P 16: Low Pressure Plasmas II

Zeit: Donnerstag 11:00–12:25 Raum: HS 21

P 16.1 Do 11:00 HS 21

Velocity distribution of titanium neutrals in the target region of high power impulse magnetron sputtering discharges — •Julian Held[1], Ante Hecimovic[2], Achim von Keudell[1], and Volker Schulz-von der Gathen[1] — [1]Experimental Physics II, Ruhr University Bochum, Germany — [2]Max Planck Institute for Plasma Physics, Garching, Germany

The velocity distribution function of titanium neutrals in the target region of a high power impulse magnetron sputtering discharge was investigated by optical emission spectroscopy. A high-resolution plane grating spectrograph combined with a fast, gated, intensified CCD camera was used to study the shape of selected optical emission lines. Doppler broadening and shift were analyzed to gain information about the velocity distribution of sputtered titanium neutrals. The velocity distribution function was found to depend on the discharge power for target power densities up to 0.6 kW cm^{-2}. Above that value, the velocity distribution was constant. The collision processes of sputtered neutrals close to the target were described using a modified version of the Krook collisional operator. Using this interpretation, evidence for strong scattering of the titanium neutrals in the target region was found. This scattered population is found to be created from previously scattered ions by resonant charge exchange.

P 16.2 Do 11:25 HS 21

Plasma chemical studies of nitrocarburizing plasmas with a carbon active screen in industrial and laboratory reactors — •Alexander Puth[1], Stephan Hamann[1], Lukas Kusýn[1,2], Igor Burlacov[3], Anke Dalke[3], Horst Biermann[3], Jürgen Röpcke[1], and Jean-Pierre van Helden[1] — [1]Leibniz Institute for Plasma Science and Technology, Greifswald, Germany — [2]Masaryk University, Brno, Czech Republic — [3]Institute for Materials Engineering, TU Bergakademie Freiberg, Germany

Active screen plasma nitrocarburizing (ASPNC) is a process to enhance the tribological properties of steel components. As a possible advancement, the use of a carbon active screen as a substitute for carbon-containing feed gas admixtures is investigated. Therefore, carbon fibre composite screens have been studied in low-pressure pulsed dc N_2-H_2 plasmas on industrial- and laboratory-scale. The plasma chemical conditions were monitored in-situ by laser absorption spectroscopy (LAS) with tunable diode lasers (TDL), external-cavity quantum cascade lasers (EC-QCL), and a frequency comb.
We will present concentrations of CH_3, CH_4, C_2H_2, C_2H_4, C_2H_6, C_2N_2, CO, CO_2, HCN, H_2O, and NH_3 in dependence on plasma power, gas pressure, flow, and precursor composition. Translational and rotational temperatures of selected species were determined by line profile analysis and Boltzmann plots. Measured concentrations ranged from 10^{12} to 10^{16} molecules cm^{-3}, with temperatures reaching up to 800 K. Analysis of surface-microstructures of treated samples complements the LAS measurements for improved process understanding.

P 16.3 Do 11:40 HS 21

Study of particle transport above the target in high power impulse magnetron sputtering plasmas using a marker technique — •Sascha Thiemann-Monjé, Marc Sackers, and Achim von Keudell — Ruhr University Bochum, Germany

High power impulse magnetron sputtering (HiPIMS) has established itself as one of the premier methods for depositing high-quality hard coatings. Nevertheless, the plasma discharge itself is not fully understood yet. Especially the potential structure of the so-called spokes, which are believed to be rotating instabilities and the particle movement inside the plasma are part of current research. Both affect the redeposition of particles on the magnetron target surface during the plasma discharge.

In this work, a marker technique for the analysis of the particle transport inside the plasma is introduced. The marker targets are made of 50 mm Al magnetron targets with a different metal in form of a cylindrical insert placed in the middle of the racetrack. The distribution of redeposited marker material on the surface is analyzed by spatially resolved X-ray photoelectron spectroscopy (XPS) and combined with electrical and optical measurements of the plasma discharge.

It could be shown that the distribution of marker material contains information about the plasma discharge. Particularly correlations with the marker material as well as the discharge power were found. It was as well possible to find evidence for the assumed potential structure of the spoke phenomenon.

P 16.4 Do 11:55 HS 21

Separated effects of plasma particle species during surface activation — •Beatrix Biskup[1], Marc Böke[1], Jan Benedikt[2], and Achim von Keudell[1] — [1]Experimental Physics II - Reactive Plasmas, Ruhr-University Bochum, 44780 Bochum, Germany — [2]Experimental Plasma Physics, Christian-Albrechts-University Kiel, Germany

A short plasma pre-treatment can improve the barrier effect of a-C:H /a-Si:H multilayers on polymer substrates, while a prolonged treatment can negatively influence the properties. In this work, we are investigating the influence of different plasma particle species, namely ions, metastables and (V)UV-photons, during the surface activation in an inductively coupled plasma.

To separate the different species, we build an ion-repelling grid system (IReGS), which repels ions from the substrate. In a second approach we further separate the effect of argon metastables from the effect of (V)UV-photons.

The change in surface energy of the polymer substrate is than analyzed by contact angle measurements at different activation times and particle composition to find an optimal activation process.

P 16.5 Do 12:10 HS 21

Directionally resolved characterization of momentum transfer during sputter processes — •Mathis Klette, Thomas Trottenberg, Manuel Maas, and Holger Kersten — Institute of Experimental and Applied Physics (IEAP), Kiel University, Germany

In the past, the directional distributions of reflected and sputtered particles of a sputter plume have been investigated using various methods like mass spectrometry, optical emission spectroscopy, or quartz crystal microbalances. Some of these methods require a complex setup, while others can only detect certain species of particles or rely on secondary effects like deposition.

In this study, we present a characterization of sputter plumes using interferometric force probes [1]. In contrast to conventional diagnostics, these probes do not require a complex setup and they can measure the momentum flux of all charged and neutral species. In the experiment, an ion beam is focused on a rotatable sputter target. For different angles of incidence, a force probe rotating around the target characterizes the sputter plume. A second force probe determines the vector of the force acting on the sputter target. The angular ejection distributions are compared with simulated data based on the sputter code SRIM [2]. For the experiment, copper and silver targets and different noble gases were used. The energy of the impinging ions and the background gas pressure were varied to change the momentum transfer.

[1] Spethmann et al., **24**(2017), 093501.
[2] J. Biersack et al., Nucl. Instrum. Methods **174**, 257 (1980).