P 4: Plasma Technology

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

Hauptvortrag P 4.1 Mo 14:00 HS 2010

Atmospheric reactive plasma jet machining technologies for ultra-precision optical surface manufacturing — •Thomas Arnold — Leibniz-Institut für Obrflächenmodifizierung e.V. Leipzig/TU Dresden

Atmospheric chemically reactive plasma jets are versatile tools utilized for ultra-precision surface machining. Nowadays, optical elements like lenses and mirrors require very high surface form accuracy and low waviness and micro-roughness in the range of a few nanometers or even below. At the same time, optical surface shapes differ significantly from simple basic forms like planar, spherical or cylindrical geometries. In modern optical applications e.g. for laser beam shaping, space-based astronomical telescopes, or synchrotron beam-lines optics, more and more complex aspherical or freeform surface are required. Deterministic and precise machining of optical materials like fused silica, silicon or silicon carbide by reactive plasma jets has shown a great potential over conventional mechanical-abrasive optical manufacturing since no mechanical forces are exerted to the surface and the chemical nature of plasma surface-interaction is utilized to well controlled local damage-free surface modification. Plasma jets containing halogenated precursors (e.g. CCl4, CF4) are applied in dry etching processes to remove surface material, while polymer forming precursors (e.g. CH4, hexamethyldisiloxane HMDSO) are employed for localized thin film deposition. The presentation will cover problems of plasma-surface interactions as well as technology related aspects in plasma assisted surface machining processes.

P 4.2 Mo 14:30 HS 2010

Deposition of SiO_x coatings by means of inductively coupled plasma — •Markus Brochhagen, Vincent Layes, Marc Böke, and Jan Benedikt — Experimentalphysik II, Ruhr-Universität Bochum, Universitätsstraße 150, 44801 Bochum

SiO_2-like films can serve as barrier coatings on polymeric substrates, where the barrier properties depend on the amount of carbon inside the layer. Such layers can be produced in a plasma process using evaporated HMDSO and admixed Argon or Oxygen. This mixture influences the amount of carbon inside the layer. The less carbon is inside the layer, the better is the barrier property of the film. The process is studied under high plasma density conditions in an ICP plasma with in-situ ellipsometry, FTIR spectrometry and XPS. Additionally the thickness is measured with a profilometer. Also the impact of argon ions and metastables is investigated in a process with prolonged Ar-plasma treatments of thin SiO_2-like layers. It is tested if carbon free films can be achieved even without O_2 admixture as it was reported for atmospheric plasmas.

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P 4.3 Mo 14:45 HS 2010

CO2-based test for the detection of defects in oxygen barrier layers — •Mariagrazia Troia[1], Andreas Schulz[1], Matthias Walker[1], and Thomas Hirth[2] — [1]Institute of Interfacial Process Engineering and Plasma Technology IGVP, University of Stuttgart, Stuttgart, Germany — [2]Karlsruher Institut für Technologie KIT, Karlsruhe, Germany

Barrier layers performances are severely limited by the presence of punctual micro- and sub-micro-metrical defects. In order to determine the density of defects in barrier layers obtained through PEVCD, their origin and overall effect on oxygen transmission rate, a new non-destructive test has been developed and optimized.

Silica-like films acting as oxygen barrier layers have been deposited by means of an Electron Cyclotron Resonance low-pressure, MW-sustained plasma through gaseous feeds with different HMDSN/O2 ratios.

The coated sample is interposed between a pure CO2 atmosphere and a limewater solution: CO2 permeates preferentially through the pinholes in the barrier layers, causing the precipitation of CaCO3 crystals on top of them. Real-time analysis is performed by means of an optical microscope on top of the testing cell.

Average defect densities for different substrates and for various thicknesses and chemical compositions of barrier layers have been calculated and compared to their respective oxygen transmission rate and barrier improvement factor: the reduction of defects number shows very good accordance with the reduction in the oxygen transmission rates.

P 4.4 Mo 15:00 HS 2010

Spitze - zu - Wasser - Entladung: optische, elektrische und chemische Charakterisierung sowie Anwendungsbeispiele — •Michael Schmidt[1], Ioana Cristina Gerber[2], Torsten Gerling[1], Beke Altrock[1] und Thomas von Woedtke[1] — [1]INP Greifswald — [2]University of Iasi

Die Behandlung von Wasser mittels nicht-thermischen Plasmas führt zur Veränderung der chemischen Zusammensetzung des Wassers in Abhängigkeit von der Plasmaleistung und der Dauer der Einwirkung sowie der Art des behandelten Wassers. Vorgestellt wird eine anwendungsnah konzipierte Plasmaquelle zur Behandlung von Wasservolumina bis 1 L, basierend auf elektrischen Entladungen zwischen metallischen, hochspannungsbeaufschlagten Elektroden und einer Wasseroberfläche. Es werden optische und elektrische Untersuchungen an der Plasmaquelle sowie chemische Analysen unterschiedlicher behandelter Wasserarten diskutiert. Hierbei zeigt sich, dass sich die Leitfähigkeit und der pH-Wert bei demineralisiertem Wasser und bei Reinstwasser stark ändern, bei Leitungswasser jedoch nur geringfügig. In einer Anwendungsstudie wird die Inaktivierung unterschiedlicher Mikroorganismen, abhängig von der Art des behandelten Wassers und der Einwirkdauer, untersucht. Es kann gezeigt werden, dass alle behandelten Wasserarten antimikrobiell wirksam sind.

