyo, Kansai, Chubu)
(2) "Weibull Analytics of Observed and Suspended Failure Data - A tutorial on a Weighted Linear Regression Approach" by Prof. Robert Ross (IWO&TUD, Netherlands)

E. Plenary lectures

Five plenary lectures were given as follows:

(1) "The Role of Condition Monitoring and Diagnostic Technologies in Electric Energy Systems to Support the Creation of a Sustainable Society" by Mr. Koji Kawakita (Chubu Electric Power Grid, Japan)
(2) "Condition Assessment of Power Transformers by UHF PD Measurements" by Prof. Dr. -Ing. Stefan Tenbohlen (University of Stuttgart, Germany)
(3) "Anomalous decreasing power loss of ZnO varistor ceramics during the dc aging: phenomena, insights and perspectives" by Prof. Jianying Li (Xi'an Jiaotong University, China)
(4) "Application of Machine Learning Technique and Sweep Frequency Response Analysis to Classify Stator Winding Insulation Defects" by Prof. Yong Joo Kim (Chung Ang University, Korea)
(5) "Diagnostic Accuracy and Technical Considerations for MV Cable Field Partial Discharge" by Mr. Sarajit Banerjee (Kinectrics, Canada)

F. Banquet and Technical tour

On-site participants enjoyed the banquet at a hotel near the conference site (Fig. 12) and the technical tour to a storage battery substation (Fig. 13).

CMD2022 was hosted by IEEJ Technical Committee on Dielectrics and Electrical Insulation, technically co-sponsored by IEEE DEIS, and supported by City of Kitakyushu, Kitakyushu Convention & Visitors Association, SECOM Science and technology Foundation, Kyushu Chapters of The Institute of Electrical Installation Engineers of Japan and IEEJ, IEEE Fukuoka Section. The 10th anniversary CMD will be held on October 2-25, 2024, at St. John's Hotel, Gangneung, Gangwon-do, Korea.

Fig. 11. Best student paper awardees.


Figure 12 Banquet.


Figure 13 Technical tour.

Naoki Hayakawa, Nagoya University
Shosuke Morita, CRIEPI
Toshihiro Takahashi, CRIEPI
Hiroaki Miyake, Tokyo City University
CMD2022 Organizing Committee

International Conference to be held in Asia

ISEIM 2023 (International Symposium on Electrical Insulating Materials)

Dates: September 24-28, 2023
Venue: Kunibiki Messe, Matsue-city, Shimane Pref., Japan
Sponsored by:
IEEJ Technical Committee on Dielectrics and Electrical Insulation
Technically co-sponsored by:
IEEE Dielectrics and Electrical Insulation Society (under negotiation)

Honorary Chair
Prof. N. Hayakawa (Nagoya University)
General Chair
Dr. T. Takahashi (CRIEPI)
URL:
http://www2.iee.or.jp/~adei/iseim/iseim2023/index.html

ISEIM is positioned as the international version of the domestic symposium held every year by IEEJ TC-DEI. The 10th conference will take place in Kunibiki messe, Matsue-city, Shimane prefecture, Japan. Matsue is the capital city of Shimane Prefecture, in Southwest Japan. A former feudal stronghold, Matsue is a true castle town crossed with many canals and boasts one of the twelve remaining original castles in Japan. Southern Matsue is strongly linked with Japanese mythology, and you can find many Shinto shrines and historic sites here. The Ancient Province of Izumo was ruled from this area.

The conference promotes opportunities to be an effective rallying point for polymeric insulators and outdoor insulation, space charge measurements, on-line monitoring and diagnostics of power apparatus, development of polymeric cables and joints for higher electric fields, organic and inorganic thin films, and new and functional materials.

In addition, the organizing committee is planning to hold special events; a workshop on manufacturing a novel sensor of PEA measuring system for HVDC cable insulation, a demonstrative exhibition on partial discharge measuring system accompanied by actual partial discharge generated at some fundamental electrode system such as a needle-plane electrode, a void-embedded epoxy molded electrode, and so on. Other special events are now under consideration, thus visit the conference website frequently.

Conference Topics:
- Digital transformation on the electrical insulating materials
- Development of electrical insulating materials in the digital transformation era.
- Space charge, surface and interfacial phenomena
- Electrical properties of dielectrics and measurement and testing techniques
- Nanotechnology for dielectrics
- Inorganic and functional dielectric materials
- Organic thin films and electronics
- Dielectric materials for electronics and telecommunication
- Dielectric properties of biological objects and biodielectronics
- Dielectric phenomena under inverter surges
- Partial discharge
- Asset management for dielectrics applied apparatus
- Insulation design, reliability, aging and degradation, their detection and monitoring
- Polymeric insulators and outdoor insulation
- Eco-friendly dielectric materials and recycling
- Electrical insulation phenomena and charging under cosmic and radiological environment
- Electrical insulation for power electronics devices
- Computational techniques for dielectrics
- Collaborate work with industries and universities
- Novel technologies for dielectric

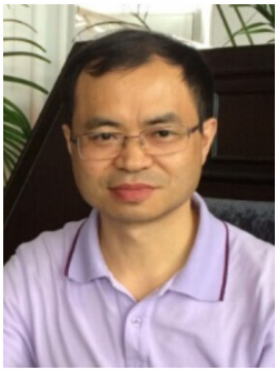
The Inuishi Memorial Lecture:
The 2023 Inuishi Memorial Lecture will be given by Prof. Stanislaw Gubanski of Chalmers University of Technology, Sweden. Research activities of Prof. Gubanski concentrate on introducing polymeric materials into electric insulation systems and on measurement techniques for diagnosing insulation condition. The goal is to develop reliable, cost efficient, and environmentally friendly components of future transmission and distribution electric power networks based on high voltage direct current technology, HVDC. Solutions for components of smart grids are also in focus. Stanislaw Gubanski is a Fellow of IEEE and a distinguished member of CIGRE.

