Shape and lattice distortion effects on infrared spectra of olivine particles

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Physical and chemical properties of circumstellar and interstellar dust have been investigated by comparing infrared spectra of astronomical observations and those of laboratory measurements. Generally, infrared spectral feature vary depending on physical and chemical properties such as temperature, chemical composition. Moreover, the spectra of small particles are affected also by particle size, shape, lattice distortion and other physical properties. Effects of chemical composition and temperature have been investigated so far, but those of shape and lattice distortion of crystals have not been yet well known experimentally.

In order to examine the shape and lattice distortion effects on the infrared absorption spectra, we prepared sub-micron particles of olivine (Fo_{92}: from San Carlos, Arizona, USA) by grinding olivine grains using a "planetary ball mill" and a mortar by hand. The sizes and shapes of the particles were observed under a field emission scanning electron microscope and the lattice distortion was estimated by peak broadenings of x-ray powder diffraction patterns. From these analyses, it is found that the shapes of the sample ground by the ball mill were more spherical than those by hand. But particles ground by the ball mill have crystal lattice distortion. This sample was annealed at 700, or 1000^oC for 3 hours to release the distortion. The infrared absorption spectra of the three samples (by hand, by ball mill, and annealed) were measured by FT-IR spectrometer. The spectra were changed depending on the particle shape and the lattice distortion. As a result, we found that the peak positions of particles of which shape distribution are near spherical shape are shifted to short wavelength, and the spectra features became broader by the effect of the lattice distortion.