PRESOLAR SILICATE GRAINS FROM PRIMITIVE CARBONACEOUS CHONDRITES Y-81025, ALHA 77307, ADELAIDE AND ACFER 094. S. Kobayashi[1], A Tonotani[1], N. Sakamoto[1], K. Nagashima[1], A. N. Krot[2], and H. Yurimoto[1], [1]Department of Earth and Planetary Sciences, Tokyo Institute of Technology, Ookayama 2-12-1, Meguro, Tokyo 152-8551, Japan. (sachio@geo.titech.ac.jp), [2]Hawai'I Institute of Geophysics and Planetology, School of Ocean and Earth Science and Technology, University of Hawai'i at Manoa, Honolulu, HI 06822, USA.

Introduction: Recently presolar silicates were found in a few meteorites, Acfer 094 (ungrouped type 3), NWA 530 (CR2), Bishunpur (LL3.1) and Semarkona (LL3.0) [1-4]. Acfer 094 which is thought to be the most pristine chondrite represents the highest abundance of ~40, 30 and 110 ppm [1-3].

Some researchers suggest that there are some effects of alteration and metamorphism in matrix even in the petrologic subtype 3.0 chondrites [e.g., 5]. Therefore, it is unclear for the effect of alteration and metamorphism against the submicron order of presolar silicates even in type-3 chondrites.

In this study we report the presolar silicates from the least altered and metamorphosed carbonaceous chondrites, Y-81025 (CO3.0) [6], ALHA 77307 (CO3.0) [7], Adelaide (ungrouped, linked to CV-CO) [8] and Acfer 094 (ungrouped, linked to CO-CM) [9], which there are some agreement that the above chondrites are one of the most pristine chondrites [10].

Experimental: The polished thin sections of Y-81025 (paired of Y-81020), ALHA 77307, Adelaide and Acfer 094 were selected in this study. Petrography and mineralogy were studied using scanning electron microscope (JEOL JSM-5310LV) equipped with energy dispersive X-ray spectrometer (Oxford LINK ISIS).

Isotope images were obtained by the TiTech isotope microscope (Cameca ims-1270 + SCAPS [11]). The analytical techniques are mostly same as [2] but different in several conditions. A 50 µm contrast aperture (CA) was used as well as a 150 µm one in order to obtain higher lateral resolution. Lateral resolution of isotopographs obtained by the 50 µm CA was ~0.3-0.5 µm. The Cs^+ beam of 0.3 nA was rastered over area of 75 x 75 μm^2 and image size is corresponding to ~60 x 60 μm^2 on the sample surface. The typical acquisition sequence for secondary ion images was $^{12}C^-$, $^{13}C^-$, $^{12}C^-$, $^{27}Al^-$, $^{28}Si^-$, $^{16}O^-$, $^{18}O^-$, $^{16}O^-$, $^{17}O^-$ and $^{16}O^-$ (150 µm CA used for C isotopes and 50 µm CA for the others). Total integration time for one analysis was ~1 hour with sputtering depth of less than 100 nm. The digital image processing using a moving average of 3 x 3 pixels (corresponding to 0.6 x 0.6 μm^2) was applied to simple isotope ratio image (isotopograph) in order to reduce the statistical error. The scale of O-isotopograph is normalized to O isotopic compositions of each meteorite.

The selection criterion for isotopically anomalous presolar grain candidates is that the isotopic composition is 2σ away from 3σ ellipse of the distribution of the normal matrix materials.

Matrix-normalized abundances of presolar silicates are expressed as ppm and grain density (number of grains per analyzed area). The abundance is calculated assuming the grains are 0.3 µm in diameter that is an average size of presolar silicate grains reported to date.

Results: Total analyzed areas, number of presolar silicate grains, abundance (ppm) and grain density for each meteorites are shown in Table 1. Three O-isotope diagram of presolar silicate grains is shown in Fig. 1.

Numbers of 22, 8, 5 and 14 presolar silicates were identified in isotopographs (Fig. 2) of ~34,000 μm^2 (11 matrix areas), ~25,000 μm^2 (8 matrix areas), ~11,000 μm^2 (4 matrix areas) and ~166,000 μm^2 (40 matrix areas) for Y-81025, ALHA 77307, Adelaide and Acfer 094, respectively. Matrix-normalized abundances of presolar silicates were respectively, calculated to be 58, 29, 41 and 8 ppm (assuming 0.3 µm in diameter) and 647, 320, 445 and 84 /mm^2 for grain density.

