

SURFACES, INTERFACES AND COATINGS TECHNOLOGIES

PLASMA PROCESSING AND TECHNOLOGY



TRIBOLOGY INTERNATIONAL CONFERENCE



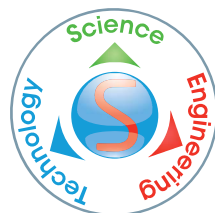
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HYBRID JOINT CONFERENCES

27-29 Avril, 2022 - Barcelona, Spain

Book of Abstracts

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**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. Czerwicz, 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

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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.

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