

ICPADM 2021 List of Abstracts

Title	Abstract	Presenter
A Comprehensive Survey on Alternating Fluids Used for the Enhancement of Power Transformers	In recent days, the insulating fluids plays an essential role in the design of power transformers, because the performance of the power system is highly depends on the transformers used in the system. Conventionally, the mineral oils are used in the transformers for increasing the cooling effect, but is less biodegradable and has a reduced fire resistant characteristics. So, it is important to identify an alternating insulating oil for enhancing the power transformers. Due to this reason, this research work intends to survey the characteristics of various alternating oils used for the power transformers. In this analysis, the oils and its characteristics have been surveyed with the specific usage. It includes the vegetable oil, ester oil, magnetic oil, silicone gel, and nano fluids. Based on this, the characteristics of the transformer oil can be enhanced by mixing the nano particles with the vegetable oil. Then, the conditional assessment of these oils are validated by using the measures of breakdown voltage, viscosity, dielectric constant, flash point, fire point, and acidity.	Gopakumar S
A Hybrid Method of Self Organizing Maps with Statistical Feature Extraction for Accurate and Efficient Partial Discharge Recognition and Clustering	Partial discharge is the phenomena that affecting the health of power transformer. The problem with delay in identifying will deteriorate the transformer insulation condition and ultimately reduced the network security and reliability. In this paper, author proposed a hybrid method combining pinnacle statistical features with self organizing method for partial discharge recognition and clustering to replace the conventional way. Overall, the proposed method achieved decent clustering result with fast computation time (less than 10 seconds)	Zul Bohari
A New Technology of GIS Partial Discharge Location Method Based on DFB Fiber Laser	With the improvement of voltage level and the expansion of power grid scale, GIS equipment is widely used in the power industry. Due to the closeness of GIS, many traditional preventive test projects cannot be carried out. The stable operation of GIS equipment is very important to the security of power grid. According to the past experience, the deterioration of insulation affects GIS The biggest threat to safe and stable operation. Traditional PD detection methods such as ultrasonic detection have the disadvantage of low detection sensitivity. The accuracy of traditional pulse current method is general. The detection method of ultraviolet imaging has good detection effect for the location detection of external partial discharge of equipment, but it can only detect the ultraviolet signal in the sun blind area in the frequency band of 200nm ~ 280nm Etc. In this paper, DFB fiber laser sensing technology is used to locate the partial discharge point. DFB fiber laser sensor adopts high-precision interferometric phase demodulation technology to realize highprecision and wide-band measurement. The principle is that when the fiber sensor vibrates, the cantilever beam will bend due to the inertial action, which will cause strain on the DFB fiber grating and cause the laser output wavelength to drift. The wavelength change of DFB fiber laser is converted into phase change by interferometer, and then wavelength demodulation is realized by PGC phase demodulation. Based on the cylindrical structure of GIS equipment, six optical fiber vibration sensors are arranged and pasted on the surface of GIS at equal intervals. By simulating the discharge of different spatial positions in GIS, the experimental results show that the positioning distance error is less than 5%. It can be widely used in fiber optic fiber optic partial discharge (FDB) sensor with high line width and low frequency distribution.	Chenglong Jia
A Tool to Determine the Hydrophobicity of Insulators Using Contact Angle of a Water Droplet	Measurement of hydrophobicity can be used to determine the surface condition of polymeric and polymer coated porcelain insulators. This paper presents a monitoring and diagnostic tool to determine the hydrophobicity of a polymeric surface in a laboratory environment. Image processing techniques are used to measure the hydrophobicity of insulator surface using the contact angle method. STRI hydrophobicity classification guide is used to determine surface condition of insulators using contact angles of water droplets which are placed on the insulator surface. Results show that the surface degradation of the insulators due to aging can be identified so that the degraded insulators, which have a higher probability of having flashovers, can be replaced early to increase the reliability of the power system.	Rasara Samarasinghe
Accuracy of Furanic Compound Analysis in Determining the Ageing of Power Transformers	Insulation system of power transformers with the presence of moisture, heat and oxygen will be degraded and eventually can cause failure of in-service transformers. The reaction of hydrolysis, pyrolysis and oxidative will break the cellulose chain polymer, breaking the glucose monomer and produce glucose molecules, moisture and carbon monoxide gases. Further degradation will generate organic acid and furanic compounds as ageing by-products. Thus, these ageing by-products are commonly used as indicator of the transformer ageing and many empirical equations have been developed to correlate furanic compounds with insulation paper's Degree of Polymerization (DP). Nevertheless, the degradation of insulation system is not uniform and follows the thermal gradient of transformer winding which affect the accuracy of furanic compounds in determining the ageing of transformers. Of much interest to the power utilities is knowledge of which model provides more accurate estimation. This paper presented the finding on the analysis of DP test results from paper samples on various locations from transformer winding and its comparison analysis with furanic compound. Preliminary findings show discrepancies among the models and suggested that further research is required for better accuracy assessment.	Mohd Aizam Talib

<p>Additive Impact on Space Charge of XLPE-Based Insulators Subjected to Radio-Chemical Aging</p>	<p>The combined effects of ionizing radiation and temperature on polymers have been widely investigated from different perspectives and research fields. In the electrical engineering field, various works study this phenomenon through thermally stimulated discharge current (TSDC), electrical conductivity and dielectric spectroscopy; but, at the moment, few studies explain in detail the effects of γ-rays on the space charge distribution.</p> <p>In general terms, aging leads to the increase of the trapped charges due to the structural defects which can arise due to various aging conditions and stressors, which can be particularly severe inside nuclear power plants environments due to the presence of e.g. ionizing radiation and high temperatures.</p> <p>In order to guarantee a long service life of the insulators and to withstand aging conditions, additives are usually included in the main insulating polymer matrix. The concentration of these additives can be very significant in the case of low-voltage cables, reaching up to 60%w/w of the final polymeric blend. It is evident that, with such a presence of external species, additives can deeply impact both the physical-chemical and electrical properties of the material. Nowadays, very little literature has been focusing on the effect of these additives on the space charge pattern of insulators.</p> <p>Under these circumstances, this paper aims to investigate the evolution of the space charge distribution through the pulsed electroacoustic (PEA) method of different crosslinked polyethylene (XLPE) blends subjected to radiochemical aging.</p> <p>This latter has been performed through three γ-radiation dose rates through a ^{60}Co γ radiation source in order to simulate typical nuclear power plant environmental conditions, namely: 8, 60 and 400 Gy/h.</p> <p>In particular, XLPE-based materials here analyzed are characterized by a growing complexity in additives, e.g. antioxidants and flame retardants. The contribution of these different additives on space charge distribution and its development with aging is highlighted and linked with the physical-chemical properties (e.g. oxidized species) of these materials.</p> <p>In conclusion, it is shown that different concentrations and types of additives can significantly change the space charge profiles of the polymer matrix, in addition to the trapped charges and carrier mobility properties, during aging.</p>	<p>Simone Suraci</p>
<p>Advanced Polymeric Cable Degradation Diagnostics Using Time Domain Reflectometry Technique</p>	<p>Power cable is an important medium to transmit electricity from generation to transmission and distributing to end users. Power utility companies hold huge responsibility in ensuring the reliability of these power cables. Despite taking various preventive measures, there are still numerous reports on power outages due to power cable failure. Power utility companies have been using time domain reflectometry (TDR) technique to locate fault in cable after fault has occurred. This requires the entire cable to be replaced which consumes long period of time causing long hours of power outage. Therefore, this study aims to investigate the application of TDR technique for monitoring current cable condition so that degradation in cable can be detected at the early stage. This study consists of TDR simulation work using MATLAB Simulink and validation of simulation results with TDR experiments. Power cable is first modelled in both good and degraded conditions with MATLAB Simulink by inputting relevant parameters to replicate the actual cable. A cable joint is then modelled using lumped parameter to reproduce a cable with single and multiple joints in MATLAB Simulink. Simulation results from all cable configurations are then validated with TDR experiments. TDR experiments are conducted using Megger Teleflex SX TDR equipment on single core 11 kV 240 mm² unarmoured XLPE cables with aluminium conductor as cable sample and a straight through joint is used to connect more than one cable. Both TDR simulation and experimental results have shown consistencies in the TDR reflections which implies that the cable and joint modelled in MATLAB Simulink have accurately replicated the real cable and straight through joint. Results have also shown that degraded cable gives distinct signatures of TDR reflections where it can be detected by observing the delay and change in magnitude of cable joint reflections. Greater delay shows higher level of degradation in the cable. Degraded cable with joint can be identified from the cable joint reflection that has a higher magnitude. With these TDR reflection signatures, degraded cable can be identified and sectionalized for cable replacement to take place immediately and thus, minimizes the electricity disruption time.</p>	<p>Tze Mei Kuan</p>
<p>Ageing Classification of Metal Oxide Surge Arrester Using Its Power Factor</p>	<p>The third harmonic component of resistive leakage current is considered as the most sensitive ageing indicator of metal oxide surge arrester (MOSA). It is essential to extract the resistive component of the total leakage current prior to determining its third harmonic content. Several methods have been proposed so far to determine the resistive leakage current. But, the implementation of complex mathematical procedures has made these techniques difficult and less accurate. Therefore, this paper is aimed to propose the power factor as a new ageing indicator of MOSA. New indicator is determined without extracting the resistive component of the total leakage current. This study has been performed experimentally on three aged samples of 120 kV rated MOSAs to determine their power factors. The results have shown that the variation in proposed indicator towards arrester's ageing is similar to that of the resistive third harmonic component. The percentage rise in the power factors of MOSA-I, II, and III by increasing the voltage from 70kV to 120kV to simulate ageing, are found to be 105%, 118%, and 108% respectively.</p>	<p>Abdullah Munir</p>

Aging Effects on Structure and Breakdown Properties of Polypropylene/Multi-Element Oxide Nanocomposites	This paper investigates the effects of thermal aging on unfilled polypropylene (PP) and PP containing 1 wt% of magnesium aluminate (MgAl ₂ O ₄), calcium carbonate (CaCO ₃), and surface modified calcium carbonate (CaCO ₃ T) nanofillers. Two different aging conditions were considered, i.e., unaged (20 oC) and aged (140 oC). The structures of the evaluated samples before and after aging were observed using scanning electron microscopy (SEM). In addition, thermal stability and electrical properties were evaluated by means of thermogravimetric analysis (TGA) and DC breakdown testing. The results showed that, the structure and thermal stability of all investigated samples were less susceptible to thermal aging. Meanwhile, the thermal stability of the unfilled PP has reduced significantly than that of nanocomposites. Besides that, the electrical breakdown strength of both the unfilled PP and PP nanocomposites containing 1 wt% of MgAl ₂ O ₄ , CaCO ₃ , and CaCO ₃ T nanofiller has reduced compared to the respective unaged samples. Of note, PP containing 1 wt% of CaCO ₃ was less susceptible to changes in DC breakdown strength after thermal aging.	Aizat Azmi
Aging of Oil-Impregnated Paper at Different Frequencies	In this work, breakdown strength and lifetime curve of oil-impregnated paper (OIP) are compared at 50Hz and 1500 Hz. For the ramp breakdown tests, sinusoidal voltage ramp of $V / \sqrt{k \cdot P \cdot S}$ is used. The ramp breakdown experiments is conducted on OIP samples made of single and double sheets of OIP. Weibull plots and interpretation of the results are presented. In order to obtain lifetime curves, a step sinusoidal voltage waveform whose peak value is close to the minimum OIP ramp breakdown voltage is applied on single sheet of OIP samples. Time to breakdown is measured, and each experiment is repeated between 20-30 times to obtain good statistical results. The experiments were focused on four different voltage levels and the lifetime curves are plotted for those two target frequencies. Parameters of the lifetime curves are extracted and the interpretation is given.	Weichuan Zhao
Air Bubble in Liquid Food Under Pulsed Electric Field Pasteurization Using Coaxial Chamber	Dielectric breakdown of bubbles embedded in sample food inside the treatment zone is a limiting factor in the pulsed electric field (PEF) pasteurization. Therefore, a proper chamber's geometry, air pressure, and estimation of electric field enhancements (due to gas bubbles) are powerful strategies to overcome this limitation. In this study, a coaxial treatment geometry loaded by dielectric liquid food encompassing a gas bubble demonstrated importance in the electric field distributions. This research has done some simulations to observe the effects of a bubble diameter and the liquid's flow speed in coaxial chamber geometry to assess and improve process homogeneity. The emergence of a gas bubble induced the field's amplitude to cut considerably near the bubble boundary, thus disturbing the uniformity of the electric field inside the chamber. Without depressurization (atmospheric conditions), the dielectric breakdown strength of the air bubbles showing the arcing threat. Air bubble with a comparable diameter has influenced more to the electric potential difference, and the position of the air-bubble also affects the value of electric potential. More variations have noticed when this air bubble has found close to the electrodes. This study will support to enhance the knowledge to design an electroporator for PEF pasteurization of liquid food.	Rai Naveed Arshad
Analysis of Direct Current Integrated Charge in Cable Insulation with Electrical Tree	The electrical-tree degradation inside XLPE cable is a serious threat to the cables under operation. In this paper, the DCIC (direct current integrated charge) method was employed to evaluate the electrical tree inside XLPE insulation. During the preparation of cable samples, the tree inception voltage of ~8 kV was tested. Then 1, 5 and 10 needle electrodes were inserted into cable samples for the tree generation. After the preparation of samples, AC voltage of 10 kV was applied onto the needle electrodes for electrical tree growth. The treeing time was set to 0, 20, 40 and 60 min for the DCIC test. During the DCIC test, a DC voltage of 2 kV was applied on the conductor, and the integral capacitor was connected between the copper shield of cable and ground. From the experiment result, it can be found that with the increase of treeing time, the charging coefficient increases obviously if there are 5 and 10 electrical trees in the cable, this is maybe caused by the occurrence of polarization. The conduction current coefficient changes obviously before and after needles insertion. The information in DCIC curve can be used to analyze electrical tree degradation and mechanical damage in cables at the same time. This nondestructive testing method proposed in this paper will improve the testing efficiency and speed.	Yufei Yao
Analysis of Permittivity and Temperature on Charge Accumulation Within Cross-Linked Polyethylene (XLPE) via Numerical Simulation	In general, High Voltage Direct Current (HVDC) transmission is primarily used for submarine applications, including to integrate offshore wind farms to land or to transmit large electrical power over long distances across the sea. Typical insulation used within HVDC cables is either Cross-Linked Polyethylene (XLPE) or Low-Density Polyethylene (LDPE). When a HVDC cable is in service and therefore stressed under DC high voltage, space charge will start to accumulate within the polymeric insulation of the power cable. It is widely accepted that the dynamics of space charge accumulation is as an important element affecting the performance of high voltage cable insulation system. This paper intends to investigate and explain the influence of different permittivity and room temperature on the space charge accumulation within XLPE through a study of numerical simulation. The numerical simulation in this paper was developed based on previous research by R M Hill and J M Alison. Three fundamental equations known as Poisson's, Transport and Continuity equations, which represent the characteristics of space charge, were employed for the numerical simulation. Preliminary results of the numerical simulation have shown that the variation of these parameters would influence the accumulation behaviour of space charge within the polymeric material.	Nik Hakimi Nik Ali

