ABUNDANCE OF COSMIC SYMPLECTITE IN ACFER 094 CARBONACEOUS CHONDRITE. K. Abe[1], N. Sakamoto[2], A. N. Krot[3] and H. Yurimoto[1, 2], [1]Department of Natural History Sciences, Hokkaido University, Sapporo 060-0810, JAPAN (abeken@ep.sci.hokudai.ac.jp), [2]Isotope Imaging Laboratory, Creative Research Institution "Sousei", Hokkaido University, Sapporo, 001-0021, JAPAN, [3]Hawai'i Institute of Geophysics and Planetology, School of Ocean and Earth Science and Technology, University of Hawai'i at Manoa, Honolulu, HI 96822, USA.

Introduction: Cosmic symplectites (COSs) have extremely heavy oxygen isotopes ($\delta^{17,18}$O=180‰) thought to be originated in primordial water in the solar system [1]. Mineralogical study revealed that COSs are composed of nanocrystalline aggregates of magnetites and iron sulfides with symplectic texture [2].

The chemical composition of COSs are typically Fe: O: S ≈ 4: 4: 1 for atomic ratio [1]. Based on the unique chemical composition of COSs, we have surveyed COSs in various chondrites using X-ray map of 1×1 mm^2 [3]. However, COS has not been discovered in other chondrites except for Acfer 094 [4]. In this study, we report continued COSs survey in Acfer 094.

Experimental: Polished two thin sections of Acfer 094 are prepared (Acfer 094#1, Acfer 094#2).

COS survey was performed by X-ray mapping technique described in [3]. In order to quantify the abundances of COS systematically, X-ray elemental maps were prepared for ten regions of 1×1 mm^2 area in Acfer 094 using the FE-SEM-EDS (JEOL JSM-7000F, Oxford INCA Energy). Although the X-ray maps consist of pixels of 0.2 µm/pixel, the spatial resolution of the X-ray maps is about 1 µm due to the electron beam broadening in the thin sections. COS grains can be identified by combined RGB map of Fe (red), S (green) and O (blue) because of the unique chemical composition. In addition to the X-ray mapping, we surveyed COS grains using contrast difference of back scattered electron image in this study.

Results: Totally 262 COS grains were found in two thin sections of Acfer 094 including previous study [3]. Areas of ten X-ray maps contained 100 COS grains (Table 1). The yellow and red points in Fig. 1 show positions of COS grains in the thin section of Acfer 094#2. Squares indicate X-ray mapping areas.

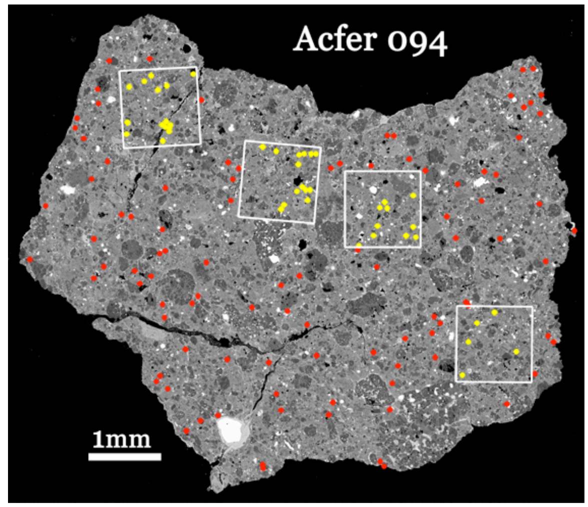

Fig. 1. Back scattered electron image of Acfer 094#2 thin section. Square regions correspond to X-ray mapping areas of 1×1 mm^2. Yellow and red points indicate positions of COS grains embedded in the matrix.

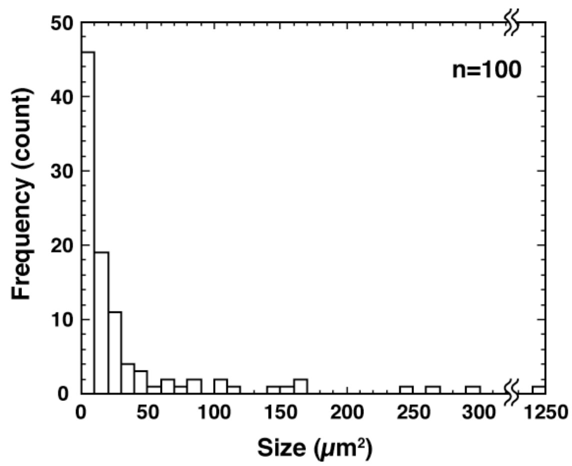

Fig. 2. Size distribution of COS grains from X-ray maps.

