P 22: Niedertemperaturplasmen II

Zeit: Freitag 9:45–11:40 Raum: HS 2

Hauptvortrag P 22.1 Fr 9:45 HS 2

Physical processes in the afterglow of pulsed low-pressure discharges in argon — •Tsanko V. Tsankov[1], Yusuf Celik[1], Dirk Luggenhölscher[1], Uwe Czarnetzki[1], Mitsutoshi Aramaki[2], and Shinji Yoshimura[3] — [1]Institute for Plasma and Atomic Physics, Ruhr-University Bochum, 44780 Germany — [2]Department of Electrical Engineering and Computer Science, Nagoya University, 464-8603, Japan — [3]National Institute for Fusion Science, Toki 509-5292, Japan

In this talk a description of the key processes in argon low-pressure afterglows will be presented which forms a unified picture of the afterglow physics [1]. The leading process is the effective electron energy loss through evaporative cooling, i.e. escape of only the most energetic electrons to the walls. On the same time scale quenching of the metastable atoms occurs. At later times the evaporative cooling is adiabatically balanced by Coulomb collisions with the ions. The established low electron temperature enhances the three-body recombination process which leads to population of Rydberg atomic levels. Through de-excitation collisions with electrons and radiative transitions electrons in Rydberg states decay to lower states and eventually end up in the metastable states. In consequence, metastable atoms are initially almost totally lost due to quenching and are recreated later by recombination. Finally, they are lost again by diffusion and energy pooling collisions. Results from measurements, analytical models and numerical simulations will be presented and compared.

[1] Y. Celik, Ts. V. Tsankov, M. Aramaki, S. Yoshimura, D. Luggenhölscher, U. Czarnetzki, *Phys. Rev. E* **85**, (2012) 046407; *ibid.* 056401

P 22.2 Fr 10:15 HS 2

Determination of plasma densities in noble gas discharges by THz Time Domain Spectroscopy — •Steffen Marius Meier, Tsanko Vaskov Tsankov, Dirk Luggenhölscher, and Uwe Czarnetzki — Institute for Atomic and Plasma Physics, Ruhr-University Bochum, Germany

Terahertz Time Domain Spectroscopy (THz TDS) is a spectroscopic method which is widely used in many scientific fields. It combines the advantages of short pico-second electromagnetic pulses and a broad spectrum in the THz range. In plasma physics these properties allow determining the complex dispersion function of a plasma as well as the plasma density and the collision frequency.

Using this diagnostic method the plasma densities of discharges in noble gases (He, Ne, Ar, Kr, Xe) are measured as a function of the power in a magnetic multi-pole ICP discharge [1,2]. Densities as high as 10^{14} cm^{-3} are obtained at a filling gas pressure of 20 Pa. An analytical model is developed to explain the obtained non-linear power-density variation. The satisfactory agreement between model and measurements indicates that neutral gas depletion effects due to high gas temperatures and non-negligible electron pressure become important.

[1] Maurmann, S.; Drepper, P.; Ferri, S.; Petershagen, N., *A magnetic multipole plasma source for the investigation of electron-atom collision processes*, Contrib. Plasma Phys. **40**, (2000), 152–157
[2] Babkina, T. M., *Generation of hyperthermal atoms through surface neutralisation*, PhD Thesis, Ruhr-Universität Bochum (2006)

P 22.3 Fr 10:30 HS 2

High density helicon plasma cell for plasma wakefield accelerators — •Birger Buttenschön[1,2], Philipp Kempkes[1,3], Olaf Grulke[1], and Thomas Klinger[1,3] — [1]MPI for Plasma Physics, EURATOM Association, Wendelsteinstr. 1, 17491 Greifswald, Germany — [2]MPI for Physics, Föhringer Ring 6, 80805 Munich, Germany — [3]Institute for Physics, Ernst-Moritz-Arndt-University Greifswald, Felix-Hausdorff-Str. 6, 17489 Greifswald, Germany

The proton-driven plasma wakefield accelerator (PDPWA) is a promising concept for future electron accelerators with beam energies in the TeV range. Simulations show that a plasma density on the order of 10^{21} m^{-3} with high axial homogeneity over a length of a few hundred metres is necessary to reach the envisaged electron energies. In contrast to the commonly used laser plasma generation, a helicon (low-frequency whistler) wave heated plasma provides scalability to the required length without suffering from interaction of the relativistic proton beam with any electrode material. Furthermore, helicon waves have no intrinsic cut-off density, which makes them an ideal choice for creating plasmas with very high densities. In this contribution, we present a helicon plasma cell currently being developed as a prototype of a PDPWA plasma cell. First measurements characterizing the discharge structure – where the helicon wave field structure and the axial plasma density distribution are key parameters – are presented along with the general scaling behaviour of the plasma density with respect to applied rf power.

