P 17: Atmospheric Pressure Plasmas - Poster

Time: Wednesday 16:15–18:15 Location: Zelt Ost

P 17.1 Wed 16:15 Zelt Ost

Analysis and direct comparison of spark discharges in air and water in a sub-mm gap — •Hans Höft[1] and Tom Huiskamp[2] — [1]INP Greifswald, Felix-Hausdorff-Straße 2, 17489 Greifswald, Germany — [2]TU Eindhoven, Dept. of Electrical Engineering, Eindhoven 5600 MB, The Netherlands

In this study, a direct comparison was made between pulsed spark discharges in air and water. Such discharges are often used as spark-gap switches in pulsed power systems. The discharges were ignited at atmospheric pressure in the same discharge arrangement for air and water, using a solid-state microsecond pulse source with $\approx 1\,\mu$s voltage rise time ($V_{\max}$ up to 37 kV). Fast voltage and current measurements were combined with iCCD imaging with high spatial resolution (better than $10\,\mu$m) on symmetrical half-sphere tungsten electrodes for electrode gaps of 0.1 to 0.7 mm for air (for water $d_{\mathrm{gap}} = 0.1 \ldots 0.3$ mm). Breakdown voltages and electrical field strengths, maximal currents, transferred charges, consumed electrical energies and the discharge emission structures (e.g. discharge channel diameters) were obtained for all cases. Using the synchronisation of the electrical data and the iCCD imaging, current and energy densities were estimated for the sparks in air and water. It was found that the breakdown voltage, the discharge current, the transferred charge, and the consumed electrical energy increase with the gap distance and that this dependence on d_{gap} is much stronger for discharges in water (compared to air). Due to the use of the same discharge arrangement and the same applied voltage, the difference in the electrical characteristics was directly quantified.

P 17.2 Wed 16:15 Zelt Ost

Investigation of a microwave plasma torch for CO2 gas conversion — •Irina Kistner, Andreas Schulz, Matthias Walker, and Günter Tovar — Institute of Interfacial Process Engineering and Plasma Technology IGVP, University of Stuttgart, Stuttgart, Germany

Since electricity from renewable sources of energy is subject to fluctuations, energy storage on demand plays a crucial role to create a reliable grid system. The CO2 conversion into syngas or higher hydrocarbons via a plasma assisted gas conversion powered by renewable energy is one promising approach towards energy storage. To make this power to gas concept beneficial over other technologies it is of critical importance to improve the energy and conversion efficiency of this process. On the basis of preliminary tests and technological requirements for a microwave plasma unit for CO2 conversion a modular plasma torch consisting of a cylindrical and a coaxial resonator has been constructed. This plasma torch enables a self-ignition and stable operation of an air and CO2 plasma over a wide range of parameters as well as a flexible rearrangement of the different components to ensure the possibility to adapt to different requirements. Via the FEM-Simulation program COMSOL Multiphysics a model of this plasma torch has been developed and the electric field distribution and the gas flow inside the plasma torch have been investigated to optimize the configuration and hence establish the most suitable operation conditions.

P 17.3 Wed 16:15 Zelt Ost

Interferometric and holographic techniques for the diagnostics of axially blown arcs — •Jan Carstensen, Bernardo Galletti, Alexey Sokolov, Charles Doiron, Oguz-Han Asnaz, and Axel Jansson — ABB Corporate Research, Segelhofstr. 1K, 5405 Baden-Daettwil, Switzerland

Recently, we have used two color spatial carrier wave interferometry to measure the electron density and heavy particle density in the stagnation point of a stable, axially blown arc in argon for currents of 50 A to 200 A and stagnation point pressures of 0.2 to 1.6 MPa. [J. Carstensen et al., Phys. Rev. Appl. 8, 024002 (2017)]. In this contribution we will discuss options to improve the sensitivity and the accuracy of the optical setup. In particular, by changing the frequency of the two lasers the minimal detectable electron density can be lowered by one order of magnitude. Furthermore, holographic techniques can simplify the alignment of the optical components and certain imperfection along the optical path can be corrected numerically in the data processing step.

P 17.4 Wed 16:15 Zelt Ost

Studies of high-intensity arcs for switching applications — •Chayma Mohsni[1,2], Margarita Baeva[2], Sergey Gortschakow[2], Steffen Franke[2], Kamel Charrada[1], and Zouhour Araoud[1] — [1]National School of Engineering of Monastir, 5000 Rue Ibn Jazzar, Monastir 5035, Tunisia — [2]Leibniz Institute for Plasma Science and Technology, Felix-Hausdorff-Str. 2, 17489 Greifswald, Germany

Investigations of the arc dynamics during a switching-off process are important to improve the interruption performance of switching devices. Alternatives to the working gas SF6, which is classified as green-house gas with a high global warming potential have to be found for reasons of environnement protection. The presented work is concerned with modelling of an electric arc between tungsten electrodes at atmospheric pressure in various gases (Ar, Air, CO2). As a first stage, a stationary 2D arc plasma model under the assumption of the local thermodynamic equilibrium (LTE) has been established using the computational platform COMSOL Multiphysics. It accounts for the properties of the near-electrode regions in the frame of a simplified sheath model. First simulation results for various current levels will be presented and discussed. Experimental observations will be considered as a reference.

