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Electric fields, electromagnetic waves and cold plasmas for the treatment of biological cells and tissues

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Abstract

Biological objects, cells and tissues, can be exposed accidentally or voluntarily to different physical aggressions. The use of short intense electric pulses in various domains (biology, medicine, food industry …) is nowadays extended and well recognized.
Cold plasmas are also applied already for the decontamination of surfaces, not only in the industry but also in medicine, for example to reduce the bacterial load in chronic wounds. Cold plasmas are a reactive mixture of electrons, radicals, ions and atoms, which emit UV light and can be associated to strong electric pulses.
Basic studies on the interaction of electric fields with biological objects demonstrate that that the delivery of short and intense electric pulses, that results in the cell membrane reversible or irreversible electropermeabilization (electroporation), causes the oxidation of phospholipids of the membrane. Electromagnetic waves pulsed emissions can also cause this type of oxidation suggesting common mechanisms for the interaction of electric and electromagnetic fields with the cells.
Regarding the cold plasmas, it is necessary nowadays to understand which one(s) of their components is the responsible for the known (and also the unknown…) effects of cold plasmas on cells in vitro and in vivo. In this work, one of the difficulties is that there are numerous sources of cold plasmas (single plasma jets, multiple plasma jets, dielectric barrier discharge), that generate "different plasmas": the radical species generated and their amounts can be very different. Even if these cold plasmas operate at atmospheric pressure, there are often generated in the presence of noble gases (He, Ar…) which have also an important influence on the plasma properties.
Under this complex situation, the application of cold plasmas will be compared to those of the pulsed electric fields..