**NANOSIMS O & S-ISOTOPE ANALYSES OF COSMIC SYMPLECTITE IN THE PRIMITIVE CHONDRITE ACFER 094**

L. G. Vacher¹, R. C. Ogliore¹, N. Liu¹ and J. B. Lewis¹, ¹Department of Physics, Washington University in St. Louis, St. Louis, MO, USA (lvacher@wustl.edu).

**Introduction:** Cosmic Symplectite (COS) are anomalous $^{17,18}$O-rich magnetite-sulfide grains ($\Delta^{17}$O = $\sim$90‰) found in the ungrouped carbonaceous chondrite Acfer 094 [1, 2]. They are thought to have formed from sulfidation and oxidation of Fe,Ni metal by H$_2$S and isotopically heavy water vapor. This $^{17,18}$O-rich water possibly originated from isotopic mass-independent fractionation (MIF) from CO photochemical self-shielding in the protoplanetary disk [3, 4].

Like for the O-isotopes, S-isotopes ($\Delta^{33}$S) may undergo MIF by UV photodissociation processes [5], but the magnitude of fractionation is smaller than for O-isotopes (only few per mil). Because COS has large O isotope MIF and contains $\approx$10 wt.% S [2], it is an important phase to investigate S-MIF in the early Solar System. Here we report petrographic and O-isotopic searches for COS in Acfer 094 and present preliminary results of S isotope measurements.

**Methodology:** COS candidates were identified from petrographic observations and SEM-EDS analyses using a Tescan Mira3 FEG-SEM (Fig. 1A). Oxygen isotope measurements on COS candidates were then performed with the Wash U NanoSIMS using a $\sim$2 pA primary beam focused to $\sim$100 nm. We acquired 10x10 µm scanning ion images of $^{16}$O, $^{18}$O, and $^{18}$O$_{18}$O using EMs. O isotope ratios of COS were normalized to their surrounding matrix, assumed to have the same composition as reported in [1]. 2σ errors were estimated to be $\approx$10‰ on $\Delta^{18}$O, $\approx$23‰ on $\Delta^{17}$O. Finally, we performed S-isotope ($^{32}$S, $^{33}$S and $^{34}$S) on these COS grains under similar analytical conditions as O isotopes. Because sulfide grains in CM-C1 chondrites fall along a mass-dependent fractionation (MDF) line [6], we corrected the $\Delta^{33}$S values of COS with micrometer sulfide grains located in the matrix that show reproducible $\Delta^{33}$S values ($\sigma$ $\approx$ 2‰), assumed to fall along a MDF line (i.e., $\Delta^{33}$S$_{sulfide}$ $\approx$ 0‰). 2σ errors were estimated to be $\approx$5‰ on $\Delta^{33}$S.

**Results and discussion:** The O-isotopic compositions of the three COS candidates reveal that these grains have anomalous O-isotopic signature compared to their surrounding matrix ($\delta^{17}$O $\approx$ $\delta^{18}$O $\approx$ 130-160‰; Fig. 1B), confirming their nature as cosmic symplectite [1, 7]. The S isotopic compositions of two COS grains are consistent with zero and one COS showed a hint of S-MIF anomaly at the 2σ level: $\Delta^{33}$S$_{COS}$ $\approx$ 6 $\pm$ 5‰ (Fig. 1C). If the COS S-MIF can be confirmed with a higher precision measurement, then this result suggests that a MIF process, e.g. UV photodissociation, for both O & S were recorded for some COS grains. The analytical uncertainties of our S isotope measurements by NanoSIMS ion imaging are too high (and dominated by systematics) to detect small mass-independent fractionation as expected for S-isotopes (only S-MIF $>$ 5‰ can be ruled out). Future S isotope analyses of a selection of identified COS using a Cameca ims 1280 are planned.


![Fig. 1](https://example.com/fig1.jpg)

Fig. 1 – (A) BSE image of a COS grain in Acfer 094. (B) $\delta^{18}$O vs $\delta^{17}$O showing the O-isotopic composition of the COS from this study and from [1]. Other data from [8] and references therein. (C) $\Delta^{33}$S plot showing $\Delta^{33}$S measurements in COS (this study) and in chondrites (Bulk CM: [9]; CM2 Pyrrhotite/Pentlandite: [6]; Organics: [10]). Errors are given as 2σ.