Table 1. Abundance of COS from X-ray maps in Acfer 094

Section	Map	Matrix (%)	Frequency (count)	Ave. size (µm^2)	Abundance (ppm)	Section	Map	Matrix (%)	Frequency (count)	Ave. size (µm^2)	Abundance (ppm)
#1	1	49	9	15.9	292	#2	1	66	10	23.3	344
	2	44	8	29.2	546		2	63	15	41.7	956
	3	64	5	14.4	116		3	60	14	16.2	382
	4	68	19	27.6	732		4	66	5	121.6	945
	5	58	2	16.6	54						
	6	68	13	134.0	2514	total		61	100	44.4	725

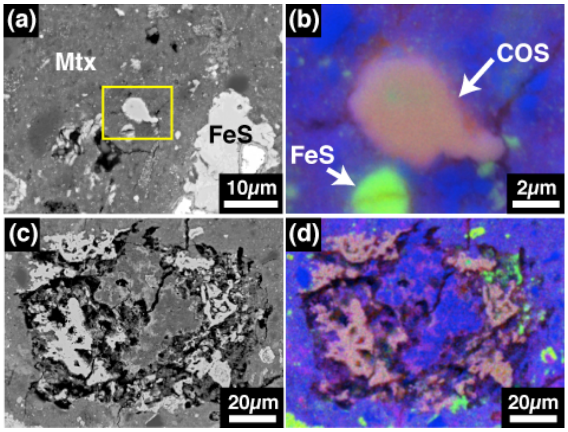

Fig. 3. (a,c) BSE images and (b,d) Fe-S-O RGB maps of COS grains in Acfer 094. COS grains appear as orange color in RGB maps.

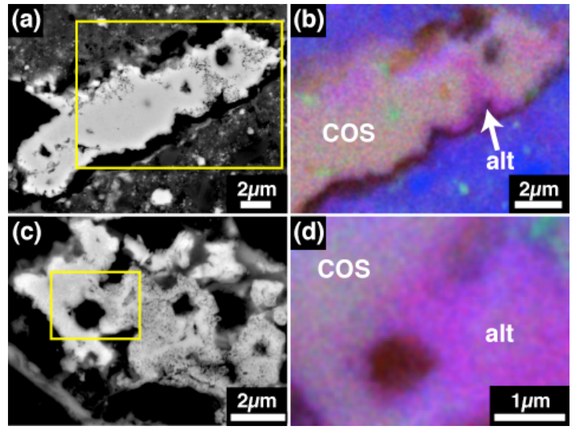

Fig. 4. (a,c) BSE images of COS grains partly depleted in sulfur. (b,d) Fe-S-O RGB maps of square regions in (a,c). alt indicates S-poor region.

COS grains distributed ubiquitously in Acfer 094 matrix (Fig. 1).

Fig. 2 shows size distribution of COS grains observed from X-ray maps. The minimum and maximum sizes observed are 0.9 μm^2 and 1241.3 μm^2, respectively. Because smaller COS grains are more abundant and the size distribution appears to follow power law, the observed minimum size would be limited by resolution limit of the X-ray mapping technique applied in this study. Fig. 3 shows occurrences of COS grains. COS appears as a characteristic orange color in the Fe-O-S RGB map (Fig. 3b,d). Isolated (Fig. 3a) and aggregated (Fig. 3c) COS grains were embedded in the Acfer 094 matrix. The aggregated COS grains contributed the abundances of COS in X-ray maps of 1×1 mm^2 rather than the frequencies of COS grains. The average size and volume abundance of COS normalized by matrix fraction (61%) were estimated from X-ray maps as 44.4 μm^2 and 725 ppm, respectively.

We found four COS grains partly depleted in sulfur whereas other COS grains have S contents homogeneously (Fig. 4). The S-poor regions contains darker wormy texture seems to be formed by aqueous alteration (Fig. 4a,c).

Discussion: Why are COS grains discovered only in Acfer 094? One possibility is that COS may be a local material for Acfer 094 because Acfer 094 is classified as ungrouped chondrite. However, the oxygen isotopic compositions of other components in Acfer 094 except for COS are not so different from those of other chondrites and the bulk oxygen isotopic composition is similar to those of CO chondrites [5]. It is difficult to find the reason why the COS is local.

Another possibility is that COSs have been decreased or erased in other chondrites. The existence of S-poor COSs indicate that COSs can be decomposed and changed its chemical composition. The absence of COS in aqueously altered dark inclusions in Acfer 094 infers that COSs had been decomposed in aqueous altered portions of Acfer 094 parent body [3]. Main mass of Acfer 094 largely escaped from aqueous and thermal processes [6] and classified as petrologic type 3.00 which means one of the most primitive object [7]. Absence of COSs in other chondrites including ALHA77307 (CO3.03) [8] suggests that COSs are easily decomposed by aqueous/thermal process on carbonaceous parent bodies. The presence of COS would be sensitive indicator of highly primitive objects.

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