P 20: Poster Session- Low Temperature Plasmas

Time: Wednesday 16:30–19:00 Location: Empore Lichthof

P 20.1 Wed 16:30 Empore Lichthof

Optische und elektrische Charakterisierung einer Oberflächen-DBE — •Rouven Klink, Manfred Kettlitz, Hans Höft und Ronny Brandenburg — Leibniz-Institut für Plasmaforschung und Technologie e.V., Felix-Hausdorff-Straße 2, 17489 Greifswald

Die Eigenschaften und die Entwicklung von Mikroentladungen bei Atmosphärendruck hängen von der Entladungskonfiguration, der elektrischen Beschaltung und der Gasart ab. Dielektrisch behinderte Entladungen (DBE) sind extrem kurzlebig und weisen eine komplexe raumzeitliche Struktur auf. Neben Volumenentladungen treten auch Oberflächenentladungen auf, die Gegenstand der Untersuchungen sind. Die Oberflächen-DBE werden in einem Stickstoff-Sauerstoff Gasgemisch bei Atmosphärendruck auf einer Keramikoberfläche erzeugt. Diese werden elektrisch und optisch durch schnelle ICCD-Kameras und eine Streakkamera diagnostiziert. Mit deren Hilfe werden das Zündverhalten und die weitere Entladungsentwicklung untersucht. Die Messungen werden durch Simulation des elektrischen Feldes der Entladungskonfiguration ergänzt.

P 20.2 Wed 16:30 Empore Lichthof

Separated effects of ions, metastables and photons on the properties of barrier layers on polymers — •Beatrix Biskup, Marc Böke, Jan Benedikt, and Achim von Keudell — Experimental Physics II - Application Oriented Plasma Physics, Ruhr-University Bochum, 44780 Bochum, Germany

Analyses of a-C:H /a-Si:H multilayers on polymer substrates indicated that prolonged ion bombardment influences negatively the properties of the barrier layer, while a short plasma pretreatment can improve the barrier effect. This work is motivated by these results and plans to investigate the influence of different plasma particle species, namely ions, metastables and (V)UV-photons, on the properties of the grown barrier layer. To separate the different species and their influence on plasma pretreatment and film growth, we will build an ion-repelling grid system, which will repel the ions from the substrate, so that only metastables and (V)UV-photons will have an effect on the layer. In a second approach we will try to separate the effect of argon metastables from the effect of (V)UV photons. In addition to the before mentioned ion-repelling grid we will use a collimator with a high aspect ratio and an argon or helium gas-shower before the substrate. With this setup it will be possible to reduce the metastable density in front of the substrate, so that only (V)UV-photons will have an effect. In this approach we will be able to study the different effects of the plasma species and also possible synergy effects, to improve the properties of the barrier layer.

P 20.3 Wed 16:30 Empore Lichthof

Sticking probability for an electron hitting a dielectric surface — •Franz Xaver Bronold and Holger Fehske — Institut für Physik, Ernst-Moritz-Arndt-Universität Greifswald, 17489 Greifswald, Deutschland

The energy of an electron hitting the wall of a low-temperature plasma is typically below 10 eV. In this energy range little is quantitatively known about the interaction of electrons with solids. For instance, the probability S with which the electron gets stuck in the wall is basically unknown. In plasma modeling S is thus very often set to unity, irrespective of the wall material (perfect absorber model for electrons). To study the material dependence of S we developed a method for calculating S from a microscopic model for the wall [1]. The method, based on an invariant embedding principle, expresses S as the probability for quantum-mechanical transmission through the wall's long-range surface potential times the probability to stay inside the wall despite of internal backscattering. Besides emission of optical phonons and/or interband Coulomb collisions we take elastic scattering due to imperfections at the plasma-wall interface into account. Applying the approach to dielectrics with positive electron affinity, we obtain energy- and material-dependent sticking probabilities significantly less than unity, in accordance with available electron beam scattering data, but in disagreement with the perfect absorber model employed in plasma modeling. — Supported by DFG through CRC/Transregio TRR24.

[1] F. X. Bronold and H. Fehske, Phys. Rev. Lett. **115**, 225001 (2015)

P 20.4 Wed 16:30 Empore Lichthof

Calorimetric probes for the characterization of an atmospheric pressure plasma jet used in plasma medicine: the ongoing search — •Diana Mance[1,2], Ruben Wiese[1], Thorben Kewitz[1], and Holger Kersten[1] — [1]Institute of Experimental and Applied Physics, Kiel University, Kiel, Germany — [2]Department of Physics, University of Rijeka, Rijeka, Croatia

During the last decade atmospheric pressure plasma jets (APPJs) have found numerous applications in medicine, dentistry and life sciences. Among others, APPJs have been used for microorganism inactivation, wound healing, cancer cells growth inhibition and deactivation of biofilms on dental implants [1]. But in spite of being in focus of many scientific researches, APPJs are still not completely understood. Determination of plasma energy influx towards the substrate can be considered as the first step in elucidating some of the unresolved issues in plasma medicine such as determining dosage in plasma treatment and understanding of plasma-liquid interactions. In the presented study we compare performances of self-made calorimetric probes [2,3] for the measurement of the energy influx of a commercial APPJ used for biomedical applications. The goal of the study was to find the most adequate calorimetric probe for energy influx measurements under specific conditions encountered in medical practice.

