P 21: Plasma Technology II

Time: Thursday 10:30–12:45 Location: SPA HS201

Invited Talk P 21.1 Thu 10:30 SPA HS201

HVDC Insulator Charging in SF6 Insulated Systems — •Ueli Straumann[1], Uwe Riechert[1], Robin Gremaud[2], Michael Schüller[3], and Christian M. Franck[3] — [1]High Voltage Products, ABB Switzerland Ldt. — [2]Corporate Research, ABB Switzerland Ldt. — [3]Power Systems and High Voltage Laboratories, ETH Zurich, Switzerland

To decarbonize our societies, electricity production from renewable sources is rising across Europe. It is widely expected that the integration of these renewables will be accompanied with a large increase of HVDC installations. For the latter, the utilization of gas insulated (GI) systems is becoming attractive, particularly as they require less space than air insulated systems, similar to the situation of gas insulated switchgear (GIS) in the case of AC.

When adapting AC GIS for DC application, one of the main challenges might be the insulators, which, under DC voltage, are charged, potentially leading to dielectric stresses differing considerably from those under AC. The temperature dependent electric conductivity of the solid insulation as wells as ions from the gas deposited on the insulators surface determine the electric field under DC conditions.

To be able to assess the role of the ion-currents charging the insulator surface, the ion production rate and their drift in the electric field have to be determined. These ions are generated by natural radiation and, in the case of excessive field strengths, by collision and field emission. Measurements show that such insulator charging may be simulated fairly well by means of the discontinuous Galerkin Method.

Invited Talk P 21.2 Thu 11:00 SPA HS201

Plasma based deposition of nanoparticles and nanocomposites — •Thomas Strunskus — Institute of Materials Science - Multicomponent Materials, Christian-Albrechts University at Kiel, Kaiserstr. 2, 24143 Kiel, Germany

Nanocomposites combine favorable features of the constituents on the nanoscale to obtain interesting new functionalities for e.g. optical, magnetic or medical applications [1]. The present talk is concerned with the plasma based deposition of metal and metal oxide nanoparticles and their combination with dielectric organic or inorganic matrices. Such nanocomposites can be created by magnetron co-sputtering of the matrix and metallic components. A more elegant way is the creation of nanoparticles prior to deposition by a magnetron sputtering process in a gas aggregation source and combination with a plasma or sputtering deposition process for the matrix. The processes occurring in the gas aggregation source under different operation conditions will be discussed. Computer simulations of the metal aggregation process in the gas phase and in the solid phase during growth will also be addressed.

[1] Metal-Polymer Nanocomposites for Functional Applications, F. Faupel, V. Zaporojtchenko, T. Strunskus, M. Elbahri, Adv. Engin. Mater. 12(12), (2010), 1177.

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P 21.3 Thu 11:30 SPA HS201

Carbon micro-crystals and micro-bubbles deposition using filamentary pulsed atmospheric pressure plasma — •Ramasamy Pothiraja, Nikita Bibinov, and Peter Awakowicz — Institute for Electrical Engineering and Plasma Technology, Ruhr-University Bochum, 44801 Bochum, Germany.

Thin plasma filaments are produced by propagation of ionization waves from spike-shaped electrode in quartz tube in argon/methane gas mixture at atmospheric pressure. Position of touching point of filaments on substrate surface can be controlled in our experiment by variations of substrate configuration and position on planar grounded electrode. Filament end-point on substrate surface is positioned in argon/hydrocarbon flow as well as in ambient air. Duration of plasma filament contact time on substrate is about one microsecond. Some carbon compounds are formed during this time at the touching points on the substrate surface. Micro-bubbles are produced if filaments touching points are under argon/hydrocarbon flow (away from ambient air). Under air conditions, micro-crystals are formed. Dimension of both compounds is approximately one micrometer (0.5 - 2 micrometer) and corresponds to about $10^{10} - 10^{12}$ carbon atoms. Neither diffusion of neutral species nor drift of ions can be a reason for the formation of such big compounds during this short period of filament-substrate interaction. Possibly carbon ions are trapped in a plasma soliton, which are propagated with ionization wave, and transported to the substrate. Mechanism of this transport and characterization of materials formed under different gas conditions will be studied in the future.

P 21.4 Thu 11:45 SPA HS201

Atmosphärendruck-Plasmamodifikation optischer Eigenschaften von Siliziumdioxid — •Christoph Gerhard[1,2], Stephan Wieneke[1,2] und Wolfgang Viöl[1,2] — [1]HAWK, Göttingen, Deutschland — [2]Fraunhofer IST-APP, Göttingen, Deutschland

In diesem Beitrag wird die Modifikation optischer Eigenschaften von Siliziumdioxid, dem Hauptbestandteil optischer Gläser, mittels wasserstoffhaltigen Atmosphärendruckplasmen vorgestellt. Hierbei wird eine gezielte plasmainduzierte chemische Reduktion von Siliziumdioxid zu Siliziumsuboxid sowie eine Einlagerung von Wasserstoff in das Bulkmaterial initiiert. Als Folge der resultierenden Stöchiometrieänderung können so relevante optische Eigenschaften wie der Brechungsindex und die damit verbundenen Reflexions-, Transmissions- und Dispersionseigenschaften modifiziert werden. Die zugrunde liegenden chemischen Modifikationen der Siliziumdioxidmatrix werden anhand von massen- und röntgenspektroskopischen Untersuchungen dargestellt. Darüber hinaus werden plasmainduzierte Änderungen der optischen Eigenschaften auf Basis spektroskopischer und ellipsometrischer Messungen präsentiert sowie bereits umgesetzte Anwendungen einer solchen Modifikation, etwa zur Laserbearbeitung transparenter Medien, vorgestellt.

