Measurements of dielectric properties of skin layers from LF to MMW region

Kanako Wake, Kensuke Sasaki, and Soichi Watanabe
National Institute of Information and Communications Technology, Japan

Extended Abstract

The dielectric properties of tissues and organs constructing a human body are essential for precise exposure assessment inside a human exposed to electromagnetic fields. In 1996, the database of dielectric properties of 43 tissues and a parametric model of those tissues are reported by Gabriel et al [1,2]. This parametric model has been used as de fact standard in the numerical simulation for exposure. Although their measurement was performed from 1 Hz to 20 GHz, relatively large uncertainties are pointed out by the authors for the measurement below 1 MHz. Since the parametric model has been applicable up to 100 GHz by extrapolating their database, larger uncertainty remains in the frequency above 20 GHz. Moreover, a spatial resolution of numerical human model tends to become higher and contain more tissues not shown in the previous database. We have been conducting measurement of dielectric properties of biological tissues for the frequency under 1 MHz to 100 GHz [3,4]. In this study, we focus on the measurement of skin tissues.

For the measurement below MHz region, we employed the parallel-plate method. The tissues were inserted between a pair of parallel plates and the dielectric properties were evaluated by the measurement of impedance. The measurement above 10 MHz was conducted by the coaxial probe method. The tissues were contacted to the coaxial probe and the dielectric properties were evaluated by the measurement of reflection by network analyzer. We have developed a probe which can be used between 500 MHz and 110 GHz [4]. The measurement from 10 MHz to 110 GHz was achieved with our developed probe together with a commercially available probe whose frequency region is from 10 MHz to 67 GHz [5]. The skin has layered structure containing stratum corneum, epidermis, dermis, and subcutaneous tissue. In the measurement, porcine skin was fractionated to epidermis, dermis and subcutaneous tissue and measured. The measure results of each skin layer were shown and compared to the previous parametric model by Gabriel [2].

Acknowledgment

This study was supported by the Ministry of Internal Affairs and Communications, Japan.

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