[1] Woedtke et al. Physics Reports 2013, 530:291-320
[2] Kewitz et al. IEEE Trans. plas. sci. 2015, 43(5):1769
[3] Wiese et al. EPJ Tech. and Instr. 2015, 2:2

P 20.5 Wed 16:30 Empore Lichthof

The Kiel research initiative "The Plasma Interface" — •Michael Bonitz[1], Holger Kersten[2], and Franz Faupel[3] — [1]Institut für Theoretische Physik und Astrophysik, CAU Kiel — [2]Institut für Experimentelle und Angewandte Physik, CAU Kiel — [3]Institut für Materialwissenschaft, CAU Kiel

Despite remarkable progress in plasma research over the recent decade quantitative knowledge of the plasma-solid boundary in low-temperature plasmas is still scarce, as there both, experiment and theory face tremendous difficulties. The effect of the solid on the plasma is usually treated purely phenomenologically, e.g. via electron and ion sticking coefficients, secondary electron emission (gamma) coefficients and similar parameters that are, in general, very poorly known. This is not only unsatisfactory, from the point of view of fundamental science, but also lacks predictive power that is needed to boost the potential of existing plasma applications and to discover new ones. Therefore, the Kiel initiative *The Plasma Interface* aims at overcoming these problems, in a unique concerted interdisciplinary effort of plasma physicists, researchers from condensed matter physics, chemistry and material science. This contribution gives an overview on the experimental and theoretical activities that are presently organized at Kiel University, with substantial contributions from Greifswald researchers.

P 20.6 Wed 16:30 Empore Lichthof

Multiscale simulation of plasma-surface processes* — Jan Willem Abraham[1], Paolo Ferriani[1], •Michael Bonitz[1], and Bernd Hartke[2] — [1]Institut für Theoretische Physik und Astrophysik, CAU Kiel — [2]Institut für Physikalische Chemie, CAU Kiel

An accurate simulation of the processes at the interface of a plasma and solid is severely hampered by vastly different parameters in the two subsystems, most importantly, extremely different electron densities. This leads to very disparate time and length scales of relaxation and transport processes in the plasma and the solid. While there exist efficient theoretical approaches to treat the electron dynamics in the plasma (e.g. PIC) and in the solid (e.g. DFT or quantum kinetic theory), no method is available to selfconsistently simulate the entire system. The only way out is to develop multi-scale simulations that combine i) an atomistic treatment of the lattice–using density functional theory (DFT) or tight-binding DFT (DFTB)–, ii) a quantum treatment of surface processes such as diffusion barriers and reaction rates–using DFT or reactive force fields (EVB-QMDFF) [1]–and iii) a mesoscopic approach for the atom dynamics and cluster growth on the surface–using kinetic Monte Carlo (KMC) or classical Langevin dynamics (LMD) in the presence of a plasma. Here we outline this concept and present results for the final stage [2, 3].

1) B. Hartke et al., Phys. Chem. Chem. Phys. **17**, 16715 (2015). 2)

J. W. Abraham et al., J. Appl. Phys. **117**, 014305 (2015). 3) J. W. Abraham, and M. Bonitz, submitted for publication (2015).
*Part of the Kiel research initiative "The Plasma Interface"

P 20.7 Wed 16:30 Empore Lichthof

Quantum Kinetic Approach to transport at the plasma interface* — Karsten Balzer[1] and •Michael Bonitz[2] — [1]Rechenzentrum der CAU Kiel — [2]Institut für Theoretische Physik und Astrophysik, CAU Kiel

For an accurate treatement of plasma-wall interaction in low-temperature plasmas and the associated transport of charge, momentum and energy, the behavior of nonequilibrium electrons and ions at the wall is crucial. This requires to go beyond the traditional empirical approach to charged particle sticking and secondary electron emission as demonstrated in [1]. Here we outline a selfconsistent kinetic approach that will, eventually, allow to combine classical kinetic theory in the plasma and quantum kinetic theory inside the solid. As a first application we present quantum kinetic results for the stopping power of protons in a graphene-type layer. We use nonequilibrium Green functions [2, 3] and dynamical mean field theory to properly treat electronic correlations. Good agreement is observed with available TRIM simulations, for weak coupling. In contrast, for strongly coupled materials deviations are observed [4]. 1) F.X. Bronold and H. Fehske, Phys. Rev. Lett. **115**, 225001 (2015). 2) M. Bonitz, *Quantum Kinetic Theory*, 2nd ed. Springer 2015. 3) K. Balzer, and M. Bonitz, *Nonequilibrium Green's Functions Approach to Inhomogeneous Systems*, Lecture Notes in Physics, Springer, vol. **867** (2013). 4) K. Balzer, and M. Bonitz, submitted for publication (2016)
*Part of the Kiel research initiative "The Plasma Interface"

