P 27: Low Temperature Plasmas III

Time: Friday 11:00–12:45 Location: b305

P 27.1 Fri 11:00 b305

The breakdown process in an atmospheric pressure parallel-plate nanosecond discharge — •Bang-Dou Huang[1,2], Keisuke Takashima[3], Xi-Ming Zhu[2], and Yi-Kang Pu[1] — [1]Department of Engineering Physics, Tsinghua University, Beijing 100084, P. R. China — [2]Institute for Plasma and Atomic Physics, Ruhr-University Bochum, Bochum 44801, Germany — [3]Department of Electronic Engineering, Tohoku University 6-6-05 Aoba Aramaki, Aoba-ku, Sendai, MIYAGI 980-8579, Japan

The breakdown process in an atmospheric pressure nanosecond discharge with parallel-plate electrodes in helium/argon mixture is investigated by temporally and spatially resolved OES. The electric field is obtained from the Stark splitting of the He I 492.1 nm line. Two effective Te, i.e. Te, high and Te, low, are obtained, using the emissions from helium and argon lines and a simple time-resolved collisional-radiative model. Compared with the nominal average electric field (V/d), the field is greatly enhanced at the ionization wave front and is significantly weakened behind the wave front, as predicted by a fluid model. The value of Te, high is much larger than that of Te, low, which indicates that an elevated high energy tail in the EEPF is built up under the strong electric field during the breakdown process. Initially, the spatial distribution of Te follows that of the electric field. However, at the end of the breakdown period, the location of the highest Te is shifted away from that of the strongest electric field (in the cathode sheath). This indicates the existence of non-local effects, which is supported by the result from a simple Monte-Carlo simulation.

P 27.2 Fri 11:15 b305

Analyse der Dynamik von RF-modulierten Elektronenbeams in kapazitiv gekoppelten Plasmen — •Sebastian Wilczek[1], Jan Trieschmann[1], Ralf Peter Brinkmann[1], Julian Schulze[2], Edmund Schüngel[2], Aranka Derzsi[3], Ihor Korolov[3], Peter Hartmann[3], Zoltán Donkó[3] und Thomas Mussenbrock[1] — [1]Ruhr-Uni Bochum, Bochum, Germany — [2]West Virginia University, Morgentown, USA — [3]Wigner Research Center for Physics, Budapest, Hungary

In kapazitiven Niederdruckentladungen ist das Beschleunigen von hochenergetischen Elektronen durch die Randschichtexpansion (Entstehung von Elektronenbeams) einer der wichtigsten Heizungsmechanismen. Der Einfluss von grundlegenden Prozessparametern (z.B. Plattenabstand, Anregungsfrequenz, Druck, Elektrodenanordnung und Elektrodenspannung) kann die Dynamik dieser Elektronenbeams signifikant beeinflussen. Sowohl die Formation als auch die Reflektion an der gegenüberliegenden Randschicht kann durch eine geeignete Wahl dieser Parameter kontrolliert werden. Infolgedessen können prozessrelevante Größen, wie Elektronendichte, Ionenfluss und Verteilungsfunktionen, optimiert werden. In diesem Beitrag werden mithilfe von 1d3v Particle-In-Cell Simulationen Parameterstudien durchgeführt, welche den Einfluss der oben genannten Prozessparameter in Bezug auf die Dynamik der Elektronenbeams und weitere relevante Plasmagrößen bestimmen.

P 27.3 Fri 11:30 b305

Simulation of laser photodetachment of negative ions in helium-oxygen barrier discharges and comparison with experiment — •Sebastian Nemschokmichal, Robert Tschiersch, and Jürgen Meichsner — Institute of Physics, University of Greifswald

Helium-oxygen discharges at atmospheric pressure are well established in applications because of their ability to produce oxygen radicals under low power consumption. The use of oxygen in a discharge always causes the formation of negative ions, but the influence of negative ions on barrier discharges is poorly investigated. Therefore, we set up a helium oxygen barrier discharge to prove negative ions in a laser photodetachment experiment.

The experiment cannot directly provide number densities of negative ions. Therefore, a supporting simulation of the laser photodetachment experiment is necessary. The presented simulation is based on the 1D fluid simulation of a helium-oxygen barrier discharge described in a further contribution. The laser photodetachment is implemented by the interaction between negative ions and a temporally and spatially dependent photon flux. Since the simulation turns out that the intrinsic negative ion density of the simulation is too low to reproduce the laser photodetachment experiment, different modifications and their capabilities of reproducing the experimental results are discussed. The comparison with the experimentally obtained dependencies of the laser photodetachment effect allows conclusions on the spatio-temporal distribution of negative ions.

