Microwave Characteristics of an Open Coplanar Waveguide Line-Based Glucose Droplet

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In the case of a liquid sample, microwave characterization was achieved by a commercial probe kit in the broadband region. However, this system is very bulky and is also expensive. In addition, sample solution of a large volume is required for microwave characterization [1]. In this study, to characterize a very small sample solution, a glucose droplet (GD) (~2 μl) were investigated by utilizing a compact and reusable coplanar waveguide device with an open gap in the microwave broadband, 0.5 GHz to 10 GHz.

For a CPW sample, it was prepared using a commercialized printed circuit board (PCB) process [2]. Meanwhile, a deionized (DI) solution was prepared using a water purification system (RiOs 5, Millipore Co.) and the glucose solution mixed with D-(+)-glucose powder (G7021, Sigma-Aldrich Co.) in the DI solution was also prepared. Here, GD samples with three different concentrations, 0.2, 0.4, and 0.6 g/ml, were tested on the proposed device and the testing result was also compared with that of a DI droplet as a control solution.

From the experimental results, as the GD concentration was high, the signal transmission was gradually low due to the impedance increase in the observed frequency ranging from 0.5 GHz to 10 GHz. In particular, among the transmission line elements, i.e., *R*, *L*, *G*, and *C*, of the pure samples, the resistance showed the clear difference with the glucose concentrations in the specific frequency region, 1 GHz to 7 GHz. As a result, it could be confirmed that the microwave properties are considerably dependent on the resistance with glucose concentration increase.

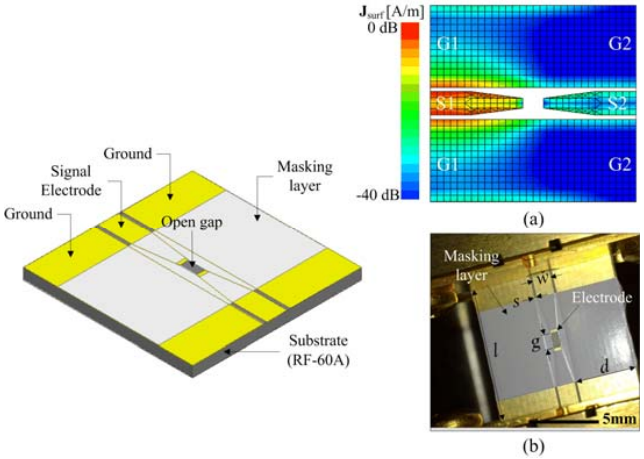

Figure 1. The schematic of microwave CPW line with an open gap for characterizing glucose droplet: (a) Surface current distribution of the simulated CPW device. (b) Image of fabricated sample. Dimensions of the CPW device are w=1.2 mm, s=0.2mm, g=1.0 mm, d=4.2 mm and its overall area are 10mm×10mm.

[1] E. Piuzzi, C. Mertia, et al., A comparative analysis between customized and commercial systems for complex permittivity measurements on liquid samples at microwave frequencies, *IEEE Trans. Instrum. Meas.* Vol. 62, No. 5, pp. 1034-1046, 2013.

[2] H.-J. Lee, K.-A. Hyun, H.-I. Jung, A high-Q resonator using biocompatible materials at microwave frequencies, *Appl. Phys. Lett.* Vol. 104, pp. 023509-1-023509-4, 2014.