P 20.8 Wed 16:30 Empore Lichthof

Light scattering by a stratified dielectric particle — •Elena Thiessen, Franz Xaver Bronold, and Holger Fehske — Institut für Physik, Universität Greifswald, 17489 Greifswald, Germany

We present an exact rewriting of the Mie coefficients describing the scattering of light by a stratified dielectric particle which enables their interpretation in terms of an hybridization of the surface modes arising at each interface. We thus obtain from the Mie theory analytically for an arbitrary number of shells and for all multipole orders and hence for arbitrarily sized particles the hybridization scenario, which so far has been employed primarily for small particles in the electrostatic approximation [1]. To illustrate the effect surface mode hybridization has on the topology of the inner and outer electromagnetic fields we analyze in detail the lowest order resonances of a dielectric core-shell particle. In accordance with the hybridization scenario they can be classified as bonding or anti-bonding. The former giving rise to in-phase and the latter to out-of-phase polarization-induced surface charges at the two interfaces of the particle. Outside the particle the Poynting field carries for both types of resonances the topology of anomalous light scattering. Inside the particle however it depends on the type of the resonance and hence reflects the core-shell structure of the particle. The same holds for the inner electric field which determines for instance the spatial variation of dissipation of energy inside the particle [2]. — Supported by the DFG through CRC/Transregio TRR24.

[1] E. Thiessen *et al.*, arXiv:1507.08122
[2] E. Thiessen *et al.*, Phys. Rev. A **91**, 043837 (2015)

P 20.9 Wed 16:30 Empore Lichthof

Untersuchung eines RF-Plasmajets mittels sich ergänzender Modelle — •F. Sigeneger, J. Schäfer, R. Foest und D. Loffhagen — INP Greifswald, Felix-Hausdorff-Str. 2, 17489 Greifswald

Ein nichtthermischer Plasmajet wird durch Kombination dreier Modelle untersucht. Der Jet besteht aus zwei konzentrischen Kapillaren und zwei ringförmigen Elektroden, die die äußere Kapillare umschließen und die RF-Leistung bei 27.12 MHz dem Argonplasma zuführen.

Untersuchungen eines einzelnen Filamentes im aktiven Volumen zwischen den beiden Kapillaren mit Hilfe eines zweidimensionalen phasenaufgelösten axialsymmetrischen Plasma-Fluidmodells liefern räumliche Strukturen des Filaments und Teilchendichten in guter Übereinstimmung mit Messungen. Das daraus ermittelte Heizungsprofil wird in einer Gesamtbeschreibung des Jets einschließlich des Gasflusses und der Reaktionen von Präkursormolekülen sowie deren Transportprozesse im Effluenten verwendet. Die erhaltenen Radialprofile der Teilchenflüsse von Präkursorfragmenten auf ein Substrat stimmen qualitativ mit gemessenen Dicken von abgeschiedenen Schichten überein.

Das dritte Modell widmet sich den beobachteten Erscheinungen von Selbstorganisation, die sich u. a. in einer azimutalen Rotation der Filamente äußert. Hierfür wird mit Hilfe des Heizungsprofils in einem dreidimensionalen Strömungsmodell der Zusammenhang zwischen der Schrägstellung der Filamente und der azimutalen Strömungskomponente nachgewiesen. Parametervariationen bestätigen experimentell gefundene Tendenzen.

Die Arbeit wird durch die DFG im SFB TRR 24 unterstützt.

P 20.10 Wed 16:30 Empore Lichthof

Measurements of Plasma Properties Using Fast Sweeping Langmuir Probe in VINETA-II magnetic reconnection experiment — •Ilya Shesterikov[1], Olaf Grulke[1], Reiner Stenzel[2] und Thomas Klinger[1,3] — [1]Max Planck Institute for Plasma Physics, 17491 Greifswald, Germany — [2]Department of Physics and Astronomy, University of California, Los Angeles, CA 90095-1547 — [3]Institut für Physik, Ernst-Moritz-Arndt Universität Greifswald, Felix-Hausdorff-Straße 6, D-17489 Greifswald

A novel, fast-sweep Langmuir probe has been constructed and successfully operated at VINETA-II magnetic reconnection experiment. This work presents the time-dependent measurements of VINETA-II plasma. The probe is biased by means of a time-dependent sinusoidal voltage signal with a fixed frequency. Current * voltage characteristics are measured along the falling and rising slopes of the applied signal. Probe permits sweep frequency up to 400 kHz. The circuit response has been tested by measuring the known current - voltage characteristics of resistors. The axial plasma current in VINETA is driven by plasma gun pulsed with the time scale of 60 μs. Probe results present the first time dependent measurement of n_e, T_e, and ϕ_{fl} of the gun discharge plasma with and without magnetic reconnection. The n_e measurements agree favorably with those derived from interferometer measurements.

