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Study on chemical reaction under microwave irradiationSatoshi Fujii^{1,2}, Shuntaro Tsubaki², Eiichi Suzuki² and Yuji Wada²¹National Institute of Technology, Okinawa College, Japan²Institute of Technology, Japan

Chemical reactions performed under microwave irradiation often demonstrate high reaction rates and high selectivities, which allows for more compact reactors and more energy-efficient processes than conventional heating methods. Consequently, our group has discovered a new chemical reaction, performed with a self-processing microwave irradiation source. We have proposed a solid-state microwave source with an ultra-precise oscillator and/or injection-locked magnetron that can be used to achieve reproducible results in microwave-mediated chemical reactions. These microwave effects can be classified into two types: thermal effects, which arise from the temperature increase caused by microwaves, and non-thermal effects, which are attributed to the interactions between the substances and the oscillating electromagnetic fields of the microwaves. For thermal effects, we have demonstrated that a silver-nanoparticle-coated polyimide thin film, which was synthesized via a microwave-mediated sintering process, displayed conductivity seven-fold greater than that of the film formed in a conventional furnace. We have developed a novel microwave-driven Pidgeon process to produce Mg metal with less energy consumption and no direct CO₂ emission. An antenna structure, consisting of dolomite as the Mg source and a ferrosilicon antenna as the reductant, was used both to confine the microwave energy emitted from the magnetron in the microwave oven and to produce a practical amount of pure Mg metal. This microwave Pidgeon process with an antenna configuration made it possible to produce Mg with an energy consumption of 58.6 GJ/t, corresponding to 68.6% reduction compared to the conventional method. For non-thermal effects, we demonstrated the microwave-enhanced electrolysis of water to generate O₂ using a α -Fe₂O₃ electrode with induction by pulsed microwave irradiation under a constantly applied potential.

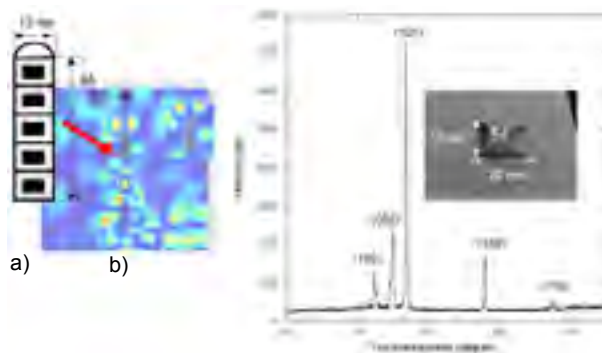


Figure 1: a) Antenna structure and b) Electric field distribution in the applicator, and c) X-ray diffraction and photo image of Mg obtained by microwave Pidgeon method.

Biography

Satoshi Fujii received his BS and MS degrees in Material Science from Tsukuba University, Ibaragi, Japan, in 1985 and 1987, respectively. He received his PhD degree in Material Engineering from Kyoto Institute of Technology in 2007. In 1987, he joined Sumitomo Electric Industries and was involved in research on GaAs ICs in Opto-electronics Laboratories. Since 1992, he has been working on diamond SAW devices at the Itami Research Laboratories, Nagoya University. In 2004, he moved to the Advanced Technology Development Center, Seiko-Epson Corp., in order to study diamond SAW devices and related modules. In 2015, he joined the Faculty of the National Institute of Technology, Okinawa as a Professor.

Notes:

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