Biological Cell Dielectric Property Variation with Temperature

Anand Vadlamani, Jie Zhuang, Juergen F. Kolb, and Allen L. Garner
School of Nuclear Engineering
Purdue University
e-mail: algarner@purdue.edu

***Abstract*— The electrical properties of biological cells can provide insight into the cellular response to electric pulses (EPs) both during and after exposure. While, the majority of these measurements are carried out at room temperature, EPs may induce both bulk and localized membrane temperature gradients that may reduce the threshold for membrane pore formation or potentially induce other molecular level effects, such as the thermoelectric effect. Elucidating the significance of the impact of temperature on EP induced cellular mechanisms requires understanding the temperature variation of cellular dielectric properties, particularly of the cell membrane, cytoplasm, nuclear envelope, and nucleoplasm. In this study, we measure the temperature dependence of these dielectric properties by time domain dielectric spectroscopy, which extracts the properties of a single cell over a wide frequency range by using a single pulse. We accomplished this by constructing a sensor to measure the reflected signal from a network analyzer into a sample holder while using a water bath to modify the cell suspension temperature. Effective medium theories were used to extract the properties of an individual cell utilizing single shell (no nucleus) and double shell (containing a nucleus) models. We will discuss the implications of this temperature dependence on treatments using EPs, alternating current (AC), and lasers.**