SESSION 2

Presolar and Early Solar System History: Hot in the Beginning

DAY 2 – Feb.18, 2016
8:30 am – 11:05 am

FORMATION AND ALTERATION HISTORY OF A UNIQUE FACETED PRESOLAR CORUNDUM. A. Takigawa[1,2], R. M. Stroud[3], L. R. Nittler[4], C. M. O'D. Alexander[5], and A. Miyake[2], [1]The Hakubi Center for Advanced Research, Kyoto University, Kyoto, Japan (takigawa@kueps.kyoto-u.ac.jp), [2]Department of Geology and Mineralogy, Kyoto University, Kyoto, Japan, [2]Naval Research Laboratory, Washington DC, USA, [3]Department of Terrestrial Magnetism, Carnegie Institution of Washington, Washington DC, USA.

Presolar grains are survivors of circumstellar dust grains formed around evolved stars such as Asymptotic Giant Branch (AGB) stars, Red Giants, and supernovae (SNe) prior to the birth of the solar system. They condensed from gas phases at ~a few stellar radii from the central stars and injected into the interstellar medium (ISM) along with the outflows (Woitke et al. 2004). They have then experienced processing in the ISM and protosolar disk. The grain morphology and crystal structure of presolar grains may reflect condensation conditions in circumstellar envelopes and alteration in the ISM and protosolar disk as well.

Corundum (α-Al_2O_3) is the most abundant refractory dust condensed in envelopes around oxygen-rich asymptotic giant branch (AGB) stars. In this study, we performed detailed analysis of presolar corundum grains and discuss the formation and alteration of circumstellar dust grains.

Aluminum oxide grains were identified from acid residues of QUE97008 (LL3.05) by energy dispersive X-ray spectroscopy (EDS) and observed by field-emission scanning electron microscope (FE-SEM) at the Carnegie Institution of Washington (CIW) according to Takigawa et al. (2013). Oxygen and Mg-Al isotopic measurements were performed with the Cameca NanoSIMS 50L ion-microprobe at CIW. Ultra-thin sections of presolar grains were prepared with the NRL FIB-SEM and were observed with transmission electron microscopes (TEMs) at NRL (JEOL JEM-2200FS) and Kyoto University (JEOL JEM-2100F).

Eight presolar grains were identified from acid residues of QUE97008 by oxygen isotopic measurements. We found a unique presolar Al_2O_3 grain with clearly faceted faces, QUE060. Grains with edges and relatively flat faces were reported by Takigawa et al. (2014) but such clearly flat and/or smooth faces have not been observed on any other presolar Al_2O_3 grains in this study and previous studies (Choi et al. 1998; Makide et al. 2004; Takigawa et al. 2014). The oxygen and Al-Mg isotopic compositions of Grain QUE060 indicate that its origin is a 1 M_{Sun} AGB star undergoing the cool-bottom-processing (Nittler et al. 1997).

A cavity was observed in the bright-field (BF) TEM image of the FIB lift-out section of QUE060. Magnesium is detected at any points on the grain with EDS but distributed heterogeneously within the grain. There are several domains containing a high amount of Mg. The detected Mg is essentially pure radiogenic ^{26}Mg ($^{26}Mg/^{24}Mg$~0.01). The selected-area electron diffraction patterns of Mg-concentrated domains show satellite spots, which reflects the modulated structure in the crystal.

The subhedral shape and smooth surface of QUE060 suggest that this grain was single crystalline corundum when it condensed in a circumstellar envelope of a low-mass AGB star and the distorted crystal structure inside the grain, voids, and the modulated structure accompanying the high Mg concentration are secondary features.