Structure of alumina grain its IR spectroscopy produced by the evaportion of Al in the mixture of O2 and Ar

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Corundum (Al2O3) is one of the most refractory phases predicted to condense first from a gas of solar composition [1]. Numerous corundum grains were found in the Murchison C2 chondrites [2]. The analysis of grains by ion microprobe mass spectrometry indicated the existence of 26Al and 16O in the early solar system. Corundum grains in meteorites tell us as one of the presolar in oxygen rich atmosphere grains. In a previous paper, we showed the extinct in spectra for gamma-Al2O3 in the wavelength from UV (Ultra Violet) to FIR (Far-Infrared) [3]. There are a lot of phases in alumina. The stable phase is the alpha-alumina and the metastable phases are rho, kappa, delta, eta, khi, gamma and theta. All metastable phase transform to the alpha-alumina at high temperature and each phase transformation temperature differs. In the case of the bulk gamma-alumina, it transform to the delta-alumina at 950 ºC, theta-alumina at 1100 ºC and the theta-alpha transformation occurs at 1300 ºC. But the detail atom positions are not known well in most metastable alumina. The high resolution transmittance electron microscope (HREM) observation is efficient to know the structures of those alumina phases.

In the present study, we succeeded to produce the alumina ultrafine grains by burning in the commercial alumina powder in a gaseous mixture of 80 % argon and 20 % oxygen gas at 100 Torr by using Ta boat. For the production of the refractory grains in laboratory, the evaporation source is one of the important factors comparing to the metallic grain formation. We recently succeeded to produce TiO2, MgSiO2, and Mg2SiO4 grain formation by using Ta boat in the atmosphere of oxygen contents. We performed the transmittance electron microscope (TEM) observation and IR spectroscopy for the ultrafine particles produced. The particles produced were the spherical and mean size of those were about 40 nm in diameter. The electron diffraction (ED) pattern indicated that the particles produced were the delta-alumina phase. In the IR spectrum for the delta-alumina, there were a lot of sharpen peaks in the region from 10 µm to 33 µm. The spectrum for the -alumina considerably differs from the other alumina spectrum. The delta-alumina has the superlattice structure of the gamma-alumina. Although the gamma-alumina has the broad peak at 13 µm, the delta-alumina has many sharpen peaks around 13 µm.

The eta-alumina phase which is produced by the oxidation of metallic Al grain by heating in air below 600 ºC showed the absorption peak at 10.8 µm. Therefore the defect of metals in an alumina grains drastically altered the IR spectra. The gamma-alumina is the defects spinel structure and it contains a lot of metallic defects in its unit cell. It is considered that those metallic defects cause the various alumina phases. Since the stable defect is only the planar defect in nano-sized particles, the new phases which are not seen in bulk may be able to exist in an ultrafine particle. In the present HREM observation, the new phase alumina particles were seen additional to the delta-alumina phase particles. The delta-alumina can be presented as the threefold super structure of the gamma-alumina with units along the c-axis. In addition to the delta structure, fourfold super structure with four units (a new delta structure) was contained in the present produced grains.

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