

24aA-1

September 24th (Thu.), <10:00-12:00>
Room 1

Surface charging when the water droplet dropped with a charge (Second report)

○Yusuke FUTAMI and Hirofumi SHIMOKAWA

Kanagawa Institute of Technology

Abstract:

This report examined charging characteristics of the surface in dropping water droplet which was charged on super-water-repellent agent (HIREC1100). In the previous report, it was shown the surface was charged negatively, when +200pC water droplet was dropped in the water-repellent surface. In this report, the similar experiment was carried out in water droplet which electric charge which is bigger than +200pC. The surface was charged positively in case of the +300pC water droplet. And, the surface was charged negatively in case of +220pC. Surface density of charge in which the surface is not charged is seen to be 24~30 $\mu\text{C} / \text{m}^2$.

24aA-2

September 24th (Thu.), <10:00-12:00>
Room 1

Current waveform and electric charge in electrostatic spraying(second report)

Kazumasa CHIKU, Hirofumi SHIMOKAWA

Kanagawa Institute of Technology

Abstract:

In this study, current waveform detected in the electrostatic atomization by the nozzle was made to synchronize with the image of high-speed camera. The change of the process according to the resistivity and the nozzle gauge of the electrostatic atomization phenomenon is observed from the synchronization, and the electrification process is revealed. The electric charge was calculated from pulse current form in dependent on the value of applied voltage and the nozzle gauge. The electric charge when the nozzle 23G has changed irregularly. After the droplets from the liquid thread breakup, the electric charge is increased by the liquid surface or thread vibrates greatly.

24aA-3

September 24th (Thu.), <10:00-12:00>
Room 1

Flow Electrification between Pure Water and PFA with Intermittent Flow

○Daichi Obata, Hiroshi Tasaka, Sunao Katsuki, Hidenori Akiyama

Graduate School of Science and Technology, Kumamoto University

Abstract:

Flow electrification phenomenon between pure water and PFA (PerFluoroAlkoxyethylene) tube was described in this paper. Essentially, pure water flowing in a PFA tube is positively electrified, but negative charges on the head of the intermittent flow are observed in high Reynolds number conditions. The amount of the negative charges depends on flow velocity, tube length, and initial residual charges on the PFA tube. These results indicate that initial residual charges on the PFA tube are collected by the head of water flow. In spite of the relatively high conductivity of pure water, the collected negative charges are not diffused because the two-phase flow condition is mixed and atomized, which means insulated condition.

24aA-4

September 24th (Thu.), <10:00-12:00>
Room 1

Thermal Endurance of Multi-doped Nanocomposite Polymeric Insulating Material Using Azo-benzoic Compound

Yoshiaki YAMANO

faculty of Education, Chiba University

Abstract:

Thermal endurance evaluation according to IEC 60216 series was carried out on the multi-doped nano-composite polymeric insulating material which we newly designed for high resistance to the electrical tree degradation. The base material was LDPE, which was added with nano-particle of Al₂O₃ and azobenzoic compound. The size of the particle is about 50 nm in average. The aging test was carried out using 3 chambers controlled at 85 °C, 90 °C and 95 °C, individually. The results indicated that RTE of the test sample was almost 40 % higher than that of LDPE, which indicates very high performance against the thermal degradation.

24aA-5

September 24th (Thu.), <10:00-12:00>
Room 1

Observation of Ultra-short Pulsed Discharge in Supercritical Carbon Dioxide

○Miyuki OTA*, Tomohiro FURUSATO**, Takahiro IMAMICHI*, Takashi SAKUGAWA*, Sunano KATSUKI*, and Hidenori AKIYAMA*

*Graduate School of science and technology, Kumamoto University, **Graduate School of Engineering, Nagasaki University

Abstract:

This paper deals with pre-breakdown phenomena in supercritical carbon dioxide (SC-CO₂) with ultra-short positive pulsed voltages. Previously, we studied a cylindrical shock wave propagated from a filament-like positive streamer channel with a rise time of 90 ns, peak voltage of 60 kV and half-width of 170 ns. For this study, we developed an ultra-short nanosecond pulse generator with a rise time of 6.6 ns, peak voltage of 9 kV and half-width of 15 ns. The voltage was applied to a needle-to-plane electrode in SC-CO₂. The gap length was set at approximately 320 μm. A filament-like streamer was observed using the shadowgraph method as with our previous study.

Furthermore, unique images of shock waves were observed in which the shock wave appeared to propagate from the vicinity of the needle tip. In addition, a relatively weak shock waves along the streamer channel were also observed. This data allowed us to infer that heating of the streamer vicinity of the needle tip was enhanced compared with the streamer tip.

24aA-6

September 24th (Thu.), <10:00-12:00>
Room 1

Measurement of infrared emission spectrometry of O₂(α 1 Δ g) in atmospheric-pressure helium plasma jet

○Yuki Inoue, Ryo Ono

Graduate School of Frontier Sciences, The University of Tokyo

Abstract:

The atmospheric-pressure helium plasma jet is an important device for plasma biomedical applications. We measured the density of singlet delta oxygen O₂(α 1 Δ g) in the plasma jet. O₂(α 1 Δ g) is effective in the treatment of blood sterilization and cancer. The measurement result shows the O₂(α 1 Δ g) density under the high voltage electrode is approximately 2-8 ppm. The O₂(α 1 Δ g) density become maximum when the oxygen concentration is 0.2% and the peak-to-peak voltage is 11kV.

24aA-7

September 24th (Thu.), <10:00-12:00>
Room 1

DEVELOPMENT OF LOW IMPEDANCE HIGH VOLTAGE NANOSECOND PULSED POWER GENERATOR

○Satoru MATSUMOTO*, Shintaro KODAMA*, Douyan WANG**, Takao
NAMIHIRA** and Hidenori AKIYAMA **

* Graduate School of Science and Technology, Kumamoto University , **Institute
of Pulsed Power Science

Abstract:

This study focuses on improving our nanosecond pulse generator by changing insulation and dielectric medium and improving the configuration of the spark gap switch (SGS). The insulation and dielectric medium were changed from silicone oil to ethylene glycol, with ϵ_r referring to the dielectric constant. The dielectric constant of silicone oil and ethylene glycol are 2.7 and 44. Therefore, characteristic impedance of silicone oil and ethylene glycol become about 50 Ω and 12.5 Ω . The pulse width of silicone oil was extended from 5.0 ns to 20 ns in ethylene glycol. Therefore, pulse width can be varied by changing the length of the triaxial Blumlein line, with the length of the line 500 mm under the previous configuration but 125 mm using the reconfigured generator. The previous SGS path was longer than the one we have currently. Therefore, due to inductance inside the switch, we developed a low inductance new SGS. It is developed five generators by combining the three previous factors. The output current of Generator 5 is about 2.6 times that of Generator 1. Generator 5 has the highest power, making it the best generator.

24pA-1

September 24th (Thu.), <15:45-17:45>
Room 1

Effect of Discharge Conditions on Inception Electric Field Strength of Streamer in Water

○Takehiko SATO*, Hidemasa FUJITA**, Seiji KANAZAWA***, Kiyonobu OHTANI*, Atsuki KOMIYA* and Toshiro KANEKO****

*, **, **** Tohoku University, ***Oita University

Abstract:

Effects of gap distance, capacitance, and water conductivity on the inception electric field strength of a primary streamer and a secondary streamer in water were investigated in the case of a single-shot pulsed positive voltage with a duration of 10 μ s. It was clarified that the inception electric field strength was not effected by discharge conditions, and threshold electric field strength for the inceptions of a primary streamer is greater than 23 MV/cm and and for that of a secondary streamer is greater than 34 MV/cm.

24pA-2

September 24th (Thu.), <15:45-17:45>
Room 1

Influence of Conductivity on DC Negative Corona Discharge from a Water Droplet

Takuya Nakajima

Graduated School of Science and Engineering, Yamagata University

Abstract:

DC corona discharge from a water droplet formed at a capillary electrode is accompanied with periodical formation and disruption of a Taylor cone.

Thus, corona discharge from a water droplet occurs intermittently with regular interval. Formation of a cone and charge transfer in a droplet might be related to ion mobility in a droplet. In this study, to confirm the influence of the conductivity of a water droplet on the negative corona discharge, the magnitude of corona current and the time variation of the droplet height were investigated. Conductivity of a water droplet was adjusted by a concentration of HNO₃ from 0.48 to 48mS/cm. The higher conductivity of a droplet, the larger corona current flows. However, the conductivity affects little the cone formation of a water droplet. It takes more time for a larger water droplet to return to the lower position of droplet. As a result, pulse trains corona discharge continues with a relatively longer duration.

24pA-3

September 24th (Thu.), <15:45-17:45>
Room 1

Basic Experiment of Rod-to-Water Electrode Discharge Using Inverter Neon Transformer

○Naoya HAYASHI, Itaru FUJITA, Sayo OKUDA, Toru HARIGAI, Yoshiyuki
SUDA, Hirofumi TAKIKAWA

Toyohashi University of Technology

Abstract:

There are nitrate ions as nutrients necessary for the growth of plants. Nitrate ions can be generated in water by discharge. In this study, rod-to-water discharge experiment that places the ground electrode in the water was presented using an inverter neon transformer.

