Spectroscopic Analysis in Terahertz-Frequency Region for Electromagnetics in Medicine and Biology

Maya Mizuno, Tomoaki Nagaoka
National Institute of Information and Communications Technology
Koganei-shi, Tokyo 184-8795, Japan
Email: mmizuno@nict.go.jp

Since the 1990s, the development of electromagnetic wave generation and detection techniques in the terahertz (THz) range from approximately 0.1 to 10 THz has been accelerated[1]. Moreover, various applications of THz spectroscopy in nondestructive testing and biological sensing among others using features such as high transparency against non-metal materials (e.g., plastics) and high sensitivity to water, have been sought[2]. In the biological sensing field, examination methods of skin condition or corneal water content have been investigated. The examinations have become possible owing to the increased reliability of THz spectroscopy systems including THz time-domain spectrometers (THz-TDSs).

On the other hand, the THz-frequency region has been considered for wireless communications (beyond 5G/6G). For these practical uses, it is necessary to investigate the effects of THz waves absorbed into biological tissues, namely, the skin and eyes, where most THz waves are absorbed. Although the International Commission on Non-Ionizing Radiation Protection (ICNIRP) guidelines for radio frequencies (~300 GHz)[3] or optical radiations (300 GHz~)[4,5] have already included exposure limits for a region of the THz frequencies, accumulation of data from biological investigations as well as clarification of exposure property by physical simulation and exposure experiments using tissue models would be recommended for the beyond 5G/6G. However, dielectric properties and electromagnetic wave scattering data for designing tissue models for the THz-frequency region are insufficient.

Therefore, our group has been conducting research on dielectric properties and electromagnetic wave scattering on animal tissues using reflection-type THz-TDSs so that we can design human tissue phantoms for THz-frequency region. In this presentation, the research results will be shown and discussed.

Acknowledgement
A part of this work was supported by Ministry of Internal Affairs and Communications Grant Number JPMI10001.

References

1. K. Sakai (Ed.), “Terahertz Optoelectronics,” Springer-Verlag, Berlin Heidelberg, 2005.
2. D. Mittleman (Ed.), “Sensing with Terahertz Radiation,” Springer-Verlag, Berlin–Heidelberg, 2003.
3. ICNIRP, “Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz),” Health Phys, Vol. 118, No. 5, pp. 483-524, 2020.
4. ICNIRP, “Guidelines on limits of exposure to incoherent visible and infrared radiation,” Health Phys, Vol. 105, No. 1, pp. 74-96, 2013.
5. ICNIRP, “Guidelines on limits of exposure to laser radiation of wavelengths between 180 nm and 1,000 μm,” Health Phys, Vol. 105, No. 3, pp. 271-295, 2013.