Important Dates:
Abstract Submission: Jan. 27, 2023
Acceptance/Rejection Notices: End of Mar., 2023
Manuscript Submission: May 19, 2023
End of Early Bird Registration: Middle of July
Conference Dates: Sept. 24 - 28, 2023

Contact to:
E-mail: iseim2023@gmail.com

China Corner

Research and Application Progress of Eco-friendly Polypropylene Cable in China



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

1. Introduction

In recent years, energy saving and carbon emissions reducing become the important directions of future development in the world due to the intensification of environmental problems such as industrial pollution and global warming. As a key equipment for power grid, power cables have a great amount of new and scrap each year in China. Most of the traditional power cables use thermoset crosslinked polyethylene (XLPE) insulation, which makes the recycling and utilization of waste cables very difficult. Conventional incineration or burial treatment will bring serious environmental pollution. Moreover, the production process of XLPE cables involves the steps of crosslinking and degassing, which greatly extend the production cycle and bring the improvement of production energy consumption. In addition, the crosslinking by-products in XLPE cables are generally difficult to remove completely, which is easy to cause space charge accumulation, further threaten the safe and stable operation of high-voltage cables, specially under the action of high-voltage DC electric fields. Therefore, traditional XLPE insulation can not meet the rapidly expanded needs of new and flexible power grid on ultra-pure and eco-friendly cable insulating material. It is necessary to develop eco-friendly thermoplastic polymer cable insulation material to meet future needs.

2. Advantages and disadvantages of PP as eco-friendly cable insulating materials

Due to the high melting temperature, excellent insulation properties and recyclability, polypropylene (PP) is regarded as a promising insulating material for the next generation eco-friendly power cable. The advantages of PP as cable insulation comparing with XLPE are listed in Table 1. Compared with XLPE, the PP insulation material does not require cross-linking and degassing process when processing as cable insulation, which can significantly shorten the cable processing time by about half, and reduce the energy consumption of production. The removing of cross-linking can also increase the purity of insulation, enhance the insulation performance of the material, which is expected to further increase the transmission capacity and reduce the designed thickness of cable insulation.

Table 1. Advantages of PP as cable insulation

XLPE	PP
low operating temperature (AC: 90 ℃, DC: 70 ℃)	operating temperature higher than 100 ℃
needing cross-linking and degassing	no need of cross-linking and degassing
containing cross-linked byproducts.	ultra-pure
thermosetting, unrecyclable	thermoplastic, recyclable

Unfortunately, PP also has some disadvantages which make it difficult to be directly used as cable insulation. PP has high mechanical modulus, which will bring difficulties to cable production and installation, and easily cause defects during installation. After blending with elastomers, the high modulus of PP will be significantly optimized, however, the electrical properties of PP will deteriorate significantly. Moreover, PP contains a large number of active hydrogen atoms attached to tertiary carbon atoms, which makes PP vulnerable to aging and less resistant to copper. The optimization of PP's combination properties as cable insulation is necessary for the industry application.

3. In-situ copolymerized eco-friendly PP insulating materials for power cable

Aiming at the problem of PP as insulation of high voltage cable, our group proposed an in-situ copolymerization method to optimize the performance of PP cable insulating materials in collaboration with petrochemical enterprises. The in-situ copolymerization process contains two steps. In the 1-st stage polymerization, the homopolymerization of propylene is mainly carried out, which is designed as the matrix. Immediately after that, the 2-nd stage is mainly for ethylene-propylene copolymerization, which is the origin of elastomer phase for the optimization of mechanical properties. By designing the parameters such as the consumption of raw materials in two stages, the additives for synthesis and the ratio of ethylene to propylene in 2-nd stages, the control of material properties can be realized. Because of the presence of some molecular chain containing both PP chain and ethylene-polymer copolymer chain as compatibilizer, the properties and phase structure stability of PP insulating materials obtained by in-situ copolymerization (IPC) are often better than the PP/elastomer blends (PPB) when the elastomer content is close. Figure 2 shown the breakdown strength and young modulus of IPC and a PPB having closed modulus with it. It can be seen that

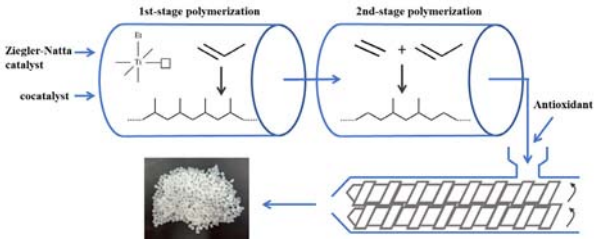


Fig. 1. The process of in-situ copolymerization modification

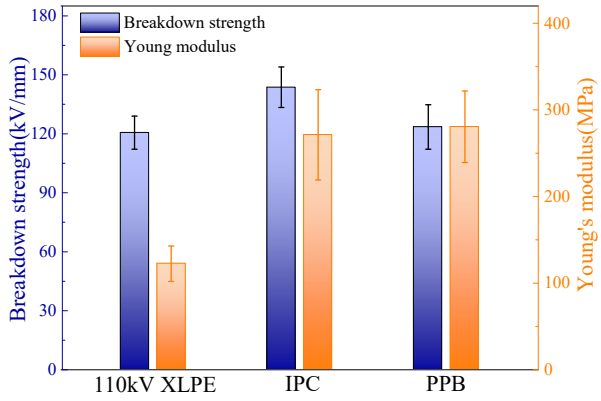


Fig. 2. Comparison of breakdown strength and Young's modulus of XLPE, IPC and PPB

the Young's modulus of IPC and PPB are about 2-3 times that of the 110 kV XLPE, which have been significantly optimized comparing pure isotactic PP. The breakdown strength of IPC and PPB are both higher than XLPE, which can meet the requirements of cable insulation. Specially, the breakdown strength of IPC is obviously higher than PPB when the modulus of them is closed, which can be seen as proof of the advantage of in-situ copolymerization.

