Tuesday, May 12

8:30 a.m. JAPT-13 Expansion of Contracted Single Rare-Gas Tubular Discharges at Atmospheric Pressure

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Rare gas discharges sustained at atmospheric pressure are affected by the phenomena of contraction (reduction of the discharge volume) and filamentation (breaking of a contracted plasma channel into two or more filaments). Contraction has been observed in DC, RF and microwave discharges while filamentation is specific to microwave discharges. Reducing or eliminating contraction and filamentation is essential in the optimization and development of some industrial applications using high pressure discharges. Recently, it was shown that it is possible to achieve non-contracted and non-filamentary microwave discharges at atmospheric pressure. A contracted/filamentary discharge in a given pure rare gas at atmospheric pressure expands/homogenizes radially upon addition to it of a specific small amount (generally less than 1%) of another rare gas having a lower ionization potential. The characteristics of contracted and expanded discharges at atmospheric pressure are described and the mechanisms causing discharge contraction as well as expansion analyzed. Radial contraction is due to the influence of non-uniform gas heating on molecular ion kinetics while the discharge expands because the charged particle-loss is governed by atomic-ion diffusion. This last fact by itself supports the essential role of molecular ions in discharge contraction.

Tuesday, May 12

8:50 a.m. JAPT-8 A Systematic Study of the Adhesive Properties of a Plasma Polymerised Primer Bonding Siloxane Elastomer to Stainless Steel

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Student Sponsorship Applicant

Plasmas have been used widely for the pre-treatment of metals prior to adhesive bonding applications. In this study the use of a plasma polymerised primer layer as a means of enhancing the adhesion of siloxane polymers to steel is investigated. The primer layer consisted of a mixture of tetraethoxysilane (TEOS) and polyhydrogenmethyl siloxane. This liquid mixture was nebulized into a helium atmospheric pressure plasma jet. The resulting primer coating was characterised using x-ray photoelectron spectroscopy (XPS), Fourier Transform infrared spectroscopy, optical profilometry, water contact angle, atomic force microscope and spectroscopic ellipsometry. The adhesion of the siloxane elastomer was accessed using 45˚ peel strength measurements. Among the parameters investigated was the influence of the atmospheric plasma jet to substrate distance on primer performance. In addition the effect of primer thickness was studied by systematically altering the number of passes of the jet over the steel substrate. The thickness of the primer investigated ranged from 50 to 600 nm. The influence of time after primer deposition on subsequent metal to siloxane elastomer adhesion was investigated up to a period of 14 days. Over a 15-fold enhancement in the adhesion of siloxane elastomer to stainless steel was achieved using the plasma polymerised primer layer.

Tuesday, May 12

9:10 a.m. JAPT-9 Equipment for Large Area Plasma Processing at Atmospheric Pressure

I. Dani, G. Maeder, J. Roch, P. Grabau, B. Dresler, D. Linaschke, S. Tschoecke, S. Kaskel, and V. Hopfe,
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Atmospheric pressure plasma technologies offer a unique combination of technological and economic advantages. For large area processing, two types of plasma sources are presented: a linearly extended DC arc discharge and a microwave plasma source. The DC arc plasma source offers a scalable working width of up to 350 mm at the moment. The second source is a scalable microwave plasma source for atmospheric pressure operation. Plasma gases are mainly mixtures of nitrogen and argon with reactive gases. PECVD reactors for inline air-to-air processing of flat substrates up to 156 mm wide for deposition of SiO_2, a-C:H, and SiN_x:H as well as a flying coater head for scanning the surface of larger substrates are presented. Also, equipment for continuous atmospheric pressure plasma-chemical etching of silicon was developed. All reactors include purge gas curtains to assure an inert working atmosphere, enabling the deposition of non-oxide films, and to prevent the leakage of reactive gases. Fluid dynamic calculations have been used to optimise the reactor and plasma source design. For process characterisation optical emission and *in situ* FTIR spectroscopy are applied. Dynamic deposition rates are up to 25 nm.m/min, rates for silicon etching can be 10 times higher.

Tuesday, May 12

9:30 a.m. JAPT-10 Current and Future Prospects of Non-Thermal Plasmas Exhaust-Air Pollution Control

R. Brandenburg, R. Basner, and K.-D. Weltmann, INP Greifswald e.V., Greifswald, Germany

In our highly industrialised society, the reduction of emissions from exhaust gas streams is becoming more and more important. Due to its impact on air, soil and water, exhaust pollution affects the environment and thus human health. Therefore environmental norms and standards are constantly increased by national and international authorities. The possibilities of air-pollution control by means of non-thermal plasmas are well known. As ionised gases, plasma contains active and highly reactive species, in particular radicals or oxidizing compounds, which can decompose pollutant molecules or organic particulate matter (e.g. soot). However, the applicability of non-thermal plasma processes has been turned out to be limited, too. It is determined by many facts, e.g. energy costs or formation of by-products. Under this aspect, hybrid processes combining non-thermal plasma with other technologies such as catalysis, absorbed agents or wet processing become a focus in recent research activities. The contribution shall summarize the possibilities of non-thermal plasma exhaust-air pollution and discuss its prospects and limits. Furthermore, it will report on commercially available plasma based and plasma assisted processes as well as discuss current trends and concepts in research.

Tuesday, May 12

9:50 a.m. JAPT-11 Environmental Applications of the Atmospheric Pressure Plasma Sources

H. Baránková and L. Bárdos, Uppsala University, Uppsala, Sweden

Non-equilibrium atmospheric plasma sources based on the hollow cathode, microwave and hybrid concepts were developed for conversion of hazardous gases and reduction of particulate matter in the exhaust gas. As these applications require a stable performance especially in molecular gases, the design of plasma sources must be such as to level off instabilities associated with molecular gases. The results on the cleaning process are presented, together with experimental results on discharge generation which formed a basis for the plasma reactor designs. The gas conversion plasma reactors have diverse applications and can be for example integrated into PE CVD atmospheric pressure systems.

Tuesday, May 12

10:30 a.m. JAPT-12 Atmospheric Pressure Plasma Deposition of Transparent Conductors - Tailoring Precursor Chemistries

K. Johnson, S. Jha, R. Sailer, and D. Schulz, North Dakota State University, Fargo, ND

Atmospheric-pressure plasma (APP) processes such as corona discharge have demonstrated utility in the cleaning steps associated with roll-to-roll manufacture. APP has more recently found applicability in the modification of surface energies given the ability to form plasma-polymerized coatings from precursors that contain an olefin functional group. The application of APP deposition to materials relevant to flexible electronics requires the use of functional precursors that maintain the following characteristics at 760 Torr: (1) a significant vapor pressure; (2) ability to be transported to the reaction zone without decomposition; and, (3) ability to form the targeted phase with byproducts that are eliminated from the growth surface. We have been investigating the utility of metal-organic complexes as precursors to transparent conducting oxides toward web-based manufacture of photovoltaics, flat panel displays, etc. In this paper we with describe our efforts toward APP deposition of In-Sn-O using Sn(II) and In(III) beta-diketonate complexes. Helium carrier gas, O_2 reactant gas and growth temperatures from ambient to 300 $^{\circ}$C have been evaluated with 20 minute growth cycles providing 50-100 nm thick coatings over 30 cm^2. The as-deposited films exhibit light transmittance in excess of 90% over the visible spectrum while maintaining resistivities on the order of 10^{-4} ohms/cm.