Identification of Silicate and Carbonaceous Presolar Grains in the type 3 Enstatite Chondrites

S. Ebata and H. Yurimoto

Department of Natural History Sciences, Hokkaido University, Sapporo 060-0810, Japan.
E-mail: ebashin@ep.sci.hokudai.ac.jp

Primitive meteorites contain presolar silicate grains that predate the formation of our solar system [1-6]. In 2006, Ebata et al. [7] have discovered the first evidence of presolar silicate grains from two type 3 enstatite chondrites. Because the sizes of presolar grains are small (~0.3 µm for silicate grains [e.g. 1, 2, 3]), presolar grains in situ determined isotopic composition and chemical composition have been limited. Here we report further in situ studies of presolar silicate and carbonaceous presolar grains in the primitive EH3 chondrites, Yamato-691, ALHA81189, Sahara 97072.

We surveyed presolar grains by isotopography using a Hokudai isotope microscope system ( Cameca ims-1270 + SCAPS [8] ). For presolar grain identification, mineralogical and petrographical characterization of matrix areas containing isotopic anomalous grains has been conducted using a field emission type scanning electron microscope (JEOL JSM-7000F) equipped with energy dispersive X-ray spectrometer (Oxford INCA).

Presolar silicates were identified by oxygen isotopographs: 3 grains from areas of about 61,000 micrometer squares for Y-691 (the volume abundance: 4ppm); 18 from about 99,000 µm² for ALHA81189 (16ppm), whereas no presolar silicates were identified from areas of about 30,000 micrometer squares for SAH 97072 (<3ppm). Presolar carbonaceous grains were also identified by carbon isotopographs: 14 grains from areas of about 63,000 micrometer squares for Y-691 (14ppm); 13 from about 96,600 µm² for ALHA81189 (11ppm); and 3 from about 32,000 µm² for SAH 97072 (8ppm).

The sizes of presolar silicates are 0.2-1.1µm (average: 0.49 µm) and carbonaceous grains are 0.1-1.2µm (average: 0.40 µm). Eight of presolar silicates were determined the chemical compositions (Enstatite: 3, Fe-rich pyroxene (En50): 1, Fe-rich olivine (Fo30): 1, SiO₂: 1, aggregates of pyroxene-like compositions: 2). The SiO₂ and aggregates may be amorphous. In the case of carbonaceous grains, ten grains were determined the chemical compositions (graphite: 4, SiC: 6).

The abundance is smaller than those of primitive carbonaceous chondrite and IDPs [e.g. 1, 5]. The average size of presolar silicate grains of the enstatite chondrite is larger than that of carbonaceous chondrites and IDPs [e.g. 1, 2, 3]. In the case of presolar carbonaceous grains, the average size is smaller than those from carbonaceous chondrites [9]. Presolar grains of pyroxene compositions are more abundant than other presolar silicate species in the enstatite chondrite, whereas olivine, pyroxene and GEMS are equally distributed carbonaceous [e.g. 2, 3], IDPs [e.g. 1] and AMMs [10]. This suggests that presolar silicates of enstatite composition were selectively survived in the enstatite parent body.