Imaging and Analysis of Heterogeneous Breast Cancer Tissue Using Pulsed Terahertz System

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Breast conserving surgery, or a lumpectomy, is the preferred method for treating sufficiently small breast cancer tumors. In this process, it is critical for the patient's health that a sufficient layer of healthy tissue exists in the margin around the excised tumor in order to minimize recurrence. This margin normally undergoes assessment by a pathologist to determine whether or not it is clean of cancerous tissue. A positive margin, where cancer extends through this margin tissue, generally requires a second surgery and excision to remove remaining tissue. However, this process takes several days to weeks to provide a result, creating a burden on medical services and patients when secondary procedures are necessary.

This research makes use of a pulsed terahertz (THz) system (TPS Spectra 3000, Teraview, Ltd., UK) at the University of Arkansas in order to perform imaging and spectrometry of samples of excised breast cancer tissue. Terahertz is useful in this range due to having improved resolution over microwave imaging, improved penetration depth from optical imaging, and low ionization energy to prevent damage to the tissue. Additionally previous research shows that cancerous and healthy tissues have differentiating electrical properties under illumination at terahertz wavelengths, as reported by (P. C. Ashworth, E. Pickwell-MacPherson, E. Provenzano, S. E. Pinder, A. D. Purushotham, M. Pepper, V. P. Wallace, *Optics Express*, vol. 17, no. 15, July 2009). The system at the University of Arkansas emits a time-domain THz pulse with a spectral range of 0.06-4 THz. It comes with several modules allowing for reflection imaging, transmission imaging, and spectroscopy of samples up to 2 cm × 2 cm, and an accessory gantry system provides the capability to image samples up to 0.8 m × 0.8 m.

Slides containing the cancer tissue and adjacent non-cancer tissue, sliced at a thickness of 10 μm, are obtained from the Cooperative Human Tissue Network (CHTN) division at the University of Alabama, Burmingham. These slides will be imaged in order to provide reflection properties of different regions of the tissue, which can then be compared to pathological assessment provided by Dr. Shree Sharma at the University of Arkansas for Medical Sciences, Little Rock. The ability to correlate the properties of the tissue under THz imaging to pathology results of different regions of tissue will serve as the foundation for future research in mapping the dielectric properties of different tissue types found in breast cancer regions, with the goal of achieving rapid cancer margin assessment.