P 20.11 Wed 16:30 Empore Lichthof

Secondary negative ions in oxygen CCP — •Sebastian Scheuer, Ralf Schneider, and Jürgen Meichsner — Institute of Physics, University of Greifswald, Felix-Hausdorff-Str. 6, 17489 Greifswald, Germany

The influence of electrode material on secondary negative ion emission was studied in an asymmetric, capacitively coupled radio frequency discharge at low oxygen pressure. Beside the stainless steel electrode the investigations were focused on several dielectrics, e.g., silica (SiO2), alumina (Al2O3), magnesia (MgO), on the powered electrode. The secondary negative ions, accelerated in the high-voltage RF sheath toward the plasma bulk and extracted at the grounded electrode, were measured by energy dispersive ion mass spectrometry. The energy distribution ranges from low energetic negative ions penetrating the low-voltage sheath at the grounded aperture of the mass spectrometer to the maximum kinetic energy corresponding to mean RF sheath voltage at the powered electrode. In particular, the high-energetic end of the ion energy distribution contains negative ions which were directly produced on the surface of the powered electrode. In the case of magnesia on the RF electrode the intensity of these energetic negative ions becomes significantly apparent in the ion energy distribution function. First results from PIC-MCC simulation adapted to the experiment are presented.

P 20.12 Wed 16:30 Empore Lichthof

Metastable densities in rf-driven atmospheric pressure microplasma jets in argon and helium — •Stefan Spiekermeier, Marc Böke, and Jörg Winter — Experimental Physics II, Research Department Plasma, Ruhr-Universität Bochum, 44780 Bochum, Germany

Rf-driven atmospheric pressure microplasma jets (μ-APPJ) are usually operated in the homogeneous glow mode (α-mode). At higher powers the glow discharge becomes unstable due to thermal instabilities and turns into a constricted γ-like discharge (constricted mode), which can damage the jet due to the significantly increased temperature in this operation mode. To prevent these instabilities, rf-driven μ-APPJs are predominantly operated in helium since it provides a better thermal conductivity than argon. However, since argon is much more cost-effective, it is worthwhile to achieve a stable operation of the μ-APPJ using argon as feed gas.

Metastable atoms play an important role in the stability of atmospheric pressure discharges, since they pose an important source of electrons via stepwise ionization and penning ionization. To understand the basic processes that lead to the transition from α- to the constricted mode, helium and argon metastable densities have been determined in the μ-APPJ in different operation modes using tunable

diode laser absorption spectroscopy (TDLAS).

Supported by DFG (FOR1123)

P 20.13 Wed 16:30 Empore Lichthof

Comparison between measured and modeled densities of negative hydrogen ions in an ICP discharge — •Sofia Cristofaro[1,2], Roland Friedl[1], and Ursel Fantz[1,2] — [1]AG Experimentelle Plasmaphysik, Universität Augsburg, 86135 Augsburg — [2]Max-Planck-Institut für Plasmaphysik, Boltzmannstr. 2, 85748 Garching

Creation of negative hydrogen ions in plasma can occur via volume or surface processes. In negative ion sources the more efficient surface production regime is achieved by caesiation of a converter surface, which leads to a transition from volume dominated to surface dominated H^- production. This transition is investigated at the laboratory experiment ACCesS (**A**ugsburg **C**omprehensive **Ces**ium **S**etup). The plasma parameters of the planar ICP discharge are close to the ones of ion sources. Prior to the investigation of the surface process, a quantification of the volume produced negative hydrogen ions is mandatory: the H^- density is measured by a **C**avity **R**ing **D**own **S**pectroscopy system (CRDS), while the plasma parameters, like electron temperature and density, are monitored by means of a Langmuir probe. By varying the pressure and the radio-frequency power, the negative ion density has been investigated and the results are interpreted by means of a 0-dimensional model for H^-. The eventual isotopic difference between hydrogen and deuterium plasmas has also been investigated.

P 20.14 Wed 16:30 Empore Lichthof

Fast plasma potential measurements within a reconnecting current sheet via laser-heated emissive probes — •Adrian von Stechow[1], Olaf Grulke[1], and Thomas Klinger[1,2] — [1]Max-Planck-Institut für Plasmaphysik, Greifswald — [2]Ernst Moritz Arndt-Universität Greifswald

During driven magnetic reconnection, a current sheet forms in the plasma between opposed field lines in response to externally applied, time-dependent magnetic fields. In contrast to paradigmatic periodic 2D reconnection models, electrostatic fields should be present not only perpendicular to the current sheet, but also parallel to it due to the axial boundary conditions present in our linear, open field line geometry. Previous results from the linear reconnection experiment VINETA.II suggest that substantial time-dependent electrostatic fields must be present in order to account for the observed current sheet structure and its temporal evolution.

Emissive probes provide a means of directly measuring the plasma potential, providing the electron emission by the probe roughly matches the electron saturation current. The electronics involved in their heating schemes are often plagued by high stray capacitance which limits their time response. In order to capture the fast temporal dynamics present in our experiment, our emissive probe is heated externally by a high-power infrared laser. This contribution presents spatio-temporal plasma potential and electric field profiles recorded by this novel, freely positionable probe system that give further insight into the complex 3D dynamics of our reconnecting system.