Discussion: The abundances of presolar silicates in the least metamorphosed and altered chondrites are ~10-60 ppm and are higher than those of most type of presolar phases. The high abundances of presolar silicates in these chondrites could be due to the nature of the least metamorphosed and altered chondrites. Among these chondrites, the abundance of presolar silicates in Y-81025 is the highest and is ~60 ppm. The second highest abundance is ~40 ppm in Adelaide and third is ~30 ppm in ALHA 77307. Acfer 094 represents the lowest abundance of ~10 ppm among chondrites used in this study. The TEM studies of matrix materials in Acfer 094, Adelaide, and ALHA 77307 suggest that the matrix in Acfer 094 largely escaped aqueous alteration and thermal metamorphism [9] and seem to be more pristine than that of Adelaide [10]. The matrix of ALHA 77307 seems to be more pristine than that of Adelaide [8] and has some similarities with that of Acfer 094 [8, 9]. Although Y-81025 has not been investigated by

TEM, Y-81025 is probably more primitive than ALHA 77307 based on the elemental distributions among matrix materials and opaque minerals [5]. Although the chondrites used in this study show slight differences of the degree of aqueous alteration and thermal metamorphism, such differences are inconsistent with the abundances of presolar silicates. The lowest abundance in Acfer 094 with most pristine matrix could exclude the possibility that the differences of presolar silicates between primitive chondrites resulted from destruction of presolar silicates by thermal metamorphism and aqueous alteration processes. The difference of the abundance of presolar silicates among the least metamorphosed and altered chondrites suggest that the presolar silicates were heterogeneously distributed among chondrite forming regions in the solar nebula.

The abundance of presolar silicates in Acfer 094 is estimated to be 30-110 ppm [1-3]. This contrasts with the abundance in this study. However, the discrepancy is likely to be systematic. If this is valid to estimate true abundances, the true abundance of presolar silicates should be more than 3-10 times higher than that in this study. The true abundances of presolar silicates in Y-81025 may be more than several hundred ppm comparable to that of IDPs estimated from [12, 13].

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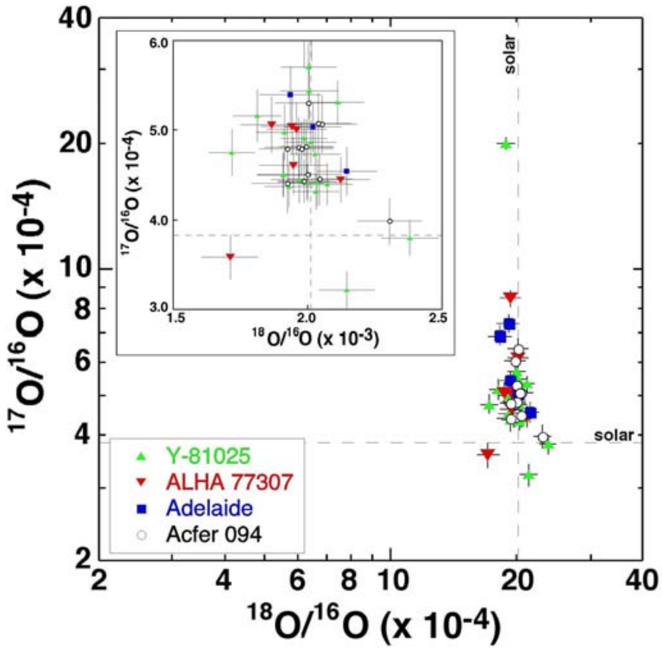

Figure 1. O-isotopic ratios of presolar silicate grains from Y-81025, ALHA 77307, Adelaide and Acfer 094. Errors are 2σ. Inset figure shows the same data at an expanded scale around the solar O-isotope ratio. Note that inset figure is linear scale. O-isotopic ratios of presolar silicates represent similar distribution in different chondrites Forty-five grains belong to Group 1, one grain belongs to group3 and three grains belong to group 4 grains of presolar oxide grains [14].

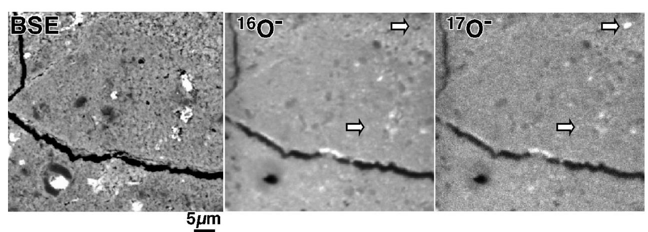

Figure 2. Corresponding images of BSE and secondary ion ($^{16}O^-$ and $^{17}O^-$). White allows indicate location of presolar grains.

Table 1: Matrix-Normalized Abundances of Presolar Silicates.

Meteorite	class	Total Area (μm^2)	No. of silicates	Abundance (ppm)	grain density (No./mm^2)
Y-81025	CO3.0	34000	22	58	647
ALHA 77307	CO3.0	25000	8	29	320
Adelaide	type-3 ungrouped	11000	5	41	455
Acfer 094	type-3 ungrouped	166000	14	8	84