P 2: Low Pressure Plasmas I

Time: Monday 14:00–15:15 Location: P-H11

P 2.1 Mon 14:00 P-H11

Influence of a remote plasma on the chemical vapour deposition of ZrO2 based layers — •Philipp A. Maass[1], Vitali Bedarev[1], Sebastian M. J. Beer[2], Marina Prenzel[1], Marc Böke[1], Anjana Devi[2], and Achim von Keudell[1] — [1]Experimental Physics II, Ruhr-University, Bochum, Germany — [2]Inorganic Chemistry II, Ruhr-University, Bochum, Germany

Chemical vapour deposition (CVD) is a widely applied technique used for thin film deposition. The combination with a plasma source (PECVD) enables the fine-tuning of parameters, opening new possibilities for the fabrication of functional coatings, such as thin thermal barrier coatings.

A metalorganic precursor is transported into the reaction chamber by a 50 sccm N2-flow at pressures of 100 Pa. A ZrO2 layer is deposited onto a heated substrate in the centre of the chamber with a growth rate of several 100 nm/h. To influence and improve the reaction chemistry, a microwave plasma source is mounted opposite the substrate surface. It interacts with the incoming precursor molecules, with the aim to reduce the reaction temperature and change the deposition properties.

During this process, the growth rate and substrate temperature are monitored by in-situ ellipsometry. The deposited layers are characterised in stoichiometry and crystallinity, using X-ray photoelectron spectroscopy (XPS) and X-ray diffraction (XRD).

Depositions are carried out with and without the use of the plasma source. The different growth characteristics are investigated and compared.

P 2.2 Mon 14:15 P-H11

High-resolution terahertz spectroscopy with quantum-cascade lasers for atomic oxygen density measurements — •Jente Wubs, Uwe Macherius, Klaus-Dieter Weltmann, and Jean-Pierre van Helden — Leibniz Institute for Plasma Science and Technology (INP), Felix-Hausdorff-Straße 2, 17489 Greifswald, Germany

Absorption spectroscopy in the terahertz (THz) spectral region between 0.3 and 6 THz provides access to energies that correspond to molecular and atomic transitions involving rotational mode changes and fine structure splitting, respectively. In addition, THz frequencies lie well above typical values for the plasma frequency, allowing the electron density to be determined from a phase shift of transmitted THz radiation. Knowledge about the electron density as well as atomic and molecular densities in plasmas is highly relevant for technological and scientific applications. A promising diagnostic for measuring these densities is THz time-domain spectroscopy. It is based on the ultrafast generation and detection of broadband THz pulses; however, the spectral resolution is limited to approximately 1 GHz. THz quantum-cascade lasers (QCLs) operating in continuous-wave mode are therefore better suited for the detection of sharp absorption lines. Although these lasers have a relatively small tuning range, their narrow linewidth (below 10 MHz) makes them an excellent THz source for high-resolution spectroscopy. In this contribution, first results are presented on the absolute density of ground state oxygen atoms, measured in a low-pressure RF plasma using a QCL operating at 4.75 THz.

P 2.3 Mon 14:30 P-H11

Operando FTIR monitoring of silicon nanoparticle treatment in a low-pressure plasma — •Oguz Han Asnaz and Jan Benedikt — Institute of Experimental and Applied Physics, Kiel University, Germany

With their unique physical, mechanical, electrical and optical properties, nanoparticles have found a wide range of applications ranging from drug carriers in bio-medicine over catalysts to batteries and solar cells. Control of the particle's bulk and surface properties is required in many of these applications. In this contribution, we present results for Silicon nanoparticles generated in a capacitively coupled low-pressure plasma. The particles are then confined in a secondary discharge for further treatment with monitoring during operation by means of in situ time-resolved FTIR spectroscopy with a multipass cell for 24 passes. Using different reactive gasses, surface passivation by hydrogen or oxygen treatment as well as deposition of thin carbon films is possible. Additionally, using an electrostatic particle extractor system (EPEX) developed in our group, particle samples are extracted at multiple moments during the treatment for further analysis with negligible disturbance of the plasma system.

P 2.4 Mon 14:45 P-H11

Plasma diagnostics combination: Calorimetric Probe and Retarding Field Analyser — •Felix Schlichting and Holger Kersten — Christian-Albrechts-Universität, Kiel, Deutschland

A recently developed plasma diagnostic, which combines a retarding field analyser (RFA) and a passive thermal probe (PTP), has been used for the characterization of different plasma environments. The PTP serves as the collector of the RFA, in front of which three centrally aligned grids are operated as the retarding field system. In this setup the collector does not only measure the incoming ion current depending on the voltage applied to the grids of the RFA, but also the incoming energy flux density of the impinging ions or neutrals, respectively. In this study the combined diagnostic is used in an RF plasma, where the probe is embedded into the grounded electrode, as well as in a DC Magnetron sputtering system, where the probe is located at substrate position. The ion energy distribution (IED) is determined regarding the energy exchange of the neutral background gas with the ions extracted from the plasma source. Furthermore, with suitable voltage applied to the grids of the RFA, the secondary electron emission from the collector can be quantified in regard to the ion energies and the material used for the collector plate.

P 2.5 Mon 15:00 P-H11

Selbstkonsistente Modellierung einer linearen Mikrowellenplasmaquelle in einem Magnetfeld — •Stefan Merli[1], Andreas Schulz[1], Matthias Walker[1], Yannick Kathage[2], Stefan Hanke[2] und Christian Day[2] — [1]IGVP, Universität Stuttgart — [2]Karlsruhe Institute of Technology (KIT), Karlsruhe

In diesem Beitrag wird der Einfluss von magnetischen Feldern auf die Eigenschaften einer linearen Mikrowellenplasmaquelle, der sogenannten Duo-Plasmaline, numerisch und experimentell untersucht. Bei dem FEM-basierten Simulationsmodell werden die Transportgleichungen für die Elektronen und der schweren Teilchen selbstkonsistent mit der elektrischen Feldverteilung der eingestrahlten Mikrowelle gelöst. Das betrachtete Plasmagas ist H_2, welches durch insgesamt 44 Elektronenstoß-, Schwerteilchenstoß- und Wandrekombinationsreaktionen in das Modell implementiert wurde. Das zeitlich konstante und homogene Magnetfeld, welches über die Diffusivitäts- und Mobilitätstensoren in die Transportgleichungen eingeht, wurde in paralleler und senkrechter Orientierung zur Plasmaquelle untersucht. Die magnetische Flussdichte wurde über einen weiten Bereich von 0 T über 87,5 mT (ECR) bis hin zu 1 T variiert. Das Hauptaugenmerk lag auf der Untersuchung des Einflusses des Magnetfeldes auf den Heizmechanismus, der Form des Plasmas, den Änderungen in der Dichte und Temperatur sowie in der Dissoziationsrate für H_2. Die Ergebnisse aus den Simulationen werden mit Untersuchungen aus dem Experiment FLIPS, bei welchem homogene Magnetfelder bis zu 250 mT parallel oder senkrecht zur Plasmaquelle erzeugt werden können, verglichen.