To provide a reference for the adjustment of the processing technology of power cables with IPC insulation, the breakdown strength and water tree resistance of IPC after different cooling rate were studied. It is found that the water tree initiation probability and length of IPC samples are significantly lower than those of XLPE samples, manifesting the water tree resistance of IPC samples is better than XLPE, which means that IPC can meet the requirements of cable insulation in terms of water tree resistance. Specially, the breakdown strength and water tree resistance of IPC are both enhanced after rapid cooling, which is contrary to common wisdom on the effect of cooling rate on the insulation properties of polymer materials. Through these experiments, we believe that IPC insulation may be more suitable for rapid cooling processing, which provides a reference for the design of subsequent molding process.

In addition to the in-situ copolymerization technology route proposed by our team, there are several other technology routes for PP cable being advanced in China. For example, the chemical graft modification route adopted by Professor He Jinliang's group from Tsinghua

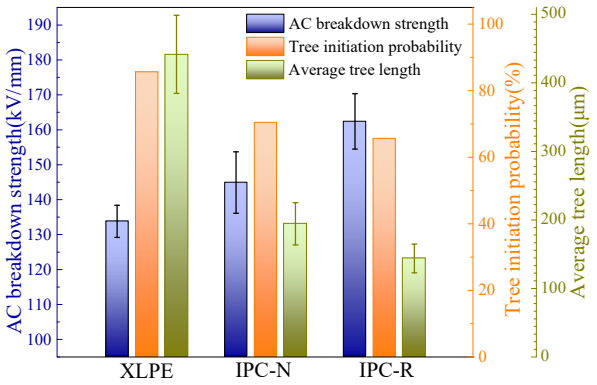


Fig. 3. Breakdown strength and water tree resistance parameters of XLPE, natural-cooled IPC (IPC-N) and rapid-cooled IPC (IPC-R)

University, the elastomer or nano-blending route adopted by Professor Huang Xingyi's group from Shanghai Jiao Tong University and Professor Du Boxue's group from Tianjin University. All these technical routes show great potential and produce corresponding achievements.

4. Application progress of eco-friendly PP cable in China

In order to promote the application of PP cable, an integrative industry-university-research-application are set up, including petrochemical enterprises, cable factories, Xi'an Jiaotong University and STATE GRID Corporation of China. Based on the in-depth study and understanding of the relationship between structure and performance of PP cable insulation, our team produced PP cable insulating materials and 10 kV PP cable. Further, under the premise that all the cable experiments have passed, we have carried out the demonstration application of 10 kV PP cable in Shenyang, Liaoning Province, which is the first independently developed PP medium voltage cable in China. Up to November 2022, this cable has been in operation for more than two years and the operation condition is stable. In 2022, 35 kV PP cables developed based on Chinese independent technology were respectively put into trial operation in Shanghai and Tianjin, indicating that the promotion and application of PP cables in China have made new progress.

As the PP insulating materials for medium voltage exceeded expectations, we attempted to further enhance the application voltage of PP cables. Based on the experience accumulated in the development and operation of 10 kV PP cable, our team successfully trial-produced 110 kV PP cable. Combined with the requirements of international standards IEC 60840:2020, the test scheme for electrical performance of 110 kV thermoplastic PP insulated power cable is prepared. The experiments were carried out strictly according to the requirements of the scheme. As witnessed by industry experts, 110 kV thermoplastic PP insulated power cable has passed partial discharge test, power frequency

voltage test and load cycle test (180 days). At a voltage of 2.5U_0 (160 kV), no partial discharge above the background was detected. The test results validate the excellent electrical resistance of thermoplastic PP cable. Near future, we believe that the 110 kV PP cable will be connected to the network for trial operation in China, which can promote the application of eco-friendly PP cable to a higher level.

5. Summary

PP is a potential eco-friendly power cable insulating material, which is not only recyclable, but also has obvious advantages over traditional XLPE in insulation performance. Thermoplastic PP insulating materials has a wide application prospect in environmental protection and lightweight of high voltage cables. At present, the research and application of eco-friendly PP cable are hot in progress in China. Medium voltage PP cable has been applied in multiple demonstration projects, and periodic achievement has been obtained for the research of high voltage PP cable. In the future, in order to ensure the long-term stable operation of PP cable and extrusion molding under the condition of greater insulating thickness, the research on the melt strength and long-term aging performance of PP needs to be paid more attention.

Acknowledgements

Thanks to Prof. Jianying Li from Xi'an Jiaotong University and Prof. Peng Zhao from China Electric Power Research Institute for their providing the relevant information.

Prof. Shengtao Li
School of Electrical Engineering and Informatics
Senior member of IEEE,
Xi'an Jiaotong University, Xi'an, China

Fig. 4. Demonstration application construction site of 10 kV PP cable.

Fig. 5. Witness test site of China's first 110kV thermoplastic PP insulated power cable.

Recent activities of international exchange in Japan

Sharing My Experiences and Impressions During Research Activities in BIOTRAFO Project

Dr. Mrutyunjay Maharana,
Fig. 1. A: at Sarakurayama Cable Car, B: at Fuji Electrc , *Japan*)

Affiliation in Japan: Kyushu Institute of Technology
Nationality: Indian
Term: April 2022 – November 2022
Current affiliation: Xi'an Jiaotong University China

Hello, my name is Dr. Mrutyunjay Maharana and I am from India. I had joined Kyushu Institute of Technology (KIT), Tobata Japan as a visiting researcher on April 2022. In KIT I joined for carrying out my research for six months.

