The Effect of Glucose on the Electrical Properties of Blood Plasma

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In recent years, considerable progress has been made in developing implantable biosensors that can continually monitor glucose levels. These biosensors rely on the interstitial fluid within the dermis to measure the interstitial glucose (IG) levels. However, to be truly beneficial, the implanted sensor must be able to function properly for an extended period of time. Current biosensors can stay functional in the body up to a week (Enlite^{TM} by Medtronic). Contributing factors for this loss of functionality include the degradation and fouling of the sensor, and the changes in the tissue surrounding the sensor such as fibrosis and inflammation. While researches explore potential solutions to improve the current implantable biosensors, there is need to investigate cost effective point-of-care technologies for rapid monitoring of glucose concentration in the blood. To achieve this goal, we investigate a sensor technology that relies on changes in the electrical properties of blood plasma as a function of glucose concentration.

In this study, we show a correlation between electrical properties (relative permittivity-ε_r and conductivity-σ) of blood plasma and plasma glucose concentration. The measurements are conducted between 500 MHz and 50 GHz band. Agilent's 85070E dielectric probe kit and an N5225A PNA network analyzer were used for measurements between 500 MHz and 50 GHz. The data at each glucose level was fitted to a single-pole Cole-Cole model, and a second order polynomial is used to model the glucose concentration dependence for the Cole-Cole parameters. In addition, we have designed a dielectric resonator as a candidate for cost effective point-of-care rapid glucose monitoring sensor and tested using plasma samples with various glucose concentrations.