Analysis of Surface Potential Decay and Charge Trap Characteristics of Water Diffused Silicone Rubber Nanocomposites	Silicone rubber is extensively used as outdoor insulation structure. In the present study the performance of silicone rubber alumina nanocomposite is analysed under water diffusion. Silicone rubber nanocomposites were prepared with different weight percentages of nano alumina. The fundamental surface potential decay along with charge trap characteristics were studied and FTIR analysis is used to evaluate change in functional groups that may arise as a result of moisture absorption. The results of the study indicate an increase in surface potential decay rate and variation in the charge trap depth with water diffused nanocomposites. The results show that 5 wt. % alumina reinforced silicone rubber nanocomposite specimen has performed better.	B Thangabalan
Anti-Electrostatic Electric Discharge Performance of ZnO/Silicone Rubber Composite with Nonlinear Conductivity	With rapid improvement of the integration level of electronic products, the electrostatic discharge capacity of the electronic components gradually decreases and finally become electrostatic sensitive devices. Due to their non-linear characteristics of conductance and dielectric, non-linear composite materials are expected to play a significant role in anti-static electronic devices. In this paper, ZnO/silicone rubber non-linear composite material was prepared. The non-linear conductivity was characterized by a source meter. According to IEC 61000-4-2, the study compared the discharge performance of ZnO/silicone rubber composite film, silicon rubber film and copper film. The results of the experiment reflect that the non-linear composite film can reduce the electrostatic voltage from 0.67 kV to 0 within 1 μ s. The silicone rubber film was able to reduce the electrostatic voltage from 4 kV to 0 within 100 ms. The copper film can reduce the electrostatic voltage from 3.2 kV to 0 within 100 ns. ZnO/silicone rubber composites with non-linear conductivity show promising prospect on anti-electrostatic discharge in electronic devices considering the discharge speed and electromagnetic effect.	Ya Sun
Breakdown Strength and Stability of Palm Oil Toughened with Natural Fibres as Liquid Insulation Material	This study aims to analyse the effect of natural fibres on the breakdown strength and stability of natural ester as liquid insulating material. Breakdown voltage test is performed to determine the breakdown strength of natural esters. In contrast, the stability of natural esters after the incorporation of natural fibre is determined by comparing the initial spectra of natural esters with the spectra of natural esters after several days. Natural ester used in this study is refined, bleached, deodorised palm oil (RBDPO). A natural fibre, rice husk, is used in the sieved form (0.063 microns) and is dispersed in palm oil. The breakdown voltage test is studied according to IEC 60156 using Megger OTS100AF oil tester. Then, the results are analysed by using Weibull statistical analysis. For the stability of samples, optical spectroscopy test is carried out by using UV-Vis spectrometer. The obtained spectra are compared with Day 1 and Day 8 of the samples to determine the filler dispersion stability in palm oil. As a result, the breakdown voltage of natural ester is improved when rice husk is added, which is expected due to the nature of rice husk as a moisture scavenger. The stability of natural esters decreased after a few days due to the agglomeration of fillers.	Mohamad Makmud
Calculation of Electrospray Profile in Multi-Electrode System for Plasma Treatment	Pollution of water from chemical substances is globally on going. Especially, accumulation of persistent substances produced by manufacturing induces many serious problems. For the limitation of further expansion of the aquatic contaminations, development of a new pollution prevention technique is expected. Discharge plasma is one of methods for decomposition of harmful organic compounds. To increase the chemical reaction rate between the radicals and the substances in water, the contact area between the plasma and the water should be enhanced as large as possible. We have proposed the use of electrospray for discharge plasma treatment to gain the surface area of water [1]. In this method, the electrode configuration is quite important because the profile of the electrospray strongly depends on the electric field in the system. To determine the optimal configuration, we have developed the simulation of electrospray in multi-electrode system for plasma treatment. In this study, we report the profiles of electrospray obtained by the simulation and experiment. Figures 1 (a) and (b) show snapshots of typical electrospray profile in one-needle electrode systems. It is clearly shown that the spray direction changes in the two-needle electrode system due to field distortion. Figure 1 (c) and (d) show simulated electrospray profiles in one-needle electrode systems, in which the simulated results show good agreement with experimental results. More detailed results and discussion will be presented at the venue.	Ryohei Ishimaru

Carbonized Surface Tracking on Pressboard Cylinder of Oil Filled Transformer Under Main Insulation Faults	<p>In recently years, main insulation faults such as short-circuit of primary winding to secondary winding, winding to bushing and winding to ground is becoming main sources for transformer explosion. During the short-circuit issues, creeping discharge along the solid-liquid interface tend to cause tree-like carbonized white marks and black marks to spread on pressboard and lead to flashover. These surface tracking phenomena are good indicators for understanding the development mechanisms of transformer insulation failures. However, up to now most of the research on surface tracking of carbonized marks is carried out in minimized test cells, e.g. need-plane electrode configuration immersed in oil/pressboard samples, the precise modelling of surface tracking along oil/pressboard interface in real transformer is still a technical challenge. In this paper, a single-phase transformer model is manufactured, with internal insulation structure imitating the practical case of a 10kV power transformer. AC power source is injected into the high-voltage bushing of the transformer model with applied voltage up to 40kV, whereas a divergent gap is artificially placed surrounding the pressboard cylinder to create main insulation failures. A 50 Ω current shunt was used to monitor the discharge development, whereas a HD camera with frame rate of 1000 fps was immersed into the oil tank to observe the surface tracking in sealed conditions. Experimental results indicate that with the increase of applied voltage, the surface tracking changes from liquid state to gaseous nature. Research findings in this paper can provide recommendations for insulation designs for transformer which is potentially suffering from main insulation failures.</p>	Muzi Li
Characteristics of Power Cable Sheathing Materials with Thermal Ageing	<p>Sheathing materials of the power cables play an important role in the protection of the cable against mechanical damage and fire accidents. The sheathing materials are selected based on the application and the installation environment of the cables. Generally used sheathing materials for power cables are Poly Vinyl Chloride (PVC), Flame Retardant Poly Vinyl Chloride (FR PVC), Flame Retardant Low Smoke Poly Vinyl Chloride (FRLS PVC) and Low Smoke & Zero Halogen (LSZH) materials. PVC possesses high mechanical strength, and electrical strength. However, the smoke and toxic gas release during fire is more for PVC. To improve the flame retardancy and smoke properties, additives and fillers are blended to PVC to make it as FR PVC and FRLS PVC. The optimal selection of additives is done in such a way that the materials retain its basic mechanical and electrical properties along with improved fire characteristics. LSZH materials emit low smoke and no halogens. It is having high amount of mineral fillers to enhance the fire and smoke properties. Lubricants, stabilizers, plasticizers, antioxidants, and colorants are also added to retain the flexibility of the cables, avoid the deterioration of the materials and to achieve the desired colors. In the present study, the various sheathing materials of new power cables are analyzed for its mechanical and fire properties with ageing. The sheathing materials are aged at its field operating temperatures for duration of up to 672 hours and the properties are measured periodically. Ageing of the special sheathing materials have not resulted into significant changes in the fire properties except the loss of chlorine in PVC & FRLS PVC. However, the ageing of the sheathing materials has resulted into loss of certain mechanical properties. Hence it is suggested to evaluate the properties of sheathing materials with accelerated ageing at the compounding stage itself for its optimal compounding blend and to ensure the integrity of the compounds throughout its lifetime.</p>	Arunjothi R
Characterization of Cold Plasma with Glow Discharge Mechanism of Plasma Jet System	<p>Cold plasma with glow discharge mechanism exhibiting an uniform ionization process when a background gas passing through the discharge region of plasma reactor under a certain optimum configuration of input parameters. A glow discharge is a homogeneous and effective mechanism of cold plasma for industrial applications due to the continuous and stable discharge process compared to the filamentary discharge. Meanwhile, the development of glow discharge plasma operated under atmospheric pressure condition is indispensable to overcome the weaknesses of filamentary discharge plasma such as non-uniform and discontinuous discharge process. The discharge mechanism is essentially dependent upon the input parameters of plasma system such as the amplitude of the voltage supply, the operating frequency, and the flow rate of the background gas. Consequently, the characteristics of plasma discharge in terms of electrical properties such as discharge capacitance, discharge voltage, and output discharge power also affected by these input parameters. In this paper, the effects of voltage supply on the characteristics of plasma discharge produced from the plasma jet reactor with high-voltage electrode are discussed. The value of voltage supply is tuned to be suitable with the discharge gap, frequency supply, and the flow rate of background gas in producing the homogeneous glow plasma discharge. The characteristics of the glow plasma discharge produced are analyzed based on the pattern of the charge-voltage Lissajous figure and time-domain discharge current techniques. Results show that the most efficient and uniform plasma are disclosed by the configuration of input parameters such 0.5 kV of supply voltage, 20 kHz of operating frequency, and 0.8 L/min of purified helium gas flow rate. The parallelogram-like Lissajous figure obtained indicating the homogeneous plasma discharge with a constant value of discharge capacitance.</p>	Norhafezaidi Mat Saman; Mohd Hafizi Ahmad

Characterization of Thermal Degradation of Glass Fiber Reinforced Polymer Used in High Voltage Composite Insulator in Nitrogen Atmosphere by FTIR and Micro-Morphology Analyses	<p>The thermal degradation behavior of glass fiber reinforced polymer (GFRP) in nitrogen atmosphere was studied in the present work by thermogravimetric analysis (TGA). The changes of GFRP during the thermal degradation process were characterized from both chemical composition and micro physical structure points of view by using Fourier transform infrared (FTIR) and scanning electron microscopy (SEM). The steps of thermal degradation of GFRP in nitrogen were investigated in detail by analyzing the residues at different set temperatures, then the temperature ranges for the disappearance of methyl and aliphatic structure and the appearance of carbonyl and polyaromatic structure were determined with a temperature resolution of 20 oC. The changes of micro physical structure of GFRP during the thermal degradation in nitrogen involved the softening, melt, shrinkage, appearing of twisted and shrink lines, debonding of interface between glass fiber and epoxy resin matrix and releasing the pyrolyzed gas consecutively. Based on the results, the entire process of thermal degradation of GFRP from initial intact to final deterioration in nitrogen up to 800 oC was characterized, the present work is helpful for better understanding of the thermal degradation behavior of GFRP used in high voltage composite insulator as well as in other industry applications involving the temperature rising condition.</p>	Yanfeng Gao
Charging and Discharging Current in Characterization of Kraft Paper Immersed in Palm Fatty Acid Ester Insulation Oil	<p>Abstract--Most insulation in the power transformers consists of oil and cellulose (paper/pressboard). Mineral oil has been used as an insulating liquid for over a hundred years. However, mineral oil is a non-biodegradable oil and has a serious impact on the environment and the non-renewable energy resources. Therefore, it is important to replace this oil with another alternative insulating liquid, and PFAE was introduced in the year 2006 in Japan. In addition, the ability of an insulating system also depends on the thickness of the monomolecular cellulose fiber on the kraft paper. Hence, it is necessary to determine the appropriate thickness of kraft paper for use as an insulator on the power transformer for this type of oil. This project presents paper-oil (PFAE) charging and discharging current characteristics. The study was carried out through the implementation of experiments in the laboratory. Polarization and Depolarization Current (PDC) test has been carried out to test the conductivity and response function of the insulating materials. It was found that the thickness of kraft paper affecting the capacitance value and the PDC measurement of the tested model. In both dry and wet conditions, the sample of two layers of kraft insulation paper shows the best insulation status as it has the lowest conductivity compared to the other samples. It can be concluded that it is necessary to determine the ideal thickness of insulating paper to ensure that the power transformer has the best insulation.</p>	Saiful Mohammad Iezham Suhaimi
Classification of Degraded Polymer Insulator Using Support Vector Machine	<p>The ability to monitor closely the surface degradation condition of polymer insulator will be really beneficial to the power utility company in order to ensure smooth and safe power transmitted to the consumer. If the level of degradation condition could be classified, then it could ease the maintenance team to take proper action as to avoid any undesirable event from happening. In this study, it has implemented the leakage current signal parameters data in the classification process of degraded field-aged insulator. These signal parameters are extracted from the Spectrogram. Prior to this analysis, the leakage current signal is captured during the testing method of inclined plane tracking. The physical evaluations such as arithmetical mean of surface roughness and static contact angle are also measured for the purpose of comparison of surface conditions. The Support Vector Machine is implemented in the machine learning test, in which the percentage of classification accuracy between degraded sample and the controlled sample is recorded. To validate the classification results obtained, the insulator sheds under test was going through the Spray Method to determine the criteria of hydrophobicity class in Table 1 of the IEC TS 62073:2016. By using the percentage of total harmonic distortion data, the consistency results of the classification accuracy percentage have been successfully determined the two significant classes and the transition class between them. However, there is an existence of insignificant classes if the root means squared leakage current data is implemented. Therefore, by implementing the appropriate leakage current signal parameter data, the degradation classification could be determined accurately.</p>	Asri Din
Classification of Fault and Stray Gassing in Transformer Oil Using SVM, NB and KNN Algorithms	<p>Power transformer is one of the most crucial components in the power system network. A major fault on the transformer can disrupt the power supply, thus causing substantial losses. The dissolved gas analysis (DGA) is used to detect incipient fault based on the transformer oil. However, stray gassing of oil could give false indication to the result. This paper aims to develop a model for considering the results obtained from DGA to investigate transformer oil fault condition. Machine learning (ML) algorithms which are Naïve Bayes (NB), support vector machine (SVM) and K-nearest neighbour (KNN) are trained to classify the DGA data into three categories; not determined (N/D), fault, and stray gassing. The algorithms achieved an accuracy of 93.0%, 95.4% and 97.7% respectively. Overall, the algorithms' performance was tested and verified using various user-input data, where correct classification was achieved successfully.</p>	Mohd Fairouz Mohd Yousof

Classification of Partial Discharge Sources by SF6 Decomposition By-Products	<p>This paper studies the decomposition characteristics of Sulfur hexafluoride under partial discharge (PD) of three common types of defects in gas-insulated switchgear, and classifies the type of defect based on the by-products. To extract the effect of each defect on insulation gas, the decomposition characteristics under partial discharge of two protrusion, free conducting particles and fixed conducting particles defect configurations were studied. The generated products and their concentrations were used as feature parameters in the space vector machine (SVM) algorithm in Python environment to predict the type of defect causing the PD. The artificial defects were designed and placed in a coaxial gas chamber simulating a GIS configuration. During the stress cycle of up to 126 hours, the applied voltage was regularly increased in steps and hence higher PD levels were measured. Gas samples were collected every 18 hours and were analyzed using Fourier transform infrared (FTIR) spectroscopy gas analyzer. Results have shown that the decomposition of SF6 under the three defects are not the same and the SVM was successfully able to identify the type of the defect based on the supplied gas concentrations.</p>	Ammar Mahdi
Classification of Partial Discharges in Insulation Materials via Support Vector Machine and Discrete Wavelet Transform	<p>Long term partial discharges (PDs) within an insulation material of high voltage equipment can cause equipment failure. Thus, it is important to detect PDs within the insulation material and classify the PD type with high accuracy so that repair and maintenance can be performed effectively. In this work, three different types of PD, which include internal, surface and corona discharges, are measured from insulation materials. To evaluate the effect of noise on the PD measurement data, different levels of Additive White Gaussian Noise were added to the signals. Then, feature extractions were performed from the PD signals using Discrete Wavelet Transform (DWT). Different types of DWT families were used for feature extraction. The extracted features were then fed into support vector machine (SVM) for training and testing purposes. The classification accuracy of each test was recorded and compared. It was found that classification of PD signals using SVM as a classifier and DWT as a feature extraction yields reasonable classification accuracy results under different noise levels, which is in the range of 90%-99%.</p>	Hazlee Azil Illias
Classification of Salt Fog Aged Silicone Rubber Micro Nanocomposites Through PCA Assisted LIBS	<p>The conductive channels formed over the silicone rubber (SR) materials due to atmospheric conditions impose a threat of arcing during the power system network operation. The present study is carried out to detect the level of contamination of insulating materials through laser induced breakdown spectroscopy (LIBS) and principal component analysis (PCA). The objective is to create a database of LIBS spectra of salt fog aged SR samples under different accelerated ageing cycles. Further, the database of spectra is transferred to new principal plane that has various clusters, and each spectrum of the ageing method aggregates at the respective cluster. Further, based on the occupancy of the LIBS spectrum of unknown material in the vicinity of already existing clusters of known samples, the level of ageing is determined qualitatively.</p>	Chillu Naresh
Comparative Analysis of the Effect of Different Substrates Materials on Microstrip Patch Antenna Operating at 3.6 GHz	<p>The quest to know the best substrate material that will produce higher antenna performance at 3.6GHz prompted the consideration of different substrate materials for the design of rectangular microstrip antenna. Transmission line model (TLM) analysis is used to obtain the antenna designs' physical dimensions for the eight different substrate materials considered at a fixed height (h) of 1.6mm. Simulations were carried out in CST Microwave Studio. The result shows an inverse relationship between the dielectric constant of substrate materials and the gain.</p>	Yakub Olufadi
Comparative Study on Electrical Equivalent Circuit of Insulators with and Without RTV Silicone Rubber Coating Under Clean Fog Condition Based on Leakage Current Waveforms	<p>This research explains the characteristics of the insulator coated with Room Vulcanized Temperature (RTV) and non coated from the leakage current by looking at the electrical circuit parameters of the insulator under clean fog conditions. To find out the characteristics of the electrical equivalent circuit, a simulation was conducted using ATPDraw software. The simulation was conducted by validating the simulation result of the leakage current parameter with the experiment result that consists of the waveform, magnitude, and harmonic component. Several insulator conditions were simulated: voltage test variation and pollution conductivity variation. The results show that the greater the test voltage applied to the insulator make the non-linear resistance circuit parameter having a smaller limit range. For conductivity, variations have a similar effect with test voltage variation. Meanwhile, the coated effect on the insulator greatly affects the equivalent circuit parameters</p>	Adjie Bagaskara

