P 4: Atmospheric Pressure Plasmas I

Zeit: Montag 14:00–15:45 Raum: HS 20

Hauptvortrag P 4.1 Mo 14:00 HS 20

Characterisation of Dielectric Barrier Discharges for analytical applications — •Joachim Franzke, Alexander Schütz, Sebastian Brandt, David Klute, Sebastian Burhenn, and Pascal Vogel — ISAS - Leibniz-Institut für Analytische Wissenschaften - ISAS - e.V., Bunsen-Kirchhoff-Str. 11, 44139 Dortmund, Germany

Two decades ago the potential of dielectric barrier discharge plasma was presented for use in analytical element spectrometry [1]. It was a miniature planar DBD, characterized by small size, low power consumption, low gas temperature and excellent dissociation capability for molecular species. Several years later a capillary shaped DBD was presented by Na et al. [2] applied as an efficient method for molecular mass spectrometry resulting in the development of a variety of methods now commonly termed Ambient Mass Spectrometry (AMS), which experienced a very rapid development during the last years. Here themes will be presented and tried to be characterized where dielectric barriers were used in the field of Analytical Chemistry like diode laser spectrometry at low pressure DBDs [1], DBD as soft ionization source at ambient air[3,4].

[1]*M. Miclea, K. Kunze, G. Musa, J. Franzke, K. Niemax, Spectrochim Acta Part B At Spectrosc, 56 (2001) 37. [2]*N. Na, C. Zhang, M.X. Zhao, S.C. Zhang, C.D. Yang, X. Fang, X.R. Zhang, J. Mass Spectrom., 42 (2007) 1079. [3] S. Brandt, FD. Klute, A. Schütz, J. Franzke, Analytica Chimica Acta, 951 (2017)16. [4]*FD. Klute, A. Schütz, S. Brandt, S. Burhenn, P. Vogel, J. Franzke, J.Phys.D.: Appl.Phys.51 (2018) 341003.

P 4.2 Mo 14:30 HS 20

Analyzing plasma-chemical processes in RF-excited atmospheric pressure plasmas using vacuum ultra-violet and visible optical emission spectroscopy — •Judith Golda, Fenja Severing, Carmelo Setaro, and Jan Benedikt — Institute of Experimental and Applied Physics, Kiel University, Germany

Non-thermal atmospheric pressure plasma jet devices effectively generate reactive species at low gas temperature such as atomic oxygen or nitric oxide. Hence, they are commonly used for surface modification and biomedical applications. To tailor species densities, detailed knowledge and profound understanding of the plasma-chemical processes is crucial. However, due to their small dimensions, diagnostic techniques are limited.

Here, we present optical emission spectroscopy measurements of an RF-excited atmospheric pressure plasma jet operated in helium with admixtures of molecular nitrogen or oxygen. High energetic photons, such as the helium excimer continuum, are analyzed using windowless VUV spectrometry. Reaction kinetics of plasma-chemical processes and rotational temperatures will be estimated by analyzing the spatial variation of emission in the visible range of a nitrogen afterglow using a high-resolution echelle spectrometer.

P 4.3 Mo 14:45 HS 20

Formation pathways of HO_2 in a cold atmospheric pressure plasma jet investigated by cavity ring-down spectroscopy — •Sarah-Johanna Klose[1], Ansgar Schmidt-Bleker[1], Katherine Manfred[2], Helen Norman[2], Michele Gianella[2], Sioned Press[2], Grant Ritchie[2], and Jean-Pierre van Helden[1] — [1]Leibniz Institute for Plasma Science and Technology (INP), Greifswald, Germany — [2]Department of Chemistry, University of Oxford, Oxford, United Kingdom

The kINPen, a plasma jet operated in argon, is often employed in biomedical applications, as it provides important species for the plasma to cell interaction, such as H_2O_2. In order to investigate the complex chemical reaction network of the plasma effluent, we analysed the production and destruction pathways of HO_2, which is an important intermediate in the production cycle of H_2O_2. Respective diagnostic methods, such as absorption spectroscopy, are challenging considering the small diameter of the effluent (about 4 mm). Moreover, due to their short lifetime, highly reactive species like radicals have to be measured directly in the effluent. An option to increase the optical path length through a small plasma volume is cavity ring-down spectroscopy (CRDS). We will present HO_2 densities obtained from CRDS measurements, varying the O_2 fraction in the surrounding nitrogen gas curtain. Additionally, we will show spatial distributions of HO_2, gained from Abel inversion, at different axial positions. The most important formation and destruction mechanisms of HO_2, identified by a simple reaction kinetics model, will be discussed.

