

81th IUVSTA Workshop on Response of Biological Materials to Plasma Treated Medium

12th to 16th March 2017, Rogla, Slovenia

Workshop scope:

The recently invented technique for treatment of biological materials with gaseous plasma treated medium has a great potential in future applications in agriculture and medicine. Plasma creates a variety of reactive species in liquid media that interact with organic materials. The interactions lead to destruction of organic molecules in the media, disinfection or even sterilization of materials as well as apoptosis or even necrosis of the biological cells. The application is foreseen for ecologically benign treatment of fruit and vegetables prior to packaging, plants and seeds for faster growing and germination as well as curing cancer diseases, especially gastroenterological and skin cancers. Many groups worldwide have shown beneficial results; however, there are also reports on marginal improvements or even noxious or otherwise harmful results. A key open issue is selectivity of interaction between plasma treated medium and biological materials. Decontamination or disinfection will be useful only if the treatment of biological materials with plasma-treated medium is harmless to the biological cells. Cancer curing will be applicable only if normal cells are unaffected by the treatment. Mild treatment even facilitates multiplication of cells and thus growing of tumors. The goal of the workshop was therefore a discussion about the critical parameters that allow for beneficial results but prevent unwanted effects. A frank estimation on applicability of such treatments was a key result of the workshop. Distinguished scientists from world leading groups in this multidisciplinary field were invited to attend the workshop.

Venue and program:

The workshop was organized in Hotel Natura in a small village Rogla in Slovenian hills. The workshop participants gathered on Sunday, 12th March. They were welcomed upon arrival to the Hotel and spent the afternoon in the fireplace lobby allowing discussions in small groups. The formal program started with registration and welcome reception. During next 4 days (Monday till Thursday) half-day oral presentations and guided topical discussions were organized. The guided discussions were organized in round tables with the following topics:

- Cancer treatment by plasma activated liquids;
- Modification of seeds, cloves, bulbs for better germination;
- Nitrogen fixation by plasma treatment of liquids as an alternative to chemical fertilizers;
- Plasma technologies for cardiovascular implants.

Oral presentations included a keynote lecture each day, invited lectures and standard talks. The keynote speakers were selected from the leading groups in this scientific field. The keynote speakers came from different continents and presented different aspects of plasma-treated media for biomedical applications:

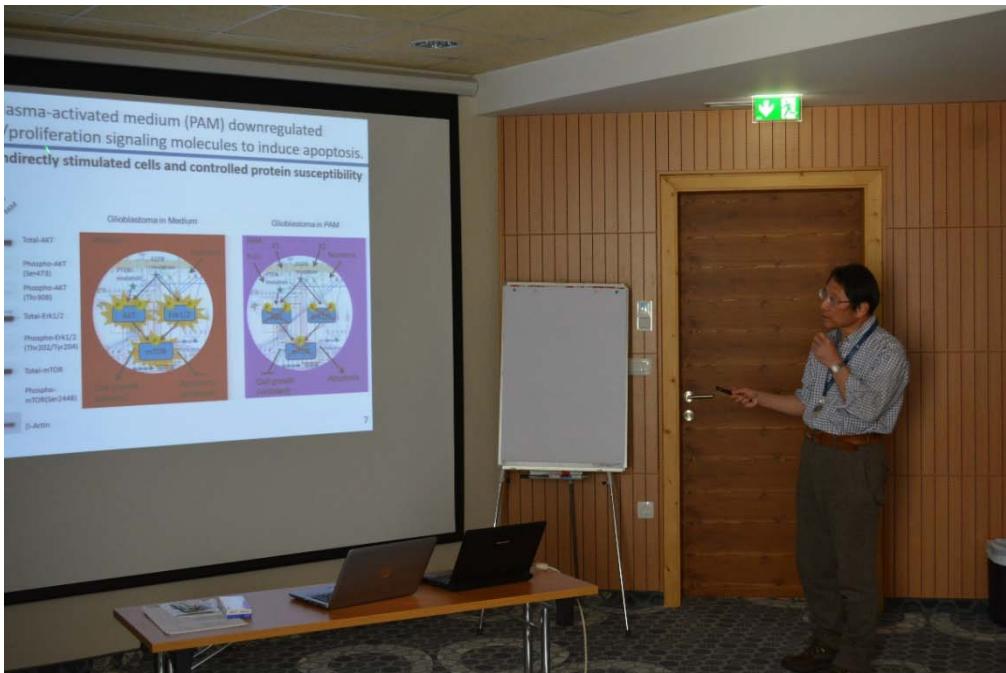
- Prof. Masaru Hori, Nagoya University, Japan, Diagnostics and control of interaction of plasma with culture medium toward a future medical treatment;
- Prof. David Ruzic, University of Illinois, USA, Effect of microwave-plasma activated medium on commercial corn and soybean germination;

