Glucose-Dependent Dielectric Properties of Blood Plasma for 500 MHz to 50 GHz

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According to the National Center for Chronic Disease Control and Prevention, approximately 30.3 million Americans had diabetes in 2017, with about 7.2 million of those people being undiagnosed. Management of chronic diseases like diabetes accounts for 86% of the $2.7 trillion health care costs in the United States. The management and monitoring of chronic disease indicators, such as glucose, are uncomfortable for patients and currently provide data for both patients and doctors in limited time intervals. Development of reliable and accurate continuous glucose monitoring technologies that also improve the lives of patients with diabetes is crucial to lessening complications that are associated with the disease. To be truly beneficial, the technology must be able to function properly for an extended amount of time. Implantable biosensors offer the capability to wirelessly transmit chronic health data from inside the human body to a monitor display system, keeping the comfort of the patient in mind. Optimization of these implantable sensors to meet demands for data and high durability include measuring the changes in electrical properties of blood plasma as a function of glucose concentration.

This paper presents the correlation found between electrical properties of rat blood plasma, specifically electrical permittivity and conductivity, which were measured with a coaxial slim form probe and network analyzer along the frequency range 500 MHz to 50GHz, and the glucose concentration levels within the plasma. We fitted the data to a single pole Cole-Cole model, calculated the parameters, and then fitted those to a second-order polynomial. The Cole-Cole model is reliable when describing various types of biological tissues and fluids and offers accurate descriptions over a very wide frequency band.