SYMP 1: Plasma in Biology and Medicine (SYMP)

Time: Wednesday 14:00–18:30 Location: A 001

Invited Talk SYMP 1.1 We 14:00 A 001

Cold atmospheric argon plasma significantly decreases bacterial load of chronic wounds in patients — •Georg Isbary[1], Wilhelm Stolz[1], Hans-Ulrich Schmidt[2], Tetsuji Shimizu[3], Bernd Steffes[3], Julia Zimmermann[3], Tetyana Nosenko[3], Wolfram Bunk[3], Roberto Monetti[3], and Gregor Morfill[3] — [1]Department of Dermatology, Allergology and Environmental Medicine, Hospital Munich-Schwabing, Germany — [2]Department of Microbiology, Hospital Munich-Schwabing, Germany — [3]Max Planck Institute for Extraterrestrial Physics, Garching, Germany

We are testing a new method of chronic wound treatment using a low-temperature argon plasma. The results of the clinical phase II of this study show a significant increase in the rate of germ reduction in plasma-treated wounds in comparison with wounds that received only standard wound care. This effect is found in all kinds of germs, regardless the resistance level. The observed bactericidal effect of plasma therapy relies on the synergy of UVR, charged particles, electric fields, ROS and RNS. The combination of these biologically active components makes plasma a promising tool for fighting multiresistant germs. The advantage of this indirect plasma device is that it can be designed and optimized for different purposes, such as germ specific biofilms or varying wound fluid compositions. Furthermore there is evidence that plasma can enhance wound healing itself.

Invited Talk SYMP 1.2 We 14:30 A 001

Cold atmospheric plasma jet for potential dentistry use — •Axel Schindler[1], Antje Lehmann[1], Stefan Rupf[2], and Matthias Hannig[2] — [1]Leibniz-Institut für Oberflächenmodifizierung e.V., Permoserstr. 15, 04318 Leipzig, Germany — [2]Universitätsklinikum des Saarlandes, Klinik für Zahnerhaltung, Parodontologie und Präventive Zahnheilkunde, 66421 Homburg/Saar, Germany

During the last decade non-thermal plasma jets have been emerged as a versatile technology for surface processing like local etching, deposition, surface cleaning and surface activation and are going to step into medicine. We have developed a miniature cold 2,45 GHz microwave driven atmospheric plasma jet. Within the frame of a R&D project, we investigate the feasibility of its future medical and dentistry applications. Besides the main characteristics of the jet source results on dentistry applications will be presented. Plasma-jet treatment reduced microbes on dentin by 3*4 log10 intervals. In situ formed oral biofilms were modified or removed from enamel and titanium surfaces. The plasma jet was found to be able to modify carious dentin. In vitro studies have been performed to modify dentin and enamel surfaces in order to improve the bonding of dental filling composite materials. In an animal experiment thermal side effects to dental pulp as well as oral mucosa were studied. Our results support future application of non-thermal atmospheric plasma jets in dentistry.

Invited Talk SYMP 1.3 We 15:00 A 001

Risk Assessment of the Application of a Plasma-Jet in Dermatology — •Jürgen Lademann[1], Heike Richter[1], Alexa Patzelt[1], Axel Kramer[2], Peter Hinz[3], Klaus-Dieter Weltmann[4], Bernd Hartmann[5], Nils-Olaf Hübner[2], and Olaf Lademann[2] — [1]Universitätsmedizin, Charité, Berlin, Department of Dermatology and Allergology, Center of Experimental and Cutaneous Physiology (CCP), Berlin, Germany — [2]Institute of Hygiene and Environmental Medicine, Greifswald, Germany — [3]Department of Emergency Surgery, Greifswald, Germany — [4]Leibniz Institute for Plasma Science and Technology e.V. (INP), Greifswald, Germany — [5]Burncenter, UKB Traumacenter, Berlin, Germany

Recently, it was reported that "cold" plasma can be applied on living tissue. In in vitro studies on cell culture it could be demonstrated that this new plasma possesses excellent antiseptic properties. In the present study, a risk assessment was performed, concerning the in vivo application of a "cold"-plasma-jet on patients and volunteers. Two potential risk factors, UV-radiation and temperature, were evaluated. It could be shown that the UV-radiation of the plasma in the used system was an order of magnitude lower than the minimal erythema dose, necessary to produce sunburn on the skin in vivo. Additionally thermal damage of the tissue by the plasma can be excluded. The results of the risk assessment in the present study stimulate the in vivo application of the investigated plasma-jet in the treatment of chronic wounds.

Invited Talk SYMP 1.4 We 15:30 A 001

Plasmachemical Processes for Bioactive Titanium Implant Surfaces — •Karsten Schröder[1], Martin Polak[1], Birgit Finke[1], Andreas Ohl[1], Ina Koban[2], Thomas Kocher[2], Barbara Nebe[3], Rainer Bader[4], Gerold Lukowski[5], Michael Schlosser[6], and Klaus-Dieter Weltmann[1] — [1]INP Greifswald — [2]Universität Greifswald, ZZMK — [3]Universität Rostock, Biomed. FZ — [4]Universität Rostock, Orthopädie — [5]IMAB Greifswald — [6]Universität Greifswald, Med. Biochem.