- Prof. Deborah O'Connell, York University, UK, Plasma-liquid interactions: the origin of species and influence of organic molecules;
- Prof. Anton Stampfl, ANSTO, Sydney, Australia, Creating living nano-bio hybrids via synchrotron white- beam radiolysis.

The invited speakers were selected from renowned researchers in the field of interaction between gaseous plasma and biological or biomedical materials and came from 10 countries: Timo Gans (UK), Vojko Flis (Slovenia), Makoto Sekine (Japan), Janez Kovač (Slovenia), Eva Kovačević (France), Jaeho Kim (Japan), Boban Mugoša (Montenegro), Slobodan Milošević (Croatia), Petr Špatenka (Czech Republic), Tomislava Vukušić (Croatia), Kinga Kutasi (Hungary), Holger Kersten (Germany), James Walsh (UK), Martina Modic (Slovenia), Zoran Petrović (Serbia), Thomas Elschner (Germany), Zoran Vratnica (Montenegro).

Recent progress in understanding interaction between gaseous plasma and liquid media was presented and discussed thoroughly. Early works focused on detection of rather stable and simple compounds in liquids. Novel reports stress the importance of complex compounds as well as short-living radicals that might represent major reactants in many future applications of plasma-treated media. Recently, attempts have been reported on determination of the origin of reactive species in liquids: some are formed in glowing plasma itself, others predominantly in the plasma-liquid intermediate space, whereas many species are also formed by chemical reactions inside the liquids. Detailed picture is still far from being well-known due to the lack of suitable experimental techniques and short life-time of some species. A breakthrough has been achieved in understanding interaction between liquid media and biological cells by developing methods for plasma treatment of media containing limited amounts of nutrients. The standard culture medium is too complex to allow for plasma modification in a highly controlled and repeatable manner, thus simpler media have been used to prepare liquids suitable for selective destruction of cancer tissue. The exact composition of such plasma treated medium is still unknown because of partial destruction of the organic compounds, however the effectiveness has been already proved at experiments with model animals.

The correlations between different applications of plasma-treated liquids have been discussed. Diverse applications of such liquids are foreseen in future; like curing cancers, treatment of seeds, bulbs etc. in agronomy, purification of waste water, treatment of hydroponic plants, final treatment of fresh vegetable/fruit prior to packaging. Despite the diversity, there are many common scientific challenges. In most cases there are organic compounds in the water and they are affected either by direct plasma treatment or, most commonly, by chemically reactive species produced upon plasma treatment of the liquid media. The interaction between highly reactive inorganic species and organic molecules then leads to destruction of viruses, inactivation of bacteria, spores and fungi, destruction of unwanted contaminants like pesticides, organic pigments etc., and triggering apoptosis of cancer cells. The key challenge for future scientific work in this niche is understanding the basics of formation of novel compounds in plasma treated liquid media. The next challenge is synthesis of inorganic reactive compounds in selective, controlled and repeatable manner. Finally, the exact interaction mechanisms with organic compounds will have to be understood. Any toxicity of newly formed molecules will have to be elaborated before broad application of plasma treated media, especially in medicine and food industry.



The first keynote speaker, Prof. Masaru Hori from Nagoya University, Japan, presented recent results on cancer treatment by different plasma-treated media.



A keynote speaker, Prof. Deborah O'Connell presented recent progress in understanding interaction between plasma-created species and organic molecules in liquids.



