Modeling the effective complex permittivity of heterogeneous breast tissue and comparison with relaxation models at millimeters wave frequencies

Tarek M. Said[1*], and Vasundara V. Varadan[2]

[1]Department of Electrical Engineering, Fayoum University, Fayoum 63514, Egypt
[2]Department of Electrical Engineering, University of Arkansas, Fayetteville, AR 72701, USA

ABSTRACT The contrast in dielectric properties between normal and malignant tissues is a basis for diagnostic applications using microwave devices. The study of normal tissues has been widely reviewed. Experimentally determined permittivity values tend to have larger inaccuracies as frequency increases due to the increased complexity of the measurement. Furthermore, it is anticipated that most tissues, especially those of high water content, will be increasingly lossy at the mm (millimeter) wave band. The goal of this paper is to model the heterogeneity of breast tissues using computer aided design so that dielectric properties at higher frequencies could be compared to the measurements. This goal will be achieved by designing and simulating a model that mimics the human breast tissue. The proposal is timely because of recent advances in software for finite element modeling of any system, coupled with greatly improved computing speeds and hence accurate results. We will start by introducing an electromagnetic model for the human breast tissue based on water content and compute its effective dielectric permittivity followed by a comparison of our results with prediction of relaxation models and available experimental results.

KEYWORDS Biological tissues; complex permittivity; free water; relaxation models

[*]Address all correspondence to: Tarek M. Said, Fayoum University, Faculty Group, Electrical Engineering Department, E-mail: tms02@fayoum.edu.eg