P 17.5 Wed 16:15 Zelt Ost

Electrical characterisation of an atmospheric pressure plasma jet — •Manuel Maas, Judith Golda, Franko Greiner, and Jan Benedikt — Institut of Experimental and Applied Physics, Kiel University

The measurement of rf power coupled into an atmospheric pressure plasma jet is challenging. We investigated the ability of several layouts of current and voltage probes to acquire reliable time series. The ability to extract the phase between current and voltage is tested for three different analysis methods. The power characteristics of an atmospheric pressure plasma jet operated in helium is compared to the intensity evolution of helium excimer band structures measured using optical emission spectroscopy.

P 17.6 Wed 16:15 Zelt Ost

Spatial Electron Temperature and Density Measurement of a Plasma Window Arc Discharge — •Andre Michel, Bernhard Bohlender, Joachim Jacoby, and Marcus Iberler — Institut für Angewandte Physik, Goethe Universität Frankfurt

Optical emission spectroscopy is used for measurements of the free electron density and temperature of a wall stabilized arc discharge inside a newly developed plasma window at the Institute of Applied Physics at Goethe University Frankfurt. The plasma window provides a membrane free beam transmission between two different pressure levels on short length scales, offering advantages over conventional atmospheric to low-pressure interfaces. Due to the different pressure levels, plasma parameters are expected to vary alongside the arc discharge resulting in electron density and temperature gradients. For quantitative estimation radial optical emission spectroscopy measurements were carried out at different axial positions of the discharge. First results of the plasma parameters are presented, depending on the arc current and pressures inside the plasma window.

P 17.7 Wed 16:15 Zelt Ost

Optical emission spectroscopy of excimer emission band structures in an atmospheric pressure helium plasma jet — •Tristan Winzer, Judith Golda, Franko Greiner, and Jan Benedikt — Institute of Experimental and Applied Physics, Kiel University, Germany

Atmospheric pressure plasmas have received increasing attention in recent years due to their potential applications not only in industrial processes but also in plasma medicine. Their non-equilibrium characteristics enable treatment of surfaces which are sensitive to heat. However, diagnostics is challenging due to their small dimensions.

Optical emission spectroscopy (OES) is a non-invasive diagnostic technique providing information about species, excitation mechanisms and gas temperature. Using OES in the visible range, an atmospheric pressure dielectric barrier discharge operating in helium was investigated. The intensity of the molecular bands of helium excimers was studied under variation of gas flow and power dissipated in the plasma. Using a Boltzmann-Plot, we calculated the rotational temperature of helium molecules and drew conclusions on the gas temperature.

P 17.8 Wed 16:15 Zelt Ost

Biofilm Sterilization on Stainless steel by Synergistic Treatment of Atmospheric Pressure Plasma and Chelators — •Chen-Yon Tobias Tschang and Markus Thoma — I. Physikalisches Institut, Justus-Liebig-University Giessen, Germany

Atmospheric pressure plasma (APP) had been show to be strongly effective against bacteria. However, The efficiency drops dramatically when treating bacteria biofilm. Chelators, such as citric acid or ethylenediaminetetraacetic acid (EDTA), are organic compounds which bonds metal ions. Chelators are assumed to prevent or interrupt biofilm forming by bonding of calcium and magnesium ions. In this study, we investigate the synergistic effect of chelators and APP on E. coli biofilms on stainless steel plates. Chelators of EDTA and citric acid with different concentration were applied. The plasma source was a surface micro-discharge (SMD). Sterilization rates of different treatment time and concentration were investigated. In addition, a system of mist plasma were also utilized in order to examine the synergistic effects of chelator aerosols and APP. Live/Dead stain were applied for preventing viable but nonculturable (VBNC) state of bacteria. Results indicate that combination treatment of 7.5% of citric acid with plasma treatment increase the sterilization efficiency at least 10 times higher, while single treatment of citric acid had almost no effects. Mist plasma treatment did not result in significant change of sterilization efficacy.

P 17.9 Wed 16:15 Zelt Ost

End on spectrometric analysis of a Plasma Windows arc discharge — •Marius Dehmer, Bernhard Bohlender, Andre Michel, Marcus Iberler, and Joachim Jacoby — Goethe Universität Frankfurt, IAP, AG Plasmaphysik

The Plasma Window is a membrane free device for transmission between two different pressure ranges allowing particles to pass through. It was originally patented by A. Hershcovitch in the 1990's*. The group of Prof. Dr. Jacoby at Goethe University Frankfurt picked up his idea and has been working on an own prototype to full fill the requirements of FAIR near Darmstadt.

