Plasma medicine

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Résumé

General principles of direct applications of non-thermal plasmas for medicine are discussed in the presentation, including physical, chemical and biological mechanisms of non-thermal plasma interaction with living tissues, plasma assisted sterilization, blood coagulation, and the non-thermal plasma-assisted healing of different diseases. The presentation summarizes the latest experimental results achieved by the plasma-medical group in the A.J. Drexel Plasma Institute. Both in-vitro and in-vivo plasma-medical experiments are discussed. From the entire variety of plasma-medical applications, this presentation is focused mostly on plasma-assisted treatment of wounds (both sterilization and healing).

Physics and engineering of all major types of cold discharges used in plasma medicine is to be discussed in the presentation. The major attention will be paid to the Floating-Electrode Dielectric Barrier Discharge (FE-DBD) and to the Pin-to-Hole Discharge (PHD). The FE-DBD is the main representative of the room- temperature atmospheric-pressure direct discharges applying treated tissue as the second active electrode. Physical, chemical and medical effects of the FE-DBD discharges are significantly dependent to the duration and shape of the applied voltage pulses, which influence plasma homogeneity and composition of the biologically active plasma-generated species. PHD represents the space non-homogeneous non-equilibrium discharges able to generate in addition to reactive oxygen species (ROS) the significant amount of nitrogen oxides (especially NO, and peroxynitrite). Gas-phase biologically active plasma-generated species are analyzed and discussed for both FE-DBD and PHD discharges.

Biological and medical effects of the non-thermal plasma on different kind of bacteria, mammalian cells, and on living tissue in general is very sensitive to the liquid-phase (including gels) interface separating the tissue from the gas-phase plasma. Experimental investigations of the biologically active components generated by plasma in the interface liquids are to be discussed. Biological responses of the tissue to the biologically active components generated by plasma in the interface liquids are to be analyzed in the presentation. Especial attention will be paid to the plasma-induced toxicity, DNA damage and related issues of the dose effect, safe treatment doses, and the selectivity of plasma treatment of the living tissue.

Discussion of the plasma medical approach to the wound healing will clarify specifics of different types of wounds, specifics of the plasma-induced wound sterilization versus the plasma-induced wound healing, effect of the plasma-tissue interface, toxicity of the plasma treatment, effects of high doses and plasma-induced burns, as well as effective depth of penetration of the plasma-treatment effects.