Z-Scan Terahertz Imaging of Embedded Three-Dimensional Breast Cancer Tissue

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The terahertz (THz) frequency range is a rapidly developing field in electromagnetics today. Biomedical imaging has become a key area of focus for THz applications due to improved depth resolution over microwave imaging while still having greater penetration than optical frequencies. THz imaging is sensitive to water content, which serves as a strong contrast factor in cancer detection and imaging.

Current research has shown great promise in the use of THz imaging for detecting different types of cancer tissue including breast cancer. In our studies with embedded excised tumors, breast cancer tissue was shown to have distinct characteristics from surrounding normal tissue. Current work by our group has shown the effectiveness of THz imaging for denoting cancer in relatively flat sections of formalin-fixed, paraffin embedded (FFPE) tissue with thicknesses of 10-40 μm. To the authors' knowledge all previous research of THz applications for breast cancer has involved primarily flat sections. Thus this current research extends the use of time-domain THz imaging to three-dimensional tissue blocks.

This research will utilize the pulsed THz imaging system at the University of Arkansas in order to perform three-dimensional imaging on breast cancer tumor tissue. The system produces a time-domain pulse with a width of <500 fs that corresponds to a frequency-domain spectrum from 0.06 to 4 THz. The use of time-domain imaging demonstrates the measurement of multiple reflections from changing tissue regions within the tumor. The time delay of the reflections can then be correlated to the physical depth of the tissue regions to obtain the 'z-scan' of three-dimensional tumors.

FFPE tissue for this research will be obtained embedded in paraffin blocks from Northwest Arkansas Pathology Associates and the National Disease Research Interchange. Following the z-scan of the embedded tumors, the blocks will be sectioned and will undergo pathology assessment and THz imaging of flat sections associated with the measured depths. The pathology will then be compared to the THz imaging in order to correlate the three-dimensional imaging results.