P 7: Atmospheric Pressure Plasmas I

Time: Tuesday 14:00–15:30 Location: P-H11

P 7.1 Tue 14:00 P-H11

Towards *in situ* plasma surface interaction studies utilizing a microplasma in a TEM — •Luka Hansen[1], Niklas Kohlmann[2], Ulrich Schürmann[2], Lorenz Kienle[2], and Holger Kersten[1] — [1]Institute of Experimental and Applied Physics, Kiel Univeristy, Kiel, Germany — [2]Institute for Material Science, Kiel University, Kiel, Germany

The idea of *in situ* investigating a microplasma in a transmission electron microscope (TEM) was first successfully demonstrated in 2013 [1]. Since then no attempts have been taken to observe the plasma surface interaction in real time. Various technical challenges, e.g. size limitations, gas sealing and handling of high voltages, have to be overcome to enable the *in situ* imaging.
A stable atmospheric pressure microplasma discharge was developed and studied *ex situ* in advance to gain insight in the plasma surface interaction by several diagnostics [2]. Prototypes of the vacuum-proof microplasma cell have been build and preparations for the *in situ* studies are ongoing right now.
In the contribution the microplasma and its vacuum-proof encapsulation is addressed and a report on the current state of the *in situ* experiments will be given.

[1] K. Tai *et al.*, 2013 *Scientific Reports* **3** 1325
[2] L. Hansen *et al.*, *PSST* **(Submitted)**

P 7.2 Tue 14:15 P-H11

Breakdown and quasi-DC phase of a nanosecond discharge — •Nikita Lepikhin[1], Jan Kuhfeld[1], Zoltán Donkó[1,2], Dirk Luggenhölscher[1], and Uwe Czarnetzki[1] — [1]Institute for Plasma and Atomic Physics, Ruhr University Bochum, D-44780 Bochum, Germany — [2]Wigner Research Centre for Physics, Budapest, Hungary

A nanosecond Atmospheric Pressure Plasma Jet (ns-APPJ) is studied by picosecond Electric-Field Induced Second Harmonic generation (E-FISH) and spatially/temporally resolved Optical Emission Spectroscopy (OES). Two distinct phases of the discharge are identified: fast breakdown at high electric field is followed by a quasi-DC phase at lower permanent electric field and high electron density. The spatial structure of the discharge after the breakdown is found to be similar to that of a DC-glow discharge. It is demonstrated that the bulk electric field in the quasi-DC phase is independent of the amplitude of the voltage applied to the discharge and, consequently, the electric field strength during breakdown. It is also shown that the voltage and current waveforms and the discharge morphology weakly depend on the gas mixture. The experimental results are compared with the results of PIC/MCC simulations and an analytical model. Good agreement is found throughout.

P 7.3 Tue 14:30 P-H11

Investigations on the impact of electrode proximity on streamer breakdown and development of pulsed dielectric barrier discharges — •Hans Höft, Jente R. Wubs, Manfred Kettlitz, Markus M. Becker, and Klaus-Dieter Weltmann — Leibniz Institute for Plasma Science and Technology (INP), Felix-Hausdorff-Straße 2, 17489 Greifswald, Germany

The impact of the electrode proximity on the streamer breakdown and development of pulsed-driven dielectric barrier discharges (DBDs) in a single-filament arrangement was investigated in a gas mixture of 0.1 vol% O_2 in N_2 at 0.6 bar and 1.0 bar. To this end, the gap distance was varied from 0.5 mm to 1.5 mm, while the applied voltage was adapted correspondingly to create comparable breakdown conditions in the gap. The development of the DBDs was recorded by an iCCD and a streak camera system, which enabled sub-ns temporal and μm spatial resolution. Simultaneously, fast electrical measurements provided insight into relevant discharge characteristics such as the transferred charge and consumed energy. The results demonstrate that breakdown in a smaller gap is characterised by a slower streamer propagation but a significantly higher acceleration. It can therefore be concluded that the proximity of the cathode has a strong impact on the characteristics of the streamer breakdown. However, after the streamer has crossed the gap, the discharge structure in front of the anode was found to be the same independent of the actual gap distance.

This work was funded by the DFG in the framework of the MultiFil project (project number 408777255).

