P 3: Plasma Surface Interaction I

Zeit: Montag 11:15–12:45 Raum: HS 21

Hauptvortrag P 3.1 Mo 11:15 HS 21

Plasma-based surface modification for life-science applications — •Katja Fricke and Klaus-Dieter Weltmann — Leibniz Institute for Plasma Science and Technology e.V. (INP), Felix-Hausdorff-Strasse 2, 17489 Greifswald, Germany

Materials with tailored chemical and morphological properties provide an indispensable platform to induce a certain response when exposed to biological systems. Hence, bioactive surfaces are of growing interest for a vast number of applications such as biochips, biosensors, drug delivery systems, implants and tissue engineering. Plasma enhanced surface modifications are the key applications for plasma technology since decades. Due to the fact that these processes are environment-friendly, highly reproducible, and most importantly, enable changes in surface properties for nearly every material. Furthermore, the high flexibility in terms of geometry and electrode configuration, process gases and operation parameters, qualify both, low-pressure and atmospheric-pressure plasma sources especially for surface engineering. This contribution reports on the plasma-based surface modification to improve the attachment of bioactive compounds and living cells. Recent innovations in the functionalization of surfaces and the deposition of high-quality functional thin films by using atmospheric-pressure plasma processes are presented.

P 3.2 Mo 11:45 HS 21

Development of a 3D model for hydrogen outgassing from ion-irradiated materials — •Md Al-Beruni, Dmitry Matveev, Bernhard Unterberg, and Christian Linsmeier — Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung, 52425 Jülich, Germany

In future fusion reactors such as ITER and DEMO, plasma-material interactions impose limitations on the plasma performance. High heat and particle loads, implantation of hydrogen isotopes cause deterioration of material properties and build-up of radioactive tritium in the plasma-facing wall components, which represents a safety concern. Together with dedicated experiments, computational modeling is utilized to understand the fundamental processes of hydrogen transport and retention. Trapping and de-trapping of hydrogen from lattice defects of materials, hydrogen diffusion, as well as recombination of hydrogen atoms to molecules leading to molecular desorption can be modeled by systems of coupled non-linear PDEs. So far, those non-linear PDE systems have been successfully solved numerically in 1D. However, in some cases, non-uniform distributions of the ion flux, material properties, temperature, as well as other geometrical effects require a consistent 3D description. In this contribution, examples of 3D simulations implemented in Wolfram Mathematica and COMSOL Multiphysics will be presented and compared with respective 1D simulations.

P 3.3 Mo 12:00 HS 21

Light reflection in the line shape of sputtered atoms of high-Z plasma facing components in the linear plasma device PSI-2 — •Stephan Ertmer, Oleksandr Marchuk, Sven Dickheuer, Arkadi Kreter, and Sebastijan Brezinsek — Forschungszentrum Jülich GmbH - Institut für Energie- und Klimaforschung - Plasmaphysik, Partner of the Trilateral Euregio Cluster (TEC), 52425 Jülich, Germany

Linear plasma devices like PSI-2 are useful tools to study plasmas-wall-interaction and test possible plasma facing materials. Spectroscopy is a powerful means to determine the particles fluxes, e.g. by S/XB values at the plasma edge. In the last decades enormous efforts are undertaken to improve the understand the underlying physics as well as experimental conditions. It is demonstrated in argon plasmas ($T_e \approx 3\,eV, n_e \approx 3.5 \cdot 10^{12}\,cm^{-3}, E_{ion} = 40 - 160\,eV$) that the light reflection at aluminum and tungsten surfaces has a strong impact on the line intensities and the line shapes of sputtered particles. Thus for instance the emission is increased by a factor two for line-of-sights terminating at surfaces. Moreover, the degradation of the optical properties of surfaces polished aluminum was detected in the line shape of emission by sputtered particles. The experiments are performed in PSI-2 plasmas, where other bordering mechanisms such as the Zeeman effect can be neglected because of a magnetic field in the order of 0.1 T. The clear difference between spectra observed at different lines-of-sight is detected. The studied effect must included in evaluating the S/XB values and existing codes such as ERO.

P 3.4 Mo 12:15 HS 21

Towards an understanding of the force low-temperature plasmas exert on walls — •Thomas Trottenberg and Holger Kersten — Institut für Experimentelle und Angewandte Physik, Christian-Albrechts-Universität zu Kiel, D-24098 Kiel

Low-temperature plasmas exert tiny forces ($\mu N\,cm^{-2}$) on their solid bondaries. Recent force measurements, where small test surfaces were brought in contact with a plasma, have shown that the “plasma pressure” is in the order of magnitude of the electron pressure [1,2]. However, the measured forces range from significantly smaller forces up to a few times the electron pressure force. So far, only qualitative descriptions of the underlying mechanisms for this behavior could be presented [1,2]. A one-dimensional fluid model (including spherically symmetric geometry) was applied in a general treatment of the problem, and it was concluded that the pressure at the wall should equal the electron pressure in the center of the discharge [3]. However, the found systematic deviations remained unexplained. In this study, we provide a short summary of the experiments performed in Kiel so far with force measurements in capacitively-coupled radio-frequency discharges and microwave-generated plasmas, and we report on our latest attempts to understand the observed features of the force.

[1] Trottenberg, Richter, and Kersten, *Eur. Phys. J. D* **69**, 91 (2015).
[2] Trottenberg and Kersten, *Plasma Sources Sci. Technol.* **26**, 055011 (2017).
[3] Czarnetzki and Tsankov, *Eur. Phys. J. D* **69**, 236 (2015).

P 3.5 Mo 12:30 HS 21

Decoupling of ion- and photon-activation mechanisms in polymer surfaces exposed to low-temperature plasmas — •Rahel Buschhaus[1], Maik Budde[1], Carles Corbella[2], and Achim von Keudell[1] — [1]Experimentalphysik II, Ruhr-Universität Bochum — [2]Department of Mechanical and Aerospace Engineering, The George Washington University, Washington, USA

The treatment of polymers by plasmas and ion beams is a common technique to optimize surface properties e.g. regarding roughness. The impact of plasma components, namely ions, neutrals, electrons and photons, were analyzed separately to investigate synergistic effects. The elementary processes on surfaces are mimicked by sending quantified beams of ions and atoms to the polymers in an ultra-high vacuum reactor. Polypropylene (PP) and Polyethylene (PET)[1] layers, are exposed to argon ions (200eV, 500eV), which are extracted from an electron-cyclotron-resonance (ECR) plasma source. This ion beam is separated from the photons (UV and VUV) generated in the plasma volume by an ion beam deflector. Fourier transformed infrared spectroscopy (FTIR) is applied in situ for analyzing etching rate and chemical state of the surfaces. Etching measurements are performed with either Ar^+ or Ar^+ plus photons by removing the ion beam deflector. With a surface coverage model, we will describe the time dependency of etched thickness, calculate sputter yields and discuss the ion-and photon activation mechanisms. Additionally, reactive sputtering is mimicked by adding neutral oxygen beams to the Ar measurements. [1]M. Budde et al., Plasma Process Polym, 15(4):1700230(2018)