P 24: Low Temperature Plasmas II

Time: Thursday 14:30–16:25 Location: b305

Invited Talk P 24.1 Thu 14:30 b305

Design and characteristics of the COST Reference Microplasma Jet for bio-medicine — •Judith Golda, Julian Held, and Volker Schulz-von der Gathen — Experimental Physics II, Ruhr-University Bochum, Bochum, Germany

Low temperature atmospheric pressure plasma jet devices enable the production of reactive species while the gas temperature is low. Hence, a variety of different sources is commonly used for surface modification and especially considered for use in bio-medicine. To understand and predict the interaction of plasma with biological tissue, a profound knowledge of the complex system and the underlying processes is crucial.

However, the variety of sources complicates the comparability of results and thus leads to a huge delay in scientific progress. To solve this problem, we developed the COST Reference Microplasma Jet within the European COST Action MP1101 for scientific purposes. Researchers around the world should be able to compare the characteristics of their own sources and their results with this device.

Here, we show the simple and robust design as well as a basic characterization of the COST-Jet. Requirements for reproducible results as well as power, optical emission spectroscopy and gas temperature measurements are presented. Additionally, the heat impact on a treated surface is investigated by Schlieren imaging, thermocouple measurements and comparison to numerical simulations.

Funded by the DFG within "PlaCID (Plasma Cell Interaction in Dermatology)" SCHU-2353/3-1.

Fachvortrag P 24.2 Thu 15:00 b305

Electronegativity during E-H transition in inductively coupled RF oxygen discharge — •Thomas Wegner, Christian Küllig, and Jürgen Meichsner — Institute of Physics, University of Greifswald

The E-H transition of an inductively coupled radio frequency oxygen discharge (ICP) is investigated using enhanced plasma diagnostics. Therewith, the positive ion saturation current, electron density and temperature, gas temperature, ground state ($O_2\left(X^3\Sigma_g^-\right)$) and metastable ($O_2\left(a^1\Delta_g\right)$) density are measured with high resolution in RF power input during the E-H transition. Further, the RF sheath dynamics are although studied. The attenuation of the RF sheath heating and especially the vanishing electric field reversal during the E-H transition indicates an decreasing electronegativity defined as the ratio between the negative atomic ion (O^-) and electron density. Additionally, the electron density peak due to collisional detachment of the negative ions with metastables in the early afterglow of a pulsed RF discharge gives information about the negative atomic oxygen ion density, too. Beside of these experimental findings, analytical calculations using a set of particle balance equations provide the negative ion density and consequently the electronegativity. The measured parameter which are mentioned above are used as input parameter for these calculations. The experimental investigations as well as the analytical calculations show that the electronegativity drops drastically from about 25 to 0.2 during the E-H transition.

//Funded by the DFG CRC/Transregio 24, project B5.

P 24.3 Thu 15:25 b305

Plasma series resonance as a surface wave phenomenon — •Denis Eremin, Thomas Mussenbrock, and Ralf-Peter Brinkmann — Ruhr-Universität Bochum, Universitätsstrasse 150, D44801, Bochum

The plasma series resonance (PSR) is an important phenomenon in low-pressure capacitively coupled plasmas. Such bounded plasmas have a natural eigenfrequency determined by the energy oscillation between the electrostatic field in the plasma sheath and the kinetic energy of the bulk plasma electrons and can be resonantly pumped, should the rf current exhibit a finite-amplitude harmonic at that frequency. In the low-pressure plasmas the PSR significantly contributes to the plasma heating by generating highly energetic electron beams. Traditionally, the PSR has been treated in the literature as a 1d phenomenon. However, it appears to be a part of a more general phenomenon of a surface wave propagating in the discharge. This talk will discuss the connection between the PSR and the surface wave using both theoretical analysis and numerical results.

