SURFACES, INTERFACES AND COATINGS TECHNOLOGIES

PLASMA PROCESSING AND TECHNOLOGY

TRIBOLOGY INTERNATIONAL CONFERENCE

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27-29 Avril, 2022 - Barcelona, Spain

Book of Abstracts

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28 April 2022		
Plasma Tech Session II: Plasma Processing / materials interactions / coatings		
Onsite Conference Room Glorias A		
Session's Chairs: Prof. Mark J. Kushner, University of Michigan, USA Prof. Vasco Guerra, Technical University of Lisbon, Portugal		
09:00 - 09:30	Selectively changing key surface properties via atmospheric gliding arc plasma deposition **T. Danny Michl**, A. Goel and S. Neuhaus	**Dr. Thomas Danny Michl**, University of Applied Sciences and Arts Northwestern Switzerland, **Switzerland**
09:30 - 09:45	On the formation of carbon nanoparticles in expanding laser-induced plasma **A. Kaczmarek** and J. Hoffman	**Ms. Agata Kaczmarek**, Institute of Fundamental Technological Research Polish Academy of Sciences, **Poland**
09:45 - 10:00	Carbon nanostructure production from ethanol by cold plasma **A. Jurov**, J. Zavašnik and U. Cvelbar	**Dr. Andrea Jurov**, University of Zagreb, **Croatia**
10:00 - 10:15	Hydrophobic and Amphiphobic Postmodification of Mesoporous Aerogels via Cold Plasma Coating **B. Schroeter**, I. Jung, P. Gurikov and I. Smirnova	**Dr. Baldur Schroeter**, Hamburg University of Technology, **Germany**
10:15 - 10:30	Plasma Activated Liquids: a Method for Efficient Surface Modification of Semiconductor Nanostructures **P. Galář**, F. Matějka, J. Khun and K. Kůsová	**Dr. Pavel Galář**, Institute of Physics of the Czech Academy of Sciences, **Czech Republic**
10:30 - 11:00	**Coffee Break**	
11:00 - 11:15	UV-LED, UV-laser and Corona discharge treatments for polypropylene surface functionalization and optimization of PP-Fiber Reinforced Concrete **B. Malchiodi**, P. Pozzi and C. Siligardi	**Mrs Beatrice Malchiodi**, University of Modena and Reggio Emilia, **Italy**
11:15 - 11:30	Fast Switch From Hydrophilic to Hydrophobic Surface of Cellulose Film by Low-Temperature Plasma Treatment **A. Oberlintner**, V. Shvalya, B. Likozar and U. Novak	**Ms Ana Oberlintner**, National Institute of Chemistry, **Slovenia**
11:30 - 11:45	Recent progress in the electrical management of the plasma electrolytic oxidation process **J. Martin**, V. Ntomprougkidis, C. Tousch, A. Maizeray, G. Marcos, T. Czerwiec, T. Belmonte and G. Henrion	**Dr Julien Martin**, University of Lorraine, **France**
11:45 - 12:00	Promoting resource preservation by PECVD barrier coatings for refillable PET bottles **P. Alizadeh** and R. Dahlmann	**Dr. Philipp Alizadeh**, RWTH Aachen University, **Germany**
12:00 - 12:15	Cathodic plasma electrolytic deposition of an aluminium oxide based hydrogen permeation barrier **M. Wetegrove**, M. Rohloff, U. Lindemann, A. Quade and A. Kruth	**Dr. Marcel Wetegrove**, Leibniz Institute for Plasma Science and Technology, **Germany**
12:00 - 14:00	**Lunch Break**	

On the formation of carbon nanoparticles in expanding laser-induced plasma

A. Kaczmarek [1,*], J. Hoffman [1]
[1] Department of Experimental Mechanics, Institute of Fundamental Technological Research Polish Academy of Sciences, Warsaw, Poland
[*] akaczmar@ippt.pan.pl

Abstract:
Nowadays, there are numerous works devoted to characterizing the properties of carbon nanoparticles obtained by laser ablation in various media, e.g. in liquid [1]. Therefore, it is possible to optimize and control the size of particles, their optical and morphological properties and link them with synthesis parameters, such as the kind of liquid medium or laser fluence. However, the description of primary formation processes of carbon nanoparticles after laser ablation in vacuum, gas or liquid remains incomplete [2].
There have been several attempts to describe the formation of carbon nanoparticles. One of them [3] considered the entire lifecycle of carbon ablation plasma. According to this study, nanoparticles are formed as a result of the ejection of fragments of the target (graphite). Another possibility is ejection of liquid droplets as an effect of so called phase explosion and explosive boiling [4]. Other studies postulate that nanoparticles are formed during plasma-phase expansion [2, 5] and that this process can be divided into two two main phases: (1) nucleation and (2) growth and crystallization.
The aim of this work is to analyze possible nucleation and growth paths of particles in carbon plasma. The consideration of nucleation type is based on the following equation:

$$\Delta G = -\frac{4\pi r^3}{3V} kT \ln S + 4\pi r^2 \gamma,$$

where ΔG is Gibbs free energy, r nucleus size, V volume occupied by the single atom or molecule in nucleus, T is temperature, S supersaturation ratio and γ surface tension [2].
Further modifications to the above equation are made to account for ion nucleation. It has been found that in the case of carbon plasma the purely thermodynamic approach of continuous media is insufficient. It is necessary to include in the considerations various kinds of carbon macromolecules.
Moreover, the discussion of the conditions for the formation of particles solely from the expanding plasma and the avoidance of their ejection from the target is presented.

Keywords: nanoparticles, carbon dots, laser ablation, nucleation, ion-induced nucleation.

References:

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