P 4.4 Mo 15:00 HS 20

Radio-frequency driven atmospheric pressure microplasma jets: voltage waveform tailoring and its effect on electron heating — Yue Liu[1], Ihor Korolov[2], Julian Schulze[2], Torben Hemke[2], and •Thomas Mussenbrock[1] — [1]Brandenburg University of Technology Cottbus-Senftenberg, 03046 Cottbus, Germany — [2]Ruhr University Bochum, 44780 Bochum, Germany

Capacitive microplasma jets driven at atmospheric pressure by sinusoidal or particularly tailored voltage waveforms are employed as efficient plasma sources for surface modification and other processes. One special variant is the micro atmospheric pressure plasma jet (μAPPJ). In this contribution the characteristics of the μAPPJ driven by different voltage waveforms in a helium-oxygen mixture are studied by numerical simulations in conjunction with experiments. The electron dynamics, as well as the dynamics of reactive species are investigated in both the region between the electrodes and within the effluent, particularly with regard to the effect of different driving voltage waveforms. — Financial support granted by the German Research Foundation in the frame of SFB 1316 (project A4) is gratefully acknowledged.

P 4.5 Mo 15:15 HS 20

Energy flux measurements in atmospheric pressure plasmas — •Luka Hansen[1], Kristian Reck[1], Stephan Reuter[2], and Holger Kersten[1] — [1]Institute of Experimental and Applied Physics, Kiel University, Kiel, Germany — [2]Department of Computer and Electrical Engineering, Lublin University of Technology, Lublin, Poland

Passive thermal probes (PTPs) have been successfully used to diagnose energy dissipation in low pressure discharges relevant for plasma surface interaction in e.g. film growth, and surface cleaning and activation. The present work implements PTP diagnostics to study plasma surface interaction at atmospheric pressure, where mass transport by convection and diffusion plays an important role for the energy transfer. The gained insight may proof useful for many industrial and biomedical applications.

Measurements on a surface barrier discharge (DSCBD) and on a cold atmospheric pressure plasma jet (CAPjet) are presented to show the role of fluid dynamics on the energy flux. Variation of the working gas for the DCSBD demonstrate the influence of gas- and surface reactivity on the energy flux. For the CAPjet, first time Rayleigh measurements of flow regime in combination with the PTP measurements show the effect of laminar vs. turbulent flow on energy dissipation. Charging of the (biased) PTP by the impinging jet with varying gas composition and flow indicate that Penning ionization and ion recombination time scales are relevant factors for the energy transfer from the plasma to surface.

P 4.6 Mo 15:30 HS 20

On the plasma bullet shape of He and He/O2 capillary plasma jet devices and interaction with dielectric surface — •Constantinos Lazarou[1,2], Charalambos Anastassiou[2], Ionut Topala[3], Alina Chiper[3], Ilarion Mihaila[4], Valentin Pohoata[3], and George Georghiou[1,2] — [1]FOSS, University of Cyprus, Nicosia, Cyprus — [2]ENAL, University of Cyprus, Nicosia, Cyprus — [3]IPARC, Alexandru Ioan Cuza University of Iasi, Iasi, Romania — [4]CERNESIM, Alexandru Ioan Cuza University of Iasi, Iasi, Romania

In this study, a two-dimensional axi-symmetric model has been used to study the evolution of capillary helium plasma jets with and without oxygen admixtures and their interaction with a dielectric surface placed normal to the jet axis. The model considers the gas mixing of helium and ambient air and the analytical chemistry between helium, nitrogen and oxygen species.

In particular, this work examines, from first principles, the shape and speed of the of the plasma bullet, the intensity of the induced electric (IEF) field on a dielectric surface and the underlying dominant chemical reactions of the plasma. Furthermore, this work provides insight and understanding into the mechanisms behind many experimental observations such as the torus (or donut) and sphere plasma bullet shapes for pure Helium and He/O2 plasma, respectively.