Next generations of hip and knee joint endoprosthesis and dental implants will require a combination of antimicrobial and cell-adhesive properties. Plasmachemical processes have the unique potential to fulfil these contradictory requirements by suitable combinations of multistep processes.

Physicochemical surface analyses like XPS, FTIR, contact angle, SEM, and AFM played an important role during process developments to improve understanding of the complex biointerphase. Very thin surface modification procedures are required to prevent changes in morphology of implants unalterable for healing.

An overview about the results of different plasma processes and their application in plasmamedicine will be presented.

The treatment of implants is a strong interdisciplinary field of research with growing interest regarding its applications.

30 min. break.

Invited Talk SYMP 1.5 We 16:30 A 001

Pulsed electric field degrades melanoma cells — •Uwe Pliquett[1] and Richard Nuchitelli[2] — [1]Institut für Bioprozess- und Analysenmesstechnik e.V., Heilbad Heiligenstadt, Germany — [2]BioElectroMed Corp., 849 Mitten Rd., Suite 105, Burlingame, CA 94010, USA

Nanosecond pulsed electric fields (nsPEF) trigger apoptosis in skin tumors. The mechanism involves the physical formation of nanopores in the lipid membranes of organelles and does not involve hyperthermia. Both theoretical calculation and actual temperature measurement with miniature thermocouples confirms that nsPEF induces a temperature rise of only a few degrees K during treatment. The most obvious morphological changes following nsPEF application are the pyknosis of the nucleus and the breakdown of blood capillaries that begins within minutes after treatment. Fluorescent labelling with the reactive oxygen species (ROS) indicator, carboxy-H2DCFDA, indicated ROS appeared near the plasma membrane within minutes after nsPEF application. ROS enforce the actin polymerization in an uncontrolled manner. We suggest that membrane degradation may result in part from the dynamic instability of actin filaments.

Invited Talk SYMP 1.6 We 17:00 A 001

Pulsed electric field application as a cell disintegration and decontamination technique for food-, bio- and environmental engineering — •Volker Heinz and Stefan Toepfl — German Institute of Food Technologies (DIL) e.V., Quakenbrueck, Germany

Pulsed electric field application induces permeabilization of biological membranes. This effect can be used for various applications in food and bio-processing such as improvement of mass transport or microbial inactivation. Since 2009 industrial systems are commercially available, first commercial applications have been achieved for preservation of heat sensitive liquid foodstuff. Cell disruption often is a prerequisite, e.g. for winning of intracellular substances, after treatment of plant material a release of cytoplasmic content is observed. An application to fermentation substrate allows a better access of enzymes and a reduction of reaction time during biogas production. A treatment of micro- and macroalgae results in increased extraction yield and facilitated pressing. Besides food preservation the technique is applicable for decontamination of other liquids. An application to liquid feed or nutrient media revealed the potential for a microbial inactivation while maintaining valuable constituents. The technique provides significant operational benefits in comparison to a conventional heat treatment, as heat exchangers often are limited due to biofouling of proteins and

short cleaning intervals. The techniques applicability and technical requirements will be presented along with a discussion of commercial experiences.

Invited Talk SYMP 1.7 We 17:30 A 001

Effects of Microsecond- and Nanosecond-Pulsed-Electric-Fields on Plant Cells — •Thomas Berghöfer[1], Bianca Flickinger[1], Christian Eing[1], Martin Sack[1], Petra Hohenberger[2], Peter Nick[2], Michael Pacher[3], Holger Puchta[3], and Wolfgang Frey[1] — [1]Institute for Pulsed Power and Microwave Technology, Karlsruhe Institute of Technology, 76344 Eggenstein-Leopoldshafen — [2]Botanical Institute I, Karlsruhe Institute of Technology, 76131 Karlsruhe — [3]Botanical Institute II, Karlsruhe Institute of Technology, 76131 Karlsruhe

Cellular responses on pulsed electric field exposure roughly can be divided into two groups. For pulse durations in the microsecond range and rise-times in the order of several 100 ns, predominantly the plasma membrane is targeted. It is commonly accepted, that due to an increase of transmembrane voltage hydrophilic pores are created which allow an exchange of liquids and ions through the membrane and simultaneously affect the charging process of the membrane. At the IHM this effect predominantly is applied for the extraction of cellular ingredients, e.g. from wine grapes or sugar beets, and the conditioning of green biomass. For a second type of field induced cell response, the pulses have to exhibit a rise time considerably shorter than the charging time of the plasma membrane. In this case the electric field penetrates into the cell interior and affects intracellular components. Recent experiments have shown that structures of the cytoskeleton of plant cells are affected by 10 ns pulses of 30 kV/cm and that the growth behaviour of plants and fungi can be influenced by nanosecond pulse treatment.

Invited Talk SYMP 1.8 We 18:00 A 001

Electrochemotherapy - An efficient electroporation based tumor treatment — •Damijan Miklavcic — University of Ljubljana

When cells are exposed to a sufficient high electric field, permeability of their plasma membrane is increased. This allows molecules, that otherwise can not penetrate through the membrane, to enter the cell. One of the most advanced applications taking the advantage of this phenomenon is electrochemotherapy. Electrochemotherapy is currently used in daily clinical practise for treatment of superficial tumor nodules. Electrochemotherapy as a local treatment combining cancer dugs such as bleomycin or cisplatinum with short high voltage electric pulses results in approximately 80% complete responses irrespective of histological origin of the tumor.