In the year 2019 April I obtained my PhD degree from Indian Institute of Technology (IIT) Guwahati in the area high voltage insulating material. In November 2019 I joined as a post doctoral researcher in the school of Electrical Engineering Xi'an Jiaotong University and promoted to an Assistant Professor in June 2020 in the same department. My previous research is mostly focusing on area of condition monitoring and fault diagnosis of the transformer oil, liquid insulation, nanofluid and ageing analysis. In the year 2022, I got an opportunity to work with Dr. Masahiro Kozako (Associate Professor (Electrical and Electronics Engineering, KIT Japan) as a visiting researcher for six months in Biotrafo financed project funded by European Commission Horizon 2020 Research and Innovation Programme under the Marie Skłodowska Curie Action Research and Innovation Staff Exchange (MSCA-RISE) grant. Since Kyutech Japan is a partner to Biotrafo project, I was assigned to carry out the research evaluation of insulation strength of the biodegradable vegetable oils at different saturation moisture content. Before deciding the final topic of research, our research advisors, Emeritus Prof. Masayuki Hikita and Assoc. Prof. Masahiro Kozako and visiting professor Dr. Motoo Tsuchie carried out a meeting to align my research in the objective of Biotrafo project. Finally, the topic was decided that is "Effect of relative saturation moisture content (RSMC) on the insulation strength and partial discharge of biodegradable insulating oils.

There are so many stories and memories during our research stay at Kyutech and research visit to different parts of Japan during these six months. I have described my fascinating journey about my research and how I have visited different parts of Japan.

On 20th April 2022, I reached in Kokura, Kitakyushu city, Fukuoka Prefecture, Japan, in the afternoon I met Dr. Masahiro Kozako. As I was undergoing Quarantine we maintained a safe distance and discuss.

During our research at Kyutech, I got companion also of master student, Mr. Kyouhei Hamasuna, Mr. Okumara Diago, and Mr. Okamoto. In the first week, our activity was for resident registration at the Tobata Ward Office.

The research activities began with a campus and laboratory tour. Our research advisors, Emeritus Prof. Masayuki Hikita and Assoc. Prof. Masahiro Kozako, asked to join all laboratory research on the High Voltage Engineering Laboratory. In May 2022, it was decided that the research topic is focused on effect of saturation moisture on the partial discharge behavior of biodegradable insulating oil such as FR3 and plam fatty acid ester (PFAE) oil.

A. Research activities

On the second week of May 2022, Dr. Motoo Tsuchie, Mr. Kyouhei Hamasuna and Prof. Kozako explained me the experimental facilities available in the Kozako laboratory. As I had to perform the partial discharge analysis of liquid dielectric using needle plane electrode, all the electrode arrangements and containers were checked thoroughly. During this process, Mr Seto also helped us in fixing the scientific equipments. As we

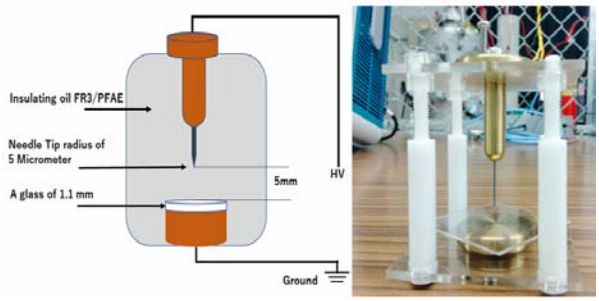


Fig. 2. Needle plane Electrode.

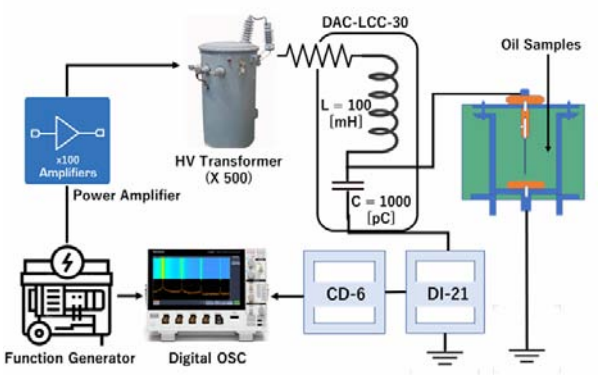


Fig. 3. Circuit Diagram for PDIV measurement.

Fig. 4. Presenting lecture in Kozako Laboratory. By Dr. Maharana.

need to measure the PD of the oil, we have selected the needle plane electrode.

This study simulates the corona discharge with the help of a needle-plane electrode arrangement for the measurement of PD. Figure 2 shows the experimental setup for the measurement of PD with needle-plane electrode arrangement. The needle tip has a curvature radius of 5 μm. The needle electrode is made up of mild steel. The high voltage source is connected to the needle electrode and the bottom plane electrode is firmly connected to the ground. In order to maintain a stable PD source from the needle-plane electrode arrangement, a 1.1 mm thick glass plate is used upon the plane electrode. The gap distance between the needle and ground electrode is maintained at 5 ± 0.2 mm. The electrode arrangement is clearly shown in Fig. 3.

A sinusoidal voltage at the commercial frequency of 60 Hz was output at an increased rate of 1 kV_{rms}/s using a AC signal generator (FG300 from YOKOGAWA Corp.) and applied to the samples through a power amplifier (ES 2000S from NF Corp.) and a transformer (100 V/50 kV). A coupling capacitor (1000 pF) is connected in parallel with the sample. Detection impedance (DI-21, NKS Co., Ltd.) is inserted between the sample and the ground. The pulse voltage appearing at its ends was amplified with a PD meter (CD-6 from NKS Co., Ltd.) and measured as PD pulse signal with a mixed-signal oscilloscope (Tektronix, MSO58, 350MHz, 6.25 Gs/s.) at a detection sensitivity of 0.5 pC. The entire electrode system was immersed in insulating ester

