Sustainable Humanosphere, vol. 10, p.13, 2014

Microwave Heating of Various Carbon Powder by using Spatially Separated Magnetic Fields [1]

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

Keiichiro Kashimura, Tomohiko Mitani and Naoki Shinohara

We experimentally investigated the microwave heating characteristics of non-magnetic conductive multi-particle systems using spatially separated electric and magnetic fields to determine the effects of the multi-particle structure on microwave heating. Pure carbon, carbon black, and artificial graphite multi-particle systems exhibited peak microwave absorption at specific relative densities under magnetic field rather than electric field. These absorptions can be categorized into two types: one originates from coupling between metal spheres, while the other originates from a heterogeneous distribution of particles.

Figure 1 shows the relative density dependence of the heating rates for various pure powder compacts subjected to E (Figure 1(a)) and H (Figure 1(b)) fields, respectively, when they were irradiated with 2.45GHz microwave whose maximum output was 1.5 kW. The pure carbon powder with a particle diameter of 20 μm has an electrical conductivity of 1 ~ 0.58 $\times 10^5$ S/m and can thus be regarded as a quasi-metal. Under magnetic field, a peak occurred in the heating rate for a relative density of 0.4205, corresponding to a maximum absorption of microwave power. For artificial graphite with a particle diameter of 80 μm (electrical conductivity: 5 ~ 2.4 x 10^3 S/m), a similar tendency was observed. These compacts show a dramatic resonance at low relative densities (pure carbon: 0.3133; artificial graphite: 0.2225). This resonance has been reliably observed for both the heating rate and the maximum temperature. In contrast, under electric field, no such maximum absorption peak was observed for any of the carbon particles. Instead, the absorption decreased with increasing relative density.

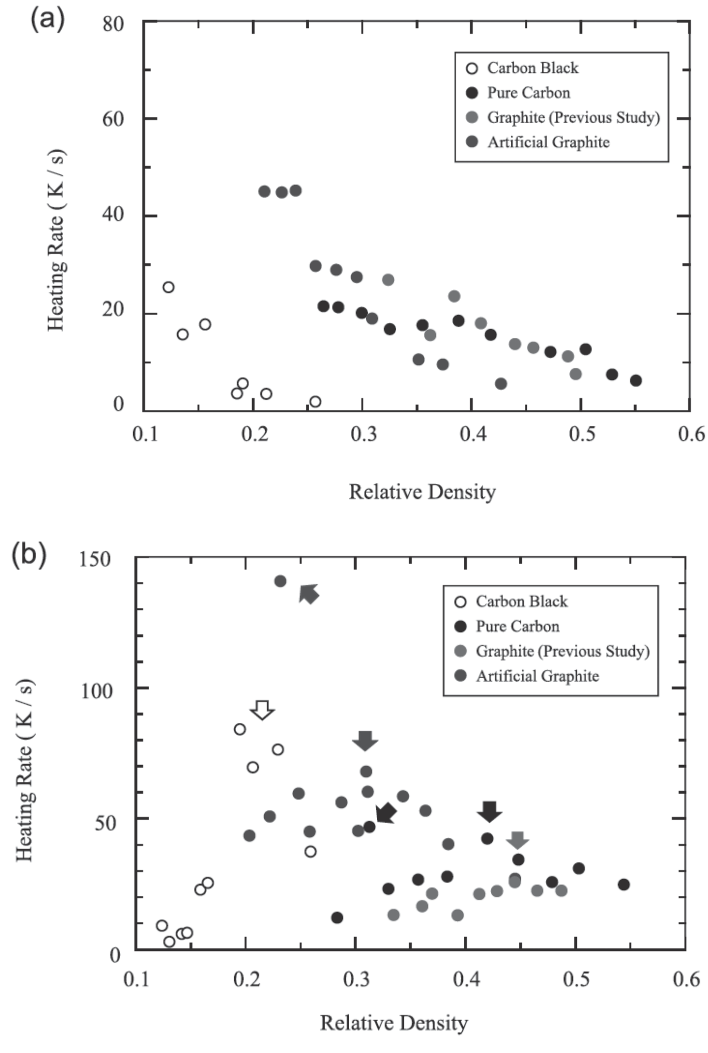

Figure 1. Relative density dependence of heating rates for various carbon powders compacts in (a) E and (b) H fields [1].

References

[1] Kashimura, K., Hasegawa, N., Suzuki, S., Hayashi, M., Mitani, T., Shinohara N., Nagata, K., "Effects of relative density on microwave heating of various carbon powder compacts microwave-metallic multi-particle coupling using spatially separated magnetic fields", Journal of Applied Physics, vol.113, no.2, pp.024902-1-024902-5, 2013.