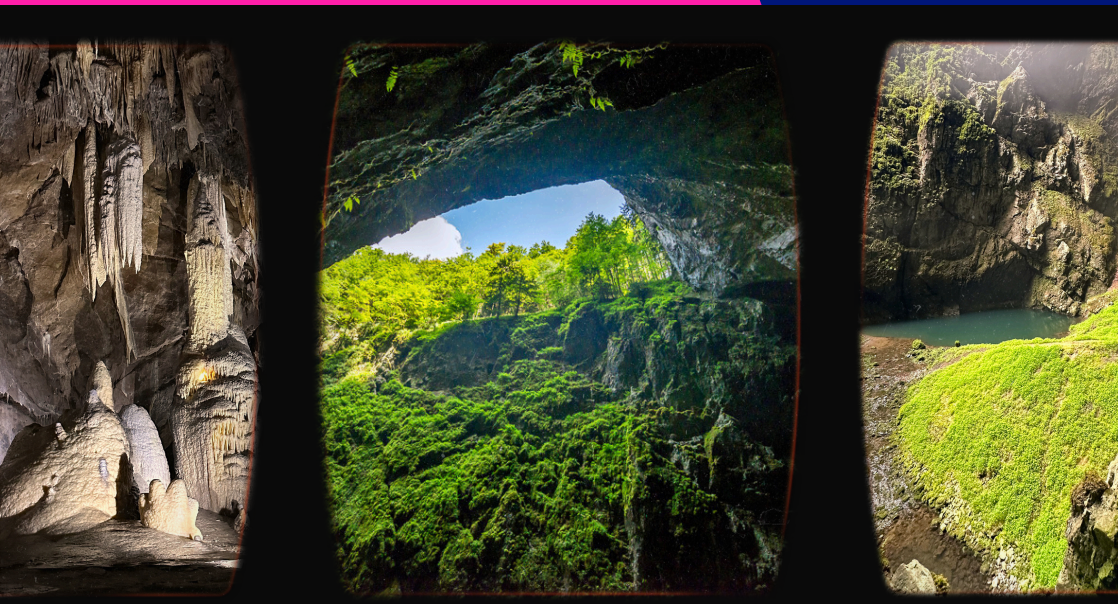
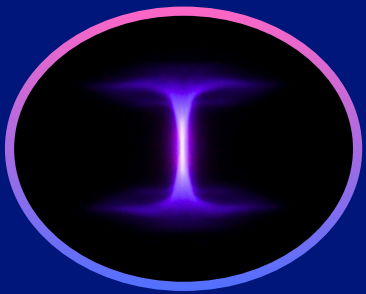
The 4th Plasma Nanotechnologies and Bioapplications Workshop

SCIENTIFIC PROGRAM & BOOK OF ABSTRACTS



Hotel OREA Resort Panorama
Češkovice
Czech Republic

OCTOBER 20-23, 2025



The 4th Plasma Nanotechnologies and Bioapplications Workshop

SCIENTIFIC PROGRAM
&
BOOK OF ABSTRACTS

October 20–23, 2025

Češkovice, Czech Republic

MUNI

Masaryk University Press

Brno 2025

The 4th Plasma Nanotechnologies and Bioapplications Workshop
Book of Abstracts
2025

Edited by

Slavomír Sihelník, Petra Šrámková, Dana Skácelová, Dušan Kováčik

Published by

1st edition, 2025
ISBN: 978-80-280-0780-5
ISBN: 978-80-280-0781-2 (online; pdf)

Supported by

The project CEPLANT – R&D centre for plasma and nanotechnology surface modifications (LM2023039) funded by the Ministry of Education, Youth and Sports of the Czech Republic.