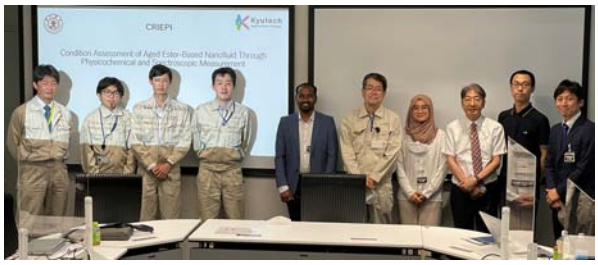
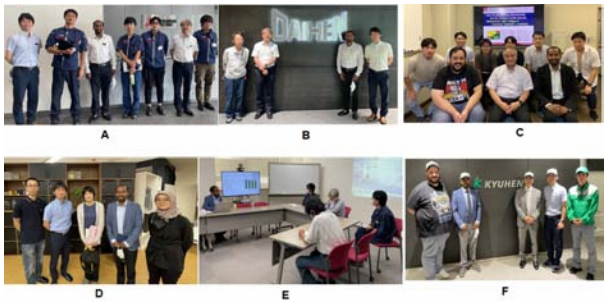


Fig. 5. Presentation by Dr. Maharana (in the centre) in CRIEPI along with researchers from CRIEPI and Kyutech.



Photos. (A) Dr. Maharana with Researchers of Mitsubishi Corp. With Prof. Hikita and Prof. Kozako (B) Dr. Maharana with Researcher of DAIHEN Corp. With Prof. Hikita and Prof. Kozako (C) Dr. Maharana with Researchers of Fukuoka University with Dr. Olmo from Spain. (D) Dr. Maharana with Prof. KUMADA Akiko at The University of Tokyo with Prof. Kozako and researcher from Kyutech (E) Dr. Maharana presenting his research to the researchers of Yuka industries (F) Dr. Maharana and Dr. Olmo visit to Kyuhen for research exchange with Prof. Kozako and Prof. Hikita research to the researchers of Yuka industries

oil. PDIV is measured at a threshold of 10 pC. It took almost fifteen days to fine-tuning the experimental facilities available in Kozako laboratory. After the experimental setup was ready I was asked to present a seminar on my previous research in the Kyutech.

On 27th May 2022, I presented a special lecture on "Development of biodegradable liquid insulating materials for next-generation power equipment" in Kozako Laboratory. This lecture was carried out in Hybrid mode of face-to-face in the 2F seminar room at Kyutech and Zoom online. In which, many researchers from international community also participated. This lecture went very fruitful many of research community wanted to discuss more about the Karanji oil methyl ester. After this event Prof. Kozako planned for a research visit and industry academia meeting from 27th May to 30th May 2022 for four days. In this visit, Dr. Maharana, Prof. Hikita, Dr. Kozako, Mr. Yao (1st year Doctor Course student) and Ms. Lunneta (1st year Doctor Course student) of Kozako Lab were participated.

Photo. Final Research presentation by Dr. Maharana in Kyutech.

Photo. Felicitation to Dr. Maharana by Kozako Lab members, Kyutech.

B. Industrial visits and cultural activities

On the first day we visited the Fuji Electric Chiba factory and seen the commercial GIS system various modern manufacturing techniques. On 28th May we visited Central Research Institute of Electric Power Industry (CRIEPI) and learn different high voltage and insulation facilities. Evening we have visited Yokohama China Town. On 28th May we visited YUKA industries and learn about the various technique of measuring the physicochemical and electrical parameters of insulating oil. I also presented the research carried out in KOZAKO Laboratory and also the previous insulating oil research. On the very same day we also visited The University of Tokyo and got a chance to visited Prof. KUMADA Akiko high voltage research laboratory. First Industry and academia tour ends and after that I had started preparing the sample for PD analysis. From these results, I had submitted one manuscript "Investigation of temperature dependence relative moisture in the natural esters and its effect on PD behavior" to 53rd IEEJ Symposium.

During my stay I had visited other industries such as Mitsubishi Corporation, Osaka, DAIHEN Corporation Osaka and KYUHEN Corporation and interacted with the senior researcher about the high voltage aid insulation monitoring. During my stay, I visited Fukuoka

Photo. Dr. Maharana with Prof Kozako and Prof. Hikita, at Shitennoji Tample Osaka.

University an present the lecture on relative saturation moisture content in the ester oil and its effect on PD.

In the beginning, everything went well. Some QCC analyses were performed for several dielectric material models using GaussView 5.09 software and then considered with the measured dielectric properties and dielectric breakdown strength of the insulating oil also performed. From the experimental results and the COMSOL simulation I was able to predict the reason for alteration of dielectric behavior of the oil. The results were published in manuscript titled "Investigation of saturation moisture in the PD behavior in the biodegradable ester oil" CMD 2022, Japan.

On 27th October 2022 I have presented my research that I had carried out in Kyutech in last 5 month. At the end of presentation we are honoured by the lab members and Prof. Kozako and Prof. Hikita arranged a Farewell parry for us. The research journey was an inseparable part of my life. I had learnt many things in a very short period of time. The culture and the tradition of Japan are really incredible. I made many Japanese friends and learnt the way of life in Japan. Besides research in Japan I have learnt to be a good human being. The thinks make Japan in my point view is the people and the discipline they follow. I have made scientific collaboration with different universities in Japan. I am sincerely looking forward for further visit to Japan and carryout scientific studies in the area of high voltage and insulation.

Finally, the most special experience was to stay for six months in Japan, especially in Kitakyushu. Nice environment, culture, humble and helpful people. My special greetings to Emeritus Prof. Masayuki Hikita and Assoc. Prof. Masahiro Kozako, and Kyushu Institute of Technology, the electrical and electronics laboratory members. It is an honor for us to join as visiting researcher program at the Kyushu Institute of Technology.

