P 10: Atmospheric Pressure Plasmas and their Applications II

Time: Tuesday 14:00–16:00 Location: WW 1: HS

Invited Talk P 10.1 Tue 14:00 WW 1: HS

Filament interaction in dielectric barrier discharges — •Hans Höft[1], Ronny Brandenburg[1], Markus M. Becker[1], and Torsten Gerling[1,2] — [1]Leibniz Institute for Plasma Science and Technology (INP), Felix-Hausdorff-Str. 2, 17489 Greifswald, Germany — [2]Competency centre for diabetes (KDK), Greifswalder Str. 11, 17495 Karlsburg, Germany

The formation and interaction of individual filaments in dielectric barrier discharges (DBDs) are essential for the efficiency and efficacy of DBD reactors. In most DBD arrangements, multiple filaments are formed, since the power input per filament is limited. Therefore, the impact of O_2 concentration and high-voltage operation (pulsed vs. sinusoidal) on the number of filaments per period and their ignition pattern is studied. The spatially 1D multi-filament arrangement had a length of about 10 mm while the gap distance was set to 1.0 mm. The working gas was a binary mixture ranging from 0.1 to 20 vol% O_2 in N_2 at 1 bar. The DBDs were characterised by iCCD camera imaging determining the filament number and the discharge development by a streak camera to obtain the filament positions during different phases of one HV period. Simultaneously, electrical measurements using fast probes were performed. The results clearly show the different effects of the performed parameter variations on pulsed and sine-driven discharges, particularly regarding the spatial stability and number of filaments. Finally, the findings for the multi-filament arrangement are linked to single-filament DBDs under the same experimental conditions.

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P 10.2 Tue 14:30 WW 1: HS

Electric field components within a micro scaled dielectric barrier discharge measured by Stark shift and splitting of helium lines — •Henrik van Impel, David Steuer, Robin Labenski, Volker Schulz-von der Gathen, Marc Böke, and Judith Golda — PIP & EP2, Ruhr-University Bochum, D-44801 Bochum

Atmospheric pressure dielectric barrier discharges (DBDs), such as the micro cavity plasma array (MCPA) [1], have emerged as promising technologies for the conversion of volatile gases. These conversion processes' effectiveness can be enhanced by integrating catalytically active surfaces. To deepen the understanding of the plasma-catalyst interaction, it is crucial to investigate the transport dynamics of reactive species to the catalytic surface. The transport is in particular affected by the electric field perpendicular to the catalytic surface. However, experimental data on the component-wise electric field strength within DBDs are rare. To address this issue, we performed polarized optical emission spectroscopy on the shifting and splitting of the allowed 492.19 nm ($^1D \rightarrow {}^1P^0$) and forbidden 492.06 nm ($^1F^0 \rightarrow {}^1P^0$) helium line pair. This diagnostic approach requires a non-radially symmetric geometry, which leads to an adapted reactor design of the MCPA allowing the side-on observation of the discharge. The discharge operates in pure helium at atmospheric pressure, utilizing a triangular excitation voltage with a frequency of 15 kHz and an amplitude of 600 V. Field components reveal differences of approximately 5 kV cm^{-1} or 20 %. The project is funded within project A6 of the SFB 1316.

[1] Dzikowski et al 2020 Plasma Sources Sci. Technol. 29 035028

P 10.3 Tue 14:45 WW 1: HS

Time-resolved ion mass spectrometry to investigate the ion chemistry of a dielectric barrier discharge — Nils Dose[1], •Luka Hansen[1,2], Tristan Winzer[1], Christian Schulze[1], and Jan Benedikt[1,2] — [1]Institute of Experimental and Applied Physics, Kiel University, Kiel, Germany — [2]Kiel Nano, Surface and Interface Science KiNSIS, Kiel University, Kiel, Germany

The ion chemistry plays a crucial role for many plasma chemical processes ranging from particle or thin film growth to the production of biomedical relevant species [1]. Ion mass spectrometry allows a direct measurement of the formed ions with the drawback of a limited temporal resolution due to the flight time of ions from the plasma through the filtering optics of the mass spectrometer to the detector [2].

To overcome this issue the ion mass spectrometer was equipped with a multi channel scaler which allows to measure the incoming ions with up to 10 ns resolution. The mass dependent ion flight times were determined using a (pulsed) dielectric barrier discharge usually utilized for deposition processes [3] and compared with SIMION simulations. The derived connection between flight times and mass can be used to correct the time-resolved ion measurements, therefore allowing to gain inside into the production and conversion of ions.

The diagnostic will be presented and its potential demonstrated on first measurements with N_2 and O_2 admixtures.