Atmospheric pressure plasma for surface functionalization and biofilm removal on polymeric tubing

Oleksandr GALMIZ[1,2], Bernard G. KIMANI[1], Zdenko MACHALA[1]

[1]Division of Environmental Physics, Faculty of Mathematics, Physics and Informatics, Comenius University in Bratislava, Mlynská dolina, 842 48 Bratislava, Slovak Republic

[2]Department of Plasma Physics and Technology, CEPLANT – R&D Centre for Plasma and Nanotechnology Surface Modifications, Faculty of Science, Masaryk University, Kotlářská 2, 602 00 Brno, Czech Republic

e-mail: oleksandr.galmiz@uniba.sk

Abstract

Plasma treatment has become an important technique for modifying polymer surfaces, allowing tailored properties for biomedical and industrial applications. Depending on the intended outcome, plasma can enhance bio-compatibility (e.g., implants, contact lenses) or induce bio-incompatibility (e.g., antibacterial surfaces, biocidal coatings). Compared to conventional wet chemical functionalization, liquid plasma-assisted processes offer a time-efficient and environmentally friendly alternative by combining surface activation, cleaning, and antimicrobial action in a single step.

The technique aimed to achieve uniform atmospheric pressure plasma treatment of inner and/or outer surfaces of polymeric tubes and other hollow bodies was developed by combining basic features of the Surface Dielectric Barrier Discharge (SDBD) and the plasmas in contact with liquids. This plasma discharge configuration was primarily developed for the surface treatment of polymer materials [1-3]. The SDBD discharge was operated at atmospheric pressure with a 10-20 kV, ≈31 kHz sinusoidal high-voltage waveform. This design also allows for direct treatment of surfaces in contact with liquids, enabling the efficient transfer of short-lived reactive oxygen and nitrogen species into the aqueous environment.

Polymeric tubing made of PTFE and PVC was selected as the model materials. Surface modifications were evaluated using complementary techniques, including water contact angle measurements, scanning electron microscopy, confocal laser microscopy, and X-ray photoelectron spectroscopy. These analyses confirmed changes

in surface morphology and chemistry, indicating effective plasma-induced activation and functionalization.

Antimicrobial efficacy was investigated through two complementary approaches. First, contaminated liquids containing planktonic *E. coli* CCM 3954 were directly exposed to plasma by employing the bacterial suspension as one of the liquid electrodes. Second, 48-hour *E. coli* biofilms pre-formed on the inner tube surfaces were treated by moving a plasma ring along the tube length. Quantification of bacterial inactivation was performed using plate counting and flow cytometry assays. Both approaches confirmed substantial antimicrobial activity, with biofilm reduction strongly influenced by power input, treatment time, and plasma ring velocity.

Altogether, these findings demonstrate the multifunctional capacity of water-based SDBD plasma to activate polymer surfaces and inactivate biofilms inside tubing. By optimizing discharge parameters and treatment protocols, the technique can be adapted for a broad range of applications, paving the way toward safer and more functional polymer-based medical devices and industrial tubing systems.

This research has been funded by the EU NextGenerationEU through the Recovery and Resilience Plan for Slovakia under the project No. 09I03-03-V04-00094 and by the project LM2023039 funded by the Ministry of Education, Youth and Sports of the Czech Republic.

Keywords:
surface dielectric barrier discharge, liquid electrodes, bacteria, biofilm

References

[1] GALMIZ Oleksandr, ZEMÁNEK Miroslav, PAVLIŇÁK David and ČERNÁK Mirko. *J. Phys. D. Appl. Phys*., 2018. Vol. 51, p. 195201.

[2] GALMIZ Oleksandr, PAVLIŇÁK David, ZEMÁNEK Miroslav, BRABLEC Antonin and ČERNÁK Mirko. *Plasma Process. Polym*., 2017. Vol. 14, p. 1600220.

[3] PAVLIŇÁK David, GALMIZ Oleksandr, ZEMÁNEK Miroslav and ČERNÁK Mirko. *Plasma Process. Polym*., 2018. Vol. 15, no 7, p. 1–12.