Unstable discharge appeared immediately at the beginning of discharge. After the discharge for 30 s, discharge was stable. The pH and nitrate ion concentration in water after discharge was increased with increasing of discharge duration.

24pA-4

September 24th (Thu.), <15:45-17:45>
Room 1

Analysis of compositions of the ions generated by atmospheric pressure helium plasma

○Kenkichi NAGATO, Mizuki ASAE and Takahito SETO

National Institute of Technology, Kochi College

Abstract:

Chemical compositions of the ions generated by atmospheric pressure helium plasma were investigated using an atmospheric pressure ionization mass spectrometry (API-MS). The plasma generator used in this experiment was composed by a union-tee, a quartz glass tube and a stainless steel rod. In the negative ion mass spectrum with a distance between the glass tube tip and the sampling orifice being 5 mm, several ion species were observed. The observed ions include O^- , OH^- , O_2^- , O_3^- , CO_3^- , HCO_3^- and HCO_4^- . Most of these ions formed hydrated cluster ions and the ions of $O_2^-(H_2O)_n$ were the most abundant in the spectrum. The spectrum changed significantly by changing the distance between the glass tube tip and the sampling orifice to 10 mm. The peak of CO_3^- became the most intense peak and the ions of O_2^- and HCO_4^- decline, which was probably due to the ion-molecule reactions with surrounding molecules.

24pA-5

September 24th (Thu.), <15:45-17:45>
Room 1

Observation of streamer discharge under high temperatures

○Taku KAMAKURA and Ryo ONO

The Univ. of Tokyo

Abstract:

Observation of streamer discharge under high temperatures Department of Advanced Energy, The University of Tokyo Kamakura Taku Pulsed positive streamer discharge in a point-to-plane gap is observed under high temperatures (300-1200 K) and compared with various applied voltages (12-30 kV). An ICCD camera is used for the optical measurements of streamer. The rises in temperature and applied voltage increase the reduced electric field E/n . The results show that the rises in temperature and applied voltage increase the propagation velocity of primary streamer and the length of secondary streamer in similar ways, while they lead to different shape of streamer (thickness, branching, etc.).

24pA-6

September 24th (Thu.), <15:45-17:45>
Room 1

Generation and Characterization of Mist-Plasma Using Atmospheric Pressure Glow Discharge

○Tomoyuki TANAKA

Graduate School of Science and Engineering, Tokyo Metropolitan University

Abstract:

In this study we constructed mist-plasma experimental system using the atmospheric pressure DC glow discharge. We carried out the characterization of the mist-plasma by the measurements of optical emission spectroscopy and droplet diameter.

24aB-1

September 24th (Thu.), <10:00-12:00>
Room 2

Study on the discharge electrode of an electrostatic precipitator

○Yoshiyuki KISANUKI*, Yuji MAKISHIMA*, Shinjirou KATSUSHIMA*, Kazunori
TAKASHIMA** and Akira MIZUNO**

AMANO Co., Ltd*, Toyohashi University of Technology**

Abstract:

By adopting ISO14000 series etc., improvement of the working environment in the factory has become an important issue. The authors have verified the effectiveness of the discharge electrode against sedimentation of the oil mist at its tip. The electrodes used in the experiment are; A) needle-plate, B) needle-circular hole, C) protruding needle-circular hole.

In order to confirm the influence of the sediment attached on the needle tip, we performed simplified measurement of ionic wind, verification of the charging efficiency and the field experiment. From the results of ionic wind measurement and the field experiment, it was found to be effective to direct the needle tips in the same direction as the main gas flow. From the verification of the charging efficiency and the field experiment, the shape C), newly invented by us, of the protruding needle-circular hole was the most effective as a discharge electrode for an electrostatic precipitator to collect fine suspended particles.

24aB-2

September 24th (Thu.), <10:00-12:00>
Room 2

Electrostatic Precipitator using the weak Corona Discharge generated by Carbon Fiber Flocking Electrodes

Atsushi KATATANI*, ○Hiroshi HOSONO**, Hikaru MURATA**, Hiroshi YAHATA** and Akira MIZUNO***

Panasonic Environmental Systems & Engineering Co., Ltd*, ○Panasonic Ecology Systems Co., Ltd**, Toyohashi University of Technology***

Abstract:

The authors have been studying the electrostatic precipitator (ESP) which can charge particles without using corona discharge to collect particles with Coulomb's force in strong electric field. In this method, we have tried to use "induction charging". DC high-voltage lower than corona-start-voltage is applied to electrostatic-flocked electrodes with carbon fibers. Particles are attracted to the fibers due to gradient force. Then, particles are induction-charged just as particles that have attached to the fibers are re-entrained. Because of the strengthened electric field by converged electric-force-lines, the particles should acquire larger induction charge compared to the case of plate electrodes without flocked fibers. After these particles detach from the fibers, they are collected by the following parallel plate electrode assembly. Even without corona discharge, the experimental results in the last study showed that a certain value of particle collection efficiency was observed. The observed collection efficiency was stable for smaller particles (from 0.3 to 1.0 μm), however, was unstable for larger particles (from 1.0 to 5.0 μm). In this study, when a weak corona discharge was generated in the flocked electrodes with carbon fibers, the collection efficiency of 80% or higher, equivalent to conventional ESPs, was obtained in all the diameter range using only 10% of the electric power consumption compared with conventional ESPs.

24aB-3

September 24th (Thu.), <10:00-12:00>
Room 2

Basic Characteristics of Ionic Wind Devices Prepared by a 3D Printer

○Wataru IMAGAWA*, Masataka KAI*, Shouhei MATSUNARI*, Shuichi
AKAMINE*,
Ryuta ICHIKI*, Seiji KANAZAWA*, Koji KANAZAWA**

* Department of Electrical and Electronic Engineering, Oita University

** Department of Aerospace Systems Engineering, Sojo University

Abstract:

The corona discharges are widely used in many industrial applications such as gas cleaning, particle precipitation, and gas flow control. Essentially, the corona discharge apparatus consists of the metallic electrodes and those supporting insulators. The insulating parts are usually made of plastic, ceramics or glass. Therefore there is a limit for the design and fabrication of the apparatus. We have introduced 3D printing technology into the development of non-thermal plasma reactors. In this study, ionic wind devices based on the dc corona discharge is studied. Except for the electrodes, the ionic wind devices were prepared by using a 3D printer. The electrode of corona discharge is a needle-to-mesh configuration. The performance of the ionic wind devices was evaluated with respect to the gas flow velocity and its spatial distribution. Moreover, we examined the effect of the array by the multi-devices. As the advantage of the array, it is possible to increase the ionic win!

d velocity and to control the air flow distribution widely.

24aB-4

September 24th (Thu.), <10:00-12:00>
Room 2

Development of an ion wind use humidification system

○Takahiro SAKAI*, Yasutaka INANAGA*, Akira MORIKAWA*, Keita
SAKAI*, Tasuku IZUTANI*

*Mitsubishi Electric Co. Advanced Technology R&D Center

Abstract:

We examined vaporization-type humidification performance control characteristics, and we paid our attention about the humidification method that used an ion style together with a filter. As a result, the wind velocity to water absorptive porous metal increased by injection electric discharge electricity and understood that the humidification performance improved. In this way understood that control of the quantity of humidification was possible.

24aB-5

September 24th (Thu.), <10:00-12:00>
Room 2

Decomposition of the Water Insoluble Odor Using Corona Discharge

○Chisaki MATSUMOTO, Nozomi HARASAWA, Josuke HONMA, Sayaka MITSUI, Azuchi HARANO

Graduate School of Science and Technology, Gunma University

Abstract:

This presentation describes the bench scale experiments of decomposition of the water insoluble odor (the flow rate of odor gas about 1 m³/min) using corona discharge. The odor concentration was adjusted by the bubbling of ethyl mercaptan solution diluted the excess ethanol into cooling container. The concentration of ethyl mercaptan was successfully controlled by the flow rate of bubbling gas (N₂) and it enabled a stable experiment for a long period of time. The decomposition of ethyl mercaptan was accomplished by the corona discharge reactor consisted of four stainless wires and achieved the 50% conversion at an initial concentration of 79ppb and electric power of 15W. Furthermore, the experimental results suggested that the most of ethyl mercaptan directly was due to decomposition into corona plasma not oxidation of the ozone produced by corona discharge.

24aB-6

September 24th (Thu.), <10:00-12:00>
Room 2

Removal of High Concentration N₂O Anesthetic Gas Using Nonthermal Plasma and Adsorbent

○Tomoyuki KUROKI*, Toshiaki YAMAMOTO*, Shunsuke NISHII*, Masayuki
AKITA**, and Masaaki OKUBO*

* Department of Mechanical Engineering, Osaka Prefecture University, **
Enomoto BeA Co., Ltd.