P 20.15 Wed 16:30 Empore Lichthof

Simulation of sputter-deposited gold cluster growth on a thin polymer film* — •Jan Willem Abraham[1], Thomas Strunskus[2], Franz Faupel[2], and Michael Bonitz[1] — [1]Institut für Theoretische Physik und Astrophysik, CAU Kiel — [2]Institut für Materialwissenschaft, CAU Kiel

The fabrication of metal-polymer nanocomposites with tailored optoelectronic properties has been a challenge since the early days of nanotechnology. In recent experiments [1], the morphology and optical properties of sputtered gold on a thin polystyrene film were monitored in real time. In this work, we provide additional computational analysis of such a system, presenting a method using Langevin molecular dynamics [2] to simulate the processes on the polymer surface that lead to the formation of gold clusters. The simulation scheme takes into account the deposition of single gold atoms, diffusion of the particles on the surface, desorption of atoms as well the creation of surface defects caused by ion impingement. Comparing heights, radii, distances, and densities of the clusters with experimentally measured data, we observe good quantitative agreement and we explain the influence of several parameters on the cluster morphology.

[1] M. Schwartzkopf et al., ACS Appl. Mater. Interfaces 7, 13547 (2015).

[2] J. W. Abraham, and M. Bonitz, submitted for publication (2015).

*This work is supported by the Deutsche Forschungsgemeinschaft via SFB-TR 24 (project A5).

P 20.16 Wed 16:30 Empore Lichthof

Plasmamedizinische Anwendungen zur Sterilisation — •Sandra Moritz[1], Janine Mandler[1], Daniela Coenen[1], Markus Thoma[1], Eugen Domann[2], Julia Zimmermann[3], Tetsuji Shimizu[3] und Gregor Morfill[3] — [1]I. Physikalisches Institut, Justus-Liebig-Universität Gießen, Germany — [2]Institut für medizinische Mikrobiologie, Biomedizinisches Forschungszentrum Seltersberg,Gießen, Germany — [3]terraplasma GmbH, Garching, Germany

In den letzten Jahrzehnten sind in der Medizin die Zulassungen von neuen Antibiotika immer weiter zurückgegangen, während immer mehr Bakterien Resistenzen gegen verwendete Antibiotikums-Wirkstoffe entwickelt haben. Dadurch kommt es gerade in Krankenhäusern, in denen der tägliche Kontakt mit diesen resistenten Bakterien unvermeidbar ist, vermehrt zu Hygieneproblemen.
Die Firma terraplasma aus Garching hat sich in diesem Zusammenhang auf die Entwicklung von Plasmageräten spezialisiert, um mit Hilfe von Plasma Bakterien, aber auch Viren, Pilze und Biofilme, zu deaktivieren, bzw. abzutöten.
Mit einer solchen Plasmakammer wurden Versuche an *Escherichia coli* K12, *Staphylococcus aureus* und *Klebsiella Pneumonia* durchgeführt, wobei Versuche hinsichtlich der Unterschiede zur Behandlung von grampositiven und gramnegativen Bakterien, der Resistenzbildung der Bakterien, sowie statistische Messreihen zur Evaluierung der Behandlung durchgeführt wurden.

P 20.17 Wed 16:30 Empore Lichthof

1D fluid simulation of helium-oxygen barrier discharges and adaption to the experiment — •Sebastian Nemschokmichal, Robert Tschiersch, and Jürgen Meichsner — Institute of Physics, University of Greifswald

Helium-oxygen discharges at atmospheric pressure are well established in applications because of their ability to produce oxygen radicals under low power consumption. The use of oxygen in a discharge always causes the formation of negative ions, but the influence of negative ions on barrier discharges is poorly investigated. Therefore, we set up a helium oxygen barrier discharge to prove negative ions in a laser photodetachment experiment.

Supplementary, a 1D fluid simulation is developed for comparison. Exemplarily, simulation results are presented and discussed for a pressure of 500 mbar, an admixture of 400 ppm oxygen to helium, and a gap width of 3 mm. In order to enable the comparison with laser photodetachment experiments, the simulation is adapted to the experimentally observed discharge current and gap voltage by varying gas temperature, flux of thermally desorpted electrons and secondary electron emission coefficients. Afterwards, the discharge is characterized by evaluation of most important elementary collision processes as well as the dynamics of charged species. Particularly, the negative ions are characterized by their spatio-temporal distribution in the gap and their production and loss processes. Furthermore, simulations with and without negative ions are compared to point out the importance of negative ions for the simulated discharge.

