P 23: Atmospheric Plasmas and their Applications VI

Time: Thursday 16:15–18:00 Location: ZHG006

Invited Talk P 23.1 Thu 16:15 ZHG006

Electric Field Determination for Fundamental and Applied Discharge Physics — •Tomas Hoder — Masaryk University, Brno, Czech Republic

The electric field is one of the key parameters describing gas discharges and their dynamics. The spatiotemporal distribution of the electric field is crucial not only for calculating local electron-driven chemistry but also, more broadly, as a central parameter for validating computational models and developing or cross-checking new diagnostic methods. In this contribution, we will discuss the evaluation of the electric field using multiple methods, primarily optical emission and laser spectroscopy based. We will demonstrate the application of these methods for understanding barrier discharges, both within the discharge volume and on dielectric surfaces, and briefly assess the applicability of each method. Special attention will be given to the comparison of experimental results with computer simulations. Examples from both fundamental and applied industrial research will be presented and discussed.

P 23.2 Thu 16:45 ZHG006

Ion energy distributions of a DBD-plasma jet impinging on surfaces — •Daniel Henze, Laura Chauvet, and Achim von Keudell — Experimental Physics II Reactive Plasmas, Ruhr-Universität Bochum

Ion energy distribution functions (IEDFs) originating from a kHz-DBD plasma helium jet expanding into open air were measured using a molecular beam mass spectrometer (MBMS). The plasma jet produces quickly propagating ionization waves as guided streamers. The species' transition into the MBMS occurs either through a 40μm metallic or 50 μm ceramic orifice. The analysis of the time-resolved IEDFs using the metallic orifice revealed that ions initially impacting on the surface are predominantly sampled at a reference energy, which is determined by the seeding of ions into the supersonic expanding helium beam formed when transitioning into the MBMS. After the impact, ions are continuously sampled at an energy a few 0.1 eVs higher than the reference. This is resolved by postulating a positive space-charge region in front of a positively charged surface. However, using the ceramic orifice, much broader IEDFs are observed. These IEDFs are in agreement with simulations by Babaeva and Kushner [2013 J. Phys. D: Appl. Phys. 46 125201].

P 23.3 Thu 17:00 ZHG006

Spatio-temporal ignition pattern in sinusoidal-driven dielectric barrier discharges — •Hans Höft[1], Markus M. Becker[1], and Ronny Brandenburg[1,2] — [1]Leibniz Institute for Plasma Science and Technology (INP), Greifswald, Germany — [2]Institute of Physics, University of Rostock, Rostock, Germany

Dielectric barrier discharges (DBDs) driven by sinusoidal high-voltage (HV) waveforms feature distinct spatio-temporal ignition pattern, which differs significantly from pulsed-operated DBDs, and are of importance for the performance of plasma-chemical reactors. This was investigated using a spatially 1D multi-filament DBD arrangement with a 1 mm gap (dielectric alumina, 1 mm around each rod electrode) and a lateral gap length of ≈ 10 mm in synthetic air at 1 bar. Electrical measurements were synchronised with iCCD and streak camera recordings to obtain information on the number of filaments and their spatio-temporal inception during the positive and negative half-cycle of the applied sinusoidal HV waveform with 11 and 14 kV_{pp} at 10 kHz. It was found that the filament positions are fixed in both HV half-cycles corresponding to current pulse series. There are alternating positions during one half-cycle, i.e. the deposited surface charges prohibit the ignition for the same polarity of the HV waveform. This pattern, however, is stable only for some subsequent periods. Furthermore, the spatial stability disappears for higher HV amplitudes, when more than two filament series occur during one half-cycle of the HV waveform.
This work was funded by the Deutsche Forschungsgemeinschaft (DFG), project number: 535827833.

P 23.4 Thu 17:15 ZHG006

Impact of ambient humidity on the OH distribution in the effluent of an atmospheric pressure plasma jet — •Robin Labenski[1], Sebastian Burhenn[1], Maike Kai[1], Pia Pottkämper[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

Atmospheric plasma jets are essential in fields like plasma medicine, as they can generate and deliver reactive oxygen and nitrogen species (RONS) to specific targets. A detailed understanding of their generation mechanisms and interactions with the ambient atmosphere is critical, particularly for hydroxyl (OH) radicals. This study examines OH dynamics in the COST microplasma jet (COST-Jet) using helium (He) as the feed gas. By employing laser-induced fluorescence (LIF) spectroscopy, absolute OH densities are mapped in three dimensions. Varying the humidity in both the feed gas and ambient air, the contributions of plasma and post-plasma processes to OH generation are analyzed. When water vapor is added to the feed gas, uniformly high OH densities ($1 * 10^{14}\,cm^{-3}$) are observed near the nozzle, followed by rapid axial and radial decay. In contrast, ambient humidity alone produces one order lower OH densities, localized at the effluent-air boundary. Higher ambient humidity shifts the OH density peak closer to the nozzle as humidity infiltrates deeper into the effluent. This work is supported by project PlasNOW and in collaboration with projects B2 and B11 of SFB1316

P 23.5 Thu 17:30 ZHG006

Surface processes during plasma-based nitrogen fixation — •Steijn Vervloedt and Achim von Keudell — Experimental Physics II, Ruhr University Bochum, Bochum, Germany

Nitrogen fixation is a vital part of artificial fertiliser production. Plasma-based gas conversion is an alternative to thermal catalytic processes currently used by the chemical industry, because it is better suited to work for a decentralised and varying energy supply of renewable energy. The efficiency of these plasma-based processes might even be improved by introducing a catalyst. In this contribution, we present our results on the surface composition of an iron foil in direct contact with a nitrogen containing plasma. A low-pressure RF plasma is ignited in N_2/O_2 and N_2/H_2 gas mixtures to study surface processes related to NH_3 and NO_x synthesis, respectively. Infrared reflection absorption spectroscopy probes the surface composition in-situ. This technique yields reflectance spectra that show a fingerprint of the surface groups on the foil. The results in a N_2/O_2 plasma show the formation of N_xO_y species on the surface and O_3 in the gas phase. The N_2/H_2 plasma results show the change in the oxidation state of the iron foil and the incorporation of nitrogen species. The interplay between these species can be used to devise a kinetic model of these surface mechanisms.

P 23.6 Thu 17:45 ZHG006

Influence of Nanosecond Pulsed Plasmas in Liquids on Copper Surfaces — •Pia-Victoria Pottkämper, Sven Weller, Neil Unteregge, Katharina Laake, and Achim von Keudell — Ruhr-Universität Bochum

One application of plasmas in liquids is the modification of metal surfaces. In this project a plasma is ignited at an electrode immersed in liquid using high voltages, nanosecond pulses and fast rise times. The plasma and plasma-activated liquid is then used to modify a coppper surface. The plasma causes a dissociation of water molecules, leading to the creation of many different reactive species with varying lifetimes such as molecular oxygen and hydrogen, solvated electrons and hydrogen peroxyde. These species elicit different reactions that lead to the modification of the copper sample. It is possible to reduce the surface or to initiate growth of nanostructures depending on the experimental conditions. The changes are monitored via FTIR spectroscopy, SEM and cyclic voltammetry. The creation of uniform copper oxide nanocubes has been observed under certain conditions. One application of these structures is the catalysis of the electrochemical reduction of CO2. During this reaction the activity of these catalysts decreases over time. The in-liquid plasma could be used to re-oxidize or create such catalytic surfaces. It is postulated that by combining an in-situ in-liquid plasma treatment with such a catalysis setup the lifetime of the catalytic surfaces can be extended.