Heating effects of high power THz pulses on water

Sitnikov D S[1,@], Ilina I V[1], Pronkin A A[1] and Revkova V A[2]

[1] Joint Institute for High Temperatures of the Russian Academy of Sciences, Izhorskaya 13 Bldg 2, Moscow 125412, Russia
[2] Federal Research and Clinical Center of Specialized Medical Care and Medical Technologies of the Federal Medical and Biological Agency of Russia, Orekhovy Boulevard 28, Moscow 115682, Russia

[@] sitnik.ds@gmail.com

Exposure of cells or biological tissues to high-power pulses of THz radiation leads to changes in a variety of intracellular processes. However, the role of heating effects due to strong absorption of THz radiation by water molecules still stays unclear. In this study, we performed numerical modelling in order to estimate the thermal impact on water of a single THz pulse as well as a series of THz pulses. A finite-element model that provides numerical solutions for the heat conduction equation is employed to compute the temperature increase. A simple expression for temperature estimation in the center of the spot of THz radiation is presented for given frequency and fluence of the THz pulse. It has been demonstrated that thermal effect is determined by either the average power of radiation or by the fluence of a single THz pulse depending on pulse repetition rate. In order to estimate the thermal effect of THz radiation on living cells experiments on human dermal fibroblasts exposure to THz pulses (with an energy of 15 μJ and repetition rate of 100 Hz) have been performed. Analysis of heat shock proteins expression has demonstrated no statistically significant difference between experimental group after 3 h of irradiation and control group.