P 20.18 Wed 16:30 Empore Lichthof

Interactions of nanoparticles with plasmas — Oleksandr Polonskyi, •Thomas Strunskus, and Franz Faupel — Chair for Multicomponent Materials, Faculty of Engineering, Christian-Albrechts University at Kiel, Germany

In the proposed project the interaction of nanoparticles (NPs) with plasma will be under detailed investigation. The general aim is to gain a fundamental understanding of low temperature low pressure plasma interactions with various types of nanoparticles (metal, metal-oxide, alloys, core-shells and also hydrocarbon or/and similar polymer based types of NPs); to provide qualitative and quantitative analyses of NPs after plasma treatment in dependence on the applied discharge parameters. The following questions should be addressed: which plasma species play the role in plasma interactions with NPs and what is the mechanism of these interactions. What is the correlation between plasma parameters and the properties of the treated nanoparticles? Particular attention will be paid to the investigation of the charging of nanoparticles (especially for case of small sizes 5-100nm) in plasmas region and as the consequence their manipulation and filtering by electrostatic forces will be studied. As one of the aspect of practical application, the plasma treatment of NPs with respect to size effect,

chemical composition and functional properties will be under detailed investigation. The aim is to gain more insight how exactly the plasma modifies the nanoparticles.

P 20.19 Wed 16:30 Empore Lichthof

Interaction of Plasmas with Ceramic Materials — •Thomas Strunskus and Franz Faupel — Institute of Materials Science - Multicomponent Materials, Christian-Albrechts University at Kiel, Kaiserstr. 2, 24143 Kiel, Germany

In this project, the interaction of different plasmas with ceramic materials (mainly tin dioxide, titanium dioxide and aluminum oxide) will be investigated. The goal is to gain fundamental insight how the plasma exactly modifies a ceramic material on and also below the surface. In recent years plasmas have been frequently used to modify oxide materials but the approach was mainly empirical just identifying the induced change of properties (e.g., change in conductance, sensoric or optical properties). Little attention has been given to the exact mechanisms of these modifications. Here, starting with identifying the relevant species in the plasma and their transport to the surface we will correlate the plasma properties with the modifications induced at the ceramic surface identified with surface analytical techniques. The investigation will also include aging of the plasma modified surfaces. Samples range from single crystals, over multicrystalline thin films to nanostructures (nanowires and nanoparticles) of the same material.

P 20.20 Wed 16:30 Empore Lichthof

The effect of different gas admixtures on nanoparticles formation in a gas aggregation source and their treatment by hollow cathode plasma — Oleksandr Polonskyi, Amir Mohammad Ahadi, •Thomas Strunskus, and Franz Faupel — Chair for Multicomponent Materials, Faculty of Engineering, Christian-Albrechts University at Kiel, Germany

Metal nanoparticles (NPs) have been of high scientific interest in the last decades as they have unique chemical, physical, electrical, magnetic and optical properties, which are particularly explored in combination with host matrix. Among the number of PVD methods for nanoparticles generation, the gas aggregation method has lately received an increased attention due to simplicity of NPs deposition and variety of parameters to control their properties (size, rate). The present talk is concerned with a such called Gas Aggregation cluster Source (GAS) for metal and metal oxide nanoparticles generation. New results of the influence of nanoparticles generation by admixing different gases into the GAS volume for noble metals (Ag, Cu) will be presented. The effect of helium/oxygen admixture on cluster formation is studied in detail. In addition we report on the combination of the established process of NPs generation by GAS with a hollow cathode (HC) plasma source for novel nanostructure formation. Here, an Ag nanoparticle beam has been treated by a HC plasma at different operation parameters.

P 20.21 Wed 16:30 Empore Lichthof

Iod als alternativer Treibstoff für Ionentriebwerke — •Nina Sarah Mühlich, Patrick Dietz, Waldemar Gärtner, Kristof Holste, Julian Kaupe, Peter Köhler, Slobodan Mitic und Peter Klar — Justus-Liebig-Universität Gießen

Ionentriebwerke basieren auf der Ionisation und elektrostatischen Beschleunigung eines Treibstoffes. An diesen Treibstoff werden bestimmte Anforderungen gestellt: Niedriges Ionisierungspotential, hohe atomare Masse und leichte Überführung in den Gaszustand. Iod stellt einen vielversprechenden Kandidaten als Treibstoff dar, der momentan am I. Physikalischen Institut der JLU untersucht wird. Wir präsentieren optische Emissionsspektren von induktiv und kapazitiv gekoppelten Iod-Plasmen in Abhängigkeit von der Neutralgasdichte sowie der in das Plasma eingekoppelten Leistung zur Diagnostik von Ionentriebwerken. Diese Spektren sollen mit theoretischen Modellen verglichen werden, um die für das Triebwerk relevanten Plasmaparameter (Ionisationsgrad, Elektronendichte) zu ermitteln.

