Production of functional and astromineralogical interested nanoparticles using the plasma field

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Direct evidence of plasma field effects on nanoparticles have been performed at the gas pressure of the gas evaporation method by using radio frequency of 13.56 MHz. By passing through metallic or semi-metallic smoke into the plasma field at the nitrogen and helium mixture gas pressure of 10 Torr, it was found that the particles changed into nitride particles in the gas mixture of nitrogen less than 1 Torr. The metallic and semi-metallic particles before passing through the plasma field were the order of 50 nm in size. It can be elucidated that the plasma field alters the structure of nanoparticles in an atmosphere of a little amount of the reactive gas.

In order to make clear the relation between the metamorphism and the plasma field effect, the carbon soot produced in methane gas was directly observed by in-situ high resolution transmission electron microscopy. Amorphous carbon with onion-like structure produced in methane gas was changed to QCC structure with the hole. Further upon heating, the QCC structure was changed to graphite sheets. It can be concluded that the existence of hydrogen incorporated in the carbon particles was attributed to the structural change of carbon particles.

Carbon particles also were passed through plasma field under the various gas atmospheres. Large C_{60} particles were formed by passing through plasma field in helium gas. It was found that the coalescence growth among C_{60} crystallites was accelerated in plasma field. By the aggregation among negatively charged particles in plasma field, C_{60} crystals were grown more than the size of 300 nm. In the methane gas atmosphere, spherical onion and carbon nanotube were grown by passing carbon particle through the plasma field. By examining carbon particles grown at the electrodes, it was found that the difference of the density of electron charge in plasma was important factor for the selective growth of carbon particles.

By introducing the flash evaporation technique, size and structure controlled ZnO particles with characteristic absorption can be obtained by passing through the plasma field. Furthermore, tungsten (W) was doped ZnO particles, the position of W in ZnO structure was decided by calculation of diffraction intensity of W doped ZnO.

Silicon oxide particles were produced by dropping $Si(C_2H_5O)_4$ liquid into the plasma field. It was found that the structure of silicon oxide particles could be controlled by the oxygen partial pressure in plasma.