Human Tissue Characterization and Cancer Margin Assessment toward Real-time THz Imaging for Clinical Applications

Woon-Gi Yeo[a], Niru K. Nahar[a], Charles L. Hitchcock[b], and Kubilay Sertel[a]
[a]ElectroScience Laboratory, Electrical and Computer Engineering Dept.
The Ohio State University, 1330 Kinnear Rd., Columbus, OH 43212, USA
[b]Dorothy M. Davis Heart and Lung Research Institute, Wexner Medical Center
The Ohio State University, 473 W. 12th Ave., Columbus, OH 43210, USA

THz waves are extremely sensitive to the degree of hydration, which is strongly correlated with electric properties and malignancies of various tissues due to their composition and morphological differences. As such, imaging in the THz band can provide a detailed picture of the malignant tumor with accurate assessment of tissue morphology and margins. Thus, here, we develop a database of the THz response of several human organ tissue groups using broadband time domain THz spectroscopy. We also investigate the use of real-time THz camera imaging to differentiate between benign and malignant tissues for the surgical margin identification in a clinical setting. For this purpose, we are developing a comprehensive study of THz spectroscopic characteristics and cancer margin assessment for human organ tissues.

Starting with the assessment of tissue water content and animal tissue characterization, we subsequently progress to major human tissue groups. In particular, purified (distilled) water and the fresh liver tissue from Ovis aries were characterized using THz time-domain reflection (TDR) spectroscopy. The raw data from the measurements provide the associated refractive indices and absorption coefficients for bulk water, bound water plus bulk water, and the liver tissue. Fresh human tissues from heart, pancreas, and gastrointestinal tract were also characterized and compared. For cancer margin assessment, we also study formalin-fixed human liver tissue, including tumor area adjacent to normal tissue. In all cases, it is demonstrated that discriminatory information can be readily obtained from terahertz images or TDR signals. At the meeting, we will present the THz reflection response and cancer margin detection for several major human organ tissues of our THz tissue database.