P 24.4 Thu 15:40 b305

Global modelling of cylindrical surface wave discharges — •Efe Kemaneci and Ralf Brinkmann — Ruhr-University Bochum, Bochum, Germany

The surface wave discharges have a unique axial structure of dielectric-plasma interface that allows the plasma to enlarge axially due to the microwave propagation along the interface. This feature differentiates them from other types of plasmas that mostly associates with much smaller axial lengths and very different axial characteristics. This unique structure is to be considered in global (0-D volume-averaged) modelling approaches in order to self-consistently define the ion and electron losses at the wall as well as the energy dissipated in the sheath. In this study, we focus on this issue and implement a global model of pulse-modulated and continuous surface wave discharges.

P 24.5 Thu 15:55 b305

Einfluss verschiedener Gefäßmaterialien auf Dissoziationsgrad und Rotationsbesetzung molekularen Wasserstoffs in einem ICP. — •David Rauner[1,2], Stefan Briefi[1] und Ursel Fantz[1,2] — [1]AG Experimentelle Plasmaphysik, Universität Augsburg, 86135 Augsburg — [2]Max-Planck-Institut für Plasmaphysik, Boltzmannstr. 2, 85748 Garching

Die Wechselwirkung von Plasmen mit Oberflächen kann wesentlichen Einfluss auf eine Reihe verschiedener Plasmaparameter haben. In Wasserstoff-Niederdruckplasmen sind dabei zum einen Prozesse zu nennen, die einen Einfluss auf den Dissoziationsgrad molekularen Wasserstoffs aufweisen, wie beispielsweise die Reformation von H zu H_2 und das Sticking atomaren Wasserstoffs an den Oberflächen. Darüber hinaus können Interaktionsprozesse mit diesen Oberflächen auch zu einer Vibrations- und Rotationsanregung bzw. -umbesetzung von Wasserstoffmolekülen führen.

In einem induktiv gekoppelten Wasserstoffplasma (13,56 MHz, 300 W) wird der Einfluss verschiedener Oberflächenmaterialien untersucht. Die Plasmaerzeugung erfolgt im Druckbereich von 1 bis 10 Pa mittels einer helikalen Spule um ein Zylindergefäß (Länge 20 cm, Durchmesser 5 cm). Verglichen wird der Einfluss verschiedener Entladungsgefäße aus den Materialien Quarzglas, Al_2O_3 und AlN u.a. bei Variation des Druckes. Die Plasmaparameter bzw. Rotationsbesetzungen werden dabei mit Hilfe der optischen Emissionsspektroskopie (OES) sowie Stoß-Strahlungsmodellierung bestimmt.

P 24.6 Thu 16:10 b305

Spatio-temporal characterisation of multiple diffuse and single filamentary breakdowns in a plane-parallel barrier discharge configuration — •Robert Tschiersch[1], Sebastian Nemschokmichal[1], Marc Bogaczyk[2], and Jürgen Meichsner[1] — [1]Institute of Physics, University of Greifswald, Felix-Hausdorff-Str. 6, 17489 Greifswald, Germany — [2]Leibniz Institute for Plasma Science and Technology, Felix-Hausdorff-Str. 2, 17489 Greifswald, Germany

Helium-nitrogen barrier discharges (BDs) were operated at gas pressures from 100 mbar up to 1 bar inside an interelectrode gap of 3 mm using a concentric, plane-parallel discharge cell configuration. The latter enables the formation of multiple diffuse breakdowns per half cycle of the sinusoidal feeding voltage, as well as laterally patterned BDs and single filamentary BDs driven by a square wave voltage. These discharge modes were comprehensively studied by electrical measurements, optical emission spectroscopy and surface charge diagnostics. Regarding the multiple diffuse breakdowns, the spatio-temporally resolved optical emission identifies the first breakdown as the glow mode, the last breakdown as the Townsend mode, and the ones in between as a hybrid of both modes. As shown by the surface charge measurements, the consecutive breakdowns ignite alternately at laterally inner and outer regions of the electrode. Regarding the breakdown mechanism of patterned BDs as well as single filamentary BDs, the investigations reveal characteristics which declare this discharge type as an intermediate between the glow mode and the microdischarge.