P 21.5 Thu 12:00 SPA HS201

Reactive magnetron co-sputtering from In and Cu(Ga) targets in Ar:H_2S or Ar:H_2Se: poisoning mechanisms of the target and influences on the discharge voltage — •Jonas Schulte and Klaus Ellmer — HZB Berlin

The reactive sputtering process from In and CuGa targets in dependence of the reactive gas content c_{RG} (H_2S or H_2Se), has been investigated in order to achieve a better understanding for the process to enable reproducible depositions of $Cu(In,Ga)(S,Se)_2$ absorber layers for thin film solar cells. In comparison to the basic Berg model of reactive sputtering processes and to detailed investigations of reactive sputtering processes in O_2 and N_2 by other groups, it was tried to relate changes of the discharge voltage V_{dis} , while applying a constant target power, to changes of the ion induced secondary electron emission (ISEE) coefficient of the target surface and hence the target poisoning mechanisms. For both targets, a clear tendency for an increasing V_{dis} for increasing c_{RG} was observed, which is very similar for the case of H_2S or H_2Se as reactive gases. This could be, however, not related to a change of the ISEE coefficient, since measurements of the discharge voltage of a sulfurized target surface shortly after reigniting the discharge in pure Ar, show that the ISEE coefficient of the poisoned target surface is not significantly changed in comparison to the metallic surface. Furthermore, this change of the ISEE coefficient depends on the specific reactive gas content used during the poisoning procedure. This indicates the formation of different metal-S (Se) phases on the target surfaces in dependence on the reactive gas content.

P 21.6 Thu 12:15 SPA HS201

Stabilität von Isoliergasgemischen unter dem Einfluss nichtthermischer Plasmen — •Thomas Hammer und Tetsuo Kishimoto — Siemens AG, CT RTC PET, Günther-Scharowsky-Str. 1, 91058 Erlangen

Gasgemische sind ein bewährtes Mittel für die elektrische Isolation in Anlagen der Energieverteilung und Übertragung im Mittel- und Hochspannungsbereich. Die dielektrische Festigkeit der Gasisolation hängt dabei maßgeblich von der Zusammensetzung des Gasgemisches ab. Kleinvolumige elektrische Gasentladungen mit Strömen im sub-mA-Bereich (auch als Teilentladungen bekannt), die an lokalen Feldstärkeüberhöhungen in elektrischen Anlagen ansetzen, können durch Bildung chemisch aktiver Radikale effizient Reaktionen anregen, die langfristig - d.h. über einen Zeitraum von typisch 30 Jahren - einerseits zum Abbau der für die dielektrischen Festigkeit wesentlichen

Gaskomponente, anderseits zur Bildung neuer Gaskomponenten führen können [1], die unter Umständen die Funktion der elektrischen Anlage beeinträchtigen. Effekte dieser Art wurden mittels dielektrisch behinderter Entladungen an einem N2O-N2-Gemisch in einem geschlossenen Rezipienten experimentell untersucht. Der Einfluss der eingetragenen spezifischen Energie auf den Abbau von N2O und die Bildung von Stickoxiden sowie die Änderung der elektrischen Eigenschaften werden präsentiert.

[1] T. Hammer: Non-thermal plasma application to the abatement of noxious emissions in automotive exhaust gases. Plasma Sources, Science and Technology Vol. 11, No. 3A, A196-201 (2002)

P 21.7 Thu 12:30 SPA HS201

Formation of metal and metal oxide nanoparticles generated in gas phase by pulsed DC sputtering in a reactive gas admixture — Oleksandr Polonskyi, Amir Mohammad Ahadi, Alexander Hinz, Egle Vasiliauskaite, •Thomas Strunskus, and Franz Faupel — Institute for Materials Science, Chair for Multicomponent Materials, Christian-Albrechts University at Kiel, Kaiserstr. 2, 24143 Kiel, Germany

This work is focused on the formation of metal and metal oxide nanoparticles (Ag, TiOx, AlxOy, SiOx) in a gas aggregation source with continuous or pulsed DC magnetron sputtering. Usually argon was used as a working gas, but in case of reactive metals (Ti, Al) a low concentration of oxygen or nitrogen is necessary for the cluster formation process. It was also observed that a gas aggregation cluster source based on pulsed reactive DC magnetron sputtering gives rise to a huge increase in deposition rate of nanoparticles by more than one order of magnitude compared to continuous operation (e.g., TiOx nanoparticles) [1]. The influence of the sputtering parameters and reactive gas admixing on the nanoparticles formation process was investigated. The prepared nanoparticles were characterized with regard to chemical composition, morphology and optical properties.

[1] Polonskyi et al., Appl. Phys. Lett. 103, 033118 (2013)