<p>Comparison of Flashover Voltages and Surface Discharges of Epoxy Resin with Montmorillonite Nanofillers and XLPE Samples with SiO₂ and Al₂O₃ Nanoparticles</p>	<p>Considerable research effort in the field of polymer nanocomposites started in 1994 and it was shown that these materials present improved electrical, thermal and mechanical properties compared with the respective conventional polymers. Polymer nanocomposites have been applied in various industries and in various fields of high voltage engineering. A comparison of two different polymeric materials enriched with wt% of three different nanoparticles. Epoxy resin samples without and with nanoparticles (0 wt%, 1 wt%, 3 wt%, 5 wt%, and 10 wt% of montmorillonite) and XLPE samples with SiO₂ and Al₂O₃ as nanoparticles (0 wt% nanoparticles and XLPE with 0.2 wt%, 0.5 wt% and 1 wt% of SiO₂ nanoparticles and XLPE with 0.2 wt%, 0.5 wt% and 1 wt% of Al₂O₃ nanoparticles) are presented in this paper. Half-cylindrical electrodes with rounded edges made of copper, a 20 kV transformer as a voltage supply, eight (8) different water conductivities (1.4 μS/cm, 100 μS/cm, 200 μS/cm, 500 μS/cm, 1000 μS/cm, 2000 μS/cm, 5000 μS/cm and 10000μS/cm) and four (4) different water droplet arrangements were used for the experiments carried out for this paper. Furthermore, this paper is taking into consideration factors, such as water droplet number and volume, droplet conductivity as well as the distance of the droplets from the electrodes and the surface roughness of the polymer nanocomposite and how these affect the surface discharges and flashover voltages. We carried out this research in order to try to find the optimum nanoparticle percentage for surface flashover of the above described insulating materials. It seems that the aforementioned factors play a key role on surface discharges and flashover voltages. In addition, it seems that the best results regarding surface flashover voltages are obtained with moderate nanoparticle percentages, i.e. our results seem to agree with experimental data published elsewhere. It seems that far too large nanoparticle percentages tend to have a negative effect on the surface flashover, which implies that an agglomeration effect seems to be noticeable.</p>	<p>Michael Danikas</p>
<p>Corona Ring Design Impact on the Electric Field Distribution Surrounding an Insulator String</p>	<p>Insulator strings are used on high-voltage transmission lines to insulate the line conductors from the grounded transmission towers. The electric field distribution along an insulator string is not uniform when an AC voltage is applied on it. To prevent unwanted phenomena such as corona discharge or flashover from happening, the electric field near the energized end of the insulator string must be minimized. This can be done by installing a corona ring. It is important to obtain a suitable design of corona ring so that the electric field magnitudes can be reduced significantly. Therefore, the effect of the design of corona ring on the electric field distribution along a 10-unit porcelain insulator string was evaluated by using Finite Element Analysis (FEA) in this work. From the simulation results, it was found that the parameters of the corona ring such as the vertical height of the corona ring along the insulator string, the outer diameter of the corona ring, and the inner diameter of the corona ring tube have an impact on the electric field distribution surrounding the insulator string. At the end, a suitable design of corona ring is proposed, which gives the lowest electric field magnitude along the insulator string based on the results obtained. A suitable design of corona ring for the modelled 10-unit porcelain insulator string was found to be 350 mm outer diameter of the corona ring, 65 mm inner diameter of the corona ring tube and 300 mm vertical height of the corona ring along the insulator string.</p>	<p>Hazlee Azil Illias</p>
<p>Correlating UV Visible Spectral Response and Thermal Ageing of Blended Transformer Oil</p>	<p>Vegetable oils (VOs) are potential replacement of Mineral oil (MO) filled power transformers due to the ecological and thermal advantages. Retro filling of power transformers filled with MO by VO is real possibility which may result into a mixture of MO and VO or simply blended oils (BOs). It is essential to characterize BOs and compare them with MO. The ageing characteristics with respect to electrical and physiochemical properties of BOs in operating transformers will be different than that of individual MO and VO. Fresh MO and VO samples are blended in three different proportions (25%, 50 % and 75%) and are thermally aged in open beaker for 168 hours at 150°C. Important ageing parameters like resistivity, dielectric dissipation factor (DDF), acidity, interfacial tension and other parameters monitored before and after thermal ageing. Extents of ageing in BOs are compared with individual MO and VO ageing. The changes in these parameters are found to be different in BOs than individual MO and VO. Variation in ageing characteristics is observed with change in MO / VO proportions. The UV- Visible spectroscopy is recorded before and after ageing and effort is made to establish any possible correlation between UV -Visible spectral response and other ageing parameters.</p>	<p>Manas Chakraborty</p>
<p>Curing Characteristic Analysis and Leakage Current Performances of Silicone Rubber via Inclined Plane Tracking (IPT) Test</p>	<p>Researches are still being performed all around the world in order to explore the unique insulating behavior of Silicone Rubber (SiR) material. Hence, this research is performed in order to analyze more on the effect of SiR formulation with different filler content, their curing characteristic and their effect upon sample performances electrically. Firstly, SiR will be formulated with three different concentration of Alumina Trihydrate (ATH) of 10wt%, 20wt% and 30wt% together with Dicumyl peroxide (DCP) as the curing agent. The cure characteristic of the SiR with all three different concentrations were tested using rheometer in accordance to ASTM D5289. The prepared SiR materials were then tested according to the standard of BSEN 60587 Inclined Plane Tracking (IPT) test in order to analyze their performances electrically via leakage current (LC) values. It was found that increase in filler loadings were followed by increase in crosslinking density (MH) and decrease in scorch time (TS2). The cure time increases with increase in filler loadings. The increase in filler loading up to 30wt% together with crosslinking density (MH) have contributed towards a SiR material with great electrical properties. The highest ATH loadings of 30wt% displayed the highest crosslinking density, lowest scorch time, highest cure time and lowest LC value of 9.7 mA. In overall, a combination of proper ATH filler loading contributes to a high crosslinking density and higher resistance of sample against tracking and erosion and hence a lower LC value.</p>	<p>Nornazurah Nazir Ali</p>

DC Leakage Current Measurements: Contribution for the Qualification of Extruded MVAC Cables for DC Operation	Due to increasing decentralized energy production and rising energy consumption, DC transmission in the MV level is becoming ever more important. The two main advantages are the operational advantages of MVDC transmission and the higher transmission capacity. To qualify MVAC cables for DC operation, it is important to determine the electrical parameters of the insulation. One key parameter of the DC insulation is the conductivity, which is obtained from LC measurements. Additionally, space charge accumulations can be detected. In this contribution results from leakage current measurements with varying thermal and electrical stress are presented. Additionally, LC measurements during polarity reversal cycles were carried out.	Patrik Ratheiser
Defects and Resistance Degradation of Sputtered Doped Lead Zirconate Titanate Thin Films	The resistance degradation of sputtered doped lead zirconate titanate thin film resulting from the lowering of the Schottky barrier height was identified by current-voltage characterization over degradation. In addition to migration of oxygen vacancies, potential hole trapping of lead vacancies was observed by Thermally Stimulated Depolarization Current measurements. Both defects were proposed to increase the effective positive space charge density near the interface depletion region along degradation and be responsible for the resulting resistance degradation. This manifestation of defects in the resistance degradation was found to be separated in degradation time and dependent on the wafer position.	Kuan-Ting Ho
Design of an Ultra-Wide Band Microstrip Patch Antenna for Partial Discharge Detection on Power Transformer	The reliability of the power system depends on the quality of the electrical insulation system of high voltage power equipment. Partial discharge (PD) activity in the power apparatus is an indication of insulation degradation due to the presence of defects in the insulation. The occurrence of a partial discharge activity in the insulation may lead to a catastrophic breakdown of the power equipment and may cause a power outage and penalty costs to the power utilities. A Partial discharge monitoring system on a power transformer is an effective and accurate technique for inspecting the insulation condition and identifying potential faults in power transformers. UHF sensors such as UHF Antennas play a vital role in the UHF PD monitoring system. However, UHF sensors still have sensitivity and accuracy issues in detecting partial discharge, especially in online PD monitoring, where there is a high level of electromagnetic interference. To address noise disturbance issues that affect the UHF antenna's sensitivity, we have designed an ultra-wideband (UWB) circular microstrip patch antenna operating in the UHF range. The designed antenna was simulated and optimized using HFSS software. The antenna was designed on FR4-epoxy substrate whose thickness is 1.6mm and dielectric permittivity of 4.4. The radiating patch and ground plane of the antenna are made of a perfect electric conductor (PEC). The designed microstrip patch antenna has a working frequency from 1.18GHz to 3GHz with three frequency bands at three resonance frequencies of 1.3GHz, 2.2GHz, and 2.83GHz respectively. The multiband behaviors will allow this antenna to suppress noise such as noise due to corona and electromagnetic interferences from telecommunication such as GSM.	Jean Pierre Uwiringiyimana
Design of GIS Defects for Partial Discharge Induced SF6 Decomposition	In this paper the experimental set up including the design of artificial defects to implement the partial discharge (PD) study on sulfur hexafluoride (SF6) decomposition is discussed. This work aims to clarify the steps of the experimental arrangement followed to obtain decomposition results under PD of five different configurations of insulation artificial defect. The experimental method is explained from the design stage until the sample analysis stage, including the experimental platform and procedures. The design details include the amount and configuration of defects used, testing platform, aging time and power ratings. The experimental procedures include the design, test platform, equipment utilized, atmospheric conditions, and sample analyses. The proposed procedures suggest that valid and reliable results could be achieved through a series of experiments on SF6 decomposition that emulate the actual defects in a real gas insulated switchgear (GIS) chamber. This work can be useful in providing testing procedures applied to study the decomposition of SF6 under the presence of PD sources.	Ammar Mahdi

Development of Flexible Sensors Based on Piezoelectric Nanofibers	<p>Piezoelectric materials are considered promising for several applications, such as the realization of energy harvesting and electromechanical sensing devices for structural health monitoring systems. Among them, the piezoelectric polymers, e.g. poly(vinylidene fluoride) (PVdF), are well considered thanks to their possibility to be produced in flexible thin film shape.</p> <p>However if a piezoelectric thin film is used in a composite material, a risk of mechanical delamination may be high. In order to prevent it, the piezoelectric polymers can be produced in a form of nanofibrous layer that can be immersed in a hosting material, such as epoxy resin and polyurethane or silicon rubber, for flexible applications. Thanks to the intimate contact with the nanofibers, the delamination risk is avoided and the produced self-sensing material is able to detect the mechanical stress applied on it. A simple way to produce nanofibers is the electrospinning technique.</p> <p>Once the piezoelectric properties of the device are optimized, the signal collecting system can extract its electrical response. In a composite structure, if the electrodes of the integrated sensor are metallic layers, again mechanical delamination could occur, in particular in case of flexible and soft devices. However, if the material where the nanofibers are integrated is made conductive, the mechanical stability of the structure will be substantially increased. In this paper we dispersed carbon conductive nanopowder in the hosting material, in order to create conductive layers that can work as electrodes to collect the piezoelectric signal.</p> <p>The cross section of the device is then observed with electron microscopy images, showing a good integration of the nanofibers and the dispersion of carbon conductive nanoparticles in the electrode region.</p> <p>Once the piezoelectric sensors are manufactured, the electromechanical response is measured through mechanical tests and results showed to be comparable with the traditional piezoelectric sensors one.</p> <p>This kind of nanofibrous piezoelectric sensors can be suitable for several applications, such as flexible devices for artificial skin or health monitoring system for structural application. Moreover, if the polymeric nanofibers are replaced with the ceramic ones, that present higher piezoelectric performance, those devices could be also used in the energy harvesting field.</p>	Giacomo Selleri
Development of Power Transformer Remaining Life Model Using Multi-Parameters	<p>Power transformer is considered to be an important and costly equipment in electrical power delivery. The years of operation may decrease the condition faster than the design life. For that reason, predicting the remaining life of the asset is essential. Power transformer oil-paper insulation is the main concern for remaining life assessment. Extended studies have been done to predict the remaining life through its paper condition as the ageing is known to be irreversible. However, only a few have proposed evaluation of remaining life through multi-parameter assessment. Therefore, this paper aims to benefit the previously developed Transformer Assessment Index (TAI) to evaluate power transformer expected remaining life. A population of 150 kV transformers was employed to develop the model, and thirty-five out of service transformers data were used to be considered as the end of life criteria. The model development as well as case studies is given in this paper.</p>	Rahman Azis Prasojo
Dielectric Barrier Discharge Based Diesel Exhaust Treatment for THC Removal Through Plasma Catalysis	<p>In this paper, an electrical discharge-based gas treatment technique for total hydrocarbon (THC) removal from diesel exhaust has been discussed, utilizing pellets made from wastes of different industrial sectors. This technique, referred to as plasma catalysis, involves activation of catalytic material placed inside the highly reactive non-thermal plasma environment generated in a dielectric barrier discharge (DBD) reactor. A wire-cylinder DBD reactor configuration was used for generating non-thermal plasma. The industrial wastes used in the present work were sourced from various sectors such as agriculture (bagasse, mulberry residue), mariculture (oyster shells) and aluminum industry (bauxite residue/red mud). Pellets were made from these wastes and were tested for possible catalytic activity under plasma activation. When compared to plasma-only treatment of the exhaust, the THC removal percentage obtained using the plasma catalysis approach was found to be higher, ranging between 40% (bagasse) to 50% (oyster shell) under plasma activation of the residue pellets. A discussion on the advantages of reusing such industrial wastes for plasma catalysis and the possible reaction pathways involved in THC removal have been discussed.</p>	Katam Nishanth
Dissolved Gas Analysis of Thermally Aged Mineral Oil and Vegetable Oil Based Nanofluids	<p>Mineral oil (MO) is widely used as insulating liquid in transformers. However, environmental impact, reducing availability of petroleum resources and issues with disposal of used oil; vegetable ester oil (VO) is being considered as potential replacement of mineral oil. Moreover, with the adoption of ultra high voltage ac and dc power transmission systems, there is a need for liquid insulator with superior electrical and thermal properties. In recent times, evolution of nanotechnology has prompted research work on MO and VO based nanofluids suitable as liquid insulator. Though the nanofluids are superior in electrical and thermal properties compared to their base fluids, further studies are needed to establish their stability to thermal and electrical stresses and applicability of existing fault diagnostic tools. In this study, MO, VO, MO/VO mixture (1:1) and their nanofluids of 0.01% Al₂O₃ and 0.01% SiO₂ were subjected to accelerated thermal ageing at 150oC for 168 hours in presence of kraft paper and copper wire in sealed glass bottles with argon blanket. DGA was conducted as per IEC 60567 on all the samples after ageing. The DGA result showed variation in gas concentrations in MO, VO and MO/VO mixture. Presence of nanoparticle was observed to affect the quantity of gas generated. The concentration of gases generated in MO and its nanofluids were relatively less compared to VO and its nanofluids. Gas analysis was carried out using conventional ratio techniques, Duval triangle and Duval Pentagon for establishing suitability of diagnostic techniques applicable to various oils.</p>	Prabhat Maiti

