P 5: Low Temperature Plasmas I

Time: Monday 16:30–18:25 Location: SPA HS201

Invited Talk P 5.1 Mon 16:30 SPA HS201

Guide field effects on magnetic reconnection — •Adrian von Stechow[1], Olaf Grulke[1], and Thomas Klinger[1,2] — [1]Max-Planck-Institut für Plasmaphysik, EURATOM Assoziation, Greifswald — [2]Ernst Moritz Arndt-Universität Greifswald

Magnetic reconnection, a topological rearrangement of opposed magnetic fields, is a ubiquitous plasma phenomenon and is suggested to play an important role in, e.g., particle acceleration and heating. The details of the reconnection process depend strongly on the magnetic field configuration. A superimposed guide field has been shown to alter fundamental reconnection parameters due to modifications of the current pattern, by e.g. inhibiting Hall currents and causing a pile-up of magnetic flux at the X-point. Additionally, electromagnetic micro-instabilities are believed to contribute to the fast reconnection process.

The present contribution deals with the detailed experimental study of the current sheet fluctuations under varying guide field conditions. The experiments are conducted in two paradigmatic and complementary laboratory configurations: MRX (PPPL, Princeton) is a closed field line, toroidal device with a weak guide field and a Harris sheet-like reconnection current. In contrast, VINETA II (IPP, Greifswald) is an open field line, linear and moderate to high guide field experiment in which the current sheet is predominantly set by the magnetic field geometry. Despite the different configurations, observed instabilities show similar features such as localization within the current sheet, broadband frequency spectra in the lower hybrid range and extremely short correlation lengths.

Topical Talk P 5.2 Mon 17:00 SPA HS201

The influence of small oxygen admixture to helium on the barrier discharge operation — •Marc Bogaczyk[1], Lenka Dosoudilova[2], Robert Tschiersch[1], and Hans-Erich Wagner[1] — [1]Institut für Physik, Ernst-Moritz-Arndt Universität, 17489 Greifswald — [2]Department of Physical Electronics, Masaryk University, 60200 Brno

An innovative discharge cell configuration allows the investigation of important volume and surface processes during He/O_2 barrier discharge (BD) operation. The influence of small oxygen admixtures on the discharge mode was studied by electrical measurements combined with the electrically triggered cross-correlation spectroscopy disclosing the discharge development, and the measurement of surface charges on a BSO crystal by means of the electro-optic Pockels effect. A crucial influence of oxygen on the microdischarge (MD) formation is the effective quenching of helium metastables which induce secondary electron emission as well as Penning ionization of nitrogen impurities substantial for diffuse BDs. In the case of sine-driven BDs, adding more than 250 ppm of oxygen to helium causes a transition from the diffuse Townsend-like mode to filamentary MDs. In particular, the transition region is characterized by a rising number of successive Townsend-like breakdowns per half-period connected with an increasing oxygen admixture. Finally, the transition to the square-driven discharge operation results in higher power input which in turn aids filamentation, too. Supported by “Deutsche Forschungsgemeinschaft, Sonderforschungsbereich SFB TR24”.

P 5.3 Mon 17:25 SPA HS201

A high power helicon discharge as prototype for a plasma wakefield accelerator experiment — •Birger Buttenschön[1], Philipp Kempkes[1,2], Olaf Grulke[1], and Thomas Klinger[1,2] — [1]Max-Planck-Institut für Plasmaphysik, EURATOM Assoziation, Greifswald — [2]Ernst Moritz Arndt-Universität Greifswald

Proton-driven plasma wakefield accelerators (PWAs) are a very promising concept for future electron/positron accelerators with output beam energies in the TeV range. Simulations show that considerable acceleration is achieved at plasma densities exceeding $n_e = 7 \times 10^{19}$ m^{-3}, with high demands on the axial plasma density homogeneity.

A commonly used approach for PWAs is to use laser generated plasmas, which are limited in length by the available laser energy. Helicon wave heated plasmas, however, do not suffer from this limitation, since the heating power can be injected via a distributed set of antennas along the plasma column. This approach is in principle scalable to arbitrary lengths, while the heating mechanism does not incorporate an intrinsic limit for the plasma density. However, unparalleled heating powers on the order of 50 kW/m are required to reach the envisaged plasma densities.

This contribution presents studies on a one meter long helicon wave heated plasma cell being designed as prototype for a proton-driven PWA experiment. At heating powers up to 35 kW, the plasma is characterized with respect to peak densities and overall performance compared to power balance calculations and wave dispersion relations.