A Plasma Window consists of a wall stabilized arc discharge connection two regmies of different pressure. Its temperature and electron density correspond with the sealing effects of this device**. Therefore knowledge of these parameters is important. Situated in the early stages of the project, spectroscopy was realized end on the plasma window from the cathode side for estimations of the electron temperature. Furthermore electron density and the arcs composition were determined.

Additionally radial spectrometry along the discharge axis is currently in progress by Mr. A. Michel. Both Mr. A. Michels and Mr. B. Bohlenders work, who focuses on the setup of the Plasma Window, will be presented at this conference. * Hershcovitch, A. J. Appl. Phys., AIP Publishing, 1995, 78, 5283 ** Krasik, Y. E.; Gleizer, S.; Gurovich, V.; Kronhaus, I.; Hershcovitch, A.; Nozar, P. & Taliani, C. J. Appl. Phys., AIP Publishing, 2007, 101, 053305

P 17.10 Wed 16:15 Zelt Ost

Sterilization of Spacecraft Equipment using a Plasma Afterglow Circulation Apparatus — •Meike Müller[1], Hubertus Thomas[1], Julia Zimmermann[3], Gregor Morfill[3], and Petra Rettberg[2] — [1]Deutsches Zentrum für Luft- und Raumfahrt, Institut für Materialphysik im Weltraum, 82234 Wessling, Germany — [2]Deutsches Zentrum für Luft- und Raumfahrt, Institut für Luft- und Raumfahrtmedizin, 51147 Köln, Germany — [3]terraplasma GmbH, 85741 Garching, Germany

A new afterglow circulation apparatus using cold atmospheric plasma (CAP) is presented as a useful alternative sterilization method for spacecraft equipment. The developed setup uses the plasma afterglow generated by surface micro-discharge (SMD) technology and allows the control of gasflow, humidity and treatment volume. With the new setup we evaluate appropriate CAP conditions for a maximal sporicidal effect and examine the inactivation efficiency by increasing the treatment volume. The sporicidal effect of the apparatus is tested with bacterial endospores Bacillus atrophaeus.

A Fourier Transformation Infrared Spectrometer (FTIR) is used to analyse the detailed composition of the afterglow plasma. The study provides an insight into the plasma chemistry and the influence of the prevalent humidity involved in the inactivation of microorganisms.

We will give an overview on the status of the plasma decontamination project and present the first results of the plasma-gas-circulation apparatus funded by the Bavarian Ministry of Economics.

P 17.11 Wed 16:15 Zelt Ost

Geometrical dependent characterisation of a microplasma reactor with four sub-arrays — •Sebastian Dzikowski and Volker Schulz-von der Gathen — Experimentalphysik II, Ruhr Universität Bochum, Bochum, Germany

Microplasma pixel devices are interesting for large scale applications such as gas reformation. A representative is a metal grid array device, which is a stable alternative to silicon-based arrays. It consists of a dielectric sheet, a grounded and a powered electrode with symmetrically arranged cavities. The grounded electrode is realized by a magnet that pulls the grid to a simple sticked device. Typically, microplasma arrays are operated close to atmospheric pressure with noble gases like argon or helium. By applying a bipolar voltage waveform with an amplitude of 800 V peak-to-peak and a frequency of 10 kHz, the discharge is ignited in the cavities having a diameter of about 200 and depth of 50 micrometers.

As a comparison for a silicon-based multiple trench array discharge reactor a first reactor consisting of four metal-grid arrays was developed. The four grids are different in their cavity diameter and spacing. Here, we present time and spatial dependent optical investigations about ignition timing and line ratios of several gas mixtures including molecular admixture by using phase resolved optical emission spectroscopy.

P 17.12 Wed 16:15 Zelt Ost

Effekt einer Amtosphärendruckplasmafackel auf humane Keratinozyten — •Niklas Nawrath, Gretel Louise Chomthon-Luthe und Dieter Ihrig — Fachhochschule Südwestfalen, Iserlohn

Um Atmosphärendruckplasmen für die Handdesinfektion einsetzen zu können, ist es notwendig, die Auswirkungen auf die menschliche Haut zu untersuchen. Dazu wurden humane Keratinozyten der Zelllinie HaCaT eingesetzt. Die Zellen wurden kultiviert, mit einem Argon-Sauerstoff-Plasma behandelt und untersucht. Analysen der Zellvitalitätsrate, der apoptotischen und nekrotischen Zellen sowie der Effekt des Plasmas auf das Medium wurden durchgeführt. Zusätzlich wurde die Genexpression von 200 ausgewählten Genen über Sequenzierungsversuche analysiert, um Rückschlüsse über die Zellsignale innerhalb der Zelle zu erhalten. Die gewählten Gene steuern unter anderem die Zellproliferation, die Apoptose, die Immunantwort, den Ceramidsignalweg sowie den Actinhaushalt.