Effect of AC Interference on HV Underground Cables Buried Within Transmission Lines Right of Way	Issues and interest of AC interference from Overhead Transmission Lines (OHTL) to nearby co-located facilities not only involve pipelines, communication cables and transportation infrastructures but also to nearby High Voltage (HV) underground cables. In this paper, the effects on a three phase AC 275kV underground cable running in parallel to three phase AC double circuit of 275kV OHTL are studied using Current Distribution, Electromagnetic Interference, Grounding and Soil Structure Analysis (CDEGS) software program. The underground cable under study is placed within the OHTL Right of Way (ROW) where the modelling, simulation and analysis of both systems are presented in order to assess induced voltage on the sheath of an underground cable. This paper investigates the case when OHTL and underground cable were energized during steady state operation with respect to different length and parallelism of both systems. During the operation of both systems, induced sheath voltage on the cables has increased and voltage distribution changed significantly which can stress the sheath itself. The induced voltage on underground cable sheath has been reduced to tolerable sheath standing voltage as specified by international standard by proposing some mitigation techniques.	Zoolnasri Abu Harun
Effect of Calcination and Addition of Surfactant on Morphological and Mechanical Properties of Silicone Nanocomposites	In this study, filler dispersion variation with respect to the effect of calcination, addition of the surfactant and filler dispersion method is shown and linked to mechanical properties of nanocomposites. Filler dispersion variation is studied through morphological analysis and determination of average filler particle size distribution in nanocomposites. The effect of filler calcination and use of the electrostatic dispersion method showed the most efficient filler dispersion and improved mechanical properties of the nanocomposites.	Khadija Kanwal Khanum
Effect of Compounding Process Parameters Selection on Conductivity Level of Polymer Blends with Aluminium Oxide as Nanofiller for HVDC Cable Application	The usage of polymer nanocomposite as electrical insulating materials has gained more interest and start to be examined by the various researchers. The aims are same which is, to improve the electrical and mechanical performance of the insulation materials for high voltage application purposes. This paper will present the early finding on using compounding polymer-based nanocomposite as high voltage direct current (HVDC) cable insulating material. In this paper, the Design of Experiment (DOE) is the approach used in compounding the small amount of high-density polyethylene (HDPE) added into linear low-density polyethylene (LLDPE) blends with aluminium oxide (Al ₂ O ₃) as nanofillers. The effect of several parameters during the compounding process such as concentrations of the material, rotations per minute of the screw speed and the temperature used on conductivity value of the material will be discussed in this paper. In the end, the best parameter for the compounding process can be identify and conclude.	Syatirah Mohd Noor
Effect of Gamma-Ray Irradiation on the Electrical and Mechanical Properties of Epoxy/TiO ₂ Nanocomposite	Epoxy with nano titania was used to prepare epoxy/TiO ₂ nanocomposite. The impact of gamma radiation is necessary to understand the changes in the electrical and mechanical insulation properties of insulating materials, for its application in radiation environments. In gamma radiated samples carbonyl groups were found to be increased from the FTIR studies due to degradation of the nanocomposite. The dielectric properties of the nanocomposite materials are studied using the Dielectric relaxation spectroscopy (DRS) and found that the real relative permittivity is increased with radiation. A slight increment in the imaginary relative permittivity and tan delta is observed in the irradiated sample. Water diffusion studies show an increment in the diffusion coefficient with gamma radiation. Dynamic mechanical analysis (DMA) is performed to understand the mechanical behaviour of the materials. A decrement in activation energy and glass transition temperature with gamma radiation, is noticed.	Janjanam Naveen
Effect of Graphene Nanoplatelets (GNP) on the Dielectric and Thermal Properties of Polystyrene (PS)/Polyvinylidenedifluoride (PVDF) Blends	Polymer films are of much importance in the development of capacitor technology because of their unique properties such as high breakdown strength, good stability and economic viability. The disadvantage of low dielectric constant for polymers can be overcome by incorporating various fillers into them. In this study, polystyrene (PS) blend with 50 volume % polyvinylidenedifluoride (PVDF) was prepared and graphene nanoplatelets (GNP) in different weight % (0 to 15) were added to this blend to prepare PS/PVDF/GNP nanocomposites. The preparation of blend and its nanocomposites was carried out using melt mixing technique followed by hot pressing. Thermo gravimetric analysis and differential scanning calorimetry studies indicated that the nanocomposites exhibited better thermal stability than the blend. Dielectric properties of nanocomposites were measured at room temperature in the frequency range of 10 ¹ to 10 ⁶ Hz using a dielectric impedance analyzer. Dielectric constant of PS/PVDF blend was found to increase with increasing GNP loading. For PS/PVDF-50 volume % blend with 15 weight % GNP, dielectric constant as high as 66 and dielectric loss of 0.26 were obtained at 100 Hz. By incorporating GNP in PS/PVDF blend, the dielectric constant was enhanced and these nanocomposites can be a potential candidate material for capacitor applications.	N. Kumar

Effect of Large Mechanical Stress on Electrical Tree Characteristics of Silicone Rubber	<p>Silicone rubber (SIR) is widely used in the field of high-voltage cable accessories insulation due to its excellent electrical properties. In order to fit closely with the cable, the high-voltage cable accessories adopt the installation method of pre-expanding and maintain the expanding state in the long-term operation of the cable. The SIR is deteriorated by the circumferential mechanical stress, which is easy to lead to electrical tree and finally cause breakdown fault. At present, because the steel needle electrode is easy to form gas gap with the insulating material which results in the error of electrical tree experiment under the large deformation, the research on mechanical stress is mainly focused under 30% deformation, which is far less than the actual diameter expansion ratio of 45%. In this paper, in order to approach the actual working state of the insulation material of accessories, the initial voltage and morphological characteristics of SIR electrical tree under large tensile ratio of 0%, 25%, 45% and 60% were studied. In order to avoid the stress concentration at the tip of the traditional steel needle electrode, a new semi conducting needle electrode was designed and successfully manufactured, and a real-time observation system of electrical tree under power frequency was built. The results showed that the initial voltage of semi conducting needle electrode was higher than that of traditional needle electrode under the same tree initiation condition. With the increase of tensile mechanical stress, the initial voltage decreased from 15.30kV to 14.33kV, and the electrical tree tended to grow in the direction of stress application. Combined with the test results of DSC and TGA, it can be seen that the "melting point" and the temperature of maximum thermogravimetric rate increased first and then decreased with the increase of tensile ratio. On the whole, the physical crosslinking of silicone rubber was destroyed, some molecular segments cracked, the free volume inside the material became larger, the electrical tree was more easily induced, and the electrical tree resistance of the material decreased.</p>	Jiaxing Weisun
Effect of Static Floating Particle Shapes on Partial Discharge Characteristics in Mineral Oil	<p>The existence of metal contaminants can reduce the performance of transformer oil by leading to partial discharge or even complete breakdown. Applied electric field will make particles move or even may float in the insulation. Many studies have been made to observe free moving particles effect on electrical performance of transformer oil. In this work, investigation on floating metal particle effect on partial discharge characteristics of mineral oil was conducted. The metal particle was artificially floated between 10 mm gap of plane-plane electrodes using a plastic stick. Two different shapes of particle but having similar volume, which were 2 mm diameter of ball and 2.8 mm length of cylinder with 1.5 mm diameter, were fabricated from copper material. In addition, the particle was positioned into three different points, which were having contact with electrode, floating in the vicinity of electrode, and floating near the gap center. Then, both electrodes system and floating particles were put in new mineral oil. Partial discharge measurements and observations were carried out under AC voltage. The results showed that both particles generated slightly different partial discharge pattern and more intense when placed near the electrode. It is expected that local field enhancement around the particle and the distance between the electrode and the particle play key role on the phenomena. It can be concluded that partial discharge characteristic of the particle was quite different with the floating particle position.</p>	Daniar Fahmi
Effect of the Interphase and Agglomeration on the Tensile Properties of Epoxy/Alumina Nanocomposites	<p>Tensile properties of the epoxy nanocomposites is very much dependent on the interphase properties and agglomeration of nanoparticles. To analyze the interphase and agglomeration effect, epoxy/alumina nanocomposites were prepared with different content of alumina nanoparticles and its Young's modulus were analyzed using proposed theoretical model and adopting lognormal distribution characteristics. Agglomeration was more dominant at higher content of nanofiller. Agglomeration and effective Young's modulus decreased with the increment in the agglomerate size and their lognormal distribution curve's peak shifted to higher value for higher wt% of alumina nanofiller.</p>	Neel Mani
Effect of Thermal Aging on Direct Current Integrated Charge Characteristics of XLPE Cable Insulation	<p>The cross-linked polyethylene insulation of power cables under multiple stresses will age and deteriorate, and eventually cause insulation failure, which threatens the reliability of transmission lines. In this contribution, based on Direct Current Integrated Charge method, the performances of XLPE under thermal aging are investigated. The results show that the charge minimally injects into the unaged XLPE insulation, and the charge injected behavior intensifies with the thermal aging time. Thermal aging treatment results in greater relative permittivity, volumetric conductivity, and absorbed charge of XLPE insulation. The permittivity of the aged XLPE insulation gradually increases by 18.24%, whereas the conductivity rises by 14.48 times, and the absorption charge shoots up by 18.03 times. It is conducted that the enhancement in charge injection and the acceleration of charge accumulation reflects the cable insulation thermal aging intensified.</p>	Heyu Wang
Effect of Titanium Oxide Nanofiller on the Electrical Properties of Polypropylene Nanocomposites for HVDC Insulation	<p>Polypropylene (PP) is considered as a potential insulation material in high voltage direct current (HVDC) as it possesses excellent thermal and electrical properties. This paper aims to investigate the effect of titanium dioxide (TiO₂) nanofiller on the DC breakdown strength of PP nanocomposites. TiO₂-2 was synthesized in laboratory using Sol gel procedure. PP nanocomposites were prepared by incorporating 0.5 wt%, 1 wt% and 3 wt% TiO₂ using melt blending. The crystallinity and morphology of the synthesized nanofiller are investigated using X-ray diffraction (XRD) and field emission scanning electron microscopy (FE-SEM). The dielectric breakdown tests revealed that PP containing TiO₂ exhibited lower breakdown strength compared to neat PP. Possible mechanisms governing these changes are discussed.</p>	Muhammad Adnan

Effect of Trap Property on Charge Transport Parameters of BaTiO ₃ /Polyimide Nanocomposites	Polymers and their nanocomposite films are quite attractive as dielectrics for energy-storage capacitors. To develop advanced polymer nanocomposites with high breakdown strength and large charge density, the breakdown mechanism must be further clarified. In this paper, the effect of trap property on the charge transport parameters of BaTiO ₃ /polyimide nanocomposites (0~50 wt%) was studied. The carrier mobility and mean free path were extracted from the surface potential decay experimental results and the bipolar charge transport simulation results, which are respectively in the range of $6.2 \times 10^{-15} \sim 2.8 \times 10^{-14} \text{ m}^2 \cdot \text{V}^{-1} \cdot \text{s}^{-1}$ and $1.44 \sim 2.73 \text{ nm}$. The results show that, with the increment of average trap depth ($0.44 \sim 0.85 \text{ eV}$), which is defined to describe trap property more clearly, the mean free path decreases linearly and the carrier mobility decreases exponentially. The effect mechanism of trap property on the mobility and free path was also discussed.	Jiasheng Ru
Effect of UV Ageing on Thermo-Mechanical Properties of Ethylene-Vinyl Acetate Nanocomposite Encapsulant	Photovoltaic (PV) modules are used in outdoor and affected by ultraviolet (UV), heat and humidity which have high impact on the properties of the EVA encapsulant and cause yellowness, delamination and degradation of the material which further effects on the performance and service life of PV modules. This paper addresses the effect of UV aging of ethylene-vinyl acetate copolymer (EVA) with three different nano zinc oxide (n-ZnO) contents (0.05, 0.1, and 0.15 wt%) was performed in a xenon arc source chamber. Pure EVA, 0.05, 0.1, and 0.15 wt% of EVA/n-ZnO nano composites were prepared by solvent casting method using toluene as solvent. The prepared samples were exposed to UV light generated 0.51 W/m^2 irradiance from a xenon lamp at 340 nm wavelength for 1000 hours. The effect of UV ageing on thermal, mechanical and electrical properties of EVA nanocomposite encapsulant has been investigated. Thermal conductivity was studied at room temperature (25°C) and at elevated temperature of 50°C for before and after ageing samples. Tensile strength and elongation were conducted to check the mechanical properties after ageing. Water contact angle measurement was conducted to check the wettability of the encapsulants before and after ageing. It was observed that 0.1 wt% of EVA/n-ZnO nano composite retains better physical, mechanical and electrical properties.	Moumita Naskar
Effects of Graphene Coatings on Hindering Space Charge Injection in Epoxy Resin	The reliability of epoxy resins (and dielectrics in general) employed for HVDC applications is significantly affected by space charge accumulation in the insulating material. Several methods have been tested to limit the injection and accumulation of space charge. In this work, planar specimens featuring graphene coatings were tested. Measurements of space charge accumulation, conductivity and permittivity at different temperatures (from 30°C to 60°C) and fields (from 30 kV/mm to 50 kV/mm) were carried out on epoxy specimens with and without coatings. Results show accumulation of space charge for low fields and temperatures in the reference specimens, while a reduction can be noticed with a layer of graphene coating. On the other hand, at higher fields or temperatures, the effect is reversed.	Paolo Seri
Electric Field and Potential Changes Studies on Cast-Resin Dry-Type Power Transformer Having Misalignment	The cast resin dry type (CRDT) transformer is free maintenance during services, however, it is necessary to check the CRDT condition during manufacturing and installation to prevent any defects that give an impact on its service period. In this work, a CRDT sectional body was modeled and analysis on the pattern of the electric field and potential distribution in CRDT having misalignment was done using finite element software. The objective of this project to investigate the changes in the electrical field distribution inside the sectional body due to the above faults. The simulation was performed in HV winding for the ideal condition and when faults occurred. The electric field distribution and the electrical potential was plotted in a graph and certain condition was applied to the winding in the transformer to further analyses the pattern of the graph. The research found the highest changes of electrical potential is during misalignment faults with the increment of 11 kV compared value compared to ideal.	Norfadilah Rosle
Electric Field Calculation and Optimization of PLC Reactor in UHV Indoor DC Yard	PLC reactor is a tower-type filter equipment in indoor DC yard consisting of segmental grading ring, supporting insulators, flange, winding coil and so on. Comparing with outside DC yard, indoor DC yard has more strict requirements to uniform electric field for shielding device, due to the compact layout of filter equipment and grounding potential of roof and wall. So, it is necessary to analyze the characteristic of potential and electric field distribution of grading ring of PLC reactor. In this paper, an original $\pm 1100 \text{ kV}$ indoor DC yard model is built and analyzed with finite element method. The sub-model technique is used to calculate the surface electric field distribution on the surface of PLC reactor and the influence of different structure parameters of grading ring. According to the calculation results, the structure parameters were adjusted and separately adopted tower type and squirrel-cage type grading ring. After the optimization, the maximum surface field strength of the grading ring meet the control value 1.2 kV/mm . The calculation results could provide valuable references for the design of UHVDC filter capacitor tower.	Yiyu Guo