P 20.22 Wed 16:30 Empore Lichthof

Short Timescale Phenomena in Plasma-Surface Interactions* — •Jean-Pierre van Helden and Jürgen Röpcke — Leibniz Institute for Plasma Science and Technology (INP Greifswald), Greifswald

Understanding how plasmas interact with solid and liquid surfaces is of central importance in many fields such as microelectronics, materials and surface processing and in environmental and biomedical technologies. Improving process efficiency requires a comprehensive understanding of the kinetics of the transient intermediates involved at the plasma-substrate interface. The experimental approaches currently available provide an incomplete picture of plasma-surface interactions due to relatively low sensitivity and low time resolution, and restricted multi-species capability. We propose to use state of the art mid-infrared frequency combs (FCs) to provide novel spectroscopic data on plasma-surface problems. FCs will be used as the light sources in broadband cavity enhanced direct frequency comb spectroscopy (CE-DFCS) that can detect many transient species simultaneously yielding comprehensive data on their kinetics in proximity to the surface on a microsecond scale. Simultaneously the surface will be probed by an evanescent-wave provided by attenuated-total-reflection-CE-DFCS. The simultaneous measurement of the plasma and surface environments with the high sensitivity and time resolution of DFCS will provide new fundamental insights into the physics and chemistry of the interfacial region, an essential step for improving plasma technology in industry.

*Part of the Kiel research initiative 'The Plasma Interface'

P 20.23 Wed 16:30 Empore Lichthof

Oberflächenladungsmessungen an lateral strukturierten Barrierenentladungen auf verschiedenen Zeitskalen — •Robert Wild und Lars Stollenwerk — Institut für Physik, Universität Greifswald

In Barrierenentladungen sind Oberflächenladungen auf den Dielektrika maßgeblich am Entladungsverlauf beteiligt. Sie sind insbesondere notwendig bei der Ausbildung von lateralen Entladungsstrukturen. Durch sie wird eine Struktur über viele Entladungen erhalten und somit oft mit bloßem Auge erkennbar.

In dieser Arbeit wird die zeitlich aufgelöste Oberflächenladungsdichteverteilung auf einem elektro-optisch aktiven BSO-Kristall als Dielektrikum gezeigt. Die absolute Ladungsdichte wird aus der Polarisationsänderung eines Lichtstrahls ermittelt, der den Kristall durchläuft. Durch verschiedene zeitliche Auflösungen wird das Verhalten von Oberflächenladungen auf vier verschiedenen Zeitskalen studiert.

Die höchste zeitliche Auflösung liegt in einer Größenordnung von einigen 100 ns. Dadurch kann die Deposition von Ladung während eines Durchbruchs erstmals beobachtet werden. Auf der Mikrosekundenzeitskala werden die Abhängigkeiten der stationären Ladungsverteilungen diskutiert. Die Messung der Ladung im Millisekundenbereich zeigt den Einfluss von metastabilen Spezies im Entladungsvolumen auf die Erhaltung der lateralen Entladungsstruktur. Der Ladungsabbau und -transport wird in einer Größenordung von Sekunden untersucht.

Gefördert durch die Deutsche Forschungsgemeinschaft, Sonderforschungsbereich SFB TRR-24, Teilprojekt B14.

P 20.24 Wed 16:30 Empore Lichthof

Sulphur dioxide removal from gas streams using a sorbent powder in a dielectric barrier discharge — •Sebastian Dahle[1,2], Marina Unseld[1,2], and Wolfgang Maus-Friedrichs[1,2] — [1]Clausthaler Zentrum für Materialtechnik, Technische Universität Clausthal, Leibnizstr. 9, 38678 Clausthal-Zellerfeld, Germany — [2]Institut für Energieforschung und Physikalische Technologien, Technische Universität Clausthal, Leibnizstr. 4, D-38678 Clausthal-Zellerfeld, Germany

Emissions of sulphur dioxide (SO_2) are highly problematic for climate, health and buildings. The amount of SO_2 emitted each year, however, is currently increasing. One main origin of SO_2 emissions is the transportation sector. Further, a significantly increasing source is the use of biomass for energy production. Dielectric barrier discharge plasmas are able to completely remove the SO_2 from exhaust gas streams. This process becomes especially effective if the plasma discharges is directly combined with a cheap powder sorbent such as limestone. The combination of a quadrupole mass spectrometer and an electro-chemical sensor system was used to determine the influence of the treatment on the composition of the gas streams.

P 20.25 Wed 16:30 Empore Lichthof

Surface charge measurements on transparent dielectrics in diffuse and filamentary barrier discharges — •Robert Tschiersch[1], Marc Bogaczyk[2], Sebastian Nemschokmichal[1], and Jürgen Meichsner[1] — [1]Institute of Physics, University of Greifswald, Felix-Hausdorff-Str. 6, 17489 Greifswald, Germany — [2]Leibniz Institute for Plasma Science and Technology, Felix-Hausdorff-Str. 2, 17489 Greifswald, Germany

This work reports on the realization of surface charge measurements on dielectrics which are frequently used in barrier discharge (BD) con-

figurations. The surface charge was measured spatially and temporally resolved via the electro-optic Pockels effect of $Bi_{12}SiO_{20}$ (BSO). The innovative feature consists in covering the BSO crystal with optically transparent dielectrics, such as float glass (based on SiO_2), monocrystalline alumina (Al_2O_3), and magnesia (MgO). The dynamics and the spatial distribution of negative and positive surface charges were studied in diffuse and filamentary BDs operated in helium with variable admixture of nitrogen at elevated gas pressures. In particular, the amount of transported charge is compared with the amount of deposited surface charge. Moreover, the lateral distribution of separated surface charge spots is determined, which mark the footprints of filamentary breakdown channels. As the previously reported surface charge diagnostic was specific for a BSO surface exposed to the plasma, the present work achieves a more generalizable level making this powerful method accessible to various transparent dielectrics.

