A COMPUTATIONAL STUDY OF INTERACTIONS OF MULTIPLE PLASMA FILAMENTS IN DBDs WITH HUMAN SKIN*

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The use of atmospheric pressure air plasmas in direct contact with living tissue has therapeutic effects. When dielectric barrier discharges (DBDs) are used for this purpose, the plasma device typically contains the powered electrode while the tissue is the counter electrode.[1] The beneficial medicinal effects produced by these DBDs may involve large electric fields applied to or produced in the tissue, fluxes of chemically active neutral radicals and ions, and energetic species (VUV, ions) onto the tissue. These DBDs have filamentary and somewhat random structures, and so the treatment of the tissue is, at least locally, somewhat statistical.

In this talk, the interaction of multiple and randomly generated DBD filaments in air plasmas with skin tissue will be discussed with results from a 2-d plasma hydrodynamics model. The computational domain includes both the air and the human tissue. In the gas phase, Poisson's equation, transport equations for charged and neutral species and radiation transport are addressed. In the tissue, the electric potential and charge transport are solved for. The cellular structure of the skin in the first few mm of the tissue is incorporated into the computational mesh with local permittivities and conductivities to represent the electrical properties of the intra- and inter-cell structures.

Results will be discussed for the properties of the plasma filaments and their interaction with human skin, including charging, incidence of energetic fluxes (photons, ions) and radicals. In particular, the transient production of large electric fields within the tissue will be discussed. We have found that, depending, on the dielectric properties of the cells, electric fields in excess of 100-150 kV/cm can be produced by the charging of the surface of the skin by the plasma filaments, and the transient current pulses which produce displacement currents through the tissue. In some cases, these electric fields are sufficient to produce electroporation. Although ions and photons do not penetrate beyond the top layers of cells, the energetic fluxes are non-negligible, including ion energies exceeding 10-20 eV.

1. G. Fridman, et al. Plasma Chem. Plasma Process., **26**, 425–442 (2006).

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