Electric Field Distribution Considering the Byproducts Inhomogeneity of Crosslinking Insulation in HVDC Cable	Crosslinking byproducts are inevitable in XLPE cable crosslinking process, and will affect the DC dielectric properties of cable insulation and cause the electric field distortion. It is of great importance to effectively control the cleanness and eliminate the byproducts during crosslinking. In this paper, the byproducts contents of degassed HVDC cable insulation and undegassed HVDC cable insulation are analyzed by using the infrared spectrometer. It is found that after degassing the byproducts content decreases, while the standard deviation of radial distribution of byproducts increases 144% at most. Then, the DC conductivity at 10~50 kV/mm and 30~70 °C is measured for cables insulation. Result shows that the DC conductivity decreases but the standard deviation of logarithm of XLPE insulation conductivity increases 400% at most after degassing. Moreover, the electric field distribution has been simulated in XLPE insulation of the HVDC cables with different degassing periods. After degassing, the maximum electric field strength increases from 35.9 kV/mm to 40.4 kV/mm under 1.85U ₀ and full load condition. The results show that the inhomogeneity level of byproducts have a significant impact on electric field distribution of XLPE cable insulation, which should be taken into consideration in HVDC cable manufacture.	Li Fei
Electric Field Distribution in HVDC Cable Joint in Non-Stationary Conditions	Accessories such as joints and terminations represent a weak point in HVDC cable systems. Indeed, the DC field distribution is intimately dependent on the thermal condition of the accessory and on material properties. Moreover, there is no available method to probe charge distribution in those conditions. In this work, the field distribution in non-stationary conditions, both thermally and electrically, is computed considering different insulating materials assembled in a same geometry, with focus on the tangential field distribution. We show that the position of the maximum field varies in time in a way that is not easy to anticipate. The work points to the need of precise data on materials conductivity and to the need to probe field distribution in 3D.	Gilbert Teyssedre
Electric Field Distribution in Power Cable with Nano and Micro Filler with High and Low Permittivity	This paper shows a comprehensive comparison study between Nano components and Micro components for high voltage power lines insulation depends on polymers such as Polyethylene like Low-Density Polyethylene (LDPE) and Cross-Linked Polyethylene (XLPE). Potential incidence may happen in the power cable, which is space charge phenomena, increase in the electrical field and can lead to a breakdown in the insulator. More precisely depends on fillers' effect on electrical field distribution with different relative permittivity and size of the filler's particle in the insulation cable. Furthermore, this review implicates ample discussion regarding the impact of two materials considered as a filler material with nanometer size (100nm = 0.0001mm) and micrometer size (100µm = 0.1mm) which is zinc oxide (ZnO), borosilicate (SiO ₂). The study goal is to determine the impact of filler size, type and distribution of particles into the polymer matrix on the electrical properties such as relative permittivity, electrical breakdown and the average of the electrical field added to the structure for Nano and Micro size with fillers and without fillers are analyzed. Finally, it was concluded that the size of fillers gives a huge effect on the reduction of electric field compared to the different types of material with different relative permittivity.	Samer Wahdain; Amir Izzani Mohamed
Electric Thermal Coupling Field Calculation of GIS Conductor Joint	Various types of electrical connectors in GIS play a decisive role in the withstand voltage performance, normal load current capacity, short-circuit current tolerance and overall reliability of GIS. In order to study the electric thermal coupling field characteristics of the conductor joint under the contact finger connection mode, a three-dimensional electromagnetic heat flow coupling model of 220kV GIS conductor joint is established in this paper. The finite element analysis method is used to simulate and calculate the steady-state temperature field distribution by using COMSOL multiphysics and ANSYS-CFX, and the electric field distribution when the material performance parameters change under the influence of temperature is calculated. In addition, considering that the contact finger is affected by external factors, resulting in contact deterioration, this paper calculates the temperature field and electric field distribution of GIS conductor joint under different degrees of contact deterioration. The results show that the increase of contact resistance will cause a certain temperature rise of GIS conductor joint, and then affect the overall electric field distribution. This paper can provide a reference for the research on the heating of conductor joints in engineering.	Zhikai Li
Electrical Equivalent Circuit Simulation of Polluted RTV Silicone Rubber Coated Insulator Under Salt Fog Condition	Leakage Current (LC) identification is commonly used to diagnose the insulator's health, whether it is in good or bad condition. This paper reports the result of LC identification of polluted Room Temperature Vulcanized (RTV) coated ceramic insulator under salt fog condition. An electrical equivalent circuit of insulator was proposed to simulate the LC waveform. The simulation was done using ATPDraw software. The simulation result would be validated for its magnitude, waveform, Total Harmonic Distortion (THD), and dominant harmonic number. Several simulation case studies were conducted, which are applied voltage variation, salt fog conductivity variation, and prior to flashover condition. The results show that the insulator characteristics could be identified by analyzing the pattern of the obtained electrical parameters from each condition. The electrical properties are not much changed as the applied voltage increased. Meanwhile, the electrical properties of the insulator are affected by the salt fog conductivity. Insulators used on high conductivity salt fog will have lower resistance and a high tendency to initiate arc on the surface. Prior to flashover condition is warned by the decreasing of the surface resistance and high severity level of arcing.	Muhammad Majid

Electromagnetic Fields Characteristics from Overhead Lines, Underground Cables and Transformers Determined Using Finite Element Method	<p>Magnetic fields may have detrimental potential health effects and can be in our homes or workplaces. This study focuses on magnetic fields only as it can vary. This study is to simulate and analyse magnetic fields radiations in the vicinity of</p> <p>132 kV overhead power lines for two cases; with straight conductors and with conductors sags, 11 kV triangular straight underground cable for two cases; as 185 mm², and 120 mm² cross-sectional area at 0.9 m in depth, and for 1000, 1600, and 2000 kVA transformers determined using finite element method via ANSYS Maxwell. Also, to compare the results with the safety limits as defined in recent international standards. The results are showing safe exposure level of magnetic fields as long as the distance is respected and It is advisable that safety precautions should be taken to prevent prolong exposure of electromagnetic fields (EMF) radiation to human body.</p>	Mohammed Khaled Omar Basharahil
Evaluation of the Impact of Initial Thermal Aging on the Performances of the Methyl Ester/Paper Composite Insulation	<p>Oil immersed transformers are essentially used for electric power transmission. In order to improve the current safety level of distribution and power transformers, natural esters have been proposed as a reliable solution. According to various recent studies, the use of natural esters can extend the operating time of the solid insulation as compared to the use of mineral oils (MO). To reduce their viscosity, natural esters are transesterified to produce methyl esters with a kinematic viscosity below 50 centistokes. Up to date, very few literature data is available on the aging of the methyl ester/paper insulation. Hence, the aim of this work is the improvement of the understanding of the influence of thermal aging on the performances of the monoesters/paper mixed insulation. Firstly, we explain the elaboration and performance analysis processes of monoesters of palm kernel and castor oils. Then we present the aging procedure; the oil/paper composite insulation was aged during 100 hours at 110°C. Finally, we show the results of the analyses performed. Three analyses were realized, namely the determination the Total Acid Number (TAN) based on the standard ASTM D974, UV-visible spectroscopy according to the standard ASTM D6802 and finally the Breakdown Voltage (BDV) of the insulation paper based on the standard ASTM D149. For comparison, the same analyses were performed on the mineral oil/paper complex. In view of the results obtained, the excellent dielectric of monoglycerides can be confirmed.</p>	Gerard Ombick Boyekong
Fault Diagnosis of the External Insulation Infrared Images Based on Mask RCNN and Perceptual Hash Joint Algorithm	<p>Recently, infrared technology is increasingly used in condition monitoring of external insulations, e.g. bushing, reactor and potential and current transformers in substation. Even through the infrared technology can detect the failures of external insulation due to overheating in fast response time. However, the massive infrared images need to be manually analyzed by human for fault classification, which is a very time and consuming task. There are also technical trials in applying intelligent image recognitions technology for sorting out infrared images, but these smart technologies are mainly based on machine learning framework suitable for shape recognition and only very few types of faults can be automatically figured out. In this paper, an improved automatic fault diagnosis method was designed based on Mask Region convolutional neural network (Mask RCNN) for infrared image segmentation combined with perceptual hash algorithm for fault characteristic recognition. This intelligent method consists of three steps, i.e., the normalization of infrared images according to grayscale, the fault region detection of infrared images by using Mask RCNN and the collection of fault spectrum through the similarity recognition by perceptual hash. With the proposed joint algorithm on infrared images for external insulation with condition in known, it is confirmed that the accuracy of fault recognition reaches more than 90%. This automatic fault detection algorithm provides a desirable solution for the field application of infrared image-based diagnosis for external insulations.</p>	Wenbin Tang
Fault Identification in Power Transformers Using Dissolve Gas Analysis and Support Vector Machine	<p>Transformer faults need to be identified accurately at the early stage in order to ease the maintenance of power transformer, reduce the cost of maintenance, avoid severe damage on transformer and extend the lifespan of transformer. Dissolved Gas Analysis (DGA) is the most commonly used method to identify the transformer fault in power system. However, the existing transformer fault identification methods based on DGA have a limitation because each method is only suitable for certain conditions. Thus, in this work, one of the artificial intelligence techniques, which is Support Vector Machine (SVM), was applied to determine the power transformer fault type based on DGA data. The accuracy of the SVM was tested with different ratio of training and testing data. Comparison of the results from SVM with artificial neural network (ANN) was done to validate the performance of the system. It was found that fault identification in power transformers based on DGA data using SVM yields higher accuracy than ANN. Therefore, SVM can be recommended for the application of power transformer fault type identification in practice.</p>	Hazlee Azil Illias
FRA Indicator Limit for Faulty Winding Assessment in Rotating Machine	<p>This paper presents a study on the applicability of frequency response analysis (FRA) for diagnosing faulty stator winding of a three-phase induction motor. Initially, two different faults were simulated on a 2.2 kW induction motor. FRA tests were performed on the units before and after the fault to observe the influence of the fault on the response. Three statistical indicators were used to compute the amount of changes between responses. This was done on three different frequency ranges, which are low, medium, and high regions, as each region was governed by different winding parameters, namely winding resistance, inductance, and capacitance, respectively. Consequently, benchmark limits for two indicators, ASLE and CC were proposed for the estimation of normal and faulty winding conditions. Finally, the result also presents FRA measurement on 6.6 kV, 1700 kW induction motor, which clearly indicates the perfect correlation between responses, hence normal winding.</p>	Mohd Fairouz Mohd Yusof

Harmonic Currents Generated by MV Modular Converters and Thermal Insulation Aging of Polymeric Cables	<p>The trend towards higher voltage and current, thus specific power, and efficiency for converters designed for electrification transport (automotive, ships, aircraft) is going to introduce new and important challenges for electrical insulation system design, from overheating to partial discharges. Insulating materials could be available, or specifically designed, to match the increasing specific-power trend. To this aim, accurate calculation of the thermal and electrical stresses an insulation must withstand, is a fundamental starting point. It is worthy to recall that an while an increase of operating temperature, T, of 10° can half thermal life, an increase of electrical stress, E, of 10% with respect to design field can reduce electrical insulation life by 5 times. While thermal endurance is described by an exponential (Arrhenius) law, electrical life tends to fit to an inverse power model, which is linear in log-log coordinate system, with slope that is inversely proportional to the so-called voltage endurance coefficient, VEC. Due to the type of life law and the typical values of VEC of electrical insulating materials, similar per cent variation of stress translates into much more significant life reduction for electric than for thermal stress. Aging process can be dramatically accelerated, resulting in much premature failure with respect to design life, if highly-energetic phenomena are triggered, such as thermal instability and partial discharges.</p> <p>This paper focuses on the effect of high frequency voltage and current content present, at both AC and DC side, in the polymeric cables connecting MV power electronic modular converters, using fast switches and high modulation frequency. In particular, the additional dielectric losses caused by the high-frequency harmonic content in the common mode voltage and currents, and the consequent insulation temperature rise with respect to the insulating material thermal class, or temperature index, is estimated for typical dielectrics used for MV applications, that is, XLPE and EPR. The effect of the temperature rise due to harmonic currents on cable thermal life is evaluated, showing that good design and effective harmonic suppression strategies can limit dielectric losses and relevant overheating to values which may not be significantly shortening thermal life of cables.</p>	Gian Carlo Montanari
Hydrophobicity and Surface Microstructure Changing Regulations of HTV Silicone Rubber Under Corona Accelerated Aging	<p>This paper built a constant temperature and humidity corona aging platform to explore relation between hydrophobicity and the surface micro-structure of high-temperature vulcanized silicone rubber. The hydrophobicity /recovery test, Fourier Transform infrared spectroscopy (FTIR), Trap density, trap energy level test and SEM test were applied to analysis the surface structure and the surface element distribution. The mechanism of corona aging and hydrophobicity loss and recovery is further discussed.</p>	Ya'nan Peng
IDC Sensor for Monitor Ageing of Power Cable - Simulation	<p>Polymeric insulated cables play an important role in electric power transmission especially for energy transfer for offshore windfarms. The assessment of cable status and condition becomes a vital part of energy security. Cable insulation deteriorates over the service period due to the combined thermal and electrical stresses. It is difficult to predict due to variable loadings, therefore, it is crucial to be able to monitor the insulation status of the cables and joints. It has been reported that the interdigital capacitance (IDC) sensor has a potential to measure capacitance and its variation of the cable. In this paper, the performance of IDC sensor has been simulated based a model cable. Different designs were tested and an optimal arrangement was selected to further study the influence of insulation ageing by varying the permittivity of the insulation. It has been found that it is possible to sense the variation of permittivity. Considering the structure of IDC, it may be more useful for the cable joints where the most failures take place in the service.</p>	George Chen
Identification and Classification of Incipient Discharges in GIS Adopting Machine Learning Techniques	<p>In the present study, the PD due particle movement, surface discharge, floating particle and corona defect in GIS are detected by adopting UHF sensor. The FFT analysis of UHF signal for all four defect shows the dominant frequency around 1GHz. To identify and classify the various PD source in GIS, multi classifier machine learning techniques are adopted. The spectral data of the obtained UHF PD signals for each of the four types of discharge signals were obtained after performing the Fast Fourier transform of the UHF signals frequency data. Random Forest and K Nearest Neighbour classifiers are adopted in the present study for PD classification. In order to improve the performance of RF classifier, the inbuilt hyperparameters are optimized for a better performance and accuracy, using a technique called Random Search CV. The modified Random Forest classifier showed significant improvement in the classification accuracy.</p>	Sneha Jayaganthan
Impact of Gamma Irradiation on Surface Potential and Thermo-Mechanical Properties of Epoxy Micro-Nanocomposites	<p>Use of epoxy based insulators in nuclear power plants and space equipment is gaining importance in recent years. Epoxy micro-nanocomposites reinforced with micro-sized silica fillers and IXEPLAS nanoparticles have been subjected to gamma irradiation of different dosages (4 kGy and 8 kGy). Surface potential decay studies reflected a marginal reduction in the initial surface potential along with increment in surface potential decay rate. Increase in carrier mobility is noticed with increment in gamma irradiation dose. From the Fourier-transform infrared spectroscopy (FTIR) studies, increased oxidation level and degradation as irradiation dosage increases was noticed compared to virgin specimen. As the irradiation dosage increases the thermal stability tends to decrease due to radiation induced degradation reactions. From dynamic mechanical analysis (DMA) results, the reduced glass transition temperature and reduced activation energy is observed in gamma irradiated specimens compared to virgin specimens.</p>	Pabbati Vinod