Dr. Mrutyunjay Maharana
Assistant professor
School of Electrical Engineering,
Xi'an Jiaotong University, Xi'an, China

Development of Sophisticated Cone-Type Insulating Spacer for 245 kV Class GIS by Functional Insulating Materials

The downsizing of gas-insulated switchgears (GIS) and gas-insulated transmission lines (GIL) will lead to a reduction in their cost, installation area, manufacturing energy, and use of SF_6, which is an extremely potent greenhouse gas. In particular, the downsizing of insulating spacers composed of composite materials based on epoxy resin is effective. For example, if the diameter is reduced by 30%, the volume is reduced by 50%. Therefore, the SF_6 gas is also reduced. However, there is a limitation in insulation techniques using only the conventional composite material technology. Accordingly, the New Energy and Industrial Technology Development Organization (NEDO) supported a five-year research and development project in Japan, "Development of Innovative Functional Insulating Materials for Electric Power Apparatus," which started in 2017. As part of this project, research and development has been conducted to downsize the insulating spacer of GIS and GIL using the latest functional insulating materials such as permittivity (ε) functionally graded materials (ε-FGM).

An actual-size cone-type ε-FGM insulating spacer of 245 kV class GIS was fabricated, and the FOV was measured. The permittivity distribution of the ε-FGM spacer was optimized by an inverse calculation technique using a newly developed electric field analysis method. Figure 1 shows the cross section of the actual-size cone type ε-FGM spacer. The outer diameter of the HV conductor was 90 mm, and the inner diameter of the grounded tank was 240 mm. The configuration of the grounded tank around the spacer was modified considering the actual GIS spacer. The relative permittivity (ε_r) is reduced in six steps, from ε_r = 10 around the HV conductor to ε_r = 4 around the grounded tank. Figure 2(a) shows the electric field distribution around the uniform spacer with the same configuration as the FGM spacer and a constant ε_r = 4, whereas Fig. 2(b) shows the electric field distribution around the FGM spacer in Fig. 1. The electric field stress at the shield edge of the HV conductor on the concave side of the uniform spacer is defined as 1.0 a.u., which is higher than those on the coaxial HV conductor and spacer surface on the concave and convex sides. In contrast, the electric field stress at the same point of the FGM spacer is 0.74 a.u., which is 26 % lower than that of the uniform spacer and almost equivalent 0.77 a.u. on the coaxial HV conductor. The electric field strength on the spacer surface on the convex side of the uniform spacer is increased from 0.50 a.u. to 0.73 a.u., which implies that the electric field distribution in SF_6 gas around the FGM spacer is equalized owing to its permittivity distribution.

As shown in Table 1, two types of composite materials were prepared in advance: a $SrTiO_3$ filler (ε_r = 332) containing a high-permittivity composite material and a SiO_2 filler (ε_r = 4) containing a low-permittivity composite material. By changing the ratio of these two types of composite materials and mixing them, the permittivity distribution was changed, and by casting them into a mold sequentially, a cone-type FGM spacer with permittivity graded from ε_r = 10 to ε_r = 4 was produced. Figure 3(a) shows a uniform spacer of ε_r = 4, and Figure 3(b) shows a FGM spacer of ε_r = 10-4. In Fig. 3(b), the white region corresponds to ε_r = 10, the black region corresponds to ε_r = 4, and the gray region between them is a permittivity graded region.

The fabricated cone-type spacer was installed in a tank filled with SF_6 gas at 0.3-0.6 MPa-abs and

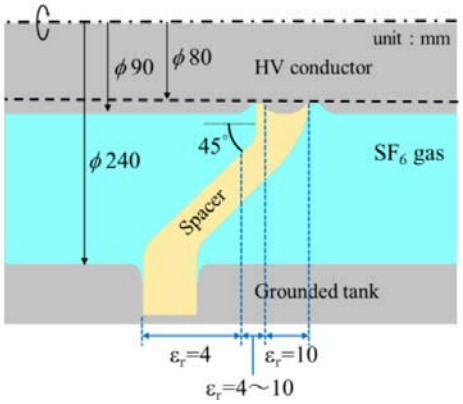


Fig. 1. Actual-size cone-type spacer model.

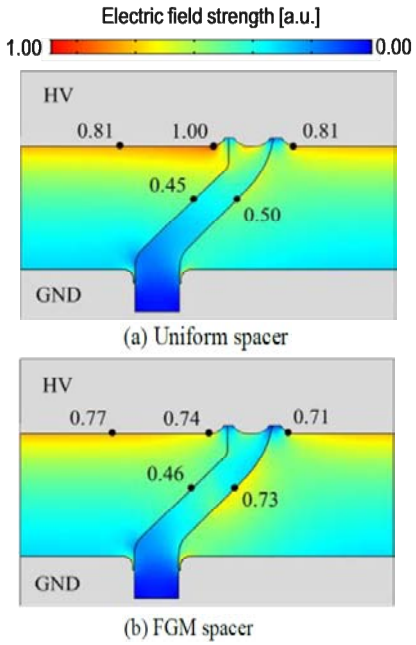


Fig. 2. Calculated electric field distribution.

Table 1: Specification of filler materials.

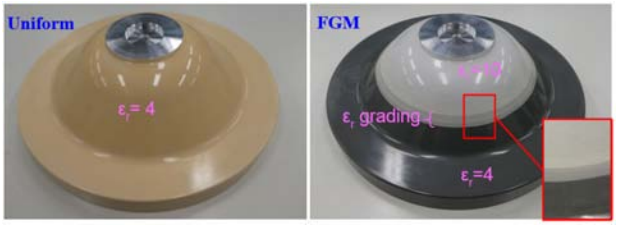
Filler material	$SrTiO_3$	SiO_2
Mean diameter	1.0-1.5 μm	1.5 μm
Relative permittivity	332	4

exposed to negative standard LI voltage. The applied peak voltage started at approximately 0.5 a.u., denoted by an arbitrary unit, and increased by approximately 0.05 a.u. Three samples of uniform spacers and two samples of FGM spacers were tested. The cross symbols in Fig. 4 show the measured FOV of uniform (black) and FGM (red) spacers as a function of SF_6 gas. At 0.6 MPa-abs, two FGM spacers were flashover at 1.63 a.u., whereas two uniform spacers were flashover at 1.34 a.u. and 1.39 a.u. At 0.5 MPa-abs, two FGM spacers were flashover in the range of 1.39 a.u. to 1.48 a.u. (acquired 8 times), whereas two uniform spacers were flashover in the range of 1.15 a.u. to 1.25 a.u. (acquired 3 times). Thus, it was experimentally verified that the FOV of the FGM spacer increased more than that of the uniform spacer between 0.3 and 0.6 MPa, and the average of the FOV increase was 21% higher at 0.5 MPa-abs and 19% higher at 0.6 MPa-abs.

