P 17: Low Temperature Plasmas II

Time: Thursday 14:15–15:50 Location: B 305

Topical Talk P 17.1 Th 14:15 B 305

Wechselwirkung von Stromfilamenten in einer planaren Wechselspannungsentladung — •Lars Stollenwerk — Institut für Plasmaforschung, Universität Stuttgart

In einer planaren, dielektrischen Barrierenentladung (DBD) mit sehr kurzem Entladungsabstand und sehr großer Elektrodenfläche wird eine Glimmentladung in Helium gezündet. Aufgrund des großen Aspektverhältnisses bilden sich einzelne Stromfilamente. Diese Filamente können sich bei geeigneter Parameterwahl regelmäßig anordnen oder erratisch umherlaufen. Im Falle umherlaufender Filamente kommt es immer wider zu Kollisionen, bei denen üblicherweise einer der Stoßpartner vernichtet wird.

In dieser Arbeit wird der Wechselwirkungsvorgang zweier Filamente näher untersucht. Dazu wird mit einem elektrooptischen Kristall auch die Oberflächenladungsverteilung, die als Gedächtnis zwischen den Durchbrüchen in der DBD wirkt, beobachtet. Neben dem bloßen Abbild des Durchbruchs, wie er in der Leuchtdichteverteilung beobachtet wird, zeigt sich in der negativen Ladungsverteilung ein zusätzlicher Ladungsring um das einzelne Filament. Die sich dabei ergebende innere Struktur des Filaments kann mit verschiedenen Situationen des Wechselwirkungsvorgangs in Zusammenhang gebracht werden.

Topical Talk P 17.2 Th 14:40 B 305

Simulation of a thin cathode discharge in argon at high pressures — •Sebastian Mohr, Beilei Du, Dirk Luggenhölscher, and Uwe Czarnetzki — Institut für Plasma- und Atomphysik, RUB

A thin cathode discharge consists of two electrodes separated by a dielectric layer with a thickness of ca. 100 μm. While the anode can have essentially an arbitrary width, the cathode has to be thin in order to ensure a high current density (100 μm in our case). The discharge burns in a hole of 200 μm diameter that penetrates this „sandwich". When such a device is operated with a DC supply voltage at pressures of several 100 hPa, it shows a self-pulsing behavior. Electrical measurements and CCD-images indicate, that this can be explained by the repeated ignition of a short-living arc discharge at the edge of the hole. Due to the high pressure and the related high collision frequencies, the afterglow of this discharge was expected to last several 10 ns. Instead, lifetimes of several 100 ns were observed. In order to identify the mechanisms responsible for this long-living afterglow, a kinetic model of the afterglow was developed. As a result, Penning-ionisation and superelastic collisions with metastables and excimers were found to play a crucial role in heating the electrons. Furthermore, the gas temperature has a significant influence on the lifetime of the afterglow.

P 17.3 Th 15:05 B 305

Spatio-temporal Development of a Surface Barrier Discharge at Atmospheric Pressure in Air — •Helge Grosch, Tomáš Hoder, Ronny Brandenburg, and Klaus-Dieter Weltmann — INP Greifswald, Felix-Hausdorff-Str. 2, 17489 Greifswald, Germany

Surface barrier discharges (SBDs) have a large field of application. They are used for pollution control, surface treatment. In recent years biomedical applications or their use as gas flow actuators and attenuators is under intensive study worldwide. Similar as in classical barrier discharges the plasma of a SBD in air consist of single microdischarges (MDs). In order to study the MD development a special SBD arrangement consisting of two needle electrodes in an asymmetric set-up on opposite sides of a 0.6 mm alumina plate was prepared. SBD was driven by a sinusoidal voltage of several kV in dry air at atmospheric pressure. The spatial and temporal development was measured with the cross-correlation-spectroscopy (CCS) and an iCCD camera equipped with a far field microscope. The CCS apparatus is characterized by a high spatial and temporal resolution (0.01 ns and 0.01 mm) as well as reasonable spectral resolution. For the first time the development of a single filament can be shown for both polarities of the SDB. In both polarities a surface ionizing waves starting from the exposed needle electrode are observed and their velocities are discussed.

P 17.4 Th 15:20 B 305

Vorticex Created by Plasma Actuator — Eduard Son[1] and •Dmitry Tereshonok[2] — [1]Institute of High Temperature, Moscow, Russia — [2]Moscow Institute of Physics and Technology, Dolgoprudny, Moscow Region, Russia

In the paper plasma flow control is presented. Flow control can be performed by four types of actuators - mechanical, acoustical, thermal and plasma. Last two actuators have an advantages to mechanical and acoustical: quick response, usability, absence of mechanical appliances. Plasma actuator produces the vorticity by interaction of the total electric field and space charge gradient. The vorticity of the thermal actuator are created by vectors production of pressure gradient and temperature. A plasma and thermal vorticity produced by electric discharge on the surface is proved by experimentally. Theoretical analysis of an atmospheric electric discharge shows that problem can be splitted on plasma and hydrodynamics equations because all processes can be divided into 3 types - fast, slow and residual time order. Electron distribution function is found from solution of Boltzmann equation two-term approximation with elastic and inelastic processes - excitation of rotation, vibration, electronic molecular states, dissociation, direct ionization. Crossection of processes are taken from overview last years. After the calculation of a different constant rates in plasma discharge vortex generation has been modeled.

P 17.5 Th 15:35 B 305

The Plasma Boundary Sheath as a Nonlinear Element — •Abd Elfattah Taha Elgendy and Ralf Peter Brinkmann — Lehrstuhl für Theoretische Elektrotechnik, Ruhr-Universität Bochum

The formation of a non-neutral, electron depleted boundary sheath in front of material surfaces is a universal plasma phenomenon; it is due to the facts that i) the electrons in a plasma are much more mobile than the ions, and that ii) the plasma is much larger than its own Debye length λ_D. The boundary sheath scales with λ_D and comprises therefore only a small fraction of the plasma. Yet, it is responsible for many aspects of its macroscopic behavior. A thorough understanding of its properties is therefore of paramount theoretical as well as practical importance. The multitude of scientific research devoted to the sheath bears witness to this statement. This work will focus on the global behavior of the sheath, i.e., the relation between the electrical current through the sheath and the overall voltage drop across it. Effective "lumped element" models will be studied which allow to describe the sheath dynamics in simple, though nonlinear engineering terms like resistance, capacitance, and inductance. It will be investigated how such models can be derived from a more detailed representation of the sheath physics, and how their properties depend on the parameters of the discharge as a whole. The accuracy of the models will be critically assessed by comparison with more elaborate simulations and also experiments.