Bioplasmas and Plasmas with Liquids

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BOOK OF ABSTRACTS

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Air transient spark discharge vs. helium plasma jet: the effects on bacteria, cells, and biomolecules

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Self-pulsing DC transient spark (TS) discharge operated in air and a pulsed DBD plasma jet (PJ) operated in helium in contact with water solutions were used for the treatment of bacteria, mammalian cells and selected biomolecules. Direct exposure to the TS was compared with indirect exposure to the TS activated gas flow and to the effect of pulsed He DBD plasma jet. The direct exposure to TS showed significant chemical effects in the treated water solutions: acidification and high concentrations of generated RONS [1-2], which were by one order of magnitude higher than concentrations of species generated by the PJ [1,3]. The TS systems also showed strong bactericidal effects, both in non-buffered (3-5 log) and buffered solutions (1-2 log), as well as cytotoxic effects on eukaryotic cancerous (HeLa) and normal (Vero) cells. The maximum cytotoxicity of 94% was found with frequency of 4 kHz and 10 min exposure time in the TS water electrospray system. Small concentrations of active species generated in water solutions by the PJ resulted in limited bactericidal activity (< 1 log reduction) and cytotoxic effects on cells (< 10%). The effect of the PJ was also smaller when compared with the indirect exposure to the TS plasma. The cell cycle analysis showed cell cycle block in G2/M stage for normal cells, and in G0/G1 for cancerous ones. The results of viability, apoptosis, and cell cycle showed that the plasma can selectively target cancerous cells, which is very important for possible future development of new plasma therapeutic strategies in biomedicine. The treatment of biomolecules demonstrated the potential of cold plasma for successful fragmentation of DNA and denaturation of protein. Our comparisons of the air TS discharge and the He PJ clearly show that the chemical, bactericidal, and cytotoxic effects are stronger in the air plasma of the TS than in the He plasma jet. In our comparison, even indirect exposures to TS air plasma activated gas flow resulted in stronger effects than direct treatment by the PJ, which indicates the dominant role of RONS as key plasma agents. These results successfully demonstrated a great potential of the air self-pulsing TS discharge as an efficient tool for biomedical applications that is applicable in most settings, perhaps except direct in vivo tissue treatment.

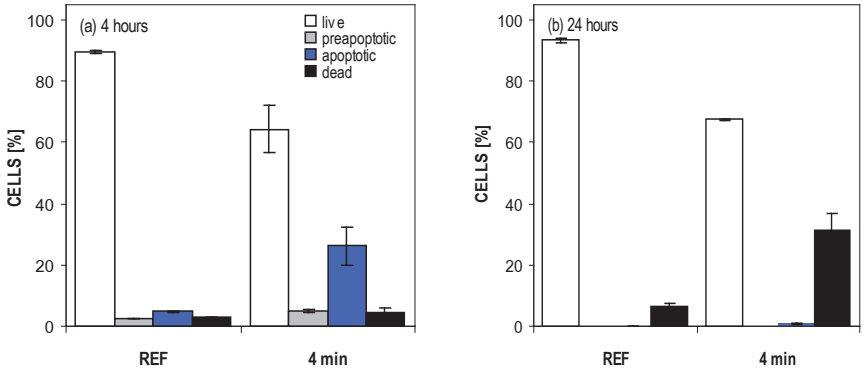

Figure 8. The percentage distribution of the live, preapoptotic, apoptotic, and dead cancerous **HeLa** cells after indirect exposure to the **TS** and 4 hours (a) and 24 hours (b) of incubation.

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