

The Role of the Concentration and Distribution of Water in the Complex Permittivity of Breast Fat Tissue

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ABSTRACT The structure of breast tissue is complicated and highly variable and presents a great challenge in the development of physical models that may be used to obtain its effective complex permittivity. Empirical models are commonly used by researchers to fit measured data and extrapolated to higher frequencies. However, these models have not been verified experimentally at higher frequencies. Theoretical models of tissue permittivity to explain the role of water are not available today. This communication is a systematic study of several models to estimate the complex permittivity of breast fat tissue based on volume content and distribution of water in the tissue. These models are implemented in (i) long wavelength, sparse concentration limit; (ii) full wave finite element simulation; and (iii) numerical implementation of dynamic multiple scattering theory. A comparison of the proposed models with experimental data is done at 3.2 GHz. Some of the measurement values are in fair agreement with the modeling. The results of the present study are useful for interpreting the large variability in experimentally measured values of the permittivity of breast fat tissue by taking the distribution of water into account.

KEYWORDS Biological tissues; complex permittivity; free water; multiple scattering theory

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