P 9: Atmospheric Pressure Plasmas II - Helmholtz Graduate School III

Zeit: Dienstag 11:00–12:40 Raum: HS 21

Hauptvortrag P 9.1 Di 11:00 HS 21

Laser diagnostics of plasmas using fs- and ps-lasers — •Stephan Reuter — Princeton University, MAE-Department, Princeton, USA — Lublin Technical University, Lublin, Poland

Dynamics in plasma jets at atmospheric pressure span orders of magnitude in time scales, ranging from picosecond (ps) time scales of electron dynamics and energy transfer to heavy particles, to mass transport on a micro- and millisecond time scale by convection and diffusion into open atmosphere. Recent advances in ultrafast laser diagnostics, adapted from methods developed for combustion and aerospace engineering, allow highly resolved plasma diagnostics: Picosecond time and micrometer space resolved electric field measurements were recently achieved using a femtosecond (fs)-laser sheath in a plasma jet effluent: Electric field induced second harmonic (E-FISH) light generation is utilized to quantify the electric field induced by the fast ionization wave of the plasma jet. Comparing fs-1D resolved to ps-point wise measurements shows the potential of fs-E-FISH. Fs-lasers can also be used for recently developed fs-electronic excitation tagging (FLEET) to study the plasma jet's gas flow field into open atmosphere. Quantitative 1D gas velocity vector fields are determined by using the emission of excited nitrogen molecules as tracer. The great potential as well as challenges of ultrafast lasers for plasma diagnostics conclude the talk. Funding by Alexander von Humboldt Foundation and Princeton University is gratefully acknowledged.

P 9.2 Di 11:30 HS 21

Channel Reillumination in Pulsed Corona-like Discharges in Water — •Raphael Rataj, Hans Höft, and Juergen F. Kolb — INP Greifswald, Felix-Hausdorff-Straße 2, 17489 Greifswald

Investigations of corona-like discharges in water have shown the importance of the fall time of sub-microsecond high-voltage pulses regarding a reignition of discharge channels. So far it was reported that, despite similar pulse durations and amplitudes, a reillumination starts either during the high-voltage plateau, the falling edge of the pulses or not at all. Furthermore, a reillumination of a single filament or all previously formed channels were reported. For a detailed study, single, reproducible voltage pulses with adjustable fall times between 20 and 45 ns, amplitudes of 50 kV and 100 ns duration were applied to a point-to-plane geometry in deionized water. Time-resolved measurements of voltage, current and emitted visible light intensity were obtained for individual discharges, and plasma current, discharge energy and channel length could be calculated accordingly. In addition, subsequent images of single discharge events were taken with a framing camera and compared to the electrical measurements. While no change in discharge development was found for the initial phase during the high-voltage plateau, a reillumination was observed only during the falling slope for all applied pulses. A transition from a reignition of single filaments to a reillumination of every channel with decreasing fall time was visible both in the framing camera images and the plasma current. The detailed investigation for each fall time will be presented and a possible explanation for the observed transition will be given.

P 9.3 Di 11:45 HS 21

Analysis of a dielectric barrier discharge in argon for wide pressure and frequency ranges — •Marjan Stankov, Markus M. Becker, Robert Bansemer, and Detlef Loffhagen — Leibniz Institute for Plasma Science and Technology (INP), 17489 Greifswald, Germany

Dielectric barrier discharges (DBDs) are widely used plasma sources e.g. in plasma medicine, for surface treatment and ozone generation. Here, a laboratory DBD is investigated by means of fluid modelling and electrical measurements. It has a symmetric plane-parallel geometry with electrodes covered by quartz glass dielectric. A specific feature of this device is that gas pressure and frequency of the sinusoidal voltage signal can easily be adapted in the pressure range from 100 to 1000 mbar and for frequencies between 10 and 100 kHz. Argon is used as a reference gas. The time-dependent, spatially one-dimensional fluid model comprises balance equations for the particle densities and the electron energy density involving the drift-diffusion approximation for the fluxes. Poisson's equation is solved to determine the axial electric field, and the accumulation of surface charges on the dielectric surfaces is included as a boundary condition. First modelling results of the electrical discharge characteristics are presented and discussed providing a detailed understanding of surface and volume memory effects over the whole pressure and frequency range. In general, good agreement with measurements of the discharge current are obtained.

Funded by the Deutsche Forschungsgemeinschaft (DFG) - project number 368502453.

P 9.4 Di 12:00 HS 21

Influence of a catalyst on CO_2 dissociation in a non-equilibrium atmospheric pressure helium plasma jet — •Theresa Urbanietz, Steffen Schüttler, Christoph Stewig, Marc Böke, Volker Schulz-von-der-Gathen, and Achim von Keudell — Experimental Physics II, Ruhr-University Bochum, 44780 Bochum

Excitation of CO_2 in an atmospheric pressure plasma may be an energy efficient method to generate solar fuels from renewable energies. The non-equilibrium excitation of specific states of the molecules in the plasma can cause of high energy efficiency. The influence of a catalyst can even enhance the energy and dissociation efficiency. The dissociation of CO_2 in an atmospheric helium RF plasma jet in the presence of a catalyst is analyzed for varying absorbed plasma powers and compared with measurements without catalyst. Fourier transform infrared spectroscopy is used to evaluate the concentration of CO_2 and CO as well as the rotational and vibrational temperature of the species. A strong non-equilibrium excitation of CO_2 and CO with rotational temperatures around 400 K and vibrational temperatures up to 1600 K has been found. The dependence of these excitation temperatures on the plasma power is rather weak.

P 9.5 Di 12:15 HS 21

Phase-resolved study of single microdischarges in cathodic pin polarity of a metal pin-to-hemispherical dielectric-covered electrode arrangement — •Sina Jahanbakhsh[1], Volker Brüser[1], and Ronny Brandenburg[1,2] — [1]Leibniz-Institut für Plasmaforschung und Technologie (INP), Felix-Hausdorff-Str. 2, 17489 Greifswald — [2]Institut für Physik, Universität Rostock, Albert-Einstein-Straße 23*24, 18059 Rostock

Single microdischarges (MDs) in a barrier corona arrangement are investigated. The discharge is operated in atmospheric pressure, and dry air at 300 SCCM flowrate is used to flush the discharge cell. The radius of curvature of stainless steel pin and the hemispherical alumina-covered electrode are 0.2 and 2 mm, respectively. A sinusoidal voltage at the frequency of 7.5 kHz and amplitude of 11.5 kVpp is applied. Using an ICCD camera and a Rogowski coil current probe, images and current pulses of MDs are recorded simultaneously. Multi-dimensional time correlated single photon counting (TC-SPC) is used to record the phase-resolved spatio-temporal development of the MDs. The properties of MDs apearing in the two polarities of the sinusoidal voltage differ significantly. This contribution will focus on the results of the cathodic pin polaritty. In this polarity, MDs have an erratic behavior in terms of inception phase and current pulse amplitude. Using phase-resolved diagnostic techniques, it is shown that, depending on the inception phase, the development and properties of the MDs vary significantly. MDs appearing in low and high applied voltages are similar to DBD microdischarges and transient sparks, respectively.