Fine Particle Production by Spray Pyrolysis Method

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The spray pyrolysis method was used to produce fine oxide particles for use in the study of a cosmic dust analogue. Spray pyrolysis is a method which enables submicron-sized particles to be prepared through the pyrolysis or hydrolysis reaction within a droplet containing the precursors. By using a droplet, whose surface tension holds it in a spherical shape, the solutes reacting within the droplet tend to form into spherical-shaped particles. Restricting the particle shape to spherical makes the optical analysis free of effects from the particle's shape.

In the spray pyrolysis method, the solutions containing the molecular solutes are converted to fine particles through the following steps:

(1) formation of the droplet containing solutions by sonic vibrator
(2) transport of the droplet by air or inactive gas to the reactors
(3) decomposition of the solute to fine particles in the reactors
(4) entrapment of the particles on Teflon thin sheets

The concentration of solutions used is typically 0.01 mol/L, and the droplet size is 10 μm so that 10^9 molecules are contained in each droplet. The instrument has four reactors that can be heated up to 1000°C. The droplet flight time in the reactors is 30 seconds with a typical gas flow rate of 1 L/min.

Submicron size particles of SiO_2, Al_2O_3, TiO_2, Mg_2SiO_4 have been produced so far. The X-ray diffraction pattern of the SiO_2 produced shows it to be amorphous, and SEM imaging showed it had a highly spherical shape. Its transmission spectra from visible to far infrared were measured by embedding the particles in KBr and polyethylene pellets, and its dielectric constant were derived from this measurement. By restricting the particle shape to spherical, the derived dielectric constant is free of the effect of the particle shape so that this parameter is a useful standard for the amorphous silica particle. The Al_2O_3 produced was γ alumina with a low crystalline order and with high sphericity, so its dielectric constant was derived. For Mg_2SiO_4 and TiO_2, the particles look like accretions of numerous smaller sub-particles, with low sphericity which may be due to the higher crystalline order of these particles.