Implementation of Self-Organizing Map and Logistic Regression in Dissolved Gas Analysis of Transformer Oils	<p>The occurrence of incipient faults in a transformer is attributed to several types of thermal, electrical, chemical and mechanical stresses which deteriorate the transformer insulation and cause ageing. Thus it is of utmost importance to carry out periodic maintenance of this electrical equipment as well as to develop a method that would provide an early stage diagnosis of the transformer insulation abnormalities. Dissolved Gas Analysis(DGA) is widely considered to be a powerful approach to detect the incipient faults in oil-immersed transformers. But shortcomings in the conventional methods based on DGA are nowadays addressed by various intelligent techniques with enhanced accuracy of fault detection. This paper introduces the implementation of machine learning and proposes a method which utilizes Self-Organizing Map(SOM) and Logistic Regression(LR) to detect and predict the faults occurring in a transformer based on DGA. The DGA dataset used in this paper consists of a variety of cases with six types of faults. The proposed model presents the interpretation of this dataset using clustering analysis by SOM and the model performance parameters are found to be superior to other machine learning algorithms as well as traditional methods. Unlike other fault diagnostic methods which mostly implement single classifiers, this technique uses clustering of the DGA data followed by the application of a classification algorithm which demonstrates high accuracy and reliability of fault identification.</p>	Chandrima Saha
Influence of Cellulose Fiber Contamination and Bridging on Breakdown Voltage of PFAE Under Lightning Impulse Stress	<p>This research investigates the effect of cellulose fiber contamination and its bridging skeleton on the breakdown voltage of Palm Fatty Acid Ester (PFAE) under Standard Lightning Impulse Voltage (SLIV). An industrial microcrystalline cellulose fine fiber (particle size: 20 μm,) is selected as artificial contaminants with 0.004wt% fiber concentration level. A single stage of test transformer completed with auxiliary circuit is generated to deliver a standard impulse waveforms of 1.2/50 μs and it is applied according to the outlined of IEC60897 to obtain breakdown voltage test. The cylindrical test cell fitted with a needle-plane configuration of 0.5mm gap electrodes are utilized to create the strong non-uniform field crossed the gap. A 10kV DC power supply is connected between the electrodes in order to create and retained the cellulose bridge skeleton artificially. The microscope fitted with the digital camera responsible to monitor and capture the optical images of bridging formation between the electrodes gap. The breakdown voltage obtained from the experiment is analyzed using Weibull Cumulative Breakdown Probability. In this analysis, the Clean Oil is used as the reference. Based on the experimental results, the cellulose fiber contamination has reduced nearly 3% breakdown voltage of PFAE. The cellulose fiber contamination with bridge formation is prominently influencing lower breakdown voltage to 16% lower than clean PFAE oil.</p>	Sarizan Saaidon
Influence of SiO ₂ and ZrO ₂ Nanocomposite on the AC Breakdown Strength of Cross-Linked Polyethylene (XLPE)	<p>Evolution of high voltage (HV) cables has increased significantly over the last decade due to emerging of HVDC applications. Thus, polymer nanocomposites become one of the main research areas for exploring the potential of insulating materials in terms of dielectric strength enhancement. This is due to many convincing results of nanocomposites capabilities reported by researchers. For this, this work explores the influence of Silicene Dioxide (SiO₂) and Zirconium Oxide (ZrO₂) on the dielectric strength of Cross-linked Polyethylene (XLPE). The mixture between the filler and the base polymer is one of the major factors for improving the characteristic of the nanocomposites. The unfilled XLPE and nano-filled (1wt%, 3wt%, 5wt% and 10wt%) XLPE are prepared from powder to pellets using extrusion and cross-linking processes. These methods have been used to prepare nanocomposite samples into thin layers of 1mm. The samples are tested under AC breakdown performance of unfilled and nano-filled XLPE according to ASTM D149 standard. The results observed an improvement of breakdown performance at the low usage of nanofillers. A comparison based on SiO₂ and ZrO₂ has shown different behaviours. Therefore, this study investigates the effect of these nanofillers on the performance of nanocomposites under both AC performance.</p>	Muhamad Safwan Abd Rahman
Insulating Properties of Eco-Friendly Natural Esters Derived from Non-Edible Vegetable Oil	<p>Preparation of natural ester from non-edible vegetable oil (Pongamia Pinnata) is carried out in two stages; in the first stage removal of free fatty acids is done by acid treatment, and trans-esterification is done in second stage. The formation of natural ester is confirmed by GC-MS as per EN14103 and all of them have above the established (>99%) level. The amount of unsaturation is confirmed by iodine number as per EN14111 and the chain length (or average molecular weight) is confirmed by saponification number. Natural ester is characterized by critical parameters such as kinematic viscosity, acidity, interfacial tension, flash/fire point, breakdown voltage, tan-delta before and after adding three different types of anti-oxidants. The obtained results will be report in this paper. Natural ester with anti-oxidant shows improved insulating properties than without anti-oxidant. An objectives of the paper is to find alternate insulating fluids with eco-friendly from non-edible vegetable oil to overcome the existing environmental issue raised by conventional fluid (Mineral oil) for transformer. An advantage of chosen non-edible vegetable oil is that; to utilize the renewable resource of non-edible vegetable, it does not compete on the food market, and environmental friendly.</p>	Gnanasekaran Dhorali

Integration of Duval Pentagon to the Multi-Method Interpretation to Improve the Accuracy of Dissolved Gas Analysis Technique	Dissolved Gas Analysis (DGA) is the most effective method for detecting the gas abnormality in transformer insulating oil due to the thermal and electrical stresses received when the transformer operates. Various DGA interpretation techniques have developed rapidly. Each has its advantages and disadvantages. However, it is possible to misinterpret one oil sample. Besides that, the engineer's experiences and knowledge still have the most significant role in predicting the DGA sample subjectively. The multi-method interpretation technique is a method that is quite relevant to cover various techniques in increasing consistency and accuracy rate. This paper proposes Duval Pentagon Method (DPM) integration as the recent interpretation of the multi-method techniques. The method was developed based on IEC 10 TC database, then validated with 52 samples from previous researches. The results showed that there was a significant increase in accuracy and consistency rate with the multi-method using DPM integration.	Heri Sutikno
Investigating Surface Condition of Corona Aged Epoxy-Al Nanocomposites by Adopting Wavelet Transform	The effect of corona exposure on surface condition of epoxy Aluminium (Al) nanocomposites has been analyzed in the present study. Multi resolution signal decomposition (MRSD) analysis has been performed by employing fourth order Daubechies wavelet (db4) function, to analyze the surface profile of the test specimens. The standard deviation of approximation and detail coefficients at each decomposition level are found to be lesser for 10 wt.% epoxy Aluminium nanocomposite specimen. Surface roughness factor has reduced after Al filler inclusion up to 10 wt.%. Corona exposure has significantly affected the surface profile of the test specimens resulting in the increment of surface roughness factor at each decomposition level.	Myneni Suresh Babu
Investigation of BaTiO ₃ and TiO ₂ Based Nano-Fillers on the Space Charge and Electrical Strength of Cross-Linked Polyethylene (XLPE)	Titanium element has been used in different applications such as aerospace and electronics. However, the potential benefits of this element in the electrical application are yet to be explored. Thus, this paper is interested to study the potential of Titanium for insulating materials in terms of dielectric strength enhancement. As Titanium is a non-magnetic and a poor conductor of electricity, it may produce improvement to the characteristic of nanocomposite polymers. Hence, this work explores the effect of Barium Titanate (BaTiO ₃) and Titanium Oxide (TiO ₂) on the dielectric strength of Cross-linked Polyethylene (XLPE). These methods have been used to prepare nanocomposite samples into thin layers of 1mm. The samples are tested under AC to test the breakdown performance of unfilled and nano-filled XLPE according to ASTM D149 standard. The space charge formation has also been measured across the samples in order to investigate charge formation inside the samples. The results observed positive results in terms of space charge formation and breakdown strength. However, the optimum amount of nano-fillers need to be carefully determined in order to produce improvement. A comparison based on BaTiO ₃ and TiO ₂ has shown different behaviours on both characteristics. The study has shown a promising effect of the nanoparticles in XLPE nanocomposite.	Muhamad Safwan Abd Rahman
Investigation of Transformer Oil Properties with Advanced Multidimensional Methods	Power Transformers are basic elements in electric power systems. In case of an unplanned outage due to failure at the transformer not only to the costs reflected to the repair costs but also the costs related to interrupted power supply or the stop of production will occur. Therefore, it is necessary to assess the condition of power transformers and to identify risks early. For this, different diagnostic techniques were developed. In this context oil test, such as the measurement of the oil properties and the DGA, are well established and easy to perform methods. With the help of the insulation oil properties, possible aging of the oil can be identified and the remaining capability withstand dielectric stresses can be investigated. Because some parameters indicate the same properties (such as ageing state) it could be possible that there are pairs or groups of parameters, which give redundant results. Therefore, in this contribution it is investigated if a correlation between different insulation oil properties can be found. Furthermore, it was investigated if relationships between insulation oil properties and DGA results can be found. Both investigations were based on a huge number of oil test results of real transformers of different voltage levels, applications, age, and manufacturers.	Sebastian Schreiter
Investigation on Partial Discharge Localization in Oil Based on Time of Arrival Method	This paper present a PD localization study based on acoustic PD signal. First, the PD localization was developed utilizing Acoustic Emission Sensor (AES). A test tank was fabricated whereby the PD was generated through needle-sphere electrode configuration. The electrical PD was measured through Impedance Matching Circuit (IMC). Based on the measured acoustic PD signal, the localization was carried based on Time of Arrival (TOA) method. The time between electrical and acoustic PD signals was used to determine the time of travel. It is found that the PD can be approximately localized through the AES system and TOA approach. At least 2 AES signals intersect at the PD location in the current study.	Ahmad Hafiz Mohd Hashim

Investigation on the Effect of the Cross-Section of Insulators on the Radial Discharge Distribution of Creeping Discharges	<p>Divergent electric fields on the solid/liquid interfaces of oil-filled assets can lead to the propagation of the creeping discharges over the interface. Therefore, it has become an interest of the researchers to analyze creeping discharges in a laboratory environment for the design optimization of high voltage assets. Over the past decade, studies have been carried out to analyze creeping discharges using both experimental and simulation models. It has been observed that the shape of the interface effects on the propagating pattern according to simulation and experimental studies. This work is aimed at the study of the effect of the shape of the cross-section of the insulators on the radial discharge distribution of creeping discharges using a test apparatus and a simulating model. The test setup is based on a point plane electrode system and required solid/liquid interfaces are created by immersing the prepared insulating samples with two different cross-sections in the dielectric liquid. A model is formulated in a Laplacian field and the pattern propagates in a stepwise manner depending on the electric field distribution of the area enclosed by the boundaries of different shapes. It can be seen that the maximum value of the radial discharge distribution of the pattern can be observed in-between the center of the pattern and the edge of the interface and that point moves toward the boundary of the insulator as the applied voltage increases. It can be seen that the distribution corresponding to the square cross-section is higher than that of the circular cross-section around the center of the propagating patterns while simulation studies show that radial discharge distribution is independent of the shape of the cross-section. The study shows that experimental studies regarding the effect of the shape of the material cannot be replaced with simulations even if it may provide a theoretical foundation to analyze creeping discharges. However, the work reveals that it is better to consider the total area of the pattern instead of the distribution of the pattern to evaluate the damage done by the discharge for different kinds of insulator shapes.</p>	W. E. P. Sampath Ediriweera
Investigation on the Relationship Between Failure Rates and Health Index of Distribution Transformer Population	<p>In this paper, a study is carried out to investigate the relationship between failure rate and Health Index (HI) of the transformer population based on condition monitoring information. In total, 3192 oil samples from 370 transformers with age ranging from 1 to 25 years were analysed in this study. First, the HI and failure rate of transformer was computed based on yearly individual condition monitoring data of the oil samples. Several parameters were measured such as oil quality, dissolved gases, furanic compounds and age. The HI of transformers was determine based on scoring and weighting method while the failure rate of transformer was determined based on relative risk method. Next, the average HI and failure rate for each age was computed and the relationship between the HI and failure rate were obtained based on two-parameter exponential function model. Based on the study, it is found that the relationship between failure rate and HI of the transformer population is almost exponential. The failure rate increase almost exponentially as the HI decrease to around 55%.</p>	Nor Shafiqin Shariffuddin
Localization with Phase Resolved Partial Discharge Measured with High Frequency Current Transformer	<p>Non-intrusive localization of partial discharge (PD) is an important step in the process of condition monitoring (CM) work. Localization aims to minimize the interruption to the supply grid network security, while performing the investigation and confirmation of the PD source. SP PowerGrid (SPPG) has the medium voltage (MV) network of metal-clad gas-insulated switchgears (GIS) with underground cables. With the provision of GIS individual phase cables accessible, high frequency current transformer (HFCT) is clamped to the split core cable to measure the PD conducted currents in the high frequency (HF) range and below. This paper demonstrates with case studies how CM engineers can apply HFCT at GIS and understand the basic of phase-resolved PD (PRPD) information, to narrow down the asset with the single or multiple PD sources. The localization method is simple yet practical by fully utilizing the propagation and cross-talk characteristics of PD.</p>	Kai Xian Lai
Measuring Thermal Diffusivity of Thin Films in Thickness Direction	<p>Thin polymer films are widely used in different fields especially electrical and electronic industry, due to their good electrical insulation. The accurate thermal parameter of thin film can promote engineering thermal design and thermal management. Moreover, it is beneficial to describe the thermal characteristics of electronic devices and improve their stability and service life. Therefore, it's important to measure the thermal parameter of thin films in high accuracy. Nowadays, several different techniques for determining thermal diffusivity of materials such as Laser flash, Photoacoustic method and Mirage method may be found in the recent literature. Most of these methods can not accurately determine the thermal diffusivity for thin single-layer films. Therefore, we propose a new method base on thermal response current to achieve the measurement of the thermal diffusivity of thin film within thickness of several micrometers. A two-layer sample structure is utilized, where one of the layers acts as the detector with known thermal parameters and the other as measured film. When the heat pulse produces attenuation and dispersion after passing through the measured film and carries the thermal characteristics of the tested film to the dielectric detector, the thermal diffusivity of the sample can be deduced by analyzing the displacement current characteristics of the detector. In this paper, we detect the thermal displacement current of the detector film and analyze the time-domain characteristics of the thermal displacement current. The changing temperature distribution in the two-layer structure and the corresponding generation process of displacement current were simulated by numerical calculation, the optimal solution of the thermal diffusivity of the thin film is achieved through multiple iterations to optimize the fitting by adjusting the thermal parameter of the measured film. The thermal diffusivity measurement of the BOPP film in the thickness direction is $0.95 \times 10^{-7} \text{m}^2/\text{s}$ basically consistent with the BOPP film data provided in the literature. This method can quickly measure the thermal diffusivity in thickness direction in thin film less than 10 micrometers with high accuracy.</p>	Shijie Chen

Mitigation of Degradation in Polymers by Gamma Rays	<p>Many polymers are used for electrical insulation in many industrial facilities. In nuclear power plants, these polymers are irradiated by radioactive rays, depending on their installed places. If an accident occurs, such polymers may also suffer high-temperature steam exposure. We have conducted several experiments that aim at clarifying the effects of thermal stresses, gamma-ray irradiation, and steam exposure on various insulating polymers. A typical result obtained for silicone rubber (SiR) clearly shows that the permittivity of SiR does not become so high if it was irradiated by gamma rays to a proper dose in advance of the exposure to high-temperature steam. Another important result is that SiR exposed to steam of 200 °C for 7 days became too brittle to analyze its mechanical properties.</p> <p>In another result obtained for flame-retardant ethylene-propylene rubber (FR-EPR), we compared the surface property changes among the original unaged sample, the samples aged by the steam exposure in various conditions, those aged by the irradiation by gamma rays at room temperature, and those aged by the concurrent exposure to heat and gamma rays. The degree of the surface hardening, indicated by the indenter modulus, becomes most significant in the samples aged by the steam exposure. This shows again that the gamma-ray irradiation can mitigate the drastic change in surface property induced by the steam exposure.</p> <p>In the case of flame-retardant cross-linked polyolefin (FR-XLPO), although its degradation becomes very severe by the thermal aging at 135 or 155 °C, it can be mitigated by the gamma-ray irradiation of a proper dose in advance of the thermal aging.</p> <p>At least, the results on SiR and FR-XLPO can be understood by the assumption that the formation of proper cross-linked structures makes the samples robust compared to their initial stages.</p>	Yoshimichi Ohki
New Approach for Monitoring Contamination Level on Outdoor Insulator Based on Harmonics Components of the Leakage Current	<p>This paper presents a new and alternative approach to predict the severity of pollution by using components of leakage current LC on non-uniform polluted insulators. The LC harmonics components were measured using a new method based on wireless transmission. Laboratory tests were conducted on various pollution levels (0.05, 0.1, 0.15, 0.2, 0.25 and 0.3 mg/cm²) on 3 units string porcelain insulators under two level of voltage stress (0.23 kV/cm and 0.385kV/cm). The results of the test reported that the compare new indicator is the ratio of sum fifth and seventh frequency components to the third with the ratio of total harmonic distortion THD to odd harmonics components number n can be given as boundary for levels of pollution. According to the results of this test, the leakage current LC harmonics predictor K has a reasonable ability to determine the contamination level.</p>	Rahisham Abd. Rahman
New Thermoplastic Insulation for Track-Resistant Overhead Cables with Improved Properties	<p>Non-shielded overhead cables have been installed for a long time in different variations. This paper describes the development of a fully thermoplastic insulation system that is suitable for a 90 °C conductor temperature. This has all of the advantages of a cross-linked system, better track resistance than an XLPE insulated cable yet none of the disadvantages like a longer production process.</p>	Detlef Wald
Optimization of Grading Ring Design for Metal Oxide Arrester Using Gravitational Search Algorithm	<p>A high voltage metal oxide arrester (MOA) is used to protect power system against overvoltages. The electric field surrounding the MOA can be made uniform by installing a grading ring. It is important to have a proper way to design a grading ring with low electric field of the design. In this project, a model of 150 kV MOA was developed in COMSOL Multiphysics software. The grading ring dimensions were varied to study their effects on the electric field surrounding MOA. It was found that the grading ring dimensions strongly influence the electric field magnitude surrounding the arrester. Gravitational search algorithm (GSA) were used to obtain the optimum design of the grading ring for the MOA model. Comparison of the results between GSA and other optimization methods shows that GSA is the most suitable method to obtain an optimum design of the grading ring for MOA compared to genetic algorithm (GA), particle swarm optimization (PSO) and simulated annealing (SA). This is due to it yields the lowest electric field magnitude and has the fastest convergence.</p>	Hazlee Azil Illias
Partial Discharge and Breakdown Strength Diagnostics on Cross-Linked Polyethylene Nanocomposites Filled with Nano-Silica Powder	<p>Dispersing nanofillers into polymer matrix has the potential to improve the performance of insulating properties. The partial discharge activities and dielectric field strength are the examples of properties guaranteed to be enhanced. Cross-linked polyethylene is a type of polymer host used widely to insulate the conductor part in the application of medium and high voltage cable. The resilience of the cable commonly depends on the performance of the polymer to insulate the conduction part effectively. Nano-silica has been dispersed into the XLPE matrix with various loadings to improve the partial discharge and dielectric field strength. The loadings of nano-silica was varied to 1, 3, and 5 wt% to identify the most effective amount of fillers in improving the durability of XLPE nanocomposites. Summary of results shows that XLPE nanocomposite with 1 wt% nano-silica obtained the lowest value of maximum charge through partial discharge activities. The dielectric field strength of XLPE increased significantly as 1 wt% of nano-silica has dispersed. However, the trend was saturated when the loading was added to 3 wt%, and slightly decreased when added to 5 wt%.</p>	Norhafezaidi Mat Saman; Mohd Hafizi Ahmad

