P 11: Low Temperature Plasmas I

Zeit: Dienstag 14:00–15:55 Raum: HZO 30

Hauptvortrag P 11.1 Di 14:00 HZO 30

Cold atmospheric plasmas in medicine: basic mechanisms and practical applications — •Thomas von Woedtke — Leibniz-Institut für Plasmaforschung und Technologie e.V. (INP Greifswald), Felix-Hausdorff-Str. 2, 17489 Greifswald — Ernst-Moritz-Arndt-Universität Greifswald, Universitätsmedizin, 17475 Greifswald

Plasma medicine has been developed as innovative medical research field during the last years. The direct application of plasma as part of therapeutic concepts is most promising in dermatology, plastic surgery or dentistry, and is up to now focused on tissue regeneration, infected and/or chronic wounds as well as infective and inflammative skin diseases. Another field of big interest is oncology. To establish cold atmospheric pressure plasma sources as medical devices, detailed understanding of plasma action on living systems is indispensable. It was found that biological plasma effects are significantly caused by plasma induced changes of the liquid environment of cells and that redox-active species generated in or transferred into liquid phases by plasma treatment play a dominating role in transmission of biological plasma effects. Based on these fundamental insights the huge field of redox biology has been opened for basic research in plasma medicine because plasma generated redox-active species are the same as occurring in living cells as part of regular physiological and biochemical processes. This will contribute to consolidate a sound scientific basis of plasma medicine and will help to assess and control both further chances but also possible risks of plasma application in medicine.

Fachvortrag P 11.2 Di 14:30 HZO 30

Phase resolved correlation of surface charge distribution with emission and electrical signals from an atmospheric pressure plasma jet in helium — •Torsten Gerling[1], Robert Wild[2], Andrei Vasile Nastuta[3], Lars Stollenwerk[2], Christian Wilke[1], and Klaus-Dieter Weltmann[1] — [1]INP Greifswald, Germany — [2]University Greifswald, Germany — [3]Alexandru Ioan Cuza University, Iasi, Romania

A capillary plasma jet in helium close to a surface is investigated by means of phase resolved optical imaging and electrical current and voltage measurements. In addition the Pockels-effect is used to investigate the space and phase resolved distribution of surface charge on the dielectric surface in front of the plasma jet.

The phase resolved optical imaging reveal the discharge dynamics with a dielectric barrier discharge between the two ring electrodes as well as plasma bullets exiting the capillary. In addition, the discharge dynamics are simultaneously observed on the current signal. Finally, the contribution will correlate these results with the phase resolved distribution of surface charge. It is concluded, that the charge exchange between the jet and the surface occurs within the channel that is left behind by the plasma bullet and not from the bullet itself.

P 11.3 Di 14:55 HZO 30

Excitation Dynamics and Alpha to Gamma Transition in an Argon Micro Atmospheric Pressure Plasma Jet: Diagnostics and Modelling — •Mario Dünnbier[1,2], Markus Becker[1], Detlef Loffhagen[1], Klaus-Dieter Weltmann[1], and Stephan Reuter[1,2] — [1]Centre for Innovation Competence plasmatis, 17489 Greifswald, Germany — [2]Leibniz Institute for Plasma Science and Technology e.V. (INP Greifswald), 17489 Greifswald, Germany

Argon as a feed gas for a novel megahertz driven atmospheric pressure plasma jet (APPJ) has been investigated experimentally and numerically. The micro-scale APPJ under consideration usually runs with helium and is well described in the literature [1]. Up to now it was impossible to ignite a discharge in argon within this jet geometry. To meet this challenge a self-made plasma tuning unit (PTU) was designed. Additionally the PTU enables the measurements of the dissipated power in the plasma itself. Therefore, the power can be varied in the range between 500 and 1500 mW. Phase resolved optical emission spectroscopic measurements of the argon transition at 750.39 nm shows only one intensity maximum at each half cycle of the applied voltage for the low power range. At increasing power a second maximum arises immediately after the first one. Comparison with numerical modelling shows that the first maximum contributes to the excitation due to bulk electrons and the second maximum to secondary electrons from the electrodes.

