Presolar Grains in Primitive Enstatite Chondrites

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Presolar grains predated the formation of our solar system. Presolar grains are identified by isotopic anomalies of several isotopic compositions [e.g. 1-7]. Enstatite chondrites (hereafter ECs), ordinary chondrites and carbonaceous chondrites are typical types of primitive meteorites. These chondrites reflect redox conditions in the early solar nebula. ECs were formed under highly reducing nebula conditions [e.g. 8]. Krot et al. (2000) proposed that the redox condition was formed by enrichments of presolar carbonaceous grains [9]. Therefore, it is important to understand the spatial distribution of presolar grains in the early solar nebula. The purpose of this study is to determine mineral species of presolar grains in enstatite chondrites in order to understand decomposition processes by reduced condition in the early solar nebula.

We have surveyed presolar grains by isotopography using a Hokudai isotope microscope system (Cameca ims-1270 + SCAPS [10]). For presolar grain identification, mineralogical and petrographical characterization of matrix areas containing isotopic anomalous grains has been conducted using a FESEM-EDS system (JEOL JSM-7000F + Oxford INCA Energy). Samples used in this study were three EH3 chondrites; ALHA81189, Yamato-691 and SAH97072.

Presolar silicates were identified by oxygen isotopography: 3 grains from Y-691 (the volume abundance: 4 ppm); 19 from ALHA81189 (17 ppm), whereas no presolar silicate grains were identified from SAH 97072 (less than 3 ppm). Presolar carbonaceous grains (hereafter C-grains) were also identified by carbon isotopography: 14 grains from Y-691 (20 ppm); 13 from ALHA81189 (12 ppm); and 3 from SAH 97072 (8 ppm). The chemical compositions were determined for eight presolar silicate grains; Pyroxene: 6, Olivine: 1, SiO_2: 1. In the case of C-grains, the chemical compositions were determined for thirteen grains; graphite: 7, SiC: 6. Out of 13 C-grains, 2 presolar C-grains surrounded by sulfides were identified.

From the results of abundances and average sizes of presolar SiC and graphite grains, relatively abundant presolar graphites were survived comparing with presolar silicates in EH3 chondrites. This suggests presolar graphites were selectively survived in the EC parent body or in the EC forming region in the solar nebula because graphite phase is one of the most stable solid under reduced environment [11]. Presolar grains of pyroxene compositions are dominant in ECs. This suggests presolar silicates of enstatite composition were selectively survived in the EC parent body or in the EC forming region in the solar nebula. Sulfides surrounding a presolar SiC grain and an olivine grain surrounded by the sulfides have solar isotopic compositions, which suggest these complex grains were assembled in the solar nebula. The formation may be in reduced conditions in the solar system because such grains were only discovered in EH3 chondrites. These results indicate presolar grains in ECs were experienced in reduced environment in the solar nebula. This study shows that species of presolar grains in enstatite chondrites are consist with the redox conditions in the enstatite parent body suggesting most constituents of enstatite chondrites are heated in extremely redox solar nebula.

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