Physicochemical Characteristics and Basic Properties of the Fluorinated BOPP Surface Layer and Its Effect on Dielectric Strength	In order to promote the possible application of direct fluorination for the performance improvement of capacitor dielectric film, the commercial BOPP film was fluorinated. Surface physicochemical characteristics and basic properties of the fluorinated PP film were investigated. ATR-IR analysis shows an obvious difference in surface chemistry, and SEM observation gives direct information on the thickness and morphology of the fluorinated surface layer. Contact angle measurements and surface energy calculation show changes in wettability and surface energy by the fluorination, and surface potential measurements indicate that the fluorination led to an increase in surface conduction of the PP film. Further, DC breakdown strength measurements reveal a significant increase (by 23.4%) in DC breakdown field strength of the PP film by the fluorination.	Zhenlian An
Polarity Effect of Large Current Spikes Produced by Artificial Charge Injection from Gas Phase into LDPE Sheet	This paper presents an experimental study on spike currents possibly produced by ultra-fast charges in a low-density polyethylene (LDPE). The purpose of this study is to clarify which kinds of space charges act as the ultra-fast charges. Various kinds of ions and electrons are artificially injected into the 150- μ m-thick LDPE sheet with three-electrodes system. The sheet with evaporated-aluminum as a backing electrode was set on a grounded plane electrode. Dc high voltages (V_s and V_n) were applied to a copper mesh as a screen electrode and to a point electrode as an emitter as shown in Fig. 1. V_n is higher than V_s so that a large number of space charges are produced by the dc corona discharges in the chamber filled with air or N ₂ gas. Fig.2(a) shows relationships between the mean conduction current density and the mean applied field (V_s/d) for both the polarities. The J-E characteristics obey the well-known SCLC(space charge limited current) model. These results show that the dc component of the conduction current for the negative polarity is higher than that for the positive polarity regardless of the gas components. Relationships between the mean repetition frequency of the current spikes and V_s/d are shown in Fig.2(b). The mean repetition frequency in N ₂ for the negative polarity is much higher than that for the positive polarity. On the other hand, polarity effect in air is opposite. We measure space charge distributions in the LDPE for the above conditions by PEA method. The reason for the difference in the mean repetition frequency between the gas components will be discussed on the basis of these results.	Keisuke Yamamoto
Polarization and Depolarization Current Analysis for Field Degraded Cross Linked Polyethylene Cables	Gradual deterioration in polymeric cable insulation system, whether due to continuous applications of high voltages or ageing mechanisms, may lead to eventual cable failure and subsequent electricity disruption. This has led to the growth in need for power utility companies to explore methods to closely monitor and assess the health of cable insulation, through condition-based monitoring (CBM) exercises. Polarization and depolarization current (PDC) analysis is a non-destructive insulation monitoring method that has been widely applied to assess the health of insulation for high voltage equipment especially power transformers. This study proposes to expand on the recent interest in PDC's assessment of cross-linked polyethylene (XLPE) cable insulation degradation. It attempts to investigate the PDC behaviour by performing experimental and simulation studies on in-service field degraded XLPE cables. Comparisons between PDC measurements and simulations for 39 field cables saw matching patterns in terms of categorization by conductivity values. Based on works done by established researchers, a five level PDC based CBM categorization for cable maintenance was proposed, ranging from healthy to moderately degraded to severely degraded cable insulation conditions. Comparison between the proposed and existing PDC based CBM table of a power utility company saw a 76.92% match, suggesting that the technique can be used to ascertain cable insulation degradation.	Suhaila Sulaiman
Prediction of a Transformer's Loading and Ambient Temperature Based on SARIMA Approach for Hot-Spot Temperature and Loss-Of-Life Analyses	Hot-Spot Temperature (HST) is among the important parameters that can be used to evaluate the Loss-Of-Life (LOL) of transformers. HST can be determined through thermal modeling of which loading is one of the important parameter that needs to be obtained. This paper presents the prediction transformer's loading of a 132/33 kV, 60 MVA Oil Natural Air Natural (ONAN) transformer and ambient temperature based on Seasonal Autoregressive Integrated Moving Average (SARIMA). First, the computed loading profile was validated with the measured data. Next, the loading profile was forecasted for 1 year to evaluate the HST and LOL of the transformer. Differential model in IEC60076-7 was used to determine the HST based on the forecasted data. Based on Mean Absolute Percentage Error (MAPE), Mean Absolute Error (MAE) and Root Mean Square Error (RMSE), the best fit of SARIMA model are used to represent the transformer loading. This leads to the prediction of transformer HST that fluctuates along the 365 days and the LOL increases linearly with multiple fluctuations. It is also found that the prediction estimates the maximum HST is 66.93°C and the corresponding LOL based on predicted 1 yearly data is 666 minutes.	Najiyah Saleh
Research on a New Optical Method for Space Charge Measurement of Insulating Materials	To achieve the measurement of space charge inside insulating materials under high-frequency voltage conditions, an optical method based on stress birefringence effect is proposed. The method is expected to achieve high spatial and temporal resolutions due to its high signal-to-noise ratio, picosecond-scale excitation, and continuous wave detection by using Terahertz wave and ellipsometry measurement method. An ellipsometry system is then built to verify the key part of the proposed method. It is found that the measured signal from the balanced detector can accurately show the displacement process of actuator with different amplitudes and frequencies. The explorative research in this paper will be an important basis for the further development of the proposed optical method.	Hanwen Ren

Research on Aging Performance and Mechanism Analysis of Cross-Linked Polyethylene Wire and Cable Materials	<p>Cross-linked Polyethylene(XLPE) has been widely used in various wire and cable material, due to its excellent insulation performance and heat resistance. However with extensive using of XLPE, the better anti-aging performance of XLPE is important. In this work, Xenon lamp aging and thermal aging performance have been investigated and the aging mechanism of XLPE has been studied. Fourier Transform Infrared and Pyrolysis-Gas chromatography-mass spectrometry were used to analysis the aging mechanism of XLPE. For these samples, tensile strength, elongation at break, Volume resistivity test and Surface resistivity test were measured to clarify mechanical and dielectric properties. Results can be summarized as:(a) The volume resistivity of XLPE was still higher than $10^{14} \Omega \cdot M$ after 14 days of high temperature thermal aging. (b) The molecular chain broken of XLPE occurs on the surface first. (c) Xenon lamp aging results show that free radical reactions induced by light also promote the degradation of XLPE. (d) After xenon lamp aging, XLPE macro-molecular chain break into relatively uniform small molecular alkanes. The result provides practical and theoretical support for the production and application of XLPE.</p>	Tian Chongjun
Research on the Optimization of Grounding Methods and Power Loss Reduction Based on AC 500kV XLPE Submarine Cable Project	<p>Based on the Zhoushan alternating current (AC) 500kV cross-linked polyethylene (XLPE) submarine cable project, a method of metal sheath grounding via a low resistor, a low reactor, or a low resistor in parallel with a reactor at both terminals of the cable to reduce the power loss has been proposed in this paper. By numerically modeling the submarine cable system with the PSCAD/EMTDC software, the voltage and current distributions, and power loss on the sheath, armor and total submarine cable under three types of grounding impedors are calculated. The results show that with the increase of resistance value or inductance value, the sheath current decreases, and the armor current and sheath voltage increase, but the overall loss of the submarine cable decreases. When the submarine cable is operating under normal, short-circuit or transient conditions, in which the sheath voltage does not exceed the critical condition of these allowable values, the way that the sheath is grounded via a low resistor is the most beneficial to the power loss reduction. When the corresponding critical resistance value is 2.1 ohms at the start of cable and 1.3 ohms at the end respectively, it will reduce the power loss of cable for one phase 23.5% and the total power loss including resistors for one phase 14.2%, which is conducive to improving both the safety and operation economy of submarine cable.</p>	Xiao Du
Resistive Leakage Current Based Condition Assessment of Zinc Oxide Surge Arrester: A Review	<p>Leakage current based condition assessment is most extensively opted method to monitor the ageing and deterioration of zinc oxide surge arresters (ZnO-SA). Particularly, the resistive component of leakage current is considered to be directly related with the arrester's degradation. Therefore, the measurement of resistive leakage current is essential for the health diagnostic of the surge arrester. Several techniques have been proposed so far to extract the resistive component of total leakage current with different accuracies. But, the deficiency of a comprehensive review on the existing techniques still exists. This paper is aimed to review the resistive leakage current extraction techniques with respect to their operating principles, experimental procedures, limitations, and accuracy of the results. This study will contribute to improve the accuracy of resistive leakage current based condition monitoring of ZnO-SA.</p>	Abdullah Munir
SF6 Decomposition Under Protrusion Defect Partial Discharge	<p>The aim of this paper is to compare the decomposition characteristics of sulphur hexafluoride, using the study of decomposition by-products, under alternating current partial discharge of three protrusion defect configurations. This comparison can reveal the influence of quantity, size and material of the protrusion defect on the insulation status of GIS and demonstrate the most severe configuration by analyzing the by-products. In literature, previous researchers have shown that there is a direct relationship between the generated products and the amount of PD. In this analysis, the effect of each configuration was achieved by using the important relationship between the concentration of decomposition products and the concentration ratio of SO₂F₂/SOF₂ with the level of PD along with the stress duration. Using a coaxial gas chamber, an experimental platform was set up using various artificial protrusion defects to simulate partial discharge initiation in GIS. The applied voltage was gradually increased from the initial discharge until the breakdown over the ageing cycle. Gas samples were obtained every 18 hours and by-product gases were detected using Fourier transform infrared spectroscopy. Results show that the amount and concentration of products and the SO₂F₂/SOF₂ ratio have shown interesting trends. It is concluded that the severity of defect increases with the increase of the quantity and size of the defect. The study of the impact of protrusion, as the common form of defect in GIS, reveals the partial discharge severity in terms of produced by-product gases and their concentration are directly related to the configuration of the protrusion defect.</p>	Ammar Mahdi

Simulation Analysis and Improvement Design of Electric Field Distribution for Shielding Device in UHV Converter Station Indoor DC Yard	<p>In recent years, ultrahigh-voltage direct current (UHVDC) project has become an important direction of power system development and application. In UHVDC converter station, corona discharge may occur if the maximum electric field of metal electrode surface reaches corona electric field. The reasonable design of shielding device for different equipment in the converter station can not only effectively ensure the safety and stability operation of the system but also reduce the operation and maintenance cost. The shape and structure of different equipment are having large difference for $\pm 800\text{kV}$ UHVDC project indoor DC yard, and the zero potential wall and roof are presented and increase the surface electrical field. The filter capacitor of DC yard has a large number of components which needs high requirement for internal insulation coordination. In this paper, a 3-D finite element simulation model of filter capacitor in UHVDC project indoor DC yard was established by using COMSOL. The potential and electric field distribution of filter capacitor shielding devices were calculated and analyzed. Based on the permitted value requirement, the electrode shape was continuously optimized. The research results of this paper could provide references for development and optimization design of filter capacitor in UHVDC project.</p>	Zichen Zhao
Structure and Breakdown Properties of Polypropylene-Based Nanocomposites	<p>This work was performed to investigate the effects of different nanofillers on the structure and dielectric properties of polypropylene (PP) nanocomposites. This work considers studying three types of nanofillers, namely, magnesium aluminate (MgAl_2O_4), calcium carbonate (CaCO_3), and surface-modified calcium carbonate (CaCO_3T). PP nanocomposites containing MgAl_2O_4, CaCO_3, and CaCO_3T nanofillers were prepared using a Brabender melt mixer. The samples were melt pressed using a hydraulic laboratory press at 180°C to produce thin-film samples of $100\text{ }\mu\text{m}$ thick. The prepared samples were subjected to Fourier transform infrared (FTIR) spectroscopy and scanning electron microscopy (SEM) for chemical and morphological analysis. Meanwhile, the DC breakdown test was carried out to analyzed the dielectric properties of the evaluated samples. The results showed that PP/MgAl_2O_4 nanocomposites possessed lowered breakdown strength compared to unfilled PP. In contrast, PP/CaCO_3 nanocomposites possessed a higher breakdown strength over PP/MgAl_2O_4 nanocomposites. Meanwhile, PP/CaCO_3T nanocomposites possessed the highest breakdown strength among the nanocomposites. Possible mechanisms governing these property changes are discussed.</p>	Aizat Azmi
Study of Heat Transfer Property of the Transformer Oils on Addition of CuO Nanoparticles	<p>The electrical transformer efficiency and safety depend on the working temperature of the coolant, i.e., insulating oil. The increase in temperature causes the formation of hotspots which ultimately leads to the breakdown in the oil. Adding of nanoparticles (NP) to the oil shows a major trend in the enhancement of the heat transfer property. In this paper, heat transfer properties of mineral oil (MO), MO with NP are compared with vegetable oil (VO) and VO with NP. VO has been gaining significance due to extinct nature of MO. The NP considered in this paper is Cupric Oxide (CuO), which is added to the insulating oil in various weight by volume percentages to study the thermal conductivity (TC) and viscosity. Cupric Oxide is a semi-conductive NP, and it is proved to have enhanced electrical properties such as dielectric constant and breakdown voltage. The enhanced properties of oil can reduce the amount of oil required to cool the entire system thereby optimising the size, cost and weight of the system. The heat transfer properties such as viscosity and thermal conductivity are measured for all the above four types of oil compositions and are compared. Both the viscosity and thermal conductivity are noticed to be affected by the NP size, temperature, base fluid and volume concentration of NP. For enhancement of thermal properties, NP size should be less than 50nm. In this paper, CuO NP is chosen for the study of thermal conductivity, variation of viscosity over a range of NP addition to the base oil.</p>	Rohith Sangineni
Study of High Voltage Connectors for Coaxial Cables Used in Kicker Applications at CERN	<p>The CERN accelerator complex uses kicker magnets that are pulsed with voltages of up to 80 kV and pulse rise times as fast as 100 ns. For pulse transmission, special coaxial high voltage cables are used together with custom designed connectors with high dielectric strength, low partial discharges, and precise impedance. Several types of connectors are in use at CERN since decades. The aim is to develop a connector, which will be used for a polyethylene prototype cable at 60 kV, to possibly replace the existing SF_6 gas filled cables. Improvements for better voltage holding and significantly reduced partial discharges have been investigated and are outlined. The connectors are simulated using Finite Element Method (FEM) analysis and are subsequently high voltage tested to identify weaknesses and finally introduce a new improved connector design. Existing connectors have been inspected, simulated, HV tested in the laboratory, and their weak points have been analyzed. The influence of triple points inside the connector and the ways to treat them were studied. The test procedure, including partial discharge measurements and inception voltage tests, is outlined. Based on the knowledge gained, a new design for future 60 kV connectors has been developed and is analyzed. Results of simulations and HV tests are presented and show the initial feasibility of the design.</p>	Dimitrios Kontelis

Study of Magnetic Properties of Mineral Oil Based Nanofluids	Transformer is the most important equipment in a power system network. Thermal and electrical stresses are the major cause of concerns for failures in a power transformer. These stresses are sustained by mineral oil (MO) which provides insulation as well as acts as a coolant in the transformer. MO is extensively used in power transformers for insulation purpose since decades. To overcome the thermal and electrical stresses it is important to enhance the insulation properties. This can be possible by suspension of nanosized particles in the oil i.e. nanofluids(NFs). NFs have changed the trend in terms of breakdown, moisture saturation capabilities, etc. The generation of leakage flux in the transformer is responsible for the voltage dip on the load side; hence its reduction is important to maintain good voltage regulation and efficiency. This flux also flows through the liquid dielectric of a power transformer. Thus, it is very much important to analyze the magnetic nature of the liquid dielectric and its impact on the leakage flux. To study this phenomenon, two types of oils are considered; MO and MO based NFs (MO-NFs) with Copper oxide (CuO), Titanium oxide (TiO ₂) and Hexagonal Boron Nitride (h-BN) nano-particles (NPs) dispersed in them. These oil samples are studied for their magnetic nature using vibrating sample magnetometer (VSM). The liquid insulation magnetization for both MO and MO-NFs is plotted with respect to magnetic field strength. The magnetic characteristics of MO based nanofluids (MO-NF) are discussed in the paper.	Deepak Kanumuri
Study on Charge Trapping Processes of Epoxy Resin Nanocomposites	Space charge transport characteristics of epoxy resin composites under UHVDC play an important role in reliable performance of UHVDC dry casing and long term safe and stable operation of UHVDC transmission projects. In this paper, one-dimensional bipolar carrier transport model is established to numerically calculate the space charge distribution in epoxy resin composites. The effect of carrier mobility, trap depth and trap density on the internal space charge transport characteristics is investigated. Results show that with the increase of shallow trap distance, the carrier mobility increase which result in charge accumulation inside the samples and more serious electric field distortion. As deep trap depth and density increase, the charge accumulation area gradually moves from the center to both electrodes, effectively inhibiting the space charge injection and reducing electric field distortion. These results provide theoretical basis for reducing space charge accumulation in epoxy resin composites and optimizing structure of UHVDC dry casing.	Xi Pang
Study on the Ageing Performance on Kenaf Insulating Presspaper with Natural Ester	This study aims to evaluate the ageing performance of Kraft and Kenaf insulation press-paper in Natural Ester (NE), which could be applied in a power transformer. Kenaf fiber was produced by Kraft pulping process is considered as potential insulation press-paper due to higher cellulose. Due to environmental concerns, NE uses have been considered an alternative to mineral oil. In this experiment, an accelerated ageing test was carried out with transformer insulation press-paper. Kraft and Kenaf press-paper were impregnated in NE with a copper strip of 90°C and 140°C for 10,20 30 days. Fourier transform infrared spectroscopy (FTIR) result showed that O-H's absorption intensity decreased, while C-H, C=O, and C-O bond increased with the ageing time. The viscosity measurements have been used to compare the stability of aged NE with Kraft and Kenaf press-paper at different ageing time. It is found that the viscosity results showed aged NE with Kraft press-paper is higher than Kenaf presspaper as the duration of ageing increase.	Nurul Hashim
Study on the Thermodynamic Stability of the Organic Dielectrics in the Photovoltaic Cell	Diverse dielectric particles in the organic photovoltaic cell were studied in this paper for the thermodynamic efficiencies. Recently, conductive organic polymers are used for dielectrics and the charge characteristics are important. This research employs computational method using molecular editing program based on DFT to find stereo-chemical and optical properties of various fullerene derivatives. Optimized geometry energy levels and electrons distribution contour of solar cells are obtained. The Avogadro software is an open-source molecular editing program equipped with an auto-optimization feature, which determines the theoretical values of a certain structure's atomic properties. Variables were quantified by their optimized energies, dipole moments, and electrostatic maps, respectively, after being modeled in the program. This software allows users to build virtually any nanoparticle and optimize its geometry according to various force field options.	Richard Kyung
Study on Thermal Conductivity of BNNs/Mg(OH) ₂ /LDPE Composites Based on Melt Blending Method	Enhancing the thermal conductivity of insulation materials can reduce the operating temperature and thus increase the transmission capacity of power cables. In this work, low density polyethylene (LDPE) with the fillers of magnesium hydroxide (Mg(OH) ₂) was selected as the base insulation materials for fire retardant. Boron nitride nanosheets (BNNs) were selected as the fillers to increase the thermal conductivity. To imitate the melt extrusion in cable manufacturing process, composites with different filler ratios were prepared by HAAKE PolyLab OS and then molded at high pressure. The thermal conductivities of the composites were measured by LFA447 nanoflash and the microstructures of composites were observed by the scanning electron microscope (SEM). The filler orientation was characterized by diffraction of X-rays (XRD) to represent the anisotropic index of the composites. The results indicated that BNNs were inclined to be oriented along the extrusion plane because of the axial pressure in molding process. As a result, the composites showed anisotropic thermal conductivity. For example, in the composites with 20wt% BNNs, the thermal conductivity in through-plane direction reached 3.97W/(m·K), which was 1240% of that of LDPE. Furthermore, with the addition of Mg(OH) ₂ , the thermal conductivity of the composite was further improved, and the thinner flake samples showed stronger anisotropy in thermal property. It was shown that the multi-packing structure molded by the simple melt-blending process was a feasible method to fabricate high efficiency thermally conductive composites.	Chu Wang

Synthesis, Structural and Dielectric Characteristics of Liquid Crystalline Azo-Based Compounds with Different Terminal Length	<p>The research was conducted to study the chemical structure and their relationship between mesomorphic and dielectric properties. The understanding of the relationship between structure, liquid crystal and dielectric behaviour is very important in designing new liquid crystal materials with desirable properties for future applications. Thus, this study focused on the preparation of azo-based compounds with different terminal length. Diazotization reaction of p-nitroaniline with phenol formed 4-(4-nitrophenylazo)phenol, 1 which was alkylated with heptyl and tetradecylbromide to give a series of nitro compounds, 2a-b. Structure elucidation of these compounds were confirmed using Fourier transform infrared spectroscopy (FT-IR) and nuclear magnetic resonance spectroscopy (NMR). Liquid crystal properties of these intermediates and compounds were determined using polarized optical microscope (POM). It was found that compounds 2a-b with nitro and alkoxy terminal chains attached to azo linking units showed a smectic A (SmA) phase in the heating and cooling cycles. The presence of mesophase(s) and transitional properties of each phase of these compounds were further confirmed using differential scanning calorimetry (DSC). Based on the DSC thermograms of compounds 2a-b, two endotherms were observed in both cycles for the transition of Crystal-SmA-Isotropic phases. The dielectric characteristics showed that the relative permittivity decreased as the number of alkyl group increased. Meanwhile, the loss tangent of both compounds decreases with increasing frequency spectra.</p>	Zuhair Jamain
The Application of Magnetic Tape to Measure Lightning Peak Current in Indonesia	<p>Indonesia is known as a maritime contingent country, located in the tropical area, so this geographical condition supports the formation of lightning clouds, namely the Cumulonimbus (CB) cloud. Indonesia has many problems related to Lightning. Lightning strikes can cause damage to structures, damage to equipment, fire and human death. To minimize the danger of lightning strikes, it is necessary to design a good lightning protection system, which uses lightning parameters that are in accordance with the lightning characteristics of the area to be protected. The characteristics of lightning can be obtained using various measurement methods, including direct and indirect current measurements. Research on the Characteristics of Lightning in Indonesia is still carried out using indirect measurements. The previous study use Lightning Detection System using Time of Arrival and Magnetic Direction Finder. The lightning data obtained from direct measurement is still a little. Direct measurement of lightning currents can be done using an instrumented tower equipped with a measuring instrument. To get more local data, Peak Current Measurement System (PCM) that consist of magnetic tape and lightning event counter (LEC) can be used, especially to get lightning peak current in Indonesia.</p>	Bryan Denov
The Effect of Tap Changer Coking and Pitting on Frequency Response Analysis Measurement of Transformer	<p>The tap changer in a power transformer plays a vital function in regulating the voltage. It has been reported that the tap changer contributes to a large percentage of failures in the power transformer. This paper investigates a faulty tap changer using the frequency response analysis (FRA) test. All measurement configurations in FRA were employed to verify the effectiveness in detecting the fault. The test configurations are the end-to-end open circuit, the end-to-end short circuit, the capacitive inter-winding, and the inductive inter-winding. The coking and pitting of the tap changer are fabricated in several pieces of copper. These pieces are installed on the transformer tap selector. The FRA measurement was then performed on an 11/ 0.433 kV, 500kVA transformer at normal and faulty conditions. The variation between the FRA measurements is then calculated using the correlation coefficient (CC). This study improves the understanding of the FRA method by exploring its ability to detect tap changer faults. It is realized that the FRA method is sensitive to the tap changer coking and pitting. The results show that the tap changer coking effect at low frequencies. The response drop in magnitude at low frequencies between 20 Hz and 2 kHz. For pitting, it shows the response shifting towards higher frequencies.</p>	Salem Al-Ameri
The Effect of Water Absorption on the Dielectric Response of Calcined Zirconia-Based Polyethylene Nanocomposites	<p>Polymer nanocomposites have become one of the attractive research areas in exploring new dielectric materials. This is due to their potential dielectric property enhancements as a consequence of nanostructuration. However, the degradation of the dielectric performance of nanocomposites has also been reported, and this is can be related to the presence of water within the materials. The main objective of the current work was to investigate the effects of water absorption on the mass change and dielectric response of polyethylene (PE) nanocomposites containing uncalcined and calcined zirconia (ZrO₂) nanofillers. The results show that nanocomposites containing uncalcined ZrO₂ resulted a marginal increase in the real permittivity after water immersion. Under similar water immersion periods, nanocomposites containing calcined ZrO₂ also demonstrated a marginal increase in the real permittivity. Factors influencing the dielectric response of the nanocomposites after ZrO₂ calcination and water immersion are discussed.</p>	Kwan Yiew Lau
The Electric Field Characteristics in Clevis Type Polymer Insulators Affected by Size and Contact Angle of the Contaminants: Simulation Approach	<p>Indonesia, as an archipelago and tropical country, results in a unique working environment for polymer insulators. Then as discovered that insulators are aging in the coastal area more quickly, this study investigated the effect of size and contact angle of contaminants. There are two types of pollutants used, namely seawater and distilled water. Seawater has a salt content. Its conductivity is higher than distilled water. Insulator modeling and contaminant variation are carried out in software based on the finite-element method (FEM). Based on the study results, a unique electric field characteristic was obtained for each case study. The electric field with the highest magnitude is generated by case 3 (seawater contaminants and water droplets with a contact angle of more than 90 degrees). It is 55000 V/m.</p>	I Made Yulistya Negara

Thermal Degradation Kinetics of High Temperature Polymers for Aeronautic Cables Insulation	The perspective of increasing on board power on aircrafts leads to reconsider cable technologies, among which insulation processing. In this work, the thermal stability of three materials, Polyimide, Polytetrafluoroethylene and perfluoroalkoxy (PFA) is investigated. Based on a multi-step degradation model applied to thermogravimetric analysis curves, isothermal degradation curves are predicted. Outstanding thermal stability is anticipated for PFA on a chemical standpoint. With the advantage of being a extrusion-processable polymer, PFA constitutes therefore an excellent candidate for high performance cables with extruded insulation.	Gilbert Teyssedre
Three-Dimensional Visualization Technology for Ultrasonic Detection of Partial Discharges in Power Transformers	Partial discharges are crucial sources for insulation deterioration in power transformers, and precise detections of partial discharge is of great significance for transformer condition monitoring. Recently, visualized ultrasonic detection technology has been increasingly used as a live detection method for locating partial discharges inside transformer. It has the advantages of strong penetrating ability and fast response, but still has the problems of poor detection sensitivity and low positioning accuracy when the atmosphere noises are high. Further, the sonography indicating the region of partial discharges measured by visualized ultrasonic technology is only the two-dimensional projection of the region of interest, and the precise spatial positioning of the partial discharge cannot be evaluated. This paper proposes an improved visualized ultrasonic technology for panoramic visualization of partial discharge voiceprint on power transformers. The refined power transformer model is established through 3-D laser scanning and virtual reconstruction technology. Ultrasonic sensors with center frequency of 100 kHz were used to collect ultrasonic signals presented on the surface of power transformer. A self-developed data extraction algorithm was used to obtain ultrasonic signal digital matrix from the original collected data. In the following, 2D to 3D geometric transformation is applied to perform digital ultrasonic data on the meshed grid of transformer model. Finally, the ultrasound image on the entire hologram can be displayed holographically, which can be used to indicate partial discharge defects that occur inside the transformer in the 3-D space. Experimental verification on a converter transformer with a capacity of 382MVA confirmed that using this new visualization method, the location of the ultrasonic hot spots has a higher accuracy.	Hao Zhang
Trending of SF6 Decomposition By-Products Characteristics Under Artificially Introduced PD in GIS	This work aims to study the decomposition of Sulfur Hexafluoride (SF6) and describe the energy of partial discharge (PD). It is also aimed to identify feature or key gases generated under the activity of discharge induced by artificially introduced insulation defects. Different configurations of four types of defects were used in the discharge chamber, and the analysis of decomposition component were employed to detect the PD. The variation of decomposition by-products along the stress duration under different level of PD energy were studied, and key gases generated under each type of defect have proposed. A series of experiments have been conducted using experimental platform including testing equipment, discharge chamber and PD measurement equipment. The applied voltage were gradually increased beyond the PD inception voltage after each sampling throughout the energisation duration to study the correlation of discharge energy with concentration and amount of generated products. Decomposition by-products, detected using Fourier transform infrared spectroscopy (FTIR), have been analyzed to reveal the relationship with the energy of PD. Results have shown that products such as SO2F2, SOF2, CO2 and C3F8 were generated by some defect configurations at different rates, and sulfur contained products are more stable and correlated with the PD level. Analyses of the characteristics of decomposition by-products can be used to effectively assess the condition of SF6 gas insulated equipment (GIE).	Ammar Mahdi
Understanding the Flow Electrification of Synthetic Ester Fluid Adopting Spinning Disc Method	Accelerated thermal aging of synthetic ester fluid is carried at 120°C and their subsequent variation in charging tendency and dielectric properties with oil and pressboard were studied. Spinning disc system simulates the electrification phenomenon in laboratory conditions. The Flow electrification process is simulated with three configurations as, virgin oil with pressboard, aged oil with pressboard and aged pressboard with the fresh oil. The generation of current magnitude increases with the rotational speed of disc and with temperature. In addition, drastic reduction is observed with aged specimen. Surface potential measurement in pressboard is performed with +/-DC voltage profiles. Higher accumulation of charge and relatively lower charge decay performance is exhibited by aged specimens. In addition, Dielectric relaxation spectroscopy (DRS) studies exhibits the dielectric characterization of oil, the aged specimen is found to have a higher loss factor. Dielectric parameters are responsible for the electrification at the interface of the medium.	S. k. Amizhtan
Vacuum DC Flashover Performance Improvement by CF4 Radio Frequency Capacitively Coupled Plasma	The vacuum flashover performance of insulating materials plays an important role in the development of high-voltage insulation systems. Radio frequency capacitively coupled plasma (RF-CCP) is often used for surface modification due to its stability and uniformity. In this paper, silicone rubber is modified by CF4 RF-CCP for the improvement of surface flashover withstanding strength. The surface properties of samples were evaluated by scanning electron microscopy (SEM), X-ray photoelectron spectroscopy (XPS), and surface charge accumulation and charge dissipation measurement. The results show that the withstanding strength of SIR samples treated by RF-CCP can be promoted up to 24% in vacuum. It is considered that increased surface roughness and introduction of fluorine-containing functional groups both suppress SEEA process and improve the flashover voltage of materials.	Chenxu Wang