P 7.4 Tue 14:45 P-H11

CO_2 Konversion und Energieeffizienz eines Mikrowellen-Plasmabrenners — •Katharina Wiegers, Andreas Schulz, Matthias Walker und Günter Tovar — Institut für Grenzflächenverfahrenstechnik und Plasmatechnologie IGVP, Universität Stuttgart, Stuttgart, Deutschland

Die Menschheit ist heutzutage stark vom fortschreitenden Klimawandel betroffen, der hauptsächlich durch den zunehmenden Ausstoß von Kohlendioxid (CO_2), z. B. durch Verkehr, Kohlekraftwerke und die Industrie, verursacht wird. Ein grundlegendes Problem der Energieerzeugung durch erneuerbare Energiequellen wie Photovoltaik und Windkraftanlagen ist die häufig zu beobachtende Diskrepanz zwischen der tatsächlichen Energieproduktion und dem Energiebedarf aufgrund ihrer diskontinuierlichen Verfügbarkeit. Die so genannte überschüssige Energie kann zum Betrieb eines Mikrowellen-Plasmabrenners bei Atmosphärendruck verwendet werden. Das CO_2-Plasma führt zur Bildung von Kohlenmonoxid (CO) und Sauerstoffradikalen (O·). Um die thermodynamisch erzwungene Rekombination beider zu CO_2 beim Abkühlen zu verhindern, ist ein effektives Trennverfahren erforderlich. Keramische Hohlfasern sind ideal dafür geeignet. Das verbleibende CO kann als C_1-Baustein in der chemischen Industrie verwendet werden. Diese Arbeit konzentriert sich auf die Konversion- und Energieeffizienz des CO_2-Plasmas in Abhängigkeit von verschiedenen Prozessparametern wie Mikrowellenleistung, Gasfluss und der Position im Abgaskanal. Die Effizienzen werden mittels FT-IR und Massenspektrometrie bestimmt.

P 7.5 Tue 15:00 P-H11

Electric field strengths within a micro cavity plasma array measured by Stark shifting and splitting of a helium line pair — •Sebastian Dzikowski[1], Judith Golda[2], Marc Böke[1], and Volker Schulz-von der Gathen[1] — [1]Experimentalphysik II, Ruhr-Universität Bochum — [2]Plasma Interfache Physics, Ruhr-Universität Bochum

The electric field is a key parameter in discharge sources. Its knowledge allows to optimize promising applications by controlling plasma processes such as fluxes of charged particles onto surfaces. Especially, for plasma-enhanced catalysis in microplasmas, high electric fields provide intense ionization rates and with this high ion and electron densities. However, due to limited optical access, experimental data of electric fields in micro-structured plasmas are rare. Here, we exploit the Stark shifting and splitting of the allowed 492.19 nm and forbidden 492.06 nm helium lines on a metal-grid array. This layer-structured array consists of a nickel foil that serves as a high voltage supplied electrode and contains four different sized cavity arrangements in the 100 microns range. This nickel foil is separated from an electrically grounded magnet by a 40 microns thick dielectric. By using a combination of a 2 m long plane grating spectrometer and an attached ICCD camera, electric fields up to 70 kV/cm can be measured and controlled by parameters as cavity sizes and excitation features as polarity, voltage and frequency. As an example, smaller cavities yield to higher electric field strengths. For a better understanding a simple Townsend-model is built-up. This research is supported by DFG within SFB1316 (A6).

P 7.6 Tue 15:15 P-H11

CO_2 conversion in barrier discharges with and without packed bed filling at elevated pressures — •Rezvan Hosseini Rad[1], Milko Schiorlin[1], Volker Brüser[1], and Ronny Brandenburg[1,2] — [1]Leibniz-Institute for Plasma Science and Technology — [2]University of Rostock, Institute of Physics

A coaxial dielectric barrier discharge (DBD) reactor operated at elevated pressures up to 2 bar is investigated for the splitting of carbon dioxide. Electrical plasma parameters as well as concentraions of carbon monoxide as the main chemical product is studied without and with a packed bed (partially or fully) filling the reactors volume. A mixture Ar:CO_2 = 4:1 is used as feed gas. Argon is admixed in order to reduce the breakdown voltage, thus, enabling also a stable plasma operation at the higher pressures. Increasing the pressure leads to an increase of the CO_2 conversion and energy efficiency in case of empty as well as packed bed reactor. The energy efficiency is improved up to 31 % if the reactors volume is fully filled with glass beads with a CeO_2 coating compared with the empty reactor. The chemical performance is correlated with the discharge distribution in the DBD reactor, deduced from electrical diagnostics.