A keynote speaker was also IUVSTA Scientific director, Prof. David Ruzic, who spoke about applications in agronomy.



Prof. Anton Stampfl served as a keynote speaker presenting living bio-nano hybrids.



The talk on effects of plasma-activated medium on model biological cell walls given by the invited speaker Prof. Makoto Sekine caused sprightly discussion.



Prof. Slobodan Milosevic presented challenges in application of plasma-treated liquids in modern agronomy.



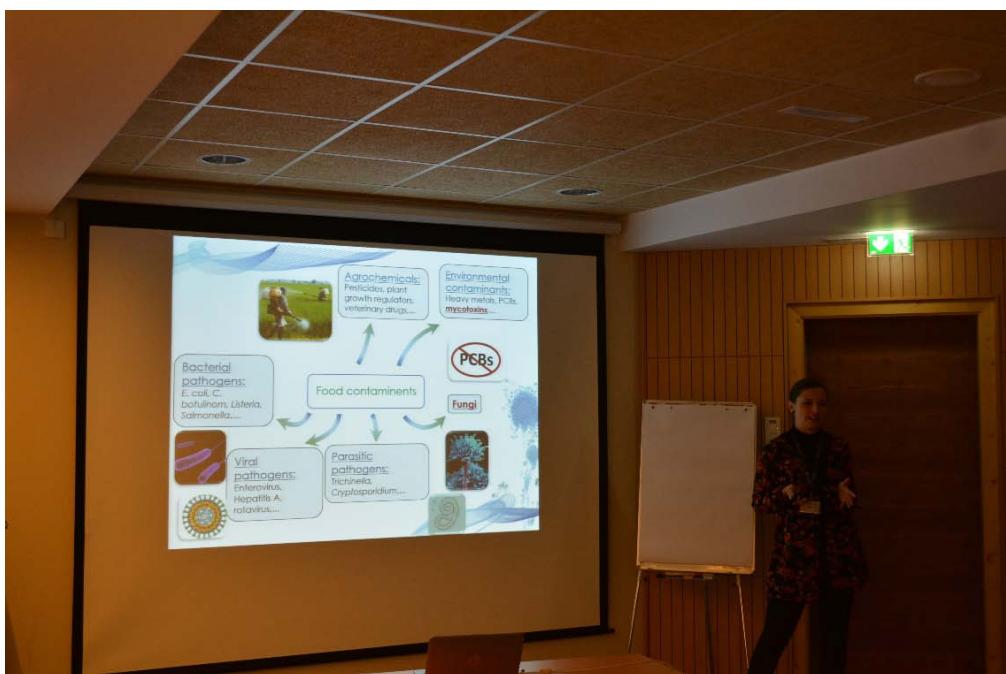
Prof. Petr Špatenka discussed results on field experiments with plasma-treated barley.



Lively discussion after presentation given by Prof. Holger Kersten.



The talk by Prof. James Welsh on plasma treatment of fruit on industrial scale attracted attention of prof. Hori.



A PhD student Nataša Hojnik presented application of plasma-treated medium for decontamination.



The Springer award for the best student presentation was given to SreeragGopi for his presentation on innovative method for water purification.



Tomislava Vukušić received the award for best presentation of a young researcher for her talk on plasma treatment of fruit juices.

The workshop was organized by members of Slovenian vacuum society. The financial support by International Union for Vacuum Science, Technique and Applications (IUVSTA) is gratefully acknowledged. Detailed program is at the workshop webpage <http://www.plasmadis.com/wp/iuvsta-workshop/program/>.

Income:

Registration fee invited speakers 17 x 600 =	10.200
IUVSTA grant	6.000
Registration fee others 21 x 700 =	14.700
Total	30.900

Costs:

Hotel bill (including accommodation, meals, room)	28553,74
Social events (additionally to hotel bill)	1292,50
Organization costs	1053,76
Total	30.900,00

The IUVSTA grant of 6000 Euro was spent for:

Lecture room	2,000.00
Subsidizing invited speakers	1,700.00
Free for 5 students/volunteers	2,300.00