Abstract:

The high concentration of N₂O removal system was investigated using nonthermal plasma combined with adsorbent. N₂O gas that simulates the waste gas from anesthetic equipment used for operation rooms was decomposed using the surface discharge plasma reactor. When N₂O was decomposed, NO_x was generated. The generated NO_x was adsorbed by NO_x adsorbent. As a result, 66% of N₂O decomposition efficiency was achieved with 12.8% of N₂O, the flow rate of 1.1 L/min, and the input power to the plasma reactor of 375 W. Furthermore, 0.4% of NO and 1.0% of NO₂ were generated upon N₂O decomposition; both of them were removed using adsorbent. The adsorbed NO_x was able to be decomposed with nitrogen plasma. It was demonstrated that high concentration of N₂O removal system can be accomplished using nonthermal plasma combined with adsorbent process.

24aB-7

September 24th (Thu.), <10:00-12:00>
Room 2

Study of hexadecane removal using atmospheric microplasma electrode

kazuo Shimizu

Organization for innovation and Social Collaboration, Shizuoka University

Abstract:

In recent years, the deterioration of IAQ (Indoor Air Quality) became a big concern. Because indoors is the place where we spend most of our life, IAQ is an important factor to be considered for a comfortable and healthy living. In this study, we evaluated by-product and deodorization process of hexadecane in small and large capacity box by using microplasma electrode. Both small and large capacity deodorization process could reduce hexadecane each of 90 % and 70 %, while CO and N₂O were generated as byproduct.

24pB-1

September 24th (Thu.), <15:45-17:45>
Room 2

Importance of Liquid Flow Induced by Plasma on Water Treatment

○Nozomi TAKEUCHI

Tokyo Institute of Technology

Abstract:

The effect of liquid flow on water treatment using a plasma generated over a solution was investigated using a two-dimensional numerical simulation of pulsed argon plasma that was generated between a needle electrode and a solution surface. The behavior of the reactive species generated by the plasma was calculated by considering electron-impact reactions, gas- and liquid-phase reactions, liquid flow, and mass transfer, assuming a gas-liquid equilibrium on the interface and flux continuity through the interface. The numerical results indicated that even a weak liquid flow could drastically change the liquid-phase chemistry.

24pB-2

September 24th (Thu.), <15:45-17:45>
Room 2

Pilot-scale Experiment of Semi-dry type Exhaust Gas Treatment for Glass Manufacturing System Using a Plasma-chemical Hybrid Process

○Hashira YAMAMOTO*,**, Tomoyuki KUROKI*, Hidekatsu FUJISHIMA* and Masaaki OKUBO*

*Department of Mechanical Engineering, Osaka Prefecture University, **Nihon Yamamura Glass Co., Ltd.

Abstract:

A pilot-scale experiment of semi-dry type simultaneous removal of NO_x and SO_x using a plasma-chemical hybrid process (PCHP) is carried out on an exhaust gas in a glass manufacturing system. The exhaust gas is produced by the combustion of fuel for raw glass materials and contains both NO_x and SO_x. NO is oxidized to water-soluble NO₂ with the plasma induced ozone gas. Na₂SO₃ is produced as a by-product of the de-SO_x process using NaOH solution at gas cooling area of 150°C or less. NO₂ is reduced to N₂ using Na₂SO₃. After the semi-dry state, the Na₂SO₃ is dried by the heat of exhaust gas, and produces Na₂SO₄. NO oxidation efficiency of more than 75% is achieved. NO and SO_x removal efficiencies are 28% and 63%, respectively. Furthermore, de-NO_x in bag filter is discussed for the injection of NaHCO₃. Due to the synergistic effect of ozone and NaHCO₃, and NO_x removal efficiency of 45% is obtained. Through this experiment, it is confirmed that this simultaneous de-NO_x and de-SO_x technology using semi-dry type PCHP is highly effective and promising for exhaust gas treatment in glass manufacturing system.

24pB-3

September 24th (Thu.), <15:45-17:45>
Room 2

Basic Treatment Property of Persistent Organic Pollutants in Wastewater Splay by Nanoseconds Pulsed Discharge in Air

○Shintaro KODAMA*, Satoru MATSUMOTO*, Douyan WANG**, Takao NAMIHIRA** and Hidenori AKIYAMA**

* Graduate School of Science and Technology, Kumamoto university, **Institute of Pulsed Power Science

Abstract:

Persistent organic pollutants (POPs) are bioaccumulative and environmentally persistent substances. POPs cannot be decomposed by conventional water treatments. For this reason, a new treatment method is required. Nano-seconds (ns) pulsed discharges enable higher energy efficiencies of plasma processing. Its advantages have been already performed at gas phase treatment such as NO_x treatment and ozone generation. On the other hand, there are few reports on the water treatment using ns discharge plasmas. In this study, we tried to decompose the organic pollutants using ns discharge method by spraying wastewater into gas phase plasma region. The discharge reactor was coaxial cylindrical geometry, and the treated wastewater was circulated and continuously treated in the reactor. The time course of pH and concentration of Non-Purgeable Organic Carbon (NPOC) in the wastewater were evaluated at several treatments.

24pB-4

September 24th (Thu.), <15:45-17:45>
Room 2

Plasma assisted catalytic oxidation of low concentration carbon monoxide in air

• ○ Toyohashi University of Technology

Dept. of Environmental and Life Sciences, Toyohashi University of Technology

Abstract:

Oxidation of low concentration carbon monoxide (CO) using a plasma-catalyst hybrid reactor at low temperature was carried out. A packed bed discharge reactor was constructed with three types of dielectric pellets, γ -Al₂O₃, Ru-Al₂O₃ and Ag-ZSM5. As a result, the reactor with γ -Al₂O₃ could not remove CO with or without using the discharge plasma. On the other hand, the reactor with Ru-Al₂O₃ showed 75% of CO removal at room temperature. In addition, 90% of CO was removed under the condition of 60°C and 0% relative humidity with both of Ru-Al₂O₃ and Ag-ZSM5. Furthermore, in the case of Ag-ZSM5, NO₂ production was smaller.

24pB-5

September 24th (Thu.), <15:45-17:45>
Room 2

Development of Ultra High Density Ozone Generation Technology

○Yoko MATSUURA, Yusuke NAKAGAWA, Noboru WADA and Yasutaka INANAGA

Mitsubishi Electric Corporation, Advanced Technology R&D Center

Abstract:

The maximum ozone density of existing ozone generator is about 400 g/Nm³, while further improvement in the ozone generation density can develop various applications in the fields of semiconductor manufacturing and water treatment. Mitsubishi Electric has developed the highly-efficient ozone generator by producing precise narrow discharge gap. Applying the highly-efficient ozone generator to the pressure-swing ozone concentration system enables the large supply rate of the ultrahigh density concentrated ozone at low running cost.

24pB-6

September 24th (Thu.), <15:45-17:45>
Room 2

Ammonia generation using discharge plasma and catalyst from diesel exhaust gas

○Ryo YOSHIDA, Hirofumi KURITA, Kazunori TAKASHIMA, and Akira MIZUNO

Department of Environmental and Life Sciences, Toyohashi University of
Technology, Japan

Abstract:

Ammonia (NH₃) generation from N₂, H₂O, CO, NO₂ was experimentally studied using a simple plasma-catalyst hybrid reactor. This is intended to be an alternative to urea hydrolysis used in urea-SCR deNO_x system for diesel engines. A packed bed type plasma reactor was used to generate intense discharge plasma on the catalyst pellet. Pellets of Pt, Rh, Pt-Rh, and Pd supported by Al₂O₃ were examined as catalyst for NH₃ generation.

Effect of carbon monoxide (CO) addition was examined to improve energy efficiency. Ammonia was generated from NO₂ and H₂O by plasma-catalytic reaction with CO and NO₂ addition. Pt-Rh resulted in very high NH₃ generation compared with other catalysts. Maximum energy efficiency for NH₃ generation in this method was 4.0 g/kWh.

24pB-7

September 24th (Thu.), <15:45-17:45>
Room 2

Pulsed Dry Methane Reforming in DBD-Catalyst Hybrid reaction and Reaction Mechanisms

Keishiro TAMURA, Seigo KAMESHIMA, Yutaro ISHIBASHI, Ryo MIZUKAMI,
Tomohiro NOZAKI

Department of Mechanical Sciences and Engineering, Tokyo Institute of
Technology

Abstract:

Dry methane reforming in dielectric barrier discharge and catalyst hybrid reactor was investigated. Optical emission spectroscopy was employed for better understanding of reaction mechanism for enhanced CH₄ and CO₂ conversion as well as carbon removal reaction. Strong emission from C₂ molecules, which is known as C₂ high pressure Swan system, was observed when CO₂ + "C(ad) or NiC" = CO + CO becomes dominant reaction. Excited C₂ molecules were produced selectively via vibrationally excited CO. Because CO is produced from adsorbed carbon or nickel carbide, emission from C₂ high pressure Swan system becomes a good indication of surface reaction enhancement by DBD. Time dependent change of gas composition and emission profiles of CO and C₂ were correlated and detailed reaction pathways is discussed.