Figure 4 also shows the estimated flashover voltage, designated by circle symbols (Uniform: black, FGM: red), based on the volume-time theory and the big data of LI FOV in SF_6 gas in the previously reported references. The dotted lines represent their approximations. The measured FOV of the FGM spacer agreed well with the estimated flashover voltage. The flashover characteristics are discussed in terms of the flashover traces. Figure 4 shows the flashover traces of (a) the uniform spacer at 0.6 MPa-abs, (b) the FGM spacer at 0.6 MPa-abs, (c) the FGM spacer at 0.4 MPa-abs. The flashover traces of the uniform spacer in Fig. 4(a) were started at the shield edge of the HV conductor on the concave side, which corresponds to the point of high electric field stress in Fig. 2(a), as well as on the spacer surface on the concave side. On the other hand, as shown in Figs. 4 (b) and (c), there were two types of discharge patterns for the FGM spacer: discharge from the concave-side coaxial HV conductor to the ground tank and discharge from the coaxial HV conductor shield edge to the spacer surface near the ground tank.

These results suggest that the flashover of the uniform spacer was a surface discharge originating from the shield edge, whereas the flashover of the FGM spacer was a gap discharge between the coaxial cylindrical electrodes. Consequently, the fabricated cone-type FGM spacer exhibited a flashover voltage improvement effect, compared with the uniform spacer, owing to the electric field grading and equalization by the FGM spacer.

In addition, a withstand voltage test of 15 times LI ±1050 kV, which is a type test of the standard LI voltage of 245 kV class GIS regulated in IEC 62271, was carried out with the sophisticated FGM spacer in



(a) Uniform spacer (b) FGM spacer

Figure 3. Fabricated actual size cone-type spacer.

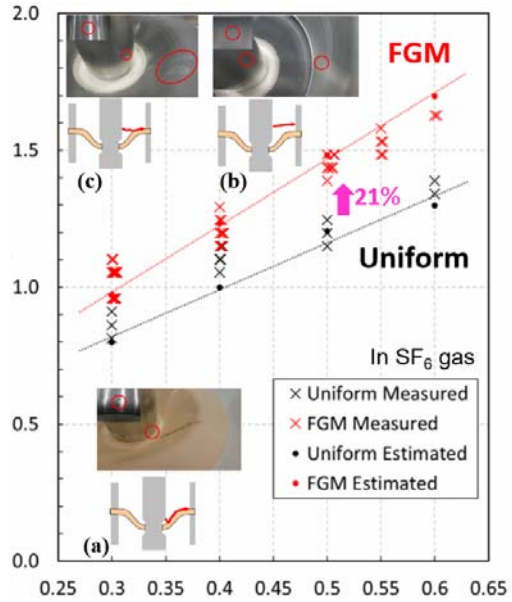


Fig. 4. LI flashover voltage of uniform and ε-FGM spacer models (Measured and estimated results).

the 30% diameter reduction 245 kV class GIS. As a result, there was no flashover and the standard requirement was satisfied. The authors also conducted an investigation of the long-term AC V-t characteristics of the ε-FGM spacers. The authors also conducted an investigation of the long-term AC V-t characteristics of the ε-FGM spacers. Four ε-FGM spacers were set in SF_6 gas of 0.6 MPa-abs, and AC voltage applied for 2000 hours at 257 kV which is 1.8 times of normal voltage to ground (245 kV/$\sqrt{3}$). During the test, the partial discharges were continuously measured using the CT. It was found that partial discharge and dielectric breakdown did not occur in all of them, and that the equivalent insulation life of 245 kV base was obtained from the inverse power law (n = 15) to be over 50 years, and that the insulation reliability was also excellent.

These results indicate that the application of the FGM technology is highly effective in gas insulation and gas solid insulation systems such as GIS and GIL, and the target of size reduction of about 30% in comparison with the conventional one at the beginning is expected.

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MISCELLANEOUS

Front Cover

Demonstration test situation to install a triaxial superconducting cable system into a commercial chemical plant Grid

Recently, reduction in CO_2 emissions as saving energy and global warming measures becomes an urgent problem. The application of high temperature superconducting (HTS) power cables could be expected to contribute greatly to solving this problem due to high energy saving effects, and the practical usage is expected in the near future.

Based on the characteristics of the superconducting cables, carrying high capacity with low voltage and high current cable is thought to be most appropriate and the triaxial cable has been selected for "compactness of the cable diameter and low cost".

In order to realize a superconducting cable to practical device, energy and cost necessary for the cryo-cooling should be drastically reduced by using the existing cold system in the plant. In this way, it is expected of HTS cable with the realization of low cost and the high energy saving effect.

SWCC Showa Cable Systems Co., Ltd. (SWCC), BASF Japan Ltd. (BASF) and The New Energy and Industrial Technology Development Organization (NEDO) have completed the world's first demonstration test of a tri-axial superconducting cable system installed in a commercial chemical plant's grid at BASF Japan's Totsuka site (Totsuka Ward, Yokohama). The test was carried out from November 2020 to September 2021.

As a result of this demonstration test, it was confirmed that a 30MW trixial superconducting cable system of 1km has an energy saving effect of 95% over and an annual CO2 reduction effect of 2000t over compared to an XLPE cable.

This article is based on results obtained from a project, JPNP14005, subsidized by the New Energy and Industrial Technology Development Organization (NEDO).

