P 16: Plasma Diagnostics III

Zeit: Mittwoch 8:30–10:10 Raum: HS 1010

Hauptvortrag P 16.1 Mi 8:30 HS 1010

Influence of released surface electrons on the pre-ionization of helium barrier discharges — •Robert Tschiersch, Sebastian Nemschokmichal, and Jürgen Meichsner — Institute of Physics, University of Greifswald, Felix-Hausdorff-Str. 6, 17489 Greifswald

The understanding of the interaction between the plasma species and a dielectric surface is still a fundamental issue in the physics of barrier discharges (BDs). The presented contribution highlights the role of residual surface electrons with low binding energy in acting as a seed-electron reservoir that favors the pre-ionization of diffuse BDs. Here, a glow-like BD was operated in helium at a pressure of 500 mbar in between two plane electrodes each covered with float glass at a distance of 3 mm. The change in the discharge development due to photodesorption of surface electrons by a Nd-YAG laser was studied by electrical measurements and optical emission spectroscopy. Moreover, adapting a 1D numerical fluid simulation of the discharge to the laser-photodesorption effect from the experiment allowed the understanding of the impact of released surface electrons on the reaction kinetics in the volume. When the laser beam hits the cathodic dielectric charged with residual electrons during the discharge pre-phase, the breakdown voltage decreases significantly. According to the adapted simulation, the laser releases only a small amount of surface electrons in the order of 10 pC which, nevertheless, supports significantly the pre-ionization. Moreover, both experiment and simulation emphasize that a further enhancement of the yield of released surface electrons triggers the transition from the glow mode to the Townsend mode.

Fachvortrag P 16.2 Mi 9:00 HS 1010

Electron and heavy particle density measurements of a stable axially blown arc in argon — •Jan Carstensen, Patrick Stoller, Bernardo Galletti, Charles Doiron, and Alexey Sokolov — ABB Corporate Research, Segelhofstr. 1K, 5405 Baden-Daettwil, Switzerland

Two color spatial carrier wave interferometry was used to measure the electron density and heavy particle density in the stagnation point of a stable, axially blown arc in argon for currents of 50 A to 200 A and stagnation point pressures of 0.2 to 1.6 MPa. The high spatial resolution achieved allows the hot core of the arc to be readily distinguished from the surrounding boundary layer. The arc radius determined from the heavy particle density decreases with increasing stagnation pressure and increases with the current in good agreement with a simple theoretical model based on the work of [Lowke and Ludwig, J. Appl. Phys., 1975. 46(8)] for arc core temperatures of approximately 16,500 K. The measured electron density at the center of the arc agrees well with a prediction based on local thermodynamic equilibrium.

P 16.3 Mi 9:25 HS 1010

Measurements on a high voltage pulsed substrate (PBII) in a HiPIMS process — •Sven Gauter[1], Maik Fröhlich[2], Wagdi Garkas[2], Martin Polak[2], and Holger Kersten[1] — [1]Institute of Experimental and Applied Physics, CAU Kiel, Germany — [2]Leibniz Institute for Plasma Science and Technology, Greifswald, Germany

In a novel experiment a HiPIMS discharge was combined with plasma based ion implantation (PBII). Proper synchronization of the HiPIMS and PBII pulses allows successive and simultaneous coating and doping of the substrate surface in a complex, finely adjustable system. The delay between the HiPIMS and the PBII pulse is a critical parameter for the synchronization of the pulses. To investigate the effect of this parameter on the energy flux towards the PBII substrate, VI-probe and calorimetric measurements were performed.

The energy flux was measured utilizing a specially designed setup for indirect calorimetric measurement of the high voltage pulsed substrate. The results reveal the effect of the delay on the energy flux and ion current to the substrate for different PBII pulse durations and PBII voltages. A maximum of electrical power and energy flux was found for delay values significantly longer than the duration of the HiPIMS pulse. This maximum is explained to be caused by an ion wave/bunch which originates at the target and travels towards the substrate with the energy obtained from the sputter process. The investigation of different PBII and HiPIMS parameters revealed additional information about the transport of the ions from the target to the substrate.

P 16.4 Mi 9:40 HS 1010

Spectroscopic studies of active screen plasma nitrocarburizing processes comparing a steel and a carbon mesh as an active screen — •Constantin Rupp[1], Stephan Hamann[1], Andy Nave[1], Igor Burlacov[2], Heinz-Joachim Spies[2], Horst Biermann[2], and Jürgen Röpcke[1] — [1]INP Greifswald, 17489 Greifswald, Germany — [2]TU Bergakadamie Freiberg, 09599 Freiberg, Germany

The active screen plasma nitriding (ASPN) is an advanced technology for the hardening of steel components. Additionally, carbon-containing gases such as CH4 and CO2 can be admixed to the N2-H2 gas achieving an active screen plasma nitrocarburizing (ASPNC) process. However, the amount of adding carbon-containing gases to the process is limited. As a new appraoch an active screen made of graphite is used as a carbon source.

This contribution presents the results of a spectroscopic study of N2-H2 containing pulsed DC plasmas in an industrial scale ASPN reactor using two different active screens (steel and graphite meshes) with an inner volume of about 1 m^3. Based on optical emission spectroscopy (OES) the emission trends of H, N and N2 were qualitatively monitored. The concentration of CH4, NH3, C2H4, HCN and CO has been determined by the usage of infra-red laser absorption spectroscopy (IRLAS). The concentrations of the monitored species were found to be in the range of 10^{13} to 10^{15} molecules cm^{-3}, whereby the concentrations of measured hydrocarbon components were found to increase significantly using a graphite mesh.

P 16.5 Mi 9:55 HS 1010

Broadening and shift of optical emission lines in a high power impulse magnetron sputtering discharge — •Julian Held, Ante Hecimovic, and Volker Schulz-von der Gathen — Ruhr-Universität Bochum, Germany

Mass spectrometers and Langmuir probes are often used to measure the energy distribution functions and densities of charged species in high power impulse magnetron sputtering (HiPIMS) discharges. However, it is not possible to use these tools in the region close to the target, where the magnetic field lines are closed, without critically disturbing the plasma. In this work, time resolved optical emission spectroscopy was employed to gain greater insight into the region close to the target, where the most important plasma processes take place. A high resolution plane grating spectrograph combined with a fast, gated, intensified CCD camera was used to analyze the discharge. Chromium or Titanium was used as the target material and the discharge was operated in pure Argon. Broadening and shift of optical emission lines was studied to gain information about the velocity distribution of sputtered species.

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