P 5.4 Mon 17:40 SPA HS201

Elektronendichte und -energien in Guided-Streamer Entladungen in Argon — •Simon Hübner, Sven Hofmann, Eddie van Veldhuizen und Peter Bruggeman — Eindhoven University of Technology, Niederlande

In dieser Studie zeigen wir räumlich und zeitlich aufgelöste Messungen der Elektronendichte und mittleren Energien an reproduzierbaren Streamern, auch ”Guided streamer”genannt, in Argon mit Hilfe von Thomson-Streuung. Ein positiver 3.5 kV Puls, mit einer Pulslänge von 500 ns und mit einer Wiederhohlfrequenz von 5 kHz wurde mit einem 20 W, frequenzverdoppeltem Nd:YAG Lasersystem synchronisiert. Ein Spektrometer mit dreifacher Gitteranordnung und ICCD Kamera dient der Aufnahme des (Thomson) gestreuten Laserlichts. Die Reproduzierbarkeit des Plasmas im ns-Bereich erlaubt die Akkumulation von Laser/Plasmaentladungen und eine akkurate räumliche Vermessung des Plasmas. Die gemessene Elektronendichteverteilung weist ein anfängliches Maximum von ungefähr $n_e = 8 \times 10^{19}$m^{-3} und eine mittlere Elektronenenergie von 4.5 eV auf. Die mittlere Energie fällt danach steil (ca. 100 ns) ab, es bildet sich ein kalter Leitungskanal mit Elektronenenergien von 0.3 eV. Auch eine 2D Verteilung der Elektronendichte konnte gemessen werden. Besonders interessant ist hierbei die Verteilung des Streamerkopfes, der signifikant breiter im Durchmesser ist als der Licht-emittierende Kanal. Eine Korrelation des Streamerkopfes mit der erwarteten Restionisation konnte gezeigt werden.

P 5.5 Mon 17:55 SPA HS201

Plasma Chemistry Induced by Low Energy Electron Beams — •Andreas Himpsl[1], Thomas Dandl[1], Thomas Heindl[1], Alexander Neumeier[1], Jochen Wieser[2], and Andreas Ulrich[1] — [1]Physik Department E12/E15, Technische Universität München, James-Franck-Str. 1, 85748 Garching — [2]excitech GmbH, Branterei 33, 26419 Schortens

A table-top setup for studying plasma chemical reactions is described. Low energy (15 keV) electrons are used to induce the chemical reactions. The experiments are performed with gases and gas mixtures at atmospheric pressure. The radiolysis of CO2 is studied as an example and a G-value of 3 was achieved for a gas flow of 14 ml/min. The experiments were performed with a total beam power of 450 mW sent into a gas cell with a volume of 40 mm3. Mass spectrometry and a spectroscopic study were used for the diagnostics. A catalytic effect of xenon for the splitting of CO2 molecules was observed and supported by comparative measurements with Ar-CO2 and Ar-Xe-CO2 mixtures. The power deposition profiles in the target cell are discussed on the basis of a numerical model. This work has been supported by the Maier-Leibnitz-Laboratorium München.

P 5.6 Mon 18:10 SPA HS201

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

The mode transition of a planar inductive coupled radio frequency (ICRF) discharge in oxygen was detailed investigated by several diagnostics. Firstly, the optical emission of atomic oxygen was measured phase and space resolved (PROES). The optical exication rate patterns from rf sheath heating and electric field reversal in the E-mode change to two excitation rate patterns in the first and second half of the RF cycle in the H-mode, respectively. In particular, the electric field reversal reveals a high electronegativity in the E-mode. All in all, the analysis of the excitation rates enables the distinction of the operation modes. Addionally, the gas temperature was determined by measuring the emission of the atmospheric A-band of the oxygen molecule at 760 nm. In the E-mode, the gas temperature is compa-

rable to room temperature (300 K) and increases up to 600 K in the H-mode. The line integrated electron density, measured by microwave interferometry, increases during the E-H-mode transition up to two orders of magnitudes from 10^{15} to $10^{17}\,\mathrm{m}^{-2}$ depending on the total gas pressure. Using the electron density, gas and electron temperature the electron impact ionization rate was calculated. The behavior of the electron impact ionisation rate during the E-H-mode transition provides an indication for a decreasing electronegativity.
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