

**1st World Congress on Electroporation and Pulsed Electric Fields in Biology,
Medicine and Food & Environmental Technologies**

incorporating

BFE2015 - The 3rd International Bio & Food Electrotechnologies Symposium

and

Bioelectrics 2015 - The 12th International Bioelectrics Symposium

Portorož, Slovenija
September 6 to 10, 2015



University of Ljubljana
Faculty of Electrical Engineering



Organised by: COST TD1104 Action
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Organised by Network "Plasma for Food"

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in the field of dermatology, wound healing, veterinary medicine and dentistry. The investigation of selected biological effects will be shown. It will be demonstrated that the combined research in physics and life sciences is fundamental for a successful transfer of plasma medicine from laboratory to clinics.

Mon-D2-O5

Antibacterial Efficacy of a Novel Plasma Reactor without an Applied Gas Flow

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The use of nonthermal plasma in the clinic has gained recent interest, as the need for alternative or supplementary strategies are necessary for preventing multi-drug resistant infections. The purpose of this study was to evaluate the antibacterial efficacy of a novel plasma reactor based on a high current version of sliding discharge and operated by nanosecond voltage pulses without an applied gas flow. This modification is advantageous for both portability and convenience. Bacterial inactivation was determined by direct quantification of colony forming units. The plasma was bactericidal against *Escherichia coli* and *Staphylococcus epidermidis* seeded on culture media. Plasma exposure significantly inhibited the growth of both model organisms following a 1-minute application ($p < 0.001$). Results indicate that *S. epidermidis* was more susceptible to the plasma after a 5-minute exposure, compared to *E. coli*. Temperature measurements taken immediately before and after plasma exposure determined that heat does not play a role in bacterial inactivation. These findings suggest the current plasma has potential application for surface bacterial decontamination.

direct on agar
much > when mediated by the nebulizer

Mon-D2-O6

Chemistry of Plasma-Liquid Interactions Related with Biocidal Effects of Non-Thermal Plasmas in Gas-Liquid Environments

Petr Lukes¹, Eva Dolezalova¹, Martin Clupek¹

¹Institute of Plasma Physics AS CR, Czech Republic

Different types of non-equilibrium atmospheric pressure plasmas (NTAPs) generated by electrical discharges in gases and liquids have been applied for biological and medical applications. NTAPs have been shown to be effective in inactivation of wide range of microbes, and have been also applied directly to the human body for the treatment of skin diseases and dental cavities, and other applications. Depending on the type of discharge, its energy, and the chemical composition of the surrounding environment various physical and chemical processes may be involved in the biological effects induced by NTAPs. These include thermal, electric field, ultraviolet radiation, shock waves, direct chemical reactions of neutral reactive species, and interactions of charged particles with living matter. Among these processes, the oxidative properties of reactive oxygen species (OH radical, atomic oxygen, ozone, hydrogen peroxide) and nitrogen species (nitric oxide, nitrogen dioxide radical) are generally accepted to play central role in the inactivation processes of NTAPs produced in gas-liquid environments - typically discharges produced in humid air touching a wet surface (biofilms, cell tissue, skin) or an aqueous liquid. There are also possible synergistic effects of the above mentioned processes and secondary chemical and biological effects can be induced in the plasma-treated liquid through the post-discharge reactions of chemical species produced by plasma in the liquid either directly, or transferred from the gas phase discharge plasma via gas-liquid interface (e.g., H₂O₂, ozone, nitrite, peroxyxynitrite). Important roles of these species in biological effects are acknowledged, however, the mechanisms and con-

tributions of these species are not fully understood because the complexity of both the plasma and biological systems. In this talk fundamental issues related with the chemistry of plasma liquid interactions will be discussed with special attention to the peroxyxynitrite chemistry in plasma treated liquids and its role in biocidal effects of air discharge plasmas.

Mon-D2-O7

Chemistry and biodecontamination induced in water electrosprayed through air plasma discharge

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¹Comenius University, Slovakia

Decontamination of water polluted with organic and microbial pollutants, and biomedical effects on cells and biomolecules mediated through aqueous solutions can be efficiently achieved by using various non-thermal (cold) plasma discharges. These effects can be further enhanced when air discharges are combined with water electrospray. The presence of the electrical discharge in the spraying area allows for very efficient mass transfer of plasma-generated species into the water.

We investigated the effect of the electrospraying of water combination with positive DC corona and transient spark discharges. Our key finding is that the discharge has a significant effect on the electrospray behavior and vice versa. Such water electrospray-air discharge systems were demonstrated to be efficient in inducing bactericidal, sporicidal, and various chemical effects in the plasma activated water, especially acidification, formation of hydrogen peroxide and nitrites that subsequently lead to cytotoxic peroxyxynitrites. [1-5]

This work was supported by Slovak Research and Development Agency APVV-0134-12 and COST Action TD1208 - Electrical Discharges with Liquids for Future Applications.

References [1] Z. Machala *et al.*, Plasma Process. Polym. (649) (2013) [2] Z. Kovalova *et al.*, Eur. Phys. J. Appl. Phys. (24306) (2013) [3] K. Hensel *et al.*, Biointerphases 10 (02) (2015) [4] B. Pongrac *et al.*, J. Phys. D: Appl. Phys. 43 (31) (2014) [5] B. Pongrac *et al.*, Eur. Phys. J. D 68 (224) (2015)

Mon-D2-O8

Use of High Voltage Atmospheric Cold Plasma for Food Preservation and Food Processing

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²Dublin Institute of Technology, Ireland

³University of New South Wales, Australia

It is estimated between 30-40% of all harvested food from spoilage in developing countries due to a lack of preservation methods such as canning, freezing, and refrigeration. The current use of synthetic chemicals to reduce or prevent post-harvest food losses is diminishing because of possible carcinogenic and teratogenic effects, high residual toxicity, potential environmental pollution, and concerns regarding their health effects on consumers. A potential alternative technology for reducing food spoilage is high voltage atmospheric cold plasma (HVACP). The HVACP technology was developed by Dr. Kevin Keener at Purdue University and allows one to significantly reduce food spoilage in some instances, sterilize food products. The HVACP is a non-thermal cold plasma that utilizes low frequency (50 kHz) and high voltage (30 - 130 kV). The HVACP technology can be applied to packaged food products (plastic bags, paper, rigid plastic containers) and potentially bulk agricultural products stored in crates, shipping containers, and bins. The technology only requires air within the packaged food

food loss: max 15% fruit & veg.
30% cereals, dairy
plasma biofilm - 300 in package