P 2: Atmospheric-pressure plasma and applications 1

Time: Monday 11:00–12:30 Location: b305

Invited Talk P 2.1 Mon 11:00 b305

Streamer inception and imaging in various atmospheres — •Sander Nijdam, Siebe Dijcks, and Shahriar Mirpour — Eindhoven University of Technology, The Netherlands

Streamers are the first stage of many discharges involving high voltages. They consist of a propagating ionization front leaving behind a trail of conductive, quasi-neutral plasma. In this contribution we will show experiments on streamers revealing some of their most important properties: their inception and their propagation and branching behaviour.

We study streamer inception by applying repetitive high voltage pulses and studying the statistics of inception delay. By means of small bias pulses between the high voltage pulses, we are able to manipulate these statistics, which reveals a lot on the processes governing the inception.

Secondly, we study the propagation and branching of streamers by a combination of stereoscopic and stroboscopic measurements of 'low complexity' streamer discharges. We have developed automated routines which can determine propagation velocities, branching angles and much more from these and can directly compare these against numerical results, thereby also giving unprecedented insights into the fundamentals of such discharges.

P 2.2 Mon 11:30 b305

Time and space resolved electron dynamics in a microplasma channel — •Simon Kreuznacht, Sebastian Dzikowski, Marc Böke, and Volker Schulz-von der Gathen — Experimental Physics II, Ruhr University Bochum, Germany

Microplasma arrays have been under investigation for a long time. These are special dielectric barrier discharges at atmospheric pressure. It is possible to generate a homogeneous discharge with these microplasma arrays over a large area by the parallel operation of many identical cavities. The microplasma arrays are operated in Helium with a triangular voltage with a frequency of about 10 kHz and an amplitude of about 700 V. The microplasma channel, that will be presented here, represents a single cavity of the microplasma arrays. This channel provides optical access to the inside of the cavity from the top and unlike the microplasma arrays from the side. A fast gated, intensified CCD camera was used to investigate the discharge. Phase-resolved images, that were taken with line of sight from the top into the channel, showed that the discharges in the microplasma channel and the microplasma arrays behave similar. With phase-resolved images from the side it was possible to gain new insights into the time and space resolved electron dynamics of the discharge.

P 2.3 Mon 11:45 b305

Breakdown and development of sub-ns pulsed spark discharges in short gaps under overvoltage conditions — •Hans Höft[1] and Tom Huiskamp[2] — [1]Leibniz-Institut für Plasmaforschung und Technologie e.V. (INP Greifswald), Felix-Hausdorff-Straße 2, 17489 Greifswald, Germany — [2]Eindhoven University of Technology, Dept. of Electr. Engineering, P.O. Box 513, 5600 MB Eindhoven, The Netherlands

Spark discharges were ignited by unipolar positive and negative rectangular HV pulses with 200 ps rise time and (15 ± 2) kV amplitude with 3 ns duration (FWHM) in N_2 and synthetic air in a 1.2 mm pin-to-pin gap (tungsten electrodes) at atmospheric pressure. The breakdown and development of the discharges were tracked by synchronised iCCD and streak camera recordings (temporal resolution up to 5 ps, spatial resolution 2 μm) in single shot operation. A two-stage breakdown regime was found, which—to the best of our knowledge—was documented for the first time. The discharge starts with a fast initial breakdown over the complete gap ($\sim 10^7$ m/s) followed by a much slower ($\sim 10^5$ m/s) propagation from both electrodes towards gap centre. There is a significant difference between positive and negative HV pulses during the initial breakdown phase, while the general discharge structure stays more or less the same, and is only slightly affected by the gas mixture. A possible explanation of the initial rapid breakdown could be field emission caused by the extremely fast rising electric field due to the steep HV slope rising with > 50 kV/ns.

P 2.4 Mon 12:00 b305

Electric field measurements in ns-APPJ with sub-ns time resolution — •Nikita Lepikhin, Dirk Luggenhölscher, and Uwe Czarnetzki — Institute for Plasma and Atomic Physics, Ruhr University Bochum, D-44780 Bochum, Germany

The work is dedicated to electric field, E, measurements in a nanosecond pulsed atmospheric pressure plasma. Due to a high reduced electric field, E/N, providing efficient excitation of the electronic states of atoms or molecules, nanosecond discharges are widely used as a source of non-thermal reactive plasmas in a variety of applications: surface treatment, plasma medicine, plasma flow control, plasma assisted ignition and combustion. The reduced electric field is the key information for plasma kinetic studies. Known temporal profiles of E/N in the discharge allow to determine the electron energy distribution function evolution and, consequently, the discharge development. Experimentally measured E/N profile accompanied by electric current measurements can be used as a benchmark to verify plasma kinetic models. In this work, the electric field in a ns-discharge in a He:N_2 mixture is studied with sub-ns time resolution. Electric-Field Induced Second Harmonic generation (E-FISH) is used as a measurement technique [A. Dogariu et. al., Phys. Rev. Appl. 7 (2017)]. A laser beam is focused into the discharge gap and in the presence of an electric field a coherent signal beam at the second harmonic of the laser frequency is generated. The method is non-resonant and can be used for any gases. The technique provides the absolute value of the electric field as well as its direction. High temporal and spatial resolutions are achieved.

P 2.5 Mon 12:15 b305

Spacio-temporal emission of an atmospheric plasmoid — •Roland Friedl[1], Ursel Fantz[1,2], Saskia Steibel[1], Martin Kammerloher[2], and Alexander Oswald[2] — [1]AG Experimentelle Plasmaphysik, Universität Augsburg, 86135 Augsburg — [2]Max-Planck-Institut für Plasmaphysik, Boltzmannstr. 2, 85748 Garching

An atmospheric pressure plasmoid is generated via a high voltage discharge (4.8 kV) above a water surface. After around 150 ms the connection to the power supply is interrupted and the plasmoid enters an autonomous phase which lasts up to 400 ms. The plasmoid has a diameter of around 30 cm and ascends in air with a velocity of about 1–2 m/s due to buoyancy. High speed video analysis (600 fps) and optical emission spectroscopy is applied to gain insight into the plasma dynamics.

Survey spectrometers ($\Delta\lambda \sim 1.4$ nm) are used to determine the dominant radiating plasma constituents for the three main evolution phases of the plasmoid: ignition, formation, and autonomous phase. Photo diodes with interference filters ($\Delta\lambda \sim 10$ nm) are used for monitoring the emission of specific plasma constituents (H, OH, Na) with high temporal resolution (0.5 ms). Applying several diodes, the vertical dynamic as well as the horizontal structure and symmetry of the plasmoid emission is obtained. High resolution spectroscopy ($\Delta\lambda \sim 0.16$ nm) with a high speed trigger system is applied to measure the OH-A-X emission system during the temporal evolution of the plasmoid. In order to gain access to the plasma chemistry, rotational and vibrational temperatures of the hydroxyl molecule are evaluated using Lifbase.