ABSTRACTS (MASTER THESIS)

Development of a Broadband Small-size Electromagnetic Wave Irradiation Applicator for Microwave Chemical Reaction

**(Graduate School of Engineering,
Laboratory of Applied Radio Engineering for Humanosphere, RISH, Kyoto University)**

Ryo Nakajima

It is known that microwave-assisted chemical reaction has some advantages. Generally, 2.45 GHz microwave is used for microwave heating, on the other hand, the efficiency of dielectric heating depends on frequency. Thus, there is a possibility that microwave-assisted chemical reaction takes place more at any other frequency efficiently than 2.45 GHz. The objective of our research is to develop a broadband small-size electromagnetic wave irradiation applicator for microwave chemical reaction. First, we measured the permittivity of sodium hydroxide solution which is assumed as solvent of chemical reaction. We calculated the penetration depth and the microwave absorbing power of sodium hydroxide solution by using the data of the permittivity. Second, we designed a broadband small-size electromagnetic wave irradiation applicator by using an electromagnetic simulator. The heated product is assumed to be a 2 mol/L sodium hydroxide solution of 20 mL. We aim that the reflection coefficient is less than -10 dB in 0.08 GHz–2.7 GHz. We simulated the several sizes of applicators. In addition, we changed the applicator in consideration of manufacturing. The reflection coefficient of designed applicator was less than -10 dB in 0.42 GHz–0.63 GHz and 2.27 GHz–2.7 GHz. Third, we manufactured a broadband small-size electromagnetic wave irradiation applicator. We conducted reflection measurement and the experimental results are approximately consistent with the simulation results. Next, we conducted heating experiment by changing the frequency, and it is shown that the temperatures of the heated product rose to 100 degrees in 290 to 370 seconds. Then, we performed thermal analysis simulation and we compared the simulation result and the experimental result. Finally, we presented the temperature control experiment. We created LabVIEW programs and we made a comparison of P control, PI control and PID control.

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