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Cells Electroporation With Subnanosecond Pulsed Electric Fields

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The ability of short pulsed electric fields (PEFs) to generate biological cells electroporation (reversible or irreversible) has been extensively studied for decades. From this knowledge has emerged a wide scope of applications in various domains such as the biomedical field or the food processing industry. In correlation with the progress in transient electric fields engineering, the use of shorter and shorter voltage pulses has been investigated for biological applications. These ultrashort pulses display distinct properties on biological membranes and cope with some technical limitations associated with the cells exposure to longer pulses. Last, but not the least, these PEFs pave the road for the development of new technologies for contactless PEF delivery. Up to now, investigations on the ability of subnanosecond pulsed electric fields to generate electroporation are still relatively scarce, mainly because of the lack of reliable pulsed power systems for cells exposure to subnanosecond PEFs [1]. In this context, permeabilization to trypan blue has been demonstrated in B16 melanoma cells treated with 800 ps duration pulses of 550 kV/cm (from 100 to 2000 pulses applied) [2]. Significant changes in the membrane conductance have been observed in RHN, NG108 and CHO cells treated with bursts of twenty-five pulses of 190 kV/cm and 500 ps duration at 1 kHz [3]. More recently, 260 ps duration pulses of about 10 kV/cm, applied for 3 seconds at a pulse repetition frequency (PRF) of 1 kHz have been shown to generate permeabilization to calcium ions in U937 lymphoma cells [4].

The present study focuses on investigating the effects of ca. 910 ps duration PEFs on the level of electroporation of bacteria (*E.Coli* DH5α strain) to the permeabilization marker YO-PRO-1 iodide, a cell-impermeant DNA binding dye. The influence of various parameters such as the number of pulses applied, the PRF, the electric field amplitude and the temperature during exposures were studied. The electric field intensity applied to the samples subjected to PEFs exposure was determined using detailed CST simulations with real input data provided by V-dot sensors. The results show efficient electroporation of *E.Coli* with such PEFs in the range of the ten of kV/cm. The higher the number of pulses delivered, the more electroporation is observed, as well as the more irreversible electroporation occurs. This work constitutes a step forward for the development of future biomedical or food processing applications using subnanosecond PEFs.

References

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