Plasma for Bio-Decontamination, Medicine and Food Security

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Plasma for Bio-Decontamination, Medicine and Food Security

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Preface

Plasmas, especially non-thermal plasmas maintained close to room temperature at normal atmospheric pressure, have recently found many breakthrough applications in biology, medicine, and security. Plasmas can efficiently kill bacteria, yeasts and molds and other hazardous microorganisms, including potential bio-terrorism agents, even spores and biofilms that are generally very difficult to inactivate by traditional methods, which are in addition non-friendly for the environment. Cold plasmas generated by electrical discharges can be employed for bio-decontamination and sterilization of surfaces, medical instruments, water, air, food, even of living tissues without causing their damage and other side effects, and represents a great potential in medicine and defense against terrorism. The sterilizing effect of plasma treatment can be attributed to several active agents, including the UV radiation, electric field, charged particles, generated radicals and reactive species, providing in total synergic mechanisms of bio-inactivation.

Direct or indirect plasma interaction with living cells of microorganisms or even humans is a new quickly developing field issuing in many bio-medical *in vivo* applications, e.g. for the treatment of skin diseases and foot ulcer. Cold plasma can also stop bleeding, making it effective in some surgical procedures and in treating intestinal ulcers and persistent nosebleeds. Enhanced blood coagulation by plasma in conjunction with its excellent aseptic properties, as well as proved success in wound healing, open up new possibilities in military and defense applications. Plasma treatment also allows cell manipulations, their removal and targeted transfer into the injured area, which could also be used to accelerate wound healing. Plasma induced apoptosis (programmed cell death) of melanoma or other tumor cells *in vivo* and *in vitro* is being successfully tested, which brings forth a great potential for cancer treatment. Besides, plasma enables painless treatment of dental caries or root canal disinfection and other dental applications.

However, plasma induced biomedical processes are still mostly regarded as an efficient "black box." Deeper understanding in elementary mechanisms of plasma-cell interaction, synergies of different mechanisms, as well as knowledge on the microorganism resistance to plasma active agents due to the cell reparation, is necessary to develop in order to efficiently apply plasma in biomedicine. There is no

doubt that multidisciplinary approach of plasma physicists, microbiologists, medical doctors and engineers is required in this area.

NATO Advanced Research Workshop (ARW) **Plasma for bio-decontamination, medicine and food security** held in beautiful Jasná mountain resort in Demänovská dolina, Slovakia, on 15–18 March 2011 became a perfect place for such scientific and social gathering. The workshop addressed various social, scientific and technical aspects of such complex and challenging problem as plasma in biomedicine and other fields of human activity. It hosted 52 participants from 16 countries, including the world-wide key players in the area of plasma decontamination and medicine.

The scientific program of NATO ARW comprised 9 key lectures, 26 oral presentations, 19 posters, and panel discussion, divided into several topical blocks: Biodecontamination, Biofilms, Food security and decontamination, Plasma interactions with cells and DNA, Wound healing and medical applications, Electric fields and plasma sources, UV irradiation and excilamps.

The workshop was very successful, inspiring and stimulating for opening new horizons for science as well as for pushing the novel scientific results into revolutionary applications in environmental protection, food security and medicine, eventually resulting in everyday engineering and clinical practices. The only shadow of the event has been recently cast by the shocking news of a sudden death of one of our participants and author of one article in this book, Mykola Guivan. We are so sorry to have lost an expert, a colleague, and a friend.

This book is a compilation of selected reviewed manuscripts issuing from the presentations at the NATO ARW Plasma for bio-decontamination, medicine and food security. All contributions passed through a tough peer-review process. The text is categorized to six major topics, although many articles hit more than one topic:

1. Plasma bio-decontamination, water chemistry and effects on cells
2. Plasma biofilm inactivation and dentistry applications
3. Plasma-based UV sterilization
4. Plasma tissue treatment and wound healing
5. Plasma and electric fields in medicine
6. Plasma for food security

This volume, in addition to well-known textbooks such as *Plasma Chemistry* (Fridman, Cambridge University Press, 2008) or the preceding NATO book *Plasma Assisted Decontamination of Biological and Chemical Agents* (Güçeri and Fridman, Springer, 2008) has own value because it provides a complimentary and comprehensive overview of current research activities in bio-decontamination, medicine and food security assisted by plasma.

At the final panel discussion, the workshop participants concluded that plasma physicists, chemists, biologists, medical doctors and engineers have to learn each others' languages to foster their tight co-operation and offer their achievements to the industry and higher authorities. Only combination of deep fundamental researches in plasmas and microbiology with clinical tests can lead to success. An emphasis

must be given to the implementation of plasma applications in food technology and clinical practices. In a spirit of the workshop and in the terminology of microbiologists we wrapped up: regardless to our different backgrounds we should act like different members of the "biofilm" (a very resistant microbial structure where various microorganisms mutually help each other to survive and to develop).

Last but not least, the editors would like to appreciate the contributing scientists, researchers and students who traveled to Slovakia from around the world and made this workshop scientifically solid and socially warm. We would also like to recognize our colleagues and students from the Faculty of Mathematics, Physics and Informatics, Comenius University in Bratislava who contributed to the smooth organization of the event and provided the technical and IT support, especially Mário Janda. Our sincere gratitude goes to all peer reviewers of the manuscripts submitted for this volume who spent a tremendous amount of their time and efforts to ensure the highest possible quality of the contributions, namely:

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Bratislava, Slovakia

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