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Rear Cover

Effect of nanoparticle surface modification on electrical treeing in polymer nanocomposite

Electrical treeing is one of the fatal failure modes in polymer dielectrics. Polymer nanocomposites have drawn much attention because of their superior insulation property. Nanoparticles act as a physical barrier for trees. It is known that the interfaces between the nanoparticles and polymer affects the electrical tree propagation. In this paper, we report an approach to inhibit electrical trees by changing the surface modification of nanoparticles.

A needle electrode-embedded epoxy/silica nanocomposite samples were used. We fabricated two types of samples with different surface modifications: A and B. An AC voltage was applied to the needle electrode to initiate electrical trees. Tree propagation was observed with a microscope.

As shown in the figure, the tree shape of sample A is branch-like shape, whereas the tree shape of B is bush-like shape. Furthermore, the tree length of sample A increased with the voltage. In contrast, the tree length of sample B kept under 0.5 mm regardless of the voltage. These results indicate that the dielectric strength of nanocomposite polymer can be significantly improved by changing the surface modification.

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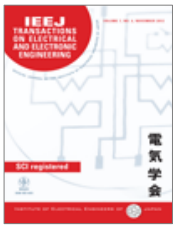
Journals of IEEJ

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



Another transaction "IEEJ Transactions on Electrical and Electronic Engineering (TEEE)" is edited in English by the five technical societies and published by John Wiley & Sons. , (SCI registered)

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

A: Fundamentals and Materials Society (This magazine is published from EINA Committee under this society.)
B: Power and Energy Society
C: Electronics, Information and Systems Society
D: Industry Applications Society
E: Sensors and Micromachines Society
(please visit Portal site of IEEJ > English Top > Technical Societies)

IEEJ Technical Reports

The A4 size technical reports listed below were prepared by investigation committees in technical societies A to E in IEEJ and published from December 2020 to November 2021. The extended summaries can be browsed in English on the web site below but the texts of technical reports are described in Japanese

Abstracts of the technical reports can be browsed on the web site:
Portal site of IEEJ > English Top > Publications > Abstract of Technical Report
(https://www.iee.jp/en/pub/tech_report/)
https://www.bookpark.ne.jp/cm/ieej/search.asp
(You can search technical reports in Japanese there where English abstracts are included.)

No.	Title	Pages	Issue Date (y/m/d)
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1543	Accurate Performance Evaluation Technology for Rotating Machines by Electromagnetic Field Analysis	111	2022/12/9
1539	Medical Application of Superconducting Technology	51	2022/10/12
1529	Trends in Health Risk Analysis of Electromagnetic Fields	72	2022/10/3
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1535	How to use linear motor effectively	87	2022/9/9
1533	Present State of Insulation in Increasingly Widespread Converter-fed Rotating Machines	82	2022/8/24
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1531	Technical features and differences of urban transport systems in Japan and abroad	43	2022/8/4
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1522	Sustainable Technologies for Maintenance, Repair and Refurbishment of DC motors and High voltage motors	184	2022/5/25
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1521	Survey Report of Positioning Technology for Geospatial Information Solutions	36	2022/1/20
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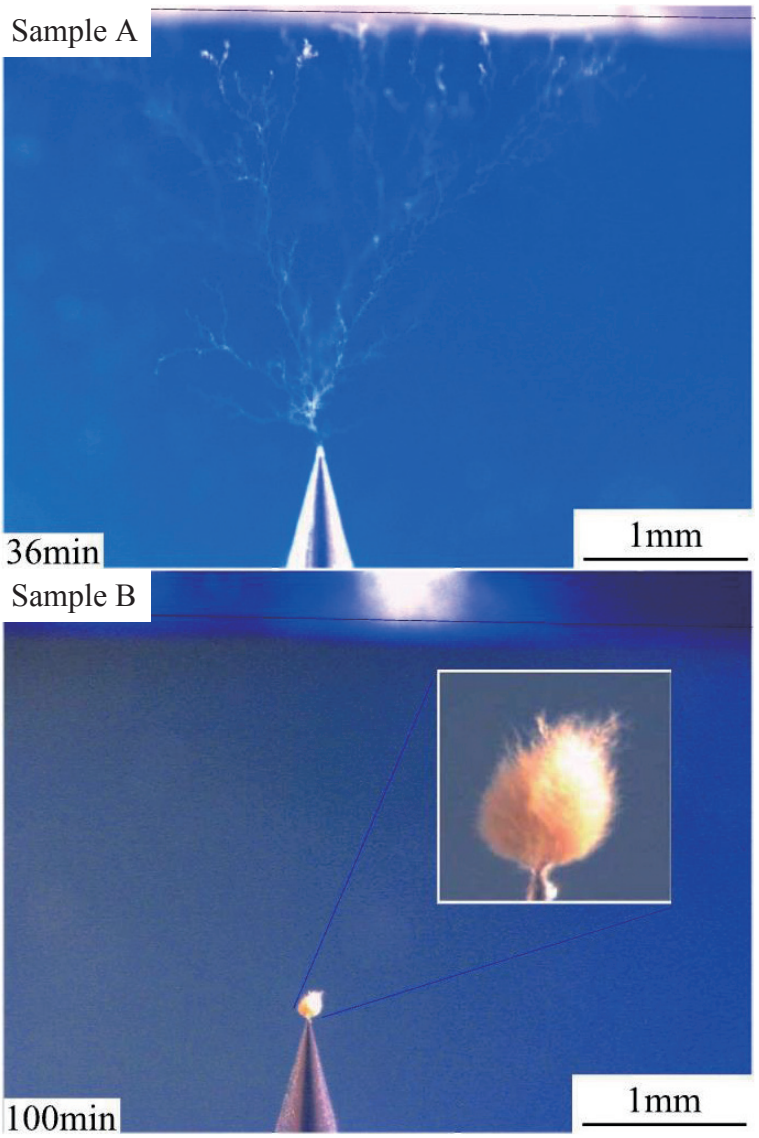

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