Characterizing Rat Tissue Samples Using Terahertz Pulsed Imaging

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***Abstract*—Terahertz Pulsed Imaging (TPI^{TM}) is a non-ionizing and non-destructive technique. Image contrast has been seen between normal and diseased tissues in *ex vivo* measurements. Due to its coherent detection, TPI can easily reveal the dielectric properties of samples and recently it has been used for studying a wide range of biological materials. In this study, we try to differentiate between freshly harvested organ samples from laboratory rats using TPI. Consistent differences in the refractive index and absorption coefficient have been seen. Results show that TPI could be an effective tool to quantify these differences.**

I. Introduction And Background

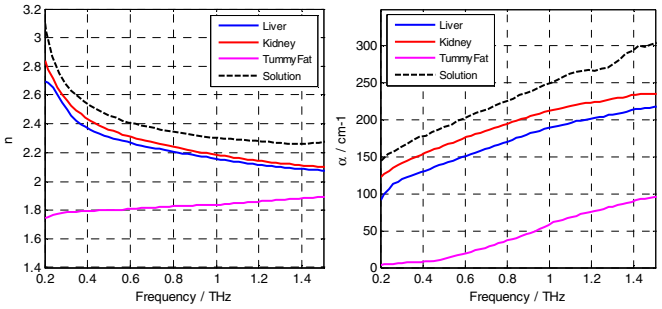
Terahertz Pulsed Imaging (TPI^{TM}) has recently drawn extensive attention in biomedical areas. Its applications in skin cancer, breast tumors and tooth cavities have been investigated. TPI is a non-invasive imaging technique for biological objects. Its coherent detection allows for the measurement of amplitude and phase parameters such that both the refractive index and absorption coefficient of the sample can be determined. Moreover, the spectral information from TPI has identified unique features for many biomolecules. Thus, due to its sensitivity to bio-molecular interactions, TPI may be able to play an important role in differentiating tissue types. Laboratory rats are widely used for a variety of medical research purposes. In this work, we employ TPI to investigate healthy tissue samples taken from different rat organs and further we quantify their subtle differences in terms of refractive index and absorption coefficient.

II. Materials And Method

Terahertz radiation is severely attenuated by water so very thin slices of biological samples would be needed for transmission spectroscopy. Therefore, it is easier to measure such samples in reflection mode. Our experimental system is the TPI Imaga 1000 (TeraView Ltd, UK). System setup details are given in [1]. Liver, kidney, heart muscle, leg muscle, pancreas and fat tissues from 9-month-old female Sprague–Dawley rats were taken and studied in vitro. To obtain meaningful comparisons, ten rats were measured. All the samples were carefully cut into flat pieces to ensure good contact with the quartz platform. For each organ sample, two different slices were selected and measured separately. In a single measurement, an image was taken and the mean values of the selected regions of interest were used for data analysis. Before measurement, all the rat organs were kept in Krebs-Henseleit solution (KHS) to prevent rapid deterioration and maintain their natural levels of water content. KHS was also measured to determine its influence on the tissue samples.

III. Results

In this section, we present the results for the liver, kidney, fat and solution measurements. Fig. 1 shows the frequency dependent refractive index and absorption coefficient. The 95% confidence intervals were calculated but are too small to be seen here.



(a) (b)

Fig. 1. (a) Mean refractive indices and (b) absorption coefficients of the tissue samples and KHS.

In conclusion, we have calculated from reflection data the refractive index and absorption coefficient of a number of freshly harvested healthy organ samples. The significant statistical differences allow us to differentiate between tissue types. These early results suggest that clinical imaging will be feasible in certain applications. They are also useful for the development of clinical protocols and for advancing the understanding of contrast mechanisms in biological terahertz images.

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References

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