P 4.5 Mo 15:15 HS 2010

Decontamination of Space Equipment Using Cold Atmospheric Plasma — •Meike Müller[1], Sylvia Binder[2], Tetsuji Shimizu[2], Igor Semenov[1], Julia Zimmermann[2], Petra Rettberg[3], Gregor Morfill[2], and Hubertus Thomas[1] — [1]Deutsches Zentrum für Luft- und Raumfahrt, Institut für Materialphysik im Weltraum; Argelsrieder Feld, Wessling 82234, Germany — [2]terraplasma GmbH, Lichtenbergstraße, Garching 85741, Germany — [3]Deutsches Zentrum für Luft- und Raumfahrt, Institut für Luft- und Raumfahrtmedizin, Linder Höhe, Köln 51147, Germany

Cold atmospheric plasma (CAP) is a very effective technology for the inactivation of microorganisms, which is of crucial interest for extraterrestrial space missions. In our study, a new designed plasma-gas circulation system has been developed and tested. The investigations with bioindicators (Bacillus atrophaeus spores) show that this technology has a high biocidal effect. Therefore, several treatment volumes were tested to optimize the CAP efficacy. In addition, we plan to perform a series of measurements for chemical composition by using a FTIR spectrometer. This provides an insight into the plasma chemistry including the influence of the humidity on the inactivation of microorganisms. In this contribution, we propose a possible design of decontamination system for larger spacecraft facilities using CAP. Furthermore we will discuss the advantage of CAP technology in comparison with conventional sterilization methods.

P 4.6 Mo 15:30 HS 2010

The milli-Newton μHEMPT as Potential Main Thruster for Small Satellites — •Max Vaupel[1,2], Franz Georg Hey[1], Alexander Sell[1], Karlheinz Eckert[1], Tim Brandt[3,4,5], Claus Braxmaier[3,4], Martin Tajmar[2], Dennis Weise[1], and Ulrich Johann[1] — [1]Airbus Defence and Space, Germany — [2]Technische Universität Dresden, Germany — [3]DLR, Institute of Space Systems, Germany — [4]Center of Applied Space Technology and Microgravity, University of Bremen, Germany — [5]Institute of Experimental and Applied Physics, University of Kiel, Germany

In the last years, small satellites become more important due to the continuing miniaturisation of key technology. Due to the constraining mass requirements of small satellites, electric propulsion with its high propellant-to-thrust ratio offers several advantages. Airbus DS in Friedrichshafen performs a downscaling of the HEMPT principle to the micro-Newton regime and additionally developed a mN-μHEMPT which can be operated towards 10 mN. The mN-μHEMPT performance was characterised by direct thrust measurement as well as an indirect thrust measurement using a retarding potential analyser and Faraday cup at the AirbusDS test facility.

P 4.7 Mo 15:45 HS 2010

Characterization of two APPJs for biomedical applications — •Daniela Coenen, Julian Kaupe, Slobodan Mitic, Jan Philipps, and Detlev Hofmann — I. physikalisches Institut, Justus-Liebig-Universität, Giessen, Germany

Two atmospheric pressure plasma jets (APPJ) for biomedical applications have been designed and investigated. Firstly an APPJ for liquid spray treatment has been built to produce plasma activated liquids. Plasma quality was characterized by optical emission spectroscopy and phase resolved imaging while effect of a plasma on liquid droplets was evaluated by detection of radicals by electron-paramagnetic-resonance. The device was shown to be an efficient source for production and deposition of plasma activated liquids.

Furthermore a DBD-APPJ has been built for treatment of bacteria and viruses in solutions. Samples can be treated in a closed chamber providing conditions for systematic study of gas mixture effect on mortality of microorganisms in controllable environment. First experiments have been conducted comparing argon and helium as a carrier gas with admixtures of N_2 and synthetic air. Moreover optical and electrical diagnostics have been performed with the aim to investigate the correlation between plasma parameters and bactericidal effects. Additionally gas temperature has been estimated from rotational temperature of nitrogen second positive spectra. Using helium as carrier gas leads to higher power consumption at constant input voltages and better bactericidal effects than usage of argon. For admixtures of N_2 a significant decrease of the ion-to-neutral-ratio of N2 was observed.