P 22.4 Fr 10:45 HS 2

Lebensdauer von elektrischen Ladungen auf BSO in Barrierenentladungen — •Robert Wild[1], Johannes Benduhn[2] und Lars Stollenwerk[1] — [1]Institut für Physik, Ernst-Moritz-Arndt Universität Greifswald — [2]Institut für Angewandte Photophysik, Technische Universität Dresden

Während des Betriebes einer Barrierenentladung werden infolge der elektrischen Ströme permanent Ladungsträger auf den dielektrischen Oberflächen deponiert. Das elektrische Feld solcher *Oberflächenladungen* beeinflusst das Verhalten der Entladung maßgeblich. Abhängig von deren Polarität wird das äußere elektrische Feld dadurch entweder abgeschwächt oder verstärkt.

In diesem Beitrag werden Untersuchungen zur Lebensdauer von Oberflächenladungen nach dem Abschalten der äußeren Spannung auf einer dielektrischen BSO-Oberfläche vorgestellt und diskutiert. Es wird gezeigt, dass die Ladungen in zwei Schritten mit unterschiedlichen Zeitskalen abgebaut werden. Eine Interpretation mit zwei superponierenden Exponentialfunktionen setzt die Anlagerung von Ladungsträgern in unterschiedlichen Bindungszuständen voraus. Dabei erfolgt der langsamere Ladungsabbau durch eine messungsinduzierte Photoleitfähigkeit im BSO-Kristall. Für den schnellen Ladungsabbau wird eine kristallinterne und E-feldabhängige Bandverbiegung in Betracht gezogen, die den Abbau von Ladungsträgern ermöglicht. Das Modell wird durch experimentelle Messungen gestützt.

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P 22.5 Fr 11:00 HS 2

Operation modes in barrier discharges: discharge development and surface charge accumulation — •Marc Bogaczyk and Hans-Erich Wagner — Institut für Physik, Ernst-Moritz-Arndt Universität, Felix-Hausdorffstr. 6, 17489 Greifswald

A new discharge cell configuration was developed which allows the joint investigation of important volume and surface processes of the barrier discharge (BD) operation. In particular, the spatio-temporal and spectrally resolved discharge emission in the volume was studied together with the temporally resolved formation of surface charges on a dielectric BSO crystal. This was possible by the application of the cross-correlation spectroscopy (CCS) and the electro-optic Pockels effect for surface charge measurement, respectively. Surface charges play an important role for the re-ignition of BDs. In pure nitrogen and helium, the diffuse Townsend-like discharge mode was studied. In addition, in helium the glow-like mode could be induced by varying the feeding voltage signal. Small admixtures of nitrogen to helium resulted in the the filamentary discharge operation. Under these conditions, the importance of the so-called memory effect has been verified.

The lateral extent of the discharge spots in the filamentary mode can be approximated by Gaussian profiles for both polarities. The deposited surface charges are in good agreement with the transferred charge of subsequent discharge breakdowns [1].

Supported by “Deutsche Forschungsgemeinschaft, Sonderforschungsbereich SFB TR24”.

[1] J. Phys. D: Appl. Phys. 45 (2012) 465202

Fachvortrag P 22.6 Fr 11:15 HS 2

Spatio-temporally resolved $\mathbf{N_2}(A^3\Sigma_u^+)$ metastables densities in nitrogen barrier discharges — •Sebastian Nemschokmichal and Jürgen Meichsner — Institute of Physics, University of Greifswald

Atmospheric pressure barrier discharges can operate in two discharge modes, the filamentary and the diffuse discharge mode. The transition between these modes depends, e.g., on the feeding gas, the dielectrics, and the discharge voltage. In a barrier discharge in pure nitrogen, driven by a sinusoidal applied voltage, the diffuse mode develops.

Adding only 500 ppm oxygen, a transition to the filamentary mode can be observed due to the strong quenching of the $N_2(A^3\Sigma_u^+)$ metastables by oxygen molecules. Hence, the metastable molecules are essential for the diffuse mode development, either because of Penning-ionization in the volume or exoemission of electrons at the (charged) dielectrics. To clarify their specific role in these processes, the density of the nitrogen $A^3\Sigma_u^+, v = 0$ metastables was measured by laser induced fluorescence spectroscopy in a discharge gap of 1 mm at a pressure of 500 mbar. The densities are in the order of magnitude of $10^{13}\,\mathrm{cm}^{-3}$. The time resolved measurement after one single microdischarge shows a delay of the metastables population with respect to the microdischarge pulse. In the diffuse mode, the axial density profiles show a maximum shifted to the respective anode. This corresponds to the larger electron density at the anode typical for the Townsend-like discharge mode. Nevertheless, the metastables density does not increase exponentially toward the anode as the electron density.