Design of Inner-Layer Capsule Dipole Antenna for Ingestible Endoscope

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1. Introduction Ingestible capsule endoscope systems is expected for healthcare applications. In order to evaluate the antenna characteristics inside the human body, it is necessary to evaluate the high efficiency capsule antenna. In this report, an inner-layer capsule dipole antenna (ICDA) was proposed.

2. Analysis model

Dimension of the rectangular column capsules are with length of 30 mm and width of 10 mm. To simplify the investigation, relative permittivity of capsule is set as the air (ε_r=1). A layer with thickness of 2 mm was made inside the capsule. Deionized water was used to fill the layer and a dipole antenna with length l_1 was placed in the inner-layer, as shown in Fig. 1. The torso shape phantom as a container of liquid is shown in Fig. 2. The human body equivalent liquid (HBEL) with temperature of 18° C is filled in the torso phantom. The origin of coordinates was located at the top of a torso phantom. The proposed capsule antenna was located in the position of (x_1, y_1, z_1) with y-polarized, and a y-polarized receiving antenna with the length of l_2 was located in the position of (x_2, y_2, z_2). The FDTD method was used with considering the dispersive effect of the liquid.

3. Results

In [1], we found if dipole antenna was placed at the interface of capsule, the impedance matching was obtained in a broadband around 1 GHz. The same idea was used in this design. At ISM band, in the case of ICDA the received power is -27.6 dB, while in the case of without inner-layer the received power is -56.6 dB at 920 MHz. The received power is almost 30 dB larger than the case of without inner-layer.

In [2], transmission factor τ was proposed which is corresponding to the received power under the complex conjugate matching conditions satisfied at both transmitting and receiving ports. τ indicates the maximum relative received power. At MICS band, the transmission factor of proposed ICDA is almost 7 dB larger than the interface antenna proposed in [1], the reason is the deinozed water layer has a relatively low conductivity loss.

4. Conclusion In this report, an inner-layer capsule dipole antenna was proposed and good performance was obtained in MICS and ISM band.

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[1] H. Sato et.al, in Proc. ISAP 2015.
[2] H. Sato et.al, in Proc. ISAP 2016.

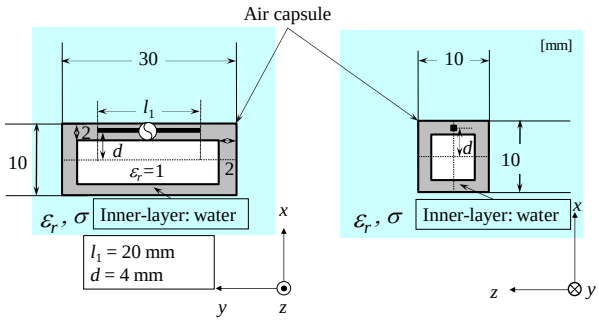

Fig.1. Structure of inner-layer capsule dipole antenna.

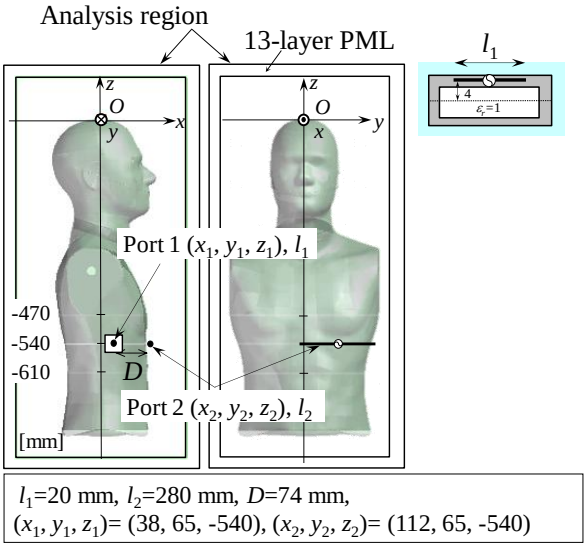

Fig.2. Simulation model.

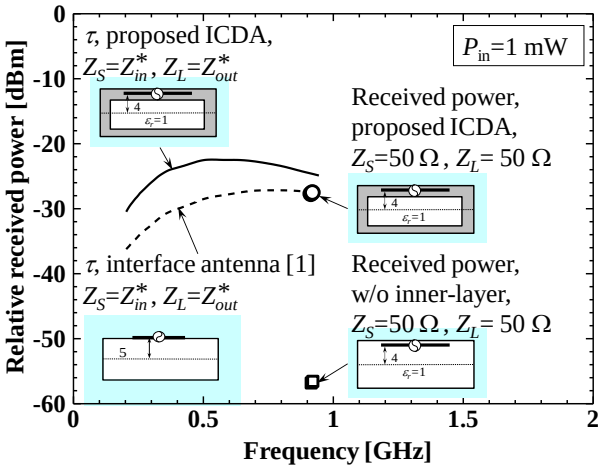

Fig.3. Relative received power.