P 20.26 Wed 16:30 Empore Lichthof

Einfluss unterschiedlicher Oberflächen auf die Produktion negativer Wasserstoffionen — •Roland Friedl[1], Uwe Kurutz[1,2] und Ursel Fantz[1,2] — [1]AG Experimentelle Plasmaphysik, Universität Augsburg, 86135 Augsburg — [2]Max-Planck-Institut für Plasmaphysik, Boltzmannstr. 2, 85748 Garching

Quellen negativer Wasserstoffionen basieren entweder auf der reinen Volumenproduktion im H_2-Plasma oder nutzen zusätzlich die Wechselwirkung mit Oberflächen. Für letztere Alternative werden typischerweise cäsierte Oberflächen verwendet, welche durch die verringerte Austrittsarbeit eine hohe Effizienz der H^--Produktion aufweisen. Die Cäsierung der Konversionsoberfläche bringt allerdings eine komplexe Umverteilungsdynamik mit sich und die hohe Reaktivität von Cs führt zu Degradierungseffekten der Austrittsarbeit. Hinsichtlich der Stabilität und Reproduzierbarkeit der H^--Ausbeute sind daher Alternativen zu cäsierten Oberflächen wünschenswert.

Vielversprechende Alternativmaterialien sind u.a. Diamantmodifikationen, Materialien, die die Volumenproduktion unterstützen, sowie Materialien niedriger Austrittsarbeit neben Cs. Diese werden am ECR-Laborexperiment HOMER systematisch hinsichtlich ihres Einflusses auf die Dichte negativer Wasserstoffionen untersucht, welche mittels Laser-Photodetachment lokal über der Probenoberfläche bestimmt wird. Dabei liegt der Fokus auf der Bewertung der bestimmten H^--Dichte relativ zu der reinen Volumenproduktion im H_2-Plasma und der bisherigen Maximalausbeute durch Beschichtung mit Cäsium.

P 20.27 Wed 16:30 Empore Lichthof

Combined quadrupole mass spectrometry and quartz-enhanced photoacoustic spectroscopy for the demonstration of a plasma-based ammonia depletion — •Sebastian Dahle[1,2], Michael Köhring[3,4], Wolfgang Schade[3,4], and Wolfgang Maus-Friedrichs[1,2] — [1]Clausthaler Zentrum für Materialtechnik, Technische Universität Clausthal, Leibnizstr. 9, 38678 Clausthal-Zellerfeld, Germany — [2]Institut für Energieforschung und Physikalische Technologien, Technische Universität Clausthal, Leibnizstr. 4, D-38678 Clausthal-Zellerfeld, Germany — [3]Fraunhofer Heinrich-Hertz-Institut, Am Stollen 19H, 38640 Goslar, Germany — [4]Energie-Forschungszentrum Niedersachsen, Am Stollen 19B, 38640 Goslar, Germany

Reducing ammonia contents in exhaust gas streams is very important for a large number of applications. The main origins of ammonia emissions are livestock feeding and industrial processing, e.g. during the production of rare earth metals. We implemented a highly efficient plasma-based process using a dielectric barrier discharge reactor. The influence of the plasma discharge on the gas composition includes a fragmentation of many gaseous components. Therefore, we used a combination of a quadrupole mass spectrometer and an inline quartz-enhanced photoacoustic sensor for our analysis.

P 20.28 Wed 16:30 Empore Lichthof

Modeling DC, CCP and ICP discharges using PlasmaPIC — •Robert Henrich, Michael Becker, and Christian Heiliger — Institut für Theoretische Physik, Justus-Liebig-Universität Gießen

PlasmaPIC is a three-dimensional particle in cell (PIC) code. It consists of an electrostatic part for modeling DC and CCP discharges as well as an electrodynamic part for modeling inductively coupled discharges. The three-dimensional description enables the modeling of discharges in arbitrary geometries without limitations to any symmetry. These geometries can be easily imported from common CAD tools. A main feature of PlasmaPIC is the ability of an excellent massive parallelization of the computation, which scales linearly up to a few hundred cpu cores. This is achieved by using a multigrid algorithm for the field solver as well as an effective load balancing of the particles. Moreover, PlasmaPIC includes the interaction of the neutral gas and the plasma discharge. Because the neutral gas and the plasma simulation are acting on different time scales we perform the simulation of both separately in a self-consistent treatment, whereas the neutral gas distribution is calculated using the direct simulation Monte Carlo method (DSMC). The merge of these features turns PlasmaPIC into a powerful simulation tool for a wide range of plasma discharges and introduces a new way of understanding and optimizing low-temperature plasma applications. This work has been supported by the "Bundesministerium fuer Wirtschaft und Energie". Grant 50RS1507