Synthesis of amorphous silicate nano-particles as analogue of interstellar dust

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Interstellar extinction in the wavelength range of UV to IR shows that grain size of interstellar dust is sub-micron. IR spectroscopic observations revealed that the interstellar dust is composed of amorphous silicates. Although it is important to study properties of such dust candidates in laboratory, it is generally difficult to obtain such fine particles by controlling their size and shape. In this study, we succeeded in synthesizing a large mass of amorphous silicate nano-particles with forsterite (Mg_2SiO_4) composition as an analogue of interstellar dust. Crystalline nano-particles were also obtained by heating the amorphous samples. Optical properties of the amorphous and crystalline samples were examined.

Amorphous nano-particles of about 100 g were synthesized using induction thermal plasma at Nisshin Engineering Co. Ltd. By spraying a slurry composed of $Mg(OH)_2$ and SiO_2 in ethanol with the Mg/Si ratio of 2 into high temperature plasma, the starting material evaporated, and then condensed into nano-particles by cooling. We changed cooling time, and produced particles with two different sizes. The specific surfaces of the particles were measured by BET method. The particles were observed under a FE-SEM, and analyzed by XRD. The IR absorption spectra were also measured. The amorphous samples were heated at 800 ^oC in 3 hours to transform into forsterite.

The sizes of the two types of amorphous nano-particles estimated by BET method are 11 and 80 nm, which are consistent with the sizes observed under FE-SEM (about 10 and 100 nm, respectively). Both types of nano-particles are spherical and homogeneous in size. XRD pattern and IR spectrum show that the unheated and heated samples are amorphous and forsterite, respectively. As these samples were synthesized in large quantities, these nano-particles can be regarded as analogues for interstellar dust particles and used for various for experiments, such as experiments for crystallization kinetics of the amorphous silicate, reproduction experiments for Stardust sample recovery in aerogel collectors, and a study of particle-particle interaction about dust aggregation in the early solar system.