[1] S. Schneider, M. Dünnbier et al., J. Phys. D: Appl. Phys. 47 50520, 2014

P 11.4 Di 15:10 HZO 30

Zündverhalten von dielektrisch behinderten Entladungen im gepulsten Betrieb mit Sub-ns-Anstiegszeit — •Hans Höft[1], Tom Huiskamp[2], Manfred Kettlitz[1] und Guus Pemen[2] — [1]INP Greifswald, Felix-Hausdorff-Straße 1, 17489 Greifswald, Deutschland — [2]TU Eindhoven, Dept. of Electrical Engineering, Eindhoven 5600 MB, Niederlande

Die Steilheit der Spannungsflanken hat bei gepulsten dielektrisch behinderten Entladungen (DBE) einen signifikanten Einfluss auf die Entladungscharakteristik. Eine koaxiale DBE wurde mit ultrasteilen Hochspannungspulsen (ca. 0,2 ns Anstiegszeit auf 20 kV, $dU/dt \sim 100\,\mathrm{kV/ns}$, 5 ns Pulsbreite) bei Repetitionsfrequenzen zwischen 1 Hz und 1 kHz in O_2/N_2-Gasgemischen bei Atmosphärendruck betrieben. Das Zündverhalten wurde mit einer schnellen iCCD zeitaufgelöst verfolgt. Der Durchbruch während des ersten Pulses ist unabhängig von der Wiederholfrequenz und der O_2-Konzentration durch eine diffuse Emission vor der metallischen Elektrode charakterisiert. Aufgrund der kurzen Pulsbreite kann sich aus diesem ionisierten Gebiet aber kein Streamerdurchbruch entwickeln. Da nicht die gesamte Energie des Pulses in die DBE eingekoppelt wird, kommt es nach dem ersten Durchbruch zu wiederholten Reflexionen des Hochspannungspulses, die zur Wiederzündung im von den vorherigen Entladungen vorionisierten Volumen führen. Während dieser Reflexionen ändert sich die Entladungsstruktur signifikant von einem diffusen Modus hin zu kontrahierten Kanälen. Dieser Übergang ist von der O_2-Konzentration abhängig.

P 11.5 Di 15:25 HZO 30

Spectroscopic studies of mw plasmas containing hexamethyldisiloxane — •Andy Nave[1], Felix Mitschker[2], Peter Awakowicz[2], and Jürgen Röpcke[1] — [1]INP Greifswald, 17489 Greifswald, Germany. — [2]Ruhr-Universität Bochum, Allgemeine Elektrotechnik und Plasmatechnik AEPT, 44780 Bochum, Germany.

Plasmas containing organosilicon precursors are used in a variety of processes to deposit thin films with advantageous mechanical, electrical or optical properties. Since many years plasma-assisted polymerization has been based on hexamethyldisiloxane (HMDSO). To open up new fields of application the deposition of coatings in a wide range of chemical and physical properties by varying plasma parameters is a challenging subject. The key to an improved understanding of related plasma chemical phenomena is the analysis of the fragmentation of the precursor and the monitoring of transient and stable reaction products.

In mw plasmas infrared absorption spectroscopy based on Tunable Diode Laser (TDLs) and External Cavity Quantum Cascade Laser (EC-QCL) has been used to monitor the ground state concentrations of HMDSO, and of the reaction products CH_4, C_2H_2, C_2H_4, C_2H_6, CO, CO_2 and CH_3 as a function of the HMDSO/O_2 mixture ratio, and the applied power at various pressure values. In addition, the neutral gas temperature could be determined. Optical emission spectroscopy has been applied as complementary diagnostics in order to evaluate electron density and electron temperature.

P 11.6 Di 15:40 HZO 30

Laser-photodetachment of negative ions in He/O_2 barrier discharges — •Robert Tschiersch, Sebastian Nemschokmichal, and Jürgen Meichsner — Institute of Physics, University of Greifswald

The influence of negative ions on the properties of atmospheric pressure barrier discharges is of fundamental interest. Laser photodetachment experiments are performed in a glow-like barrier discharge in helium with small admixtures of oxygen at a pressure of 500 mbar and a gas gap of 3 mm. The discharge properties are studied by electrical measurements and optical emission spectroscopy. A Nd:YAG laser enables both the detachment of solely O_2^- at the fundamental wavelength $\lambda = 1064\,\mathrm{nm}$, and of O^-, O_2^- as well as O_3^- at the second harmonic wavelength $\lambda = 532\,\mathrm{nm}$. The laser is guided trough the discharge gap without noticeable interaction with the electrodes. This is proofed in the pure helium discharge as there is no effect at all. In contrast, when adding oxygen the laser affects the discharge breakdown exclusively

during its pre-phase. The discharge ignition starts earlier in comparison to the unaffected discharge. This time shift indicates an enhanced pre-ionization which, most likely, is connected with the photodetachment of negative ions. Additional photoelectrons support the positive space charge formation. Furthermore, this time shift grows with increasing oxygen admixture and laser pulse energy. The investigation underlines the significant importance of the discharge pre-phase and tries to differentiate between the contribution of O^-, O_2^-, and O_3^-.