P 27: Low Temperature Plasmas

Zeit: Donnerstag 14:00–16:00 Raum: HS 2010

Hauptvortrag P 27.1 Do 14:00 HS 2010

Plasma discharges for the ambient processing of materials — •James Bradley — University of Liverpool, United Kingdom

Atmospheric-pressure plasmas are finding many applications in industry and technology, ranging from thin film deposition to wound healing. At the University of Liverpool, dielectric barrier discharges (DBD's) are being developed and studied for the processing of polymeric materials. Two configurations are being considered: parallel plate discharges for the treatment of polypropylene in packaging applications and plasma jets for the polymerisation of soft organic films in cell/tissue engineering applications and for the production of antimicrobial surfaces. To understand these plasmas better, a suite of diagnostic techniques are being used, including molecular beam mass spectrometry, non-invasive current probes and nano-second 2-D imaging. Thin films and treated surfaces produced by the different discharge configurations are analysed using XPS, FTIR and TOF SIMS.

P 27.2 Do 14:30 HS 2010

ERO modelling of surface morphology effect on metal erosion — •Alina Eksaeva[1,2], Dmitry Borodin[1], Arkadi Kreter[1], Daisuke Nishijima[3], Albrecht Pospieszczyk[1], Tobias Schlummer[1], Bernhard Unterberg[1], Stephan Ertmer[1], Andreas Kirschner[1], Juri Romazanov[1], Sebastijan Brezinsek[1], and Evgeny Marenkov[2] — [1]Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung, 52425 Jülich, Germany — [2]National Research Nuclear University MEPhI, 31, Kashirskoe sh., 115409, Moscow, Russia — [3]Center for Energy Research, University of California at San Diego, 9500 Gilman Dr., La Jolla, CA 92093-0417, USA

Linear plasma device PSI-2 with its continuous plasma operation is an excellent test bed for the investigation of plasma-facing material erosion including delicate effects like e.g. nano- and micro-scale surface structures and roughness. However, numerical modelling is indispensable for the correct interpretation of experiments. The 3D Monte-Carlo code ERO is a tool for describing the erosion and local transport of impurities taking into account the particular geometry. Several experiments have been carried out at PSI-2 facility to investigate the evolving surface morphology of tungsten (W) and chromium (Cr) and provide a consistent set of data for the interpretation with the ERO code. The aim of this work is to incorporate the effect of surface morphology into the ERO modelling based on free parameters (angular, energy distributions of sputtered particles, sputtering yields influenced by morphology evolution, metastable states lifetime) matched with the experiments.

Fachvortrag P 27.3 Do 14:45 HS 2010

Coupling mechanisms in inductive discharges with RF substrate bias driven at consecutive harmonics with adjustable relative phase — •Birk Berger[1,2], Thomas Steinberger[1], Mark Koepke[1], Thomas Mussenbrock[2], and Julian Schulze[1,3] — [1]Department of Physics, West Virginia University, Morgantown, USA — [2]Electrodynamics and Physical Electronics Group, Brandenburg University of Technology, Cottbus, Germany — [3]Institute for Electrical Engineering, Ruhr-University Bochum, Germany

In plasma etching applications a combination of inductively and capacitively coupled RF plasmas are commonly used. The reason is that the inductive coupling ensures a high plasma density, while the capacitive coupling allows for a control of the ion bombardment energy at a substrate. In our study we experimentally investigate the coupling mechanisms between a phase-locked inductive and capacitive source driven at 13.56 MHz and 27.12 MHz, respectively. In the E-Mode the DC self-bias at the electrode can be controlled via the Electrical Asymmetry Effect by adjusting the phase between both sources. In the transition region from E- to H-Mode the ion flux to the electrode was measured using a Retarding Field Energy Analyzer. The ion flux was found to be affected by the value of relative phase, which can be explained by the electron power dissipation dynamics during one RF cycle using Phase Resolved Optical Emission Spectroscopy.

Fachvortrag P 27.4 Do 15:10 HS 2010

Striations in electronegative capacitively coupled radio frequency plasmas — •Julian Schulze[1,2], Yong-Xin Liu[3], Edmund Schüngel[4], Ihor Korolov[5], You-Nian Wang[3], and Zoltan Donko[5] — [1]Department of Physics, West Virginia University, USA — [2]Institute for Electrical Engineering, Ruhr-University Bochum, Germany — [3]School of Physics, Dalian University, China — [4]Evatec, Switzerland — [5]Hungarian Academy of Sciences, Hungary

Self-organized spatial structures in the light emission from the radio frequency plasma of an electronegative gas (CF4) are observed experimentally by Phase Resolved Optical Emission Spectroscopy for the first time. Their formation is analyzed and understood with the aid of particle-based kinetic simulations. These "striations" are found to be generated by a resonance between the external driving radio-frequency and the eigenfrequency of the ion-ion plasma that leads to a modulation of the electric field, the ion densities, as well as the energy gain and loss processes of electrons in the plasma. The growth of the instability is followed by the numerical simulations [1]. The presentation introduces this effect conceptually and explains its physical origin. [1] Y.-X. Liu et al. 2016 Phys. Rev. Lett. 116 255002

Fachvortrag P 27.5 Do 15:35 HS 2010

Radiale Entwicklung des Streamerdurchbruchs in gepulsten, dielektrisch behinderten Entladungen — •Hans Höft und Manfred Kettlitz — INP Greifswald, Felix-Hausdorff-Straße 2, 17489 Greifswald

Die zeitliche Entwicklung des Durchmessers von gepulsten, dielektrisch behinderten Entladungen (DBE) wurde mit Hilfe von iCCD- und Streakkameraaufnahmen mit Sub-ns-Zeitauflösung untersucht. Dazu wurde eine Einzelfilamentanordnung mit 1 mm Entladungsspalt in einem N_2-O_2-Gasgemisch bei Atmosphärendruck (0,1 Vol.-% O_2 in N_2) genutzt. Es wurde ein Zusammenhang zwischen der axialen Propagationsgeschwindigkeit des positiven (kathodengerichteten) Streamers und der Vergrößerung des Durchmessers gefunden, d. h. der Durchmesser erhöht sich mit steigender axialer Propagationsgeschwindigkeit. Dieses Resultat wird durch die gleichzeitige Betrachtung von axialer und radialer Propagationsgeschwindigkeit ergänzt, die sich um ca. zwei Größenordnungen unterscheiden ($v_{\mathrm{Prop}}^{\mathrm{axial}} \sim 10^6\ \frac{\mathrm{m}}{\mathrm{s}}$ bzw. $v_{\mathrm{Prop}}^{\mathrm{radial}} \sim 10^4\ \frac{\mathrm{m}}{\mathrm{s}}$). Außerdem konnte die radiale Ausbreitung des kathodengerichteten Streamerdurchbruchs sowie der anschließenden transienten Glimmentladung separiert werden. Dazu wurden spektral aufgelöste Aufnahmen des zweiten positiven und ersten negativen Systems von N_2 bzw. N_2^+ (337 nm und 391 nm) genutzt. Diese Ergebnisse liefern einen Einblick in die radiale Dynamik des Streamers mit hoher Orts- und Zeitauflösung. Zusammen mit synchronisierten elektrischen Messungen können zudem Aussagen über die zeitliche und räumliche Entwicklung der Stromdichte im Entladungskanal getroffen werden.