24aC-1

September 24th (Thu.), <10:00-12:00>
Room 3

Analysis of bacterium isolated from used soluble cutting oil and it's tolerance toward pulsed-discharge plasma treatment

Makoto HIROSAWA, Takanori TANINO, Kouhei MAKITA, Takayuki OHSHIMA

Graduated School of Science and Technology, Gunma University

Abstract:

In this study, we focused on a bacterium that was isolated from used soluble cutting oil after pulsed-discharge plasma treatment. A bacteria identification analysis based on the 16s rRNA coding sequence region concluded that the bacterium is *Bacillus barbaricus* with 98.30% homology. Isolated *B. barbaricus* was cultivated both in liquid medium for 4, 22 h and on agar plate for 1 week. The former condition could allow *B. barbaricus* to be vegetative cell form and the later condition could allow it to form spore. All cells showed tolerance toward pulsed-discharge plasma inactivation treatment in distilled water. We also investigated tolerances of *B. barbaricus* toward heat and ozone inactivation treatments. Contrary to our expectations, it didn't show significant tolerances toward heat and ozone. From these results, *B. barbaricus* possesses only significant tolerance toward pulsed-discharge plasma inactivation treatment.

24aC-2

September 24th (Thu.), <10:00-12:00>
Room 3

The effect of gas flow rate and composition in nanosecond pulsed plasma irradiation on mouse melanoma cell

○Yuki Shirakawa*, Kazue Mizuno** and Ryo Ono*

*Department of Advanced Energy, The University of Tokyo, ** Department of Materials Engineering, The University of Tokyo

Abstract:

The relation between survival rate of mouse melanoma cell treated with nanosecond pulsed streamer discharge and gas flow rate and composition are investigated. Using N₂, low gas flow rate induces more cell death. Using N₂/O₂ mixed gas, O₂ concentration has little effect on cell survival rate. The results imply that in our experiment condition some reactive species derived from water vapor such as OH are more effective for mouse melanoma cell death than reactive species derived from O₂ such as O and NO.

24aC-3

September 24th (Thu.), <10:00-12:00>
Room 3

Fundamental study of a novel gene transfection of mammalian cells by water-in-oil droplet manipulation in an electric field

Yasuhiro TAKAO

Department of Environmental and Life Sciences, Toyohashi University of Technology

Abstract:

We developed a novel gene transfection method, water-in-oil (W/O) droplet electroporation, using dielectric oil and a liquid droplet containing living cells and transgene DNA. This method is based on water-in-oil droplet manipulation by using electrostatic force. When a water droplet is placed between a pair of electrodes, a reciprocal motion is made by applying a DC electric field. This droplet motion is brought about as follows. First, a droplet is carried to one electrode by Coulomb force, possibly due to electrostatic induction. When the droplet makes contact with the electrode, droplet is charged with the same polarity as the electrode. The droplet then moves to the other electrode and the same process occurs repeatedly. Furthermore, more intense electric field can induce droplet deformation and it leads instantaneous short circuit via the droplet. Small holes could be made in the cell membrane during the short circuit, and genes could be introduced into the cells. We have investigated a gene transfection using the droplet containing mammalian culture cells (HEK293 cell) and foreign plasmid DNA. Viability and transfection level measured 24 hours after the voltage application under various applied condition were investigated.

24aC-4

September 24th (Thu.), <10:00-12:00>
Room 3

Plasma Irradiation to Subcutaneous Cancer Tumor on Mice and Verification of Immune System

○Kenta YONETAMARI*, Yuki SHIRAKAWA*, Kazue MIZUNO** and Ryo ONO*

*Department of Advanced Energy, The University of Tokyo,**Department of
Bioengineering, The University of Tokyo

Abstract:

Cancer treatment using plasma has intensively studied these days. In this study, mouse melanoma cells were injected subcutaneously on mice and treated using nanosecond pulsed streamer discharge. Two types of mice were used, CD2F1 and Balb/c nu/nu.

The former has immunity and the latter lacks immunity. It was shown that the treatment of CD2F1 is effective, while that of Balb/c nu/nu is not effective. It suggests that the plasma treatment might stimulate the immune system in mice that is effective for cancer treatment.

24aC-5

September 24th (Thu.), <10:00-12:00>
Room 3

Verification of Sterilization Effect by OH radicals Using Vacuum Ultraviolet Light Method

○Kenta YONETAMARI and Ryo ONO

The University of Tokyo

Abstract:

Recently, plasma medicine is one of the most attracting fields because radicals in plasma have the therapeutic and sterilization effects. However, the mechanism is not revealed so plasma medicine is not yet to use. In this study, sterilization experiment of bacillus atrophaeus (ATCC9372) was performed using VUV method which is developed in our previous work. As a result, sterilization effect was observed when wet He and He/O₂ was used as the working gas. This result indicates that OH radical kills bacteria.

24aC-6

September 24th (Thu.), <10:00-12:00>
Room 3

Examination of Cell Separation Condition Using the Inclined Comb-shaped Dielectrophoretic Electrodes

○Masayo TAKANO, Takayuki ITOI, Takaharu ENJOJI and Yoshikazu WAKIZAKA

AFI Corporation

Abstract:

The importance of cell separation techniques are increasing with development of biopharmaceutical and regenerative medicine. Dielectrophoresis (DEP) is a noninvasive method for cell separation without labeling the cells. We had developed the DEP devices with the inclined comb-shaped electrodes for cell separation, and examined the effect of micro-gap size between electrodes, flow rate and AC voltage on cell separation efficiency. Furthermore, the viable and the non-viable cells were separated, and also one cell line was separated from mixture of two cell lines by the DEP device.

24aC-7

September 24th (Thu.), <10:00-12:00>
Room 3

Study of dielectrophoretic property of DNA-labeled dielectric microbeads for DNA detection

Michihiko Nakano, Hiromichi Kasahara, Zhenhao Ding, ○Junya Suehiro

Department of Electrical Engineering, Kyushu University

Abstract:

New DNA detection method using dielectrophoresis (DEP) of dielectric microbeads was proposed. The method is based on dynamic change of microbeads DEP by attaching DNA. Dielectric microbeads having natively negative DEP property become behaving positive DEP when they are labeled with DNA. The DNA-labeled microbeads can be collected on a microelectrode by positive DEP. DEP collection of the DNA-labeled microbeads causes the impedance change of the microelectrode. By measuring the impedance change, DNA-labeled microbeads are detected. The aim of this study is to investigate influence of DNA on the dielectrophoretic property of the dielectric microbeads. The crossover frequency of DEP and zeta potential of the microbeads were investigated. Three kinds of DNA and two kinds of microbeads were used. From the results, it was suggested that not only the conductance of DNA but also permittivity of DNA could affect DEP of the microbeads. Moreover, it is demonstrated that quantitative detection of DNA.

24pC-1

September 24th (Thu.), <15:45-17:45>
Room 3

A study on Verification of Impurity Density Spatial Distribution in Silicon Wafer through Surface Potential Measurement with Electrostatic Force Microscope

Daichi Satou*, Haruyuki Miyano***, ○Hiroaki Takatsu*, Jumpei Higashio**,
Toshio Uehara**, Yoshihiro Takahashi***, Yoshito Ashizawa***, Arata
Tsukamoto***, Katsuji Nakagawa***

Nihon University* ***, Trek Japan Co.,Ltd**

Abstract:

Electrostatic force microscope (EFM) we developed can measure voltage on surface (VS) up to 1 kV in air with extremely high sensitivity (~20 mV) as well as high spatial resolution (~10 μm). We applied the EFM to measure impurity distribution. It is revealed that the measured VS showed opposite voltage polarity depending on n- or p-type dopant. The VS should correspond work function difference between sensor metal and Si substrate to keep flat-band condition of Si substrate. We observed density distribution of impurities with EFM by this method, and discussed the results.

24pC-2

September 24th (Thu.), <15:45-17:45>
Room 3

Study on N₂ plasma processing to TiO₂ Photocatalyst

○Shota YAZAWA, Kiyozumi NIIZUMA, Yusuke KUDO

College of Industrial Technology, Nihon University

Abstract:

A photocatalyst is attracting widespread attention because it works semipermanently under light irradiation. A photocatalyst has useful characteristics such as an oxidative decomposition and a super-hydrophilicity. However, TiO₂ photocatalysts which are often used can be activated only by ultraviolet rays. The ultraviolet rays for photoactivation of TiO₂ are included nearly zero in indoor lights. If a photocatalyst can be activated with visible light as well as ultraviolet light, a photocatalyst can be used not only outdoors but also indoors. N-doped TiO₂ is one of visible light responsible photocatalysts. We tried to produce N-doped TiO₂ with N₂-plasma processing. We have focused on the sample temperature under an N₂-plasma processing. In this study, the N₂ plasma processing time to TiO₂ was changed.

