
ABSTRACTS (MASTER THESIS)

Design of Microwave Sintering Apparatus of Titanium for Industrial Mass Production

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In modern days, microwave heating is used in a variety of fields, including microwave oven in our daily lives. In 1999, Roy et al. discovered that it can be applicable to sintering various metal alloy powder. Since microwave heating is generally more highly efficient than conventional heating, a number of studies and reports on its application have been conducted in order to employ this technology in the industrial field.

In this paper, we design microwave sintering apparatus of titanium powder for industrial mass production by both electromagnetic simulations and experiments. Electromagnetic simulation needs electromagnetic properties of titanium powder, or its complex permittivity and permeability, which are still unclear for its structural complexity. Therefore before apparatus design, we evaluated its properties by both electromagnetic simulations and experiments. In the evaluation of the permittivity and permeability, the coaxial line method was utilized. In electromagnetic simulations, we simulated two models, single sphere model and unit cells model. By changing a particle radius and an interparticle distance, we obtained a variety of properties of complex permittivity and permeability. In experiments, we measured mixture of titanium powder and quartz powder at various mass fractions and estimated the complex permittivity and permeability of pure titanium powder. Combining the results of both simulations and experiments, we obtained complex permittivity and permeability of titanium powder for the electromagnetic simulations of apparatus design. The apparatus we designed basically consists of a waveguide with apertures and a belt conveyor on which the heated sample is put. Since additional apertures may let microwave energy leak through them, the energy leakage from the apertures as well as absorption energy of titanium powder were investigated. First the apparatus without apertures was investigated, and we can successfully irradiate microwave to titanium powder sample. However in an apparatus with apertures, it is found that the apertures make efficient microwave heating of titanium powder quite difficult.