Monitoring the Molecular Composition of Live Cells Exposed to Pulsed Electric Fields based on Terahertz Measurements

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1. Extended Abstract

We report a unique study of the interaction between pulsed electric fields and biological cells based on terahertz microscopy and fluorescence microscopy. Electropermeabilization consists in the destabilization of the plasma membrane by the delivery of electric pulses leading to the permeabilization of the membrane. Electropermeabilization has led to many medical applications such as electrochemotherapy which combine tumor electropermeabilization and chemotherapy [1]. Terahertz microscopy is an innovative and a label-free optical method providing detailed information about the molecular composition of the cells. As a proof of concept, terahertz measurements of live cells permeabilized by chemical agents were already performed by our group [2]. For the first time, we investigate the electropermeabilization process thanks to terahertz microscopy.

In this study, terahertz measurements of cells exposed to electric pulses were compared with fluorescence measurements which is a reference instrumentation to study cell electropermeabilization [3]. Time-lapse acquisition of the terahertz and fluorescence signals of cells were performed during the exposition to electric pulses. Live cells were exposed to pulsed electric fields with different electric field magnitudes (from 0 V/cm to 1500 V/cm). The other electric pulses parameters were fixed to 8 pulses, 100 µs pulse duration and 1 Hz repetition rate.

Our results reveal protein leakage of cells exposed to electric pulses. A dose effect in the evolution of terahertz signal according to the electric field magnitude was demonstrated. A quantitative and qualitative comparison of the terahertz and the fluorescence measurements was performed to provide new information about the electropermeabilization process.

2. References

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