24pC-3

September 24th (Thu.), <15:45-17:45>
Room 3

Improvements of 150 .C annealing technique for dye-sensitized solar cells

Shungo Zen

The University of Tokyo Department of Advanced Energy

Abstract:

Dye-sensitized solar cells (DSSCs) require annealing of TiO₂ photoelectrodes at 450C to 550C. However, high-temperature annealing is unfavorable because it limits the use of materials that cannot withstand high temperatures. In previous papers, we proposed a 150C annealing technique of TiO₂ photoelectrodes to reduce the annealing temperature from 450C to 150C using a conventional TiO₂ paste that contains organic binders. Using our technique, η of 4- μ m-thick TiO₂ film is achieved approximately 110% compared with that of 500C annealing and η of 11- μ m-thick TiO₂ film DSSCs is lower than that of 500C annealed.

In this paper, we improve the 150C annealing technique by heating Dielectric Barrier Discharge (DBD) treatment device.

24pC-4

September 24th (Thu.), <15:45-17:45>
Room 3

Synthesis and Shear Piezoelectricity of Optically Active Polysuccinimide.

○Kazuhiro TANIMOTO^{*,**}, Shota SAIHARA^{*}, Yu ADACHI^{*}, Yuhei HARADA^{*}
and Yoshiro TAJITSU^{*}

^{*}Graduate School of Engineering, Kansai University ^{**}Mitsui Chemicals, Inc.

Abstract:

Optically active crystalline polymers show shear piezoelectricity due to their asymmetric crystal structure. Polysuccinimide (PSI) is minimum structure of an optically active polyimide and we reported that optically active PSI shows shear piezoelectricity. In this study, we synthesized optically active polysuccinimides (PSI) and evaluated their shear piezoelectricity. As a result, the maximum value of shear piezoelectric d constant was 1.56 pC/N. This value is higher than many biopolymers and polypeptides.

24pC-5

September 24th (Thu.), <15:45-17:45>
Room 3

Numerical Analysis on Body Force Characteristic of Dual-Grounded Tri-Electrode Plasma Actuator

○Asa Nakano, Hiroyuki Nishida, Masaki Tamura

Tokyo University of Agriculture and Technology

Abstract:

In this research, we focus on dielectric barrier discharge plasma actuator (DBDPA).

DBDPA is an active flow control device and when high frequency AC voltage is applied to it, it generates body force brings in inducted flow. However, this induced flow is too weak to install on aerodynamic bodies in a high-speed flow so we have suggested Dual-Grounded Tri-Electrode plasma actuator (DGTEPA) which makes stronger thrust with higher efficiency. In this study, we compare the body force of DBDPA and DGTEPA for different applied voltage by a plasma simulation. First it is confirmed that the simulation results are in qualitatively agreement with the experiments from the viewpoint of plasma distribution. Next we discuss the voltage characteristics of the body force and body force - power ratio. As a result of simulation, we found DGTEPA has smaller time averaged body force with worse efficiency than DBDPA. Although the quantitative discrepancy exists, it is expected that the simulation can reproduce the qualitative trends.

24pC-6

September 24th (Thu.), <15:45-17:45>
Room 3

Production of a shock wave by a nanosecond-pulse discharge and the effects on the flow control

○Atsushi Komuro, Shuto Matsuyuki, Kaiki Konno, Kazunori Takahashi, Akira Ando

Tohoku University

Abstract:

Flow control technique driven by the nanoseconds-pulse discharge was investigated. As a fundamental experiment, we observed a shock wave generated by the nanoseconds-pulse discharge by the schlieren visualization. A complex pattern of quasi-planar and spherical compression waves was observed. From the schlieren imaging, shock wave intensity was evaluated with its contrast. The results showed that shock wave intensity increases as a pulse peak voltage increases and a rising time is lengthened.

24pC-7

September 24th (Thu.), <15:45-17:45>
Room 3

Experimental Estimation of Electrohydrodynamic Force on DBD Plasma Actuator and Its Validation

Hiroyuki Nishida

Tokyo University of Agriculture and Technology

Abstract:

To experimentally estimate the EHD force field generated by a DBD plasma actuator (DBDPA) using PIV measurement, some techniques have been proposed by several researchers. In those methods, the EHD force is estimated based on the Navier-Stokes equations under some assumptions.

Because of the assumptions, it is important to validate the result. In this study, the EHD force field is estimated by three different methods, and the comparison of these results is conducted. From the viewpoint of the time-averaged body force field, the result with the assumption of quasi-steady body force is different from other results with neglecting the pressure gradient or the vertical EHD force. From the view point of the time-varying body force, the results under the assumption of no-pressure gradient and no-vertical EHD force are similar. However both results have some estimation errors; a negative body force appears during no-discharge period.

25aA-1

September 25th (Fri.), <10:00-10:45>
Room 1

Minimally-Invasive Electrically-induced Bubble Injector for Patterning to Variety of Biological Materials

Kazuki Takahashi, Yoko Yamanishi

Shibaura Institute of Technology, JST PRESTO

Abstract:

We have successfully developed minimally-invasive bubble injector which is applicable for variety of biological materials with various hardness. The novelty is that the minimally-invasiveness of injection whose resolution is in the range of 10 - 200 μm , and hence cellular-scale injection and two-dimensional patterning injection can be fulfilled. The novelty of the present techniques are (1) unique perforation techniques by means of cavitation phenomena using high-speed bubbles cavitation, (2) powerful but minimally invasive precise perforation to wide range of biological materials, (3) high versatility that bubble-injector can be used under water and in the air. The developed injector can be used for wide range of biomedical study, especially in gene engineering. This technique has advantages over the conventional electroporation or ultrasound operation in terms of localization of injection and ability of transportation of material.

25aA-2

September 25th (Fri.), <10:00-10:45>
Room 1

A Study of Mechanism of High Piezoelectric Performance Poly (lactic acid) Film Manufactured by Solid-State Extrusion

○Mitsunobu Yoshida*,**, Yoshiro Tajitsu**

○*Mitsui Chemicals Inc., **Graduate School of Engineering, Kansai University

Abstract:

A piezoelectric film of poly (L-lactic acid) (PLLA) has no pyroelectricity and has a high voltage output coefficient g ; thus, recently, it has become a key material for realizing pressure sensors with high sensitivity.

For realizing small sensors with high sensitivity, the piezoelectric performance of PLLA films should be improved. Previously, we investigated solid-state extrusion (SSE) to improve the piezoelectric performance of poly (D-lactic acid) (PDLA), which showed that piezoelectric constant d_{14} reached 18.9 pC/N. In this paper, we conducted quantitative crystal structural analysis by X-ray diffraction (XRD) and geometric structural analysis of a helical chiral polymer to investigate the mechanism of the high piezoelectric performance of SSE films.

25aA-3

September 25th (Fri.), <10:00-10:45>
Room 1

Fundamental characteristics of discharge in the short gap length using the Cockcroft-Walton circuit

Yuma SANO

Department of Mechanical and Electrical Engineering, Nippon Bunri University

Abstract:

We were using a battery to power in this study. We have to control the voltage by the switch. And the positive DC voltage is applied to the needle electrodes in the Cockcroft-Walton circuit through the DC-AC inverter. The experiment of the basic properties of corona discharge in the closed-type needle-to-plane electrode system reactor we went.

Atmospheric pressure non-thermal equilibrium plasma is utilized in the removal of air pollutants. The Cockcroft-Walton circuit is used in the accelerator. It was applied to the needle electrode by raising the voltage at the Cockcroft-Walton circuit. It was discharged in a dark room. Bluish white light was generated at the tip of the needle electrode. If you confirm with the naked eye. DC discharge current pulsations appear to be affected by the DC-AC inverter. It is measured by the oscilloscope.

25aB-1

September 25th (Fri.), <11:00-12:00>
Room 1

Low ozone emission characteristics of a carbon brush ionizer

Hak-Joon Kim, Bangwoo Han, Chang-Gyu Woo, Yong-Jin Kim

Korea Institute of Machinery and Materials (KIMM)

Abstract:

The concentration of ozone produced as a by-product of ESP usage was measured by changing the voltage to an ionizer with thin carbon fiber brushes, and it was compared to those from general ionizers which were made of different materials for high voltage electrode or were made of carbon electrodes with different diameters and numbers. This was done in order to understand the reason why carbon brush ionizer emits low ozone, which has not been researched until now. The experimental results showed that the low ozone emission from a carbon brush ionizer was possible not by material but by sharpness of the high voltage electrode and by multi electrode effect.

25aB-2

September 25th (Fri.), <11:00-12:00>
Room 1

Hak-Joon Kim, Bangwoo Han, Chang-Gyu Woo, Yong-Jin Kim

Korea Institute of Machinery and Materials (KIMM)

Abstract:

A novel two-stage ESP for IT manufacturing industries was developed that uses indirect type carbon brush charger which is located outside of a main gas flow duct to achieve perfect separation from contact of polluted gases, and imposes additional electric field between upper and bottom plates of the charging stage to enhance collisions between ions and particles thus increase particle charges. The performance of the ESP was evaluated experimentally for ultrafine particles with a mean diameter of 100 nm based on number by varying the voltages for chargers and for additional electric field imposing, and number of the chargers. The total air flow rate for the test were approximate 110 L/min with 10 : 1 ratio of main and mixing flows in the ESP, and applied voltages for chargers and additional electric field were from -10 to -22 kV, and from -5 to -10 kV, respectively. Collection efficiencies in the ESP were linearly proportional to increase in number of chargers and applied voltage to chargers, while those were inversely proportional to increase in applied voltage for additional electric field. The collection efficiency of the ESP was reached to over 90% based on total particle number at the applied voltage to triple chargers of -15 kV and additional electric field between upper and bottom plates in charging stage of -6 kV/ 100 mm

25aB-3

September 25th (Fri.), <11:00-12:00>
Room 1

Study on influence of exhaust gas temperature in the electrostatic precipitator

○Mitsuhiro Takasaki, Hirofumi Kurita, Kazunori Takashima and Akira Mizuno

Dept. of Environmental and Life Sciences, Toyohashi University of Technology

Abstract:

A diesel engine is one of the most fuel efficient engines and expected to save energy even it is necessary to remove particulate matter (PM) contained in the exhaust gas. Diesel particulate filter (DPF) has been established as a key technology in reducing diesel PM, however, technological improvements to pressure drop is still required.