P 27.4 Fri 11:45 b305

Chemistry of neutral and charged species in the effluent of the micro atmospheric pressure plasma jet in water-helium admixture — •Gert Willems, Achim von Keudell, and Jan Benedikt — Experimental Physik II, Ruhr-Universität Bochum, Germany

A thorough understanding and good control of produced neutral and charged species by cold atmospheric plasmas is essential for potential environmental and/or bio-medical applications. In this respect, mass spectrometry of these plasmas can provide absolute number densities of stable and reactive species and relative trends of charged species. Thereby giving valuable insights into the reaction chemistry. In this study we use the COST reference micro plasma jet (μ-APPJ), a radio-frequency capacitively coupled plasma source with 1 mm electrode distance, which has been operated in helium-water vapour mixture and has been studied as a potential source of hydroxyl radicals and hydrogen peroxide molecules. The water vapour concentration was up to 1.2%. The measurements of hydrogen peroxide and hydroxyl radicals from atmospheric plasma, as measured using MB-MS, will be presented. Their dependency on water vapour concentration in the carrier gas as well as distance to target have been investigated. The measured density is between 5E-13 cm-3 (2.4ppm) and 1.5E-14 cm-3 (7.2ppm) for both hydrogen peroxide molecules and hydroxyl radicals. The achieved results are in good agreement with data from Cavity-Ringdown laser absorption spectroscopy.

P 27.5 Fri 12:00 b305

3D-PIC Simulation of an Inductively Coupled Ion Source — •Robert Henrich, Michael Becker, and Christian Heiliger — Institut für Theoretische Physik, Justus-Liebig-Universität Gießen

Inductively coupled ion sources are applied to a wide range of plasma applications, especially surface modifications. The knowledge of the behavior and precise information of the plasma parameters are of main importance. These values are tedious to measure without influencing the discharge. By applying our fully three-dimensional PlasmaPIC tool we are able to reach these plasma parameters with a spatial and temporal resolution which is quite hard to achieve experimentally. PlasmaPIC is used for modeling discharges in arbitrary geometries without limitations to any symmetry. By this means we are able to demonstrate that the plasma density can have an irrotational character in ICPs. Furhtermore we will show that for gridded inductively coupled ion sources the neutral gas pressure inside the discharge chamber depends on the extraction of ions. This effect is considered in PlasmaPIC by a self-consistent coupling of the neutral gas simulation and the plasma simulation whereas the neutral gas distribution is calculated using the direct simulation Monte Carlo method (DSMC). This work has been supported by the "Bundesministerium fuer Wirtschaft und Energie". Grant 50RS1507

P 27.6 Fri 12:15 b305

Relevanz der dissoziativen Rekombination von positiven Wasserstoffionen für die Balmer-Strahlung in Niederdruck H_2-Entladungen — •Stefan Briefi[1], Dominikus Zielke[1] und Ursel Fantz[1,2] — [1]AG Experimentelle Plasmaphysik, Universität Augsburg, 86135 Augsburg — [2]Max-Planck-Institut für Plasmaphysik, Boltzmannstr. 2, 85748 Garching

In Niederdruck-Niedertemperatur H_2-Plasmen sind Elektronenstoßanregungsprozesse im Wasserstoffatom und dissoziative Anregung des Wasserstoffmoleküls wesentlichen Besetzungkanäle für die oberen Zustände der Balmer-Linien. Aber auch die dissoziative Rekombination von H_2^+ kann eine wichtige – unter Umständen sogar dominante – Rolle spielen. Um die Relevanz der einzelnen Besetzungsprozesse dediziert zu bewerten, wurden Messungen der positiven Ionenspezies H^+, H_2^+ und H_3^+ mittels eines energieauflösenden Massenspektrometers in einer ICP-Entladung (planare Spule, HF-Frequenz 2 MHz, Leistung bis

2 kW) im Druckbereich zwischen 1 und 10 Pa durchgeführt. Zusammen mit der Elektronendichte und -temperatur, die per Langmuirsonde bestimmt werden, dienen die Ionendichten als Input-Parameter für das Stoß-Strahlungs-Modell Yacora H (siehe D. Wünderlich et al., JQSRT, 110, 62 - 71, 2009). Die mit diesem Modell berechneten Besetzungsdichten der elektronischen Niveaus im H Atom werden mit den Resultaten aus emissionsspektroskopischen Messungen verglichen wodurch der Beitrag der jeweiligen Besetzungkanäle für die oberen Zustände der Balmer-Linien bestimmt wird.

P 27.7 Fri 12:30 b305

High power impulse sputtering of chromium: correlation between the energy distribution of chromium ions and spoke formation — •Wolfgang Breilmann, Alexandra Eitrich, Christian Maszl, Ante Hecimovic, Vincent Layes, Jan Benedikt, and Achim von Keudell — Ruhr-Universität Bochum, Experimentalphysik II

The ion energy distribution functions (IEDF) of high power impulse magnetron sputtering (HiPIMS) plasmas show ions with kinetic energies up to 100eV, which do not exist in conventional dc magnetron sputtering discharges. The origin of these high energetic ions is a local maximum of the electric potential inside of ionization zones (IZ). These IZ, also called spokes, are structures of high plasma density, which rotate along the racetrack in ExB direction. With increasing peak current density the amount of spokes reduces until, in the case of a chromium target, they form a homogeneous discharge again. The transition from the no spokes to spokes regime and from the spokes to homogeneous regime have been observed with an energy and time resolved ion mass spectrometer and electrical probe experiments. Mass spectrometry measurements then showed the evolution of the IEDF and its dependence on the spokes regime. It was observed that a high energetic group of ions is generated when spokes occur. Furtheremore, the homogeneous regime mostly affects the low energy part of the IEDF, as it increases the potential difference between the discharge and the mass spectrometer. Thus, the homogeneous discharge is considered to be a single IZ.