[1] P. Tosi *et al.*, 2009 *Plasma Sources Sci. Technol.* **18** 034005
[2] J. Benedikt *et al.*, 2012 *J. Phys. D: Appl. Phys.* **45** 403001
[3] L. Bröcker *et al.*, 2023 *Plasma Process. Polym.* e2300177

P 10.4 Tue 15:00 WW 1: HS

Tunable laser absorption spectroscopy of all four Ar*(3p^{5}4s) states in a pulsed-driven dielectric barrier discharge with short gas-residence times — •Levin Krös, Hans Höft, Andy Nave, Jean-Pierre van Helden, and Ronny Brandenburg — Leibniz Institute for Plasma Science and Technology (INP), Greifswald, Germany

Dielectric Barrier Discharges (DBDs) can be applied for plasma enhanced chemical vapour deposition processes, i.e. for the deposition of thin functional films. In case of short gas-residence times realised by e.g. high working gas flows, ions play an important role in the deposition process. A significant production channel for ionic species is provided by excited argon species, especially the metastable states, via Penning ionisation. Therefore, tunable laser absorption spectroscopy is utilized to measure absolute number density of the four lowest energetic excited states of argon. The ability to determine the number density all four Ar*(3p^{5}4s) states as a function of the operation parameters, like gas flow and characteristics of the applied high-voltage pulse, is especially valuable for a comparison with numerical models. As a starting point, the number densities of these states will be measured in a pulsed-driven DBD with 3 mm gas gap flushed with pure argon at atmospheric pressure.

P 10.5 Tue 15:15 WW 1: HS

Fluid Simulation of Streamer Dynamics in Nanosecond Pulsed Surface Dielectric Barrier Discharges — •Dominik Filla, Gerrit Hübner, Nils Schoeneweihs, Ihor Korolov, Thomas Mussenbrock, and Sebastian Wilczek — Department of Electrical Engineering and Information Science, Ruhr-University Bochum

The efficient conversion of airborne pollutants, such as volatile organic compounds (VOCs) and nitrogen oxides, is not only crucial for environmental protection but also holds great scientific interest. Within this scope, surface dielectric barrier discharges (sDBD) driven by nanosecond pulses emerge as promising tools for energy-efficient gas conversion. This study delves into the streamer dynamics in sDBD systems, utilizing the 2D plasma simulation code nonPDPSIM. We demonstrate how key process parameters – such as pressure, voltage pulse amplitude, and pulse rise time – significantly influence streamer behavior, affecting its length, propagation speed, and direction. Our numerical results show a qualitative alignment with experimental data obtained from time-resolved optical emission spectroscopy. This correlation underscores the practical relevance of our simulations in advancing the understanding of plasma-based pollutant conversion.

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P 10.6 Tue 15:30 WW 1: HS

Electrical Characterization and Imaging of the Discharge Morphology in a Small Scale Coaxial Packed Bed Dielectric Barrier Discharge — •Rezvan Hosseini Rad[1], Volker Brüser[1], and Ronny Brandenburg[1,2] — [1]Leibniz Institute for Plasma Science and Technology, Felix-HausdorffStraße 2, 17489 Greifswald, Germany — [2]University of Rostock, Institute of Physics, Albert-Einstein-Str. 23-24, 18059 Rostock, Germany

Packed Bed Dielectric Barrier Discharges (PB-DBDs) are gaining widespread attention due to direct interaction between plasma and catalyst, resulting in enhanced product selectivity in gas processing. In this contribution, a small scale coaxial DBD reactor, enabling the end-on view observation of the discharge gap, has been constructed. The primary objective is to correlate electrical measurements such as voltage-charge (V-Q) plots with the plasma morphology in PB-DBD for different pressures, gas compositions, packing materials and applied voltage amplitudes. Simultaneous imaging and V-Q plot analysis, with special attention to parasitic capacitances, result in the revision of equivalent circuit for PB-DBDs and a more accurate experimental determination of the key capacitance values, namely the cell capacity (Ccell), and effective dielectric capacity (ζdiel). Additionally, the analysis includes the role of parasitic discharges, which can lead to the overestimation of input power. We aim to enhance the understanding of PB- DBDs, to provide sound knowledge about the power input and penetration of the flowing gas by active plasma.

P 10.7 Tue 15:45 WW 1: HS

Novel methods for determination and manipulation of surface charges in an atmospheric DBD microplasma — •Robin Labenski[1], David Steuer[1], Henrik van Impel[1], Marc Böke[2], Volker Schulz-von der Gathen[2], and Judith Golda[1] — [1]Plasma Interface Physics, Ruhr-University Bochum — [2]Experimental Physics II, Ruhr-University Bochum

In photo- and electrocatalysis it is already well-established that surface charges can alter the chemical adsorption and reaction paths of the catalyst. However, the novel realm of plasma catalysis lacks experimental exploration regarding the impact of plasma-induced surface charges on catalysis. We pave that way by introducing a straightforward method for precisely charging the dielectric (catalyst) using a microplasma at atmospheric pressure, while also monitoring the level of deposited surface charge over time. Through pre-charging we examine its effect on re-ignition and forming of equilibria in the discharge. Additionally, a laser assisted technique is introduced to further fine-tune the amount of surface charge on the dielectric and assess the plasma's response to this subtle manipulation of surface charge.