Therefore, we focused on an electrostatic precipitation by taking advantage of its small pressure drop and efficient collection of nano-sized particles. However, one of the problems with an electrostatic precipitator (ESP) is abnormal dust re-entrainment. To cope with this problem, we studied the effect of gas temperature and surface roughness of collecting electrode on electrostatic precipitation of diesel PM. As a result, lower gas temperature showed stable collection and high collection efficiency of particles. In addition, varying the surface roughness of collecting electrode was effective for improving the collection efficiency by installing a mesh on it.

25aB-4

September 25th (Fri.), <11:00-12:00>
Room 1

Water purification using a packed bed reactor with pulsed electric field

○Yudai TAKEDA, Yuki TAINO, Hirofumi KURITA, Hachiro YASUDA, Kazunori TAKASHIMA and Akira MIZUNO

Dept. of Environmental and Life Sciences, Toyohashi University of Technology

Abstract:

In previous study, we have developed a novel water treatment technique to remove and inactivate bacteria such as *Escherichia coli* (*E. coli*) utilizing dielectrophoresis (DEP) induced by pulsed high voltage application. The result showed that *E. coli* was successfully trapped by DEP force and at the same time, inactivated by pulsed electric field (PEF). However, the effect of electrical properties of sample water on the collection and sterilization characteristics was not studied. In this study, influence of the conductivity of the samples on the collection and sterilization of *E. coli* was investigated. The conductivity of the samples was adjusted by NaCl and mannitol addition as well as bacteria concentration. As a result, removal and inactivation rate of *E. coli* decreased with conductivity of the sample. But around 50% inactivation rate was observed even for highly conductive sample.

Comparison between *E. coli* and PS beads having nearly the same size showed that *E. coli* was collected much more effectively than PS beads probably because of its agglomerative nature. High inactivation efficiency by PEF can be resulted from the agglomeration on the pellet surface, through which it is more likely for the cell membrane to be broken when the pulsed electrostatic field is induced.

25pA-1

September 25th (Fri.), <14:00-15:15>
Room 1

Charging methods to create uniform surface charge distributions with wide potential range

A. Ohsawa

JNIOSH

Abstract:

We have investigated corona charging methods using corona needle arrays or a corona triode for the creation of a uniform surface charge distributions with wide potential range on insulating films in contact with a grounded plate. Two types of corona needle arrays were used. In the triode charger, we sought optimum conditions of the separation between the grid and the film, the way of the electrical treatment of the grid, such as isolated, grounded with a resistor from 30 M Ω to 1000 M Ω , with voltage application and the corona discharge of 7 wires of 0.1 mm or 0.05 mm driving at constant voltage or current modes. Consequently, it was found that a triode charging system with corona wires of 0.05 mm in diameter and a grid electrode at a wanted surface potential with a grounded resistor can create the uniform charge distributions on the films

25pA-2

September 25th (Fri.), <14:00-15:15>
Room 1

Numerical Simulation of Behavior of Tumor Cell in Three Dimensional Dielectrophoretic Device

KENTA Sato

Tokyo Metropolitan University

Abstract:

Effective separation and condensation processes are essential for precise detection of circulating tumor cells in early diagnosis of cancer. In this study, we proposed a dielectrophoretic device with micro pillar electrodes as cell separator. Also, we simulated the spatio-temporal behavior of model cells on the basis of microfluidics and electrokinetics. The particle trajectory in a flow direction was changed by negative dielectrophoretic force generated between the pillars. This result suggests the tumor cells can be purified from real blood under adequate electrical condition.

25pA-3

September 25th (Fri.), <14:00-15:15>
Room 1

Control of Dc Partial Discharge Development Creeping on Charged Insulating Film Surface in Air

Yoshiaki YAMANO

faculty of Education, Chiba University

Abstract:

The development of surface discharge on charged insulating film in air (one kind of ESD) was controlled by superimposing the normal component of electric field on the charged film surface. The film used was PET of 50 mm thick. The surface was charged up to ± 1 kV in maximum with corona discharges. The longest air gap between HV electrode tip of metal and the charged film surface was 1.5 mm. The results suggest that the control of discharge development on charged surface may be possible if the additional HV electrode is applied to increase the normal electric field component on the film surface.

25pA-4

September 25th (Fri.), <14:00-15:15>
Room 1

A new method for measuring electric field in air by a charged droplet

Takashi Sato

Hokkaido University of Science

Abstract:

A quadrupole electrode which is constituted with two pairs of wire electrodes was used. A charged droplet is held in the central area of the quadrupole electrode by a high-frequency electric field. If an additional electric field is applied to this system, the charged droplet is affected by it and will move or vibrate by the external field. We tried to measure the electric field strength in air from the movement of the droplet by a D.C. electric field and the vibration amplitude by an A.C. electric field.

25pA-5

September 25th (Fri.), <14:00-15:15>
Room 1

Effect of Corona Discharge on EHD Spray

Hyun-Ha KIM

AIST

Abstract:

The effect of corona discharge on the electrohydrodynamic (EHD) spray was studied for both polarities of negative and positive DC voltage. Various spray modes were visualized using a high-speed camera. The time-resolved images provided some information on the different elongation pattern according to the polarity. Typical onset streamers in air under positive polarity had minimal influence on the spray mode because they were found to be separated in time and space from the water meniscus. In contrast to the stable glow under positive polarity, many current pulses (Trichel pulse) were observed in the negative EHD spray. From the combined analysis of the corona discharges, one may conclude that the different properties of the coronas were associated with the spray patterns in both air and pure CO₂ environment.

25aD-1

September 25th (Fri.), <10:00-12:00>
Room 2

Development of the Static Measuring Equipment under Vacuum Environments.

○Tomoko NAKAYAMA, Teppei HOTOHARA, Tomofumi MOGAMI, Yoshiya MIYABAYASHI and Nobuo NOMURA

KASUGA DENKI, INC

Abstract:

Chemical compositions of the ions generated by atmospheric pressure helium plasma were investigated using an atmospheric pressure ionization mass spectrometry (API-MS).

The plasma generator used in this experiment was composed by a union-tee, a quartz glass tube and a stainless steel rod. In the negative ion mass spectrum with a distance between the glass tube tip and the sampling orifice being 5 mm, several ion species were observed. The observed ions include O^- , OH^- , O_2^- , O_3^- , CO_3^- , HCO_3^- and

HCO_4^- . Most of these ions formed hydrated cluster ions and the ions of $O_2^-(H_2O)_n$ were the most abundant in the spectrum. The spectrum changed significantly by changing the distance between the glass tube tip and the sampling orifice to 10 mm. The peak of CO_3^- became the most intense peak and the ions of O_2^- and HCO_4^- decline, which was probably due to the ion-molecule reactions with surrounding molecules.

25aD-2

September 25th (Fri.), <10:00-12:00>
Room 2

Charge neutralisation from the side surface of an insulating plate -- Use of grounded planes to control ion flows

A. Ohsawa

JNIOSH

Abstract:

This paper presents the effect of the placement of grounded planes to control ion flows on charge neutralisation from the side surface of an insulating plate. We investigated the phenomena of this charge neutralisation using 2-D electrohydrodynamic simulations with an insulating plate with 1 cm or 1 mm thick and with different initial charge distributions at $1 \mu\text{C}/\text{m}^2$. Consequently, we found that the grounded planes can modify the charge neutralisation; however, it is not easy to neutralise the surface charges uniformly, so that charge neutralisation from the side surface of an insulating plate is improper for practical applications; as concluded previously, we can suggest again that simultaneous charge neutralisation from both larger surfaces would be proper.

25aD-3

September 25th (Fri.), <10:00-12:00>
Room 2

Minimisation of offset voltage for pulse-DC corona ionisers

A. Ohsawa

JNIOSH

Abstract:

We present an experimental demonstration of a prospective idea obtained from 2-D electrohydrodynamic simulations of positive and negative ions where continuous emission of quasi-neutralised positive and negative ions from corona ionisers can yield zero offset voltage. We developed a continuous balanced pulse-DC ioniser using FET push-pull circuits and demonstrated this theory.

