P 2: Atmospheric Pressure Plasmas and their Applications I

Time: Monday 11:00–12:30 Location: WW 1: HS

Invited Talk P 2.1 Mon 11:00 WW 1: HS

Interaction of reactive components of non-equilibrium atmospheric plasmas with liquids and surfaces — •Kerstin Sgonina[1], Alexander Quack[1], Christian Schulze[1], and Jan Benedikt[1,2] — [1]Institute of Experimental and Applied Physics, Kiel University, Germany — [2]KiNSIS, Kiel University

Cold atmospheric pressure plasmas (CAP) are a source of reactive species, such as electrons, ions, radicals, excited species, and photons. Typical application fields are surface or liquid treatments, which are based on additive or synergistic effects of these species at solid surfaces or in liquids. However, knowledge about the isolated effect of each plasma component is rare. The isolated interaction of two different reactive components, positive ions and atomic oxygen, with solid surfaces or liquids, respectively, will be presented.

To study the isolated effect of positive ions on substrates at atmospheric pressure, the so-called Vacuum-ultraviolet(VUV)-photoionization chamber has been developed. It uses a helium driven CAP to generate VUV-radiation to photoionize given precursor. With this, an ion-based thin film deposition at atmospheric pressure can be realized.

For atomic oxygen, its effective reaction with organic compounds in liquids is known. However, it was unknown whether these reactions are liquid-surface or volume dominated. Phenol solutions were used as a chemical probe to be treated by the effluent of the COST-Jet as a source of atomic oxygen. The comparison of experimental and modeling results revealed the predominance of reactions of atomic oxygen at the liquid surface.

P 2.2 Mon 11:30 WW 1: HS

Investigation of atmospheric-pressure DBD for thin film deposition in Ar-HMDS mixture — •Marjan Stankov[1], Markus M. Becker[1], Lars Bröcker[2], Claus-Peter Klages[2], and Detlef Loffhagen[1] — [1]Leibniz Institute for Plasma Science and Technology, Greifswald, Germany — [2]Institute for Surface Technology, Technische Universität Braunschweig, Braunschweig, Germany

Although atmospheric-pressure plasma-enhanced chemical vapour deposition processes employing dielectric-barrier discharges (DBDs) as a plasma source are widely explored for diverse surface modifications, a thorough understanding of main aspects of this process is still lacking. This particularly pertains to identify key particle species responsible for the formation of thin films. Here, a study based on modelling and experimental analysis of DBDs in Ar with the addition of hexamethyldisilane (HMDS) as precursor is reported. A single-filament discharge driven by a 19 kHz sinusoidal voltage is investigated using a time-dependent, spatially one-dimensional fluid-Poisson model including an extensive reaction kinetics related to HMDS. The analysis of surface fluxes of particle species indicates that silicon-containing cations play an important role in the film formation process. The contribution of specific cations is investigated and related to the measured average mass of deposited ions. Furthermore, the influence of different chemical processes on the formation of the cations is discussed.

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P 2.3 Mon 11:45 WW 1: HS

Atmospheric plasma as a source of VUV radiation for particle-free thin film deposition — •Tristan Winzer, Christina Reiser, and Jan Benedikt — Institute of Experimental and Applied Physics, Kiel University, Kiel, Germany

Thin-film deposition using plasma to remotely produce VUV photons for photochemistry is an alternative to direct injection of precursor molecules into a plasma, which often results in generation of particles or strong deposition in the source, compromising the properties of the deposited films and the jet operation. This is especially the case at atmospheric pressure, due to high collision rates. At this pressure, noble gas plasmas are efficient sources of VUV radiation down to 60 nm (helium plasma), which can be utilized to initiate photochemistry with subsequent film deposition in precursor gases.

We present here a study on the photochemistry and ionic thin-film deposition from common precursors using a novel source designed for separation of plasma species, radiation and photochemistry products at atmospheric pressure. Precursors were studied for their use in photochemical vapor deposition by analyzing ionic species formed during VUV-treatment of the precursor with ion mass spectrometry and deposited films with Fourier-transform infrared spectroscopy. Particle formation was checked down to 1 nm diameter using a scanning mobility particle sizer.

P 2.4 Mon 12:00 WW 1: HS

Setup and Investigation of a Plasma Window for Heavy Particle Beam Transmission to High Pressurized Targets — •Andre Michel, Fateme Ghaznavi, Michael Händler, Adem Ates, Bernhard Bohlender, Marcus Iberler, and Joachim Jacoby — Goethe University Frankfurt

With an ever-growing enhancement of particle beam intensities and energies in accelerators around the world, a reliable vacuum to high-pressure-target separation technique is strongly needed where common separation techniques such as differential pumping stages or solid membranes might fail. A plasma window, first introduced by A. Hershcovitch [1], offers the advantage of a membraneless particle beam transmission from low- to high pressurized target areas.

At the plasma physics department of Goethe University Frankfurt, a plasma window was developed and successfully tested during the 2022 GSI UNILAC beamtime, utilizing an 48Ca10+ ion beam at 4.8MeV/u - therefore being the first plasma window setup proving its applicability on the transmission of heavy ion beams.

This talk presents the underlying working mechanisms of the plasma window, its plasma physical properties, electrical parameters, its pressure separating properties as well as the characteristics of the transmitted ion beam.

[1] Hershcovitch, A., J. Appl. Phys., AIP Publishing, 1995, 78, 5283

P 2.5 Mon 12:15 WW 1: HS

Spatio-temporal analysis of plasma electrolytic polishing: Insights from optical and electrical diagnostics — •Sehoon An[1], Luka Hansen[2], Thorben Wolff[1], Rüdiger Foest[1], Maik Fröhlich[3], and Holger Kersten[2] — [1]INP Greifswald, Greifswald, Germany — [2]Institute of Experimental and Applied Physics, Kiel University, Kiel, Germany — [3]Leupold Institute of Applied Sciences, University of Applied Sciences Zwickau, Zwickau, Germany

Plasma electrolytic polishing (PEP) has recently gained much attention for its ecological benefits and its ability to enhance the surface quality of intricate metallic components. Understanding the dynamics of the gaseous layer around the workpiece, accompanied with electrical discharges, is crucial for optimal outcomes, as it significantly influences the surface modification effect. Here, we investigate the PEP process using optical and electrical monitoring, utilizing a high-speed camera synchronized with electrical waveform measurements. The temporal development of the temperatures of the workpiece and the surrounding electrolyte is measured and discussed in relation to the discharge characteristics. The experiment involves a WC-Co workpiece immersed in a 10 wt% Na2CO3 solution, anodically polarized at 120 V for 30 s. By high-speed video (1000 fps) a temporally resolved development of the gas layer involving numerous discharges on the workpiece surface is visualized which is correlated to the current signal. We report observations on oscillating discharge currents and characteristic frequencies, analyzed using FFT, in relation to process parameters and the workpiece temperature evolution.