Study of Paraffin-embedded Brain Glioma using Terahertz Spectroscopy

Zeren Li, [1, 2] Kun Meng, [1, 2] Jiang Li, [1, 2] Sencheng Zhong, [1, 2] Lianghui Du, [1, 2] Qiao Liu, [1, 2] Zhaohui Zhai, [1, 2] Tunan Chen, [1] Liguo Zhu, [1, 2] Hua Feng, [3] Jianheng Zhao [1, 2]

[1]China Academy of Engineering Physics, Institute of Fluid Physics, Interdisciplinary Laboratory of Physics and Biomedicine, No. 64, Mianshan Road, Mianyang, Sichuan 621900, China

[2]China Academy of Engineering Physics, Terahertz Research Center, Mianyang, Sichuan 621900, China

[3]Third Military Medical University, Southwest Hospital, Department of Neurosurgery, No. 30, Gaotanyan Street, Shapingba, Chongqing 400038, China

***Abstract*—we measured the refractive indices, absorption coefficients and complex dielectric constants of paraffin-embedded brain glioma and normal brain tissues using terahertz time-domain spectroscopy system (THz-TDS). The results show distinct differences of aforementioned THz properties between brain glioma and normal tissues. The suitable THz frequency for varies imaging methods (intensity, coherent or pulsed imaging) for paraffin-embedded brain glioma are analyzed.**

BRAIN gliomas are the most common and deadly malignant brain tumors[1-3]. An accurate, early clinical diagnosis of brain gliomas is crucial for patients' treatment. Embedding brain gliomas in paraffin is a widely used first step in microscopic pathology analysis owing to its better storage and long-term tissue morphology preservation in clinical settings [4].

The most common method for microscopic pathology analysis of paraffin-embedded brain gliomas requires pathological markers [5]. The marker can be visualized using appropriate staining methods with an optical microscope. A final diagnosis is achieved based on histopathology, immunohistochemical stains, and other methods [6, 7]. Consequently, it takes a significant amount of time and resources to obtain a reliable result. Unfortunately, experience is required to interpret paraffin-embedded brain samples, which is not an objective standard and is subject to interobserver variation or error [8]. Therefore, an objective, label-free, quantitative analysis technique for paraffin-embedded brain glioma is required.

Terahertz spectroscopic is a novel medical imaging modality and has received attention for its benign nature (noninvasive and nonionizing) for human and high sensitivity to biomolecules and tissues. In recent decades, the THz spectroscopic technique has been used to identify humors on skin, breast, colon, liver and other locations.

In this work, the THz spectra (refractive index, absorption coefficient, and complex dielectric constant) of paraffin-embedded brain gliomas, which were established by standard surgical implantation of glioma models in mice, was obtained using terahertz time-domain spectroscopy system (THz-TDS). Furthermore, the THz spectral differences between brain gliomas and normal brain tissues were obtained and analyzed in this work. Compared with normal brain tissue, our results indicate that paraffin-embedded brain gliomas have a higher refractive index, absorption coefficient, and dielectric constant (see Fig.1).

From our analysis, the dielectric-constant-based imaging may give the best contrast, and it is very suitable for THz pulsed imaging. THz waves with higher frequencies, such as those in the 1.7- to 2.0-THz range, are suitable for coherent imaging, while waves with lower frequencies, especially those at 0.55 and 0.76 THz, are suitable for intensity imaging. These results demonstrate that THz technology has the potential to distinguish gliomas from normal brain tissues and are valuable for THz imaging of paraffin-embedded brain glioma.

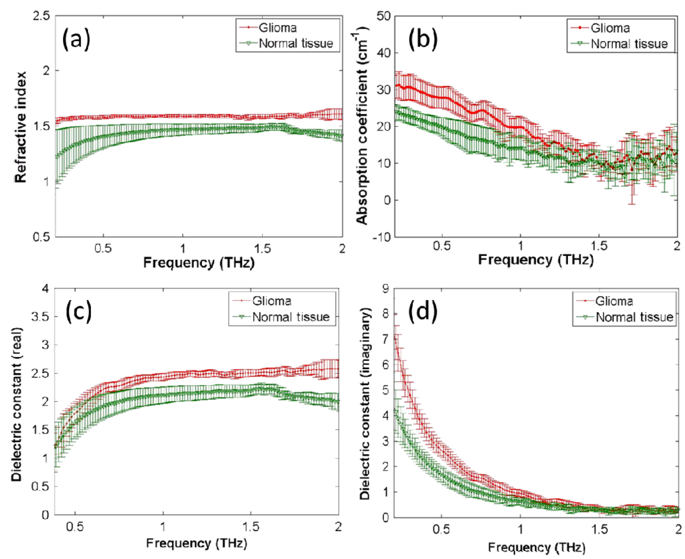

Fig. 1. THz refractive index (a), absorption coefficients (b), real (c) and imaginary part (d) of dielectric constants of glioma and normal tissue.

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