25aD-4

September 25th (Fri.), <10:00-12:00>
Room 2

Discharge Current from two-terminal devices measured by the discharge-current probe

Yutaka Soda

Probetek

Abstract:

Contact discharge from two-terminal devices was investigated using the discharge-current probe, which was newly developed current-probe for measuring the contact discharge. A contact-pin and a discharge-resistance can be connected by SMA-connector. A single stripe applied 20V on a bakelite-stage discharged with 60mA peak-current, whereas that on a metal-stage increased to 100mA. The capacitance estimated by integrating the current-waveform increased with the material of the stage rather than the size of the pattern. Two terminal devices of a resistance, an inductance and a capacitance were measured the discharge-current. The peak-values were almost equivalent, however the decay-waveforms were different as the current delayed across the element.

25aD-5

September 25th (Fri.), <10:00-12:00>
Room 2

Investigation of a Fire that Occurred while Transferring Gasoline from a Drum to a Tank of a Fixed Oiling Equipment

Hiroyuki TAMURA

National Research Institute of Fire and Disaster

Abstract:

At a fixed oiling equipment in a plant, ignition happened while transferring gasoline from a drum to a tank of a fixed oiling equipment, and worker's protective wear was damaged by a fire. The possibility of the ignition by static discharge was examined as a fire cause. Because antistatic measures were not taken, it seemed that the worker was electrified. The induction charging happened in an aspirator pipe when the electrified worker gripped the aspirator pipe. It has been understood that the electrical discharge by the electrification has energy that exceeds the minimum ignition energy of gasoline.

25aD-6

September 25th (Fri.), <10:00-12:00>
Room 2

Electric Field Strength at the Surface of a Grounded Electrode by a Charged Particle Cloud Simulated by Line charges and Condition for Discharge Inception

○Yoshio HIGASHIYAMA, Masaaki ENDO and Toshiyuki SUGIMOTO

Graduate School of Science and Engineering, Yamagata University

Abstract:

To cause a large scale electrical discharge from a space charge cloud, a charged particle cloud was formed by ejecting from a corona charger consisting of a wire to cylinder electrode. The potential distribution around the cloud and the electric field strength for streamer discharge inception from a grounded sphere electrode was investigated by field calculation using a charge simulation method. Based on the experimental data, a model of charged particle cloud was constructed. The space charge of the cloud was simulated by line charge with a charge density of around $8\mu\text{C}/\text{m}$ estimated from a discharge current. The potential in the center of the cloud reached at $350\text{kV}/\text{m}$ for a 4 m long and 1 m diameter cloud. Although the electric field strength at the surface of a spherical electrode with a smaller diameter becomes higher for the same charged cloud, under the condition when a brush discharge was observed, the electric field strength was almost the same value regardless of diameter and location of a sphere electrode. Furthermore, the ionization distance obtained by calculation was consistent with a length of a streamer discharge extending from a grounded electrode.

25aD-7

September 25th (Fri.), <10:00-12:00>
Room 2

Dust-proof performance of bi-polar electrostatic ionizer

Naoto Nogera¹, Teruo Suzuki¹, Kwangseok Choi², Mizuki Yamaguma²

Kasuga Denki Inc.¹, National Institute of Occupational Safety and Health,
Japan²

Abstract:

In this paper, we investigated the dust-proof performance of the bi-polar electrostatic ionizer experimentally. Circulating type dust testing apparatus and talcum powders 6 μm were used in this study. Compressed air supplied to the bi-polar electrostatic ionizer was in the range of 0.01 - 0.05 MPa. Each test time was 1800 s. As the result, in the inner parts of the ionizer, talcum powders did not enter under all test conditions. It was also confirmed that the ion generating ability was the same before and after the dust-proof testing.

25pB-1

September 25th (Fri.), <14:00-15:00>
Room 2

Study of Plasma-assisted Combustion for Low Emission

○Tomohiko IKEDA*

Study of Plasma-assisted Combustion for Low Emission

Abstract:

This paper proposes using a dielectric barrier discharge (DBD) instead of catalyst of catalytic combustion. The catalytic combustion is used for a stable combustion of a lean mixture, but it has some disadvantages. The DBD is expected to reduce the disadvantages of the catalyst. A lean premixed methane-air mixture flows in a DBD, then the emission gas is measured. It is shown that the DBD can cause combustion below the lean flammable limit. When the discharge energy increases, the combustion rate of methane increases, while NO_x emission increases. It means that radicals in plasma promote chemical reaction different from the usual combustion reaction.

25pB-2

September 25th (Fri.), <14:00-15:00>
Room 2

Production of Au Nanoparticle Films Using Electron-Beam Induced Non-Thermal Plasma on the Surface of Aqueous Solutions

○Teruyuki HAKODA*, Ayaka TAKAHASHI**, Akihiko SHIMADA*, Shunya YAMAMOTO*, Hirofumi ARITANI**, and Tetsuya YAMAKI*

*Japan Atomic Energy Agency, ** Saitama Institute of Technology

Abstract:

Aqueous solutions containing 1 mmol/L AuCl₄⁻ ions and 0.5-20v% alcohol (2-propanol or ethanol) were irradiated with a few tens keV electron beams (EBs). Gold (Au) films were produced on the surface of the irradiated solution. The

production rate of the Au films was high at concentrations of 0.5-1v% for 2-propanol and became lower at higher concentrations. At an alcohol concentration of 0.5v%, the Au particles of the films were 5-20 nm and

5-100 nm in diameter for 2-propanol and ethanol, respectively. The XPS analysis demonstrated that the films consisted of about 85wt% of metal Au(0), 10wt% of Au(I), and a few w% of Au(III) for 2-propanol. A Fourier transform infrared diffusion reflectance (FTIR-DR) measurement showed that CO was oxidized into CO₂ over the Au films loaded to TiO₂ substrates at a temperature of 200°C, enabling us to confirm a catalytic activity.

25pB-3

September 25th (Fri.), <14:00-15:00>
Room 2

Generation of ZnO particle using pulse arc discharge plasma

Kunisuke Fujii

Kumamoto University

Abstract:

ZnO particle has a high UV shielding property and transparency. So ZnO particle is widely applicable, for example cosmetics, medicines and plastics. But, usual creating method is difficult control and complicated equipment. In this study, ZnO particle was created using pulse arc discharge plasma. This method is easier control and complicated than usual. And, we investigated influences of component of the product, diameter of the product and shape of the product by charging energy and gas pressure.

25pB-4

September 25th (Fri.), <14:00-15:00>
Room 2

Atmospheric Plasma Hybrid Surface Treatment for Fluoropolymer Plastics (Toward Applications for Medical Devices, Biocompatible Materials, and Electronic Devices)

Masaaki Okubo, Tomoyuki Kuroki

Osaka Prefecture University

Abstract:

A surface modification technique that improves the adhesion of fluorocarbon polymer films such as polytetrafluoroethylene (PTFE) is developed using argon at atmospheric pressure and acrylic acid vapor nonthermal plasma. From results of peeling tests, XPS analyses, and SEM photograph, it is confirmed that chemical bonds with F atoms decrease greatly on the surface and that a hydrophilic layer is formed due to the process. Using the present surface treatment apparatus, it is possible to bond A4-sized sheets of PTFE and metals or rubbers without losing the excellent physical properties of PTFE.

25aC-1

September 25th (Fri.), <10:00-12:00>
Room 3

Effect of ozone applying method on removing floating weeds

○Yoshihiro KAWADA*, Keiko OSHIDA** and Hirotaka SHIMIZU*

*The Polytechnic University of Japan **Nihon University

Abstract:

Colonies of floating weeds are grown over at the stagnant water area of a lake and a river. These often cause environmental issue. Therefore, it is needed for maintain water environment to prevent growth for the floating weeds. The aim of this study is to control growth and death of floating weeds with ozone. The applying method of ozone to floating weeds is investigated. As results, when ozone is applied to the gas around floating weeds, floating weeds are dead effectively. To apply the water with ozone to the floating weeds is less effective than to apply to air around floating weeds. In case that the ozone generator is driven by solar array, the floating weeds having the leaves of approximately 5 times area as large as that of solar array could be dead.

25aC-2

September 25th (Fri.), <10:00-12:00>
Room 3

Effect of Swirling Liquid Flow on Plasma-based Water Treatment

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Abstract:

Three-dimensional (3D) printing technology is now essential in making things, and we have introduced this technology into the design and fabrication of non-thermal plasma reactors. In this study, water injection part of the plasma reactor was prepared by a 3D printer. To produce swirling liquid flow in the running water along an inner wall of a cylindrical tube, a specific design was added into the injector. Three types of the injectors were prepared by the 3D printer and those performances were evaluated by the comparison of the decolorization rate of indigo carmine solution. As a result, the swirling liquid jet type injection was most effective method under our experiments for water treatment.

25aC-3

September 25th (Fri.), <10:00-12:00>
Room 3

Influence of Pulse Width on Decomposition of Dichloromethane by Discharge Inside Bubbles in Water

○Masashi IWABUCHI*, Keita WADA*, Katsuyuki
TAKAHASHI*, Koichi TAKAKI*, Naoya SATTA**

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Abstract:

Influence of pulse width on decomposition of dichloromethane by discharge inside bubbles in water has been investigated. The discharge reactor consists of a glass tube and a tungsten wire inserted into the glass tube, which is immersed in the water. Argon gas is injected into the glass tube to generate bubbles in the water.

