

ELEMENTAL ABUNDANCES IN PRESOLAR SiC: COMPARING GRAINS SEPARATED BY ACID RESIDUE AND GENTLE SEPARATION PROCEDURES J. Tizard¹, I. Lyon^{1*}, T. Henkel¹.

¹University of Manchester, School of Earth, Atmospheric and Environmental Sciences, Oxford Road, Manchester, M13 9PL, United Kingdom, email: julia.tizard@postgrad.man.ac.uk

Introduction: Presolar grains were first isolated eighteen years ago from primitive meteorites opening a new window to study individual stars [1]. SiC is one of the more abundant presolar grains and the most studied. Most grains fall into the 0.5-5 nm size range. Many thousands of grains examined so far have been isolated using acids to dissolve the solar system material around them [2]. There is good evidence that the acids etch the grain surfaces and may alter elemental and even isotopic ratios at least in the outer surfaces of the grains [3]. Recent studies by Bernatowicz et al. [4], who located 81 presolar SiC grains in a disaggregated Murchison whole rock sample also found 60 % of SiC grains to be coated with an apparently amorphous, possibly organic phase. An explanation is that grains may have been protected during their residence in the ISM by surface coatings, including simple ices. The composition of these outer layers may hold evidence of the grain's formation and passage through the interstellar medium. It is important to know if and how different treatments to separate out the presolar grains affect their chemical and physical make up.

We have recently developed a new, effective and non-destructive method of SiC isolation from meteorites by freeze-thaw disaggregation, size and density separation [5]. This new separation method, enriches SiC grains from ~ 6 ppm abundance in Murchison whole rock ~ 1% across the 0.4 - 17 μ m size range. Individual SiC grains are thinly distributed on high purity gold foil and are easily identified using Electron Probe Micro Analysis (EPMA) mapping. The method separates out SiC grains efficiently, is applicable to very small or rare samples, and avoids the harsh acid treatments that may alter possible amorphous or non-refractory coats on the grains.

Here we present preliminary results of Time of Flight Secondary Ion Mass Spectrometry (TOF-SIMS) analysis of 4 acid residue grains (from the KJG separation created in St Louis [2]), in particular looking at elemental abundance, which are given in atomic-% relative to silicon using relative sensitivity factors derived from silicate standards. This is part of an ongoing work to compare acid residue grains to grains separated using the new gentