Comparison of Different Microwave Tissue Phantoms for the Design of an Optimal Validation System for RF Devices

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Biosensing is a technique used to examine an individual's internal anatomy without the need for invasive surgery. There are many modalities used for biosensing, but the unifying factor for each is their ability to differentiate between abnormal and healthy tissue through differences in the tissue's material properties. Among them, biosensing through the propagation of electromagnetic waves in the radiofrequency (RF) and microwave spectral regions has proven to be more effective due to its unique properties. The most ideal way to test microwave systems for biosensing is through excised tissue, however, there are health and ethical concerns related to obtaining excised tissue. As a result, tissue mimicking materials, which are also known as tissue phantoms, are a necessary tool that can be used to test microwave propagation through biological tissue. Tissue phantoms are inorganic materials that replicate the properties of biological tissue. According to the article, (S. Castello-Palacios, C. Garcia-Pardo, M. Alloza-Pascual, A. Fornes-Leal, N. Cardona and A. Valles-Lluch, "Gel Phantoms for Body Microwave Propagation in the (2 to 26.5) GHz Frequency Band," *IEEE Transactions on Atennas and Propagation,* pp. 1-10, 2019), not only do they aid in providing the desired electrical properties of the tissue, but they also help better understand the propagation of RF and microwave signals under different excitations and operating conditions.

In this work, dielectric tissue phantoms from seven different protocols were synthesized and compared. Each protocol generated tissue phantoms that mimicked the dielectric properties of one or more of the following tissue types: skin, fat, muscle, and bone. After each tissue phantom is synthesized its dielectric properties will be measured and then compared with the measured dielectric properties obtained from the Italian National Research Council website, which was referenced by (K. Sasaki, E. Porter, E. A. Rashed, L. Farrugia and G. Schmid, "Measurement and image-based estimation of dielectric properties of biological tissues – past, present, and future -," *Physics in Medicine and Biology,* no. 67, pp. 1-40, 2022). The percent error is then used as a measurement to determine the accuracy of the phantom's properties. The accuracy of the tissue phantoms dielectric properties across each protocol will be made available in a table. These values will then be used to determine the most optimal protocol(s) for each tissue type and these protocol(s) will be selected as future synthesis protocols. For future experiments, the selected tissue phantoms and their associated protocols will be tuned by adjusting the recipe. Tuning the recipe will allow the lab to improve the accuracy of the tissue phantoms and extend the protocol authors published work. At the conference, the authors will present findings comparing the dielectric properties of the tissue synthesized using seven different protocols.

This work was supported by the National Science Foundation under the award # 2104879.