Two types of pulsed generator, a magnetic pulse compression circuit and an inductive-energy storage system using semiconductor opening switch, are used to generate high voltage pulse with various pulse widths.

Dichloromethane (DCM) which is a volatile organic compound is employed as a specimen to evaluate decomposition efficiency. The DCM is decomposed successfully by discharge inside bubbles in water. TOC removal efficiency and DCM decomposition efficiency are similar in each pulse width. Energy efficiency for decomposition increases by decreasing the pulse width.

25aC-4

September 25th (Fri.), <10:00-12:00>
Room 3

Development and evaluation of pencil type solution plasma reactor

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Abstract:

Solution plasma (SP) is defined as; one type non-equilibrium, cold plasma in liquid. SP is different from other systems by avoiding inert gas usage, and generating inside solution environment. SP has been used for metal nanoparticles synthesis, surface modifications, organic-compound decompositions, and carbon materials synthesis. There are application limitations because of small plasma area inside solution. It is necessary to increase the plasma area in order to obtain higher efficiency from the process. In this study, we have developed a new reactor for continuous processing and continuous synthesis of the material. Non-equilibrium plasma was generated with two type of reactors (attached needle electrode and coil electrode or mesh electrode). Despite of two reactor usage, solution temperature didn't increase even after 30 min of discharge. It is observed that by decreasing electrodes distance, plasma is shifting from the end of needle electrode and generating between mesh and needle electrodes with a higher energy. We have succeeded in developing a new reactor, which can generate plasma continuously.

25aC-5

September 25th (Fri.), <10:00-12:00>
Room 3

Effect of irradiation distance of plasma jet on ROS supply to liquid bottom.

○Shota KUSUMEGI, Akihiro KUDO, Takuya TSURUMARU, Tomohiro
SAKANOSHITA, Akihiro SATO, Yasutaka WAKABAYASHI, Toshiyuki
KAWASAKI

Nippon Bunri Univ.

Abstract:

The supply of reactive oxygen species (ROS) to a target through liquid by plasma jet should be clarified. However, the detailed mechanisms are not clear now. Therefore, the ROS generation in liquid by the plasma jet has been studied by various measurement methods. In this study, the use of a gel reagent with iodine-starch reactions has been focused as a plasma-generated ROS detection method. The gel reagent can work even in water. In this paper, a plasma jet was irradiated onto the water surface, and the ROS reaching the water bottom were detected using the gel reagent set in the water. The plasma jet generator was made of a glass tube with wrapped powered and grounded electrodes. Helium gas with 1% oxygen was supplied into the glass tube at a flow rate of 3 L/min. The water layer with a thickness of 1 mm was placed onto the gel reagent. The irradiation distance was varied from 5 to 30 mm. As a result, the ROS supply to the water bottom by plasma jet was significantly influenced by the irradiation distance. The results obtained in this study also indicated that the ROS supply mechanisms were markedly different from the ozone exposure.

25aC-6

September 25th (Fri.), <10:00-12:00>
Room 3

Decomposition characteristic of olive oil and various fatty acids in oil-water mixture by pulsed discharge plasma and ozone treatments

○Takanori TANINO, Daiki KAWAI and Takayuki OHSHIMA

Graduated School of Science and Technology, Gunma University

Abstract:

Decomposition characteristic of olive oil in oil-water mixture by pulsed discharge plasma and ozone treatment was investigated. The decomposition profile of olive oil showed liner decrease for the initial

10 min treatment and became slower after that in the pulsed discharge plasma treatment. In ozone treatment, rapid decrease was observed for initial 5 min treatment. Solid substance was produced by both pulsed electric discharge and ozone treatment. Decomposition characteristics of several chain length fatty acids by both treatments were also investigated. As short and middle chain fatty acids, butyric and caprylic acids were used, respectively. These short and middle chain fatty acids were successfully decomposed by the pulsed discharge plasma treatment. On the other hand, ozone treatment could not decompose these fatty acids.

25aC-7

September 25th (Fri.), <10:00-12:00>
Room 3

Effect of Organic Acids on Cesium Removal from Contaminated Soil by the Electrokinetic Remediation

○Tomoaki MIURA*, Mahmudul KABIR*, Masafumi SUZUKI*, Shyunsuke
NAKAJIMA**, Shigehisa MORI**

*Graduate School of Engineering and Resource Science, Akita University,
**Sanwa Tekki Corporation

Abstract:

Radioactive materials were scattered on the vast area near Fukushima, Japan after the Fukushima Atomic Power Plant accident after the earthquake occurred on the 11th March, 2011. Among the radioactive materials, especially Cesium (Cs) caused a severe contamination of soil and due to its longer half-life (30.0 years), the removal of Cesium is urgently needed. However, the removal of Cesium from soil especially in the mountainous area is not so easy. We have proposed a method of Cesium removal which can also be applied in the slope area. Non-radioactive Cesium was used in our experiments. During the Electrokinetic process of the contaminated soil, acetic acid and citric acid were applied in purpose of more Cesium removal. These acids are easily decomposable in nature. Without any electric field, a small range of Cesium removal was possible with tap water, and the two organic acids. Performing the experiment with Electrokinetic process, using acetic acid as electrolyte, showed a better result considering the amount of removal of Cesium. Thus, our Electrokinetic process has showed good results to remove Cesium from contaminated soil.

25pC-1

September 25th (Fri.), <14:00-15:15>
Room 3

Development of volume resistivity sensor using corona charging

○Yuki YOSHIDA*, Toshiyuki SUGIMOTO*, Nobuo

Yamagata University*, KASUGA DENKI. INC. **

Abstract:

Although there is a pencil scratch hardness test to check cure degree of painted film, the painted surface will be destructed by the measurement. A noncontact type cure degree sensor has been developed using noncontact surface resistivity measurement method. The cure degree sensor can principally only apply for the paint on the insulating material. In this paper, the system was improved by changing corona charger so that the electrostatic potential at the charging spot can be measured. It was found that the surface potential of the painted layer on the grounded material was increased with the curing time.

25pC-2

September 25th (Fri.), <14:00-15:15>
Room 3

Fundamental characteristics of sheet stapler using are electrostatic force

Keisuke OZAWA

Yamagata University, KASUGA DENKI. INC.

Abstract:

Although there are many sheet products stuck by glue or adhesive material, it is very difficult to control mechanically adherence and removal. In this study, we proposed an electrostatic sheet stapler that can adhere and remove the sheet material by an electrostatic force. The sheet material is charged by the positive and negative corona charging using two needle and grid electrodes. It was found that the electrostatic sheet stapler can control adherence and removal force by the corona charging and charge elimination and that the withstanding weight is over than 30g.

25pC-3

September 25th (Fri.), <14:00-15:15>
Room 3

Internal Observation of a Levitated Microdroplet Using Electrodynamic Balance

○Yudai SHIRATORI, Kenichi SHODA, Azuchi HARANO

Graduate School of Science and Technology, Gunma University

Abstract:

The electrodynamic balance (EDB), where single charged particle or droplet can be levitated in space over periods of hours, provides the opportunity for in situ observation of aerosol morphologies. Nevertheless, the previously developed EDB has not been able to image with high-resolution from the side view. Hence, we developed a novel EDB optimized for the visual access of an optical microscope. Using this EDB, the deliquescence and solidification behaviors of the inorganic salt droplet (NaBr) was clearly observed.

25pC-4

September 25th (Fri.), <14:00-15:15>
Room 3

MEA Fabrication using Cone-jet Mode of Electrostatic Spray

○Masayuki EGASHIRA, Satoshi MIKAMI, Kodai YAMAOKA, Shota YAZAWA,
Yusuke KUDO, Tetsuo MAKITA

Nihon University, Collage of Industrial Technology, Department of Electrical and
Electronic Engineering

Abstract:

A direct methanol fuel cell (DMFC) is paid attention which is new generation portable power source. It is high cost. Because, DMFC requires a platinum to generate the power. Performance of DMFC is progress by increasing surface area of membrane electrode assembly (MEA). We have been studying about fabrication method of MEA by electrostatic spray. In this study, MEA of DMFC was fabricated by cone-jet mode of electrostatic spray.

25pC-5

September 25th (Fri.), <14:00-15:15>
Room 3

Evaluation of charge elimination property of EFD ionizer

○Yuta GOTO, and Toshiyuki SUGIMOTO

Graduated School of Science and Engineering, Yamagata University

Abstract:

Ionizers are typically used for eliminating the static charge on targets. We have proposed an Electric Field Driven(EFD) ionizer which can supply ions by an electric field in order to eliminate target charge faster than typical air ionizer. In this paper, the charge elimination characteristic of EFD ionizer was investigated. The charge elimination speed was significantly increased with increasing needle voltage and decreasing the distance h between the ionizer and the target. Converted charge eliminate rate Y is linearly increased with time for smaller h .