Chemical Reaction under Highly Precise Microwave Irradiation

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Introduction: Microwave irradiation features for chemical reactions: rapid and high-efficiency heating, rapid thermal response, selective heating, and non-thermal effects.
→ **Improving process efficiencies and conserving energy**
However, it is often pointed out that microwave irradiated reactions have a very low reproducibility.

Development of High Power Amplifier Module and Applicator: To achieve reproducibility, a solid-state microwave source with an ultra precise oscillator, high power amplifier module (HPA), and elliptical applicator is developed.

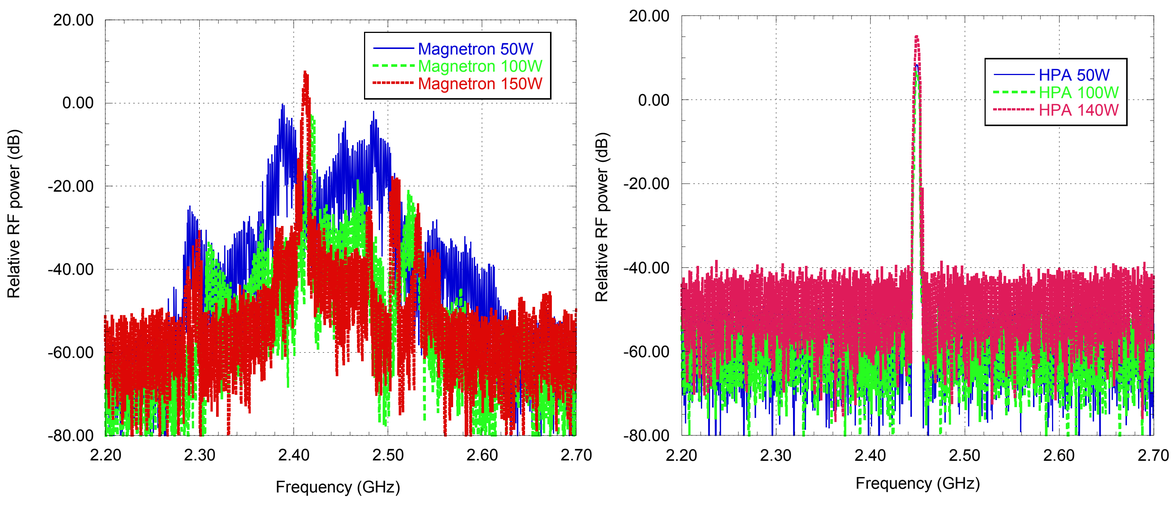

Figure 1. RF power spectrum of magnetron and HPA

Use of COMSOL Multiphysics : Chemical reaction rate greatly depends on reaction temperature. Electromagnetic (EM) wave and heat transfer simulations of the applicator with an irradiation body were performed using COMSOL Multiphysics in order to investigate heat spots.

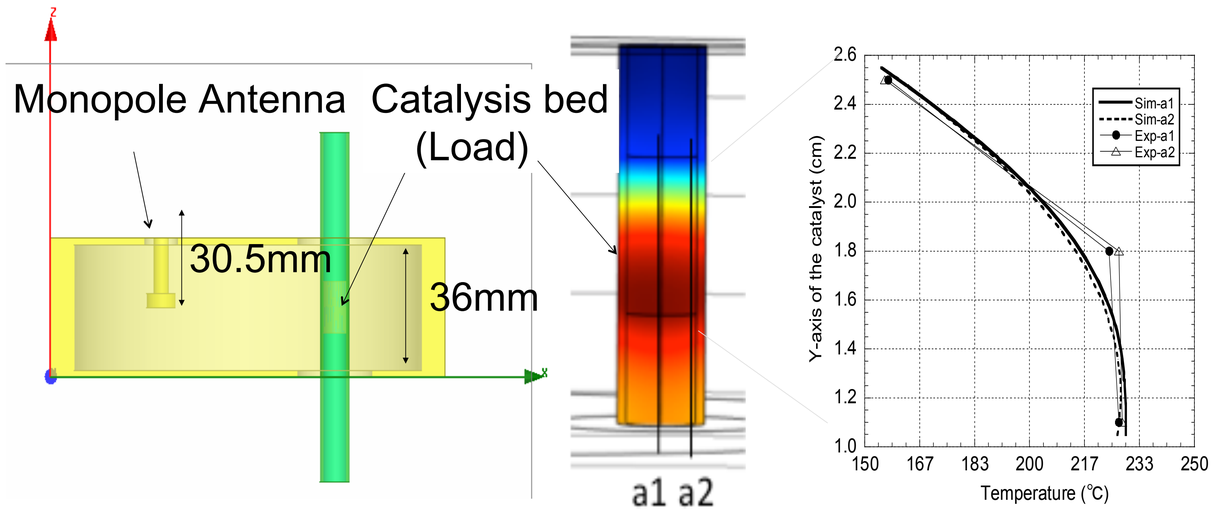

Figure 2. EM and Heat transfer simulation of the Applicator

Results: Fig. 3 shows the dependence of the hydrogen generation rate on contact time, for hydrogen generated by the methanol decomposition reaction using microwave irradiation and the electrical heating furnace. We can see that the production rate of hydrogen through the methanol decomposition reaction under microwave irradiation was approximately three times greater than that in the case of the electrical heating furnace.

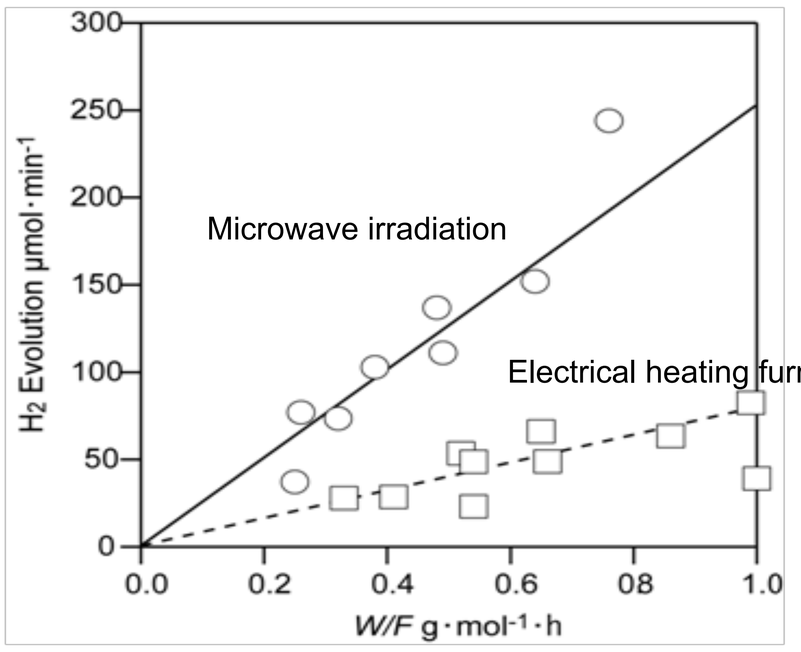

Figure 3. Rate of hydrogen generation rate by methanol decomposition

Conclusions: With the aim of obtaining high reproducibility of chemical reactions, a microwave high power amplifier (HPA) module with an ultra precise oscillator and elliptical applicator has been successfully developed. We also demonstrated methanol decomposition reaction as a model solid-gas reaction using Pd/C as a catalyst under microwave irradiation. The reaction rate under microwave irradiation was enhanced three-fold as compared with that under electric furnace

References:

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2. S. Fujii, et al, *in Proc. IEEE Frequency Control Symp*., pp. 499-502, 2005

Excerpt from the Proceedings of the 2013 COMSOL Conference in Boston