P 4: Atmospheric Pressure Plasmas I

Time: Monday 14:00–16:00 Location: KI 1.174

Invited Talk P 4.1 Mon 14:00 KI 1.174

High-resolution spectroscopic and electrical diagnostics of barrier discharges — •Tomas Hoder — Masaryk University, Brno, Czech Republic

Streamer mechanism is one of the main ionisation mechanisms in high-pressure plasma jets, pulsing coronas or barrier discharges. In atmospheric air, it is an ultra-fast process which produces a light emission or current pulses with duration of only several units of nanoseconds. In such challenging case, an enhanced diagnostic method has to be applied. In this contribution, high-resolution sensitive spectroscopic and electrical methods will be presented which enable the determination of basic plasma parameters in mentioned fast ionising events. The presented methods will be applied to barrier discharges in contact with condensed matter - solid and liquid - and their use for further applied research will be critically discussed.

P 4.2 Mon 14:30 KI 1.174

Influence of feed gas humidity and reactor geometry on surface dielectric barrier discharges — •Michael Schmidt, Manfred Kettlitz, and Markus Becker — INP Greifswald, Felix-Hausdorff-Straße 2, 17489 Greifswald

Surface dielectric barrier discharges (SDBDs) are widely used for coating, gas cleaning and treatment of liquids or as plasma actuators. To achieve high energy efficiency and for safety reasons, smooth electrical operation parameters like low amplitudes and frequencies are desirable. The applicability of frequencies < 1 kHz and high voltage amplitudes < 7 kV for SDBDs in air is investigated in the presented study. It is found that the feed gas humidity has a substantial influence on the chemical activity of the plasma as well as on the electrical behavior of the discharge. Additionally, it is found that the reactor geometry and hence the flow properties of the feed gas also influences the performance of the SDBD significantly. The study shows that under dry conditions a large reactor volume, where only a small part of the feed gas is replaced continuously, has a higher chemical activity, measured by production of ozone, compared to a smaller reactor volume. However, the influence of the feed gas humidity is much stronger for the large reactor volume than for the smaller one. This is shown by power input into the plasma, plasma distribution throughout the SDBD and ozone production.

P 4.3 Mon 14:45 KI 1.174

Optical analysis of nanosecond-pulsed plasmas generated in liquids — •Katharina Grosse, Julian Held, Marc Böke, and Achim von Keudell — Exprimental Physics 2, Ruhr-University Bochum, Germany

Plasmas generated inside liquids have aroused interest over the last years particularly in the field of plasma medicine. The reactive species created in such an environment can modify surfaces which are in direct contact with the treated liquid. The physics of these plasmas and the interaction of the particles created inside the liquid with biological and metallic surfaces is not fully investigated. The analysed plasma is generated by a high-voltage nanosecond pulser creating 10 ns pulses with varying amplitudes of 14-26 kV and a pulsing frequency of 1 Hz. The dynamics of the discharges are monitored with shadowgraphy imaging and the created species with optical emission spectroscopy. Four distinct phases of the plasma development can be identified: ignition and plasma phase (1), generation of a shock wave (2), formation of a gas bubble (3) and separation of the bubble from the high-voltage electrode (4). The shock wave velocity in phase (2) was estimated to approximately 3.3 km/s for the different applied voltages.

P 4.4 Mon 15:00 KI 1.174

Parameters of Streamer Development for Nanosecond High Voltage Discharges in Water — •Jana Kredl, Tilo Schulz, and Juergen F. Kolb — Leibniz Institute for Plasma Science and Technology e.V. (INP Greifswald), Felix-Hausdorff-Str. 2, 17489 Greifswald

More and more drinking water is contaminated by an increasing concentration of pharmaceuticals. Although, concentrations are well below medical significant doses, environmental impacts, e.g. on fish populations, have already been observed. High voltage nanosecond discharges can be used to decontaminate waste water and degrade pharmaceutical residues in drinking water. Streamer that are generated provide in particular a strong reactive chemistry for degradation and decontamination. It is not clear yet how these streamers are created and determine the reactive chemistry. Thus, it is examined how streamer lengths and densities depend on the experimental parameters, i.e. applied voltage, pulse length, water conductance and discharge geometry. Therefore, a coaxial electrode arrangement is used. The inner electrode is a tungsten wire with 0.05 mm in diameter and the outer electrode is an iron mesh. The reactor itself is made of glass for optical access. The applied voltage is supplied by a self-made Blumlein-line pulse generator, which delivers square pulses in the nanosecond-range.

P 4.5 Mon 15:15 KI 1.174

Acoustical analysis of surface dielectric barrier and micro hollow cathode discharges — •Daniel Kotschate[1], Mate Gaal[1], and Holger Kersten[2] — [1]Department of Non-destructive testing, Bundesanstalt für Materialforschung und -prüfung, Germany — [2]Institut für Experimentelle und Angewandte Physik, Christian-Albrechts-Universität zu Kiel, Germany

Due to the multi-physical appearance of gas discharges the possibilities of interaction with their surrounding environment are very wide. Some of the most common applications are the surface or material modification and acting as an ion source for mass spectroscopy applications. Since atmosphere plasma generates a massive amount of thermal energy caused by collisions in the sheath, this temperature alternation is also able to produce acoustic waves in the ambient gas volume (as lightning and thunder), which is called thermoacoustic effect.

This talk presents an overview of the experimental acoustic analysis of surface dielectric barrier and micro hollow cathode discharges. Regarding other methods of acoustic excitation, the thermoacoustic approach benefits of its massless working principle and the proper impedance matching. In addition to the characterisation, possible applications (e.g. plasma acoustic loudspeaker or transducer for air-coupled ultrasonic testing) concerning these discharge types are presented.

P 4.6 Mon 15:30 KI 1.174

Inception and Propagation of Pulsed Corona-like Discharges in Water — •Raphael Rataj, Tilo Schulz, and Juergen F. Kolb — Leibniz Institute for Plasma Science and Technology e.V., Felix-Hausdorff-Strasse 2, 17489 Greifswald, Germany

The potential of corona-like discharges in the liquid-phase for the treatment of sewage water was shown recently in chemical investigations on the degradation of pharmaceutical residues. However, the energy efficiency of this plasma treatment seems to be higher for the generation with short high voltage pulses. In particular discharges instigated with sub-microsecond high-voltage pulses were suggested.

A high-voltage Blumlein-line pulse generator for the application of defined 100-ns pulses was developed and connected to a plasma chamber with a point-to-half-sphere geometry. Single rectangular pulses were applied to the plasma reactor, which was operated with a continuous water flow. Plasma inception voltage and streamer propagation was investigated for different water conductivities, gap distances and pulse amplitudes.

First results show that neither electrode distance nor liquid conductivity have an impact on the streamer propagation lengths. For such short pulses in particular no stop-length could be identified. Detailed inception characteristics and plasma propagation behaviour are topic of the current research and will be presented.

P 4.7 Mon 15:45 KI 1.174

CO_2 dissociation in non-equilibrium atmospheric pressure plasmas — •Theresa Urbanietz, Sarah-Johanna Klose, and Achim von Keudell — Institut für Experimentalphysik II, Ruhr-Universiät Bochum, 44780 Bochum

The reduction of greenhouse gases such as CO_2 and CH_4 has gained a lot of interest in the last years. The conversion of CO_2 in a plasma can be used to produce useful chemicals and fuels such as syngas. The dissociation of CO_2 in a He/CO_2 atmospheric pressure plasma has been studied by in-situ Fourier Transform Infrared (FTIR) spectroscopy. For optimal investigation a plasma source is designed that allows to perform FTIR spectroscopy directly inside the plasma volume. The plasma volume is confined by potassium bromide (KBr) windows for

measurements perpendicular and along the gas flow. For a detailed analysis of the FTIR spectra a reference spectrum is modelled using the HiTRAN database and compared to the measured spectra. This gives information about the vibrational and rotational temperature of the species as well as the concentration of the species. A variation of CO_2 admixture and power shows conversation rates up to 20% and energy efficiencies up to 30%. The vibrational temperature of CO is around 1300K whereas the rotational temperature stays nearly at room temperature. Inside the plasma volume a catalyst can be placed to investigate its performance and influence on the plasma. First results with nickel oxide catalysts on silica show a clear increase in the conversation rate.