Breast Cancer Imaging with a Cylindrical Measurement Fixture

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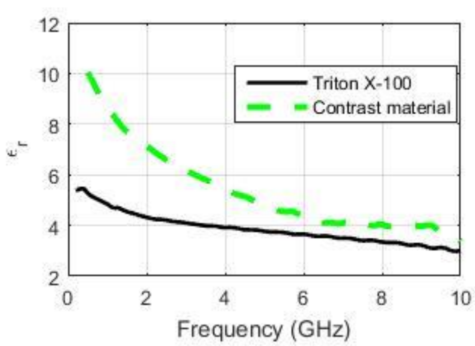
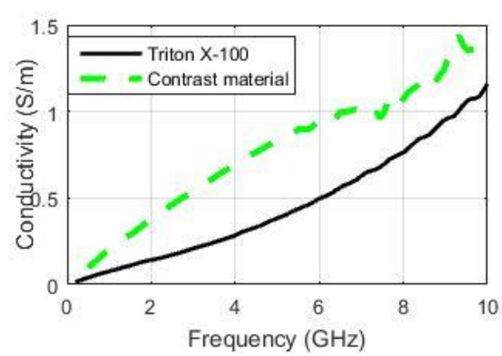
Permittivity and conductivity of materials namely, dielectric properties, governs the electromagnetic wave propagation within a medium. Thus, when the wave behavior in the media is analyzed, these properties reveal information about the material type. With this motivation, dielectric properties of biological tissues at microwave frequencies have been widely investigated within the last decade. More recently, dielectric properties of tissues with anomalies, such as cancer (malignant or tumor) tissues, have been reported in the literature. This effort mostly stemmed from the need to expose the potential of new microwave applications in medicine such as microwave breast cancer diagnosis. One problem with the breast cancer diagnosis is the scattering of the waves between air and skin boundary. Therefore, there is a need to place a matching medium between the antennas and breast. In this work, a cylindrical imaging fixture with Corian material is designed and fabricated for microwave breast cancer imaging.

Ultra wideband Vivaldi antennas designed to operate in Corian material with a permittivity of ε_r =3.7. A total of 24 Vivaldi antennas are fabricated and inserted to the Corian material in a cylindrical configuration. The antennas are then connected to the Rohde-Swartz 24 port Network Analyzer to record the S-parameter response. Triton X-100 is used for mimicking the dielectric properties of the breast tissue. A breast shaped cup placed inside the cylindrical measurement fixture. Note that the Corian material is extended to hold the breast phantom and served as a matching medium. The cup is then filled with room temperature Triton. Then a set of S-parameter measurement is taken. To mimic the malignant tumor tissue, in a beaker 20 grams Triton is heated up to 60 °C and mixed with 7 grams de-ionized water. Dielectric properties of triton and contrast material is given in Figure 1. The mixture is cooled to room temperature and a spherical object with 1 cm diameter is filled with the mixture. The object is then placed to the triton-filled cup and another S-parameter measurement is taken. Then the field distribution in the measurement fixture is calculated and plotted by using Linear Sampling and Factorization methods. A very good agreement is obtained between the experimental set-up and image results. The experiment fixture and the imaging results will be presented.



(a)



(b)

Figure 1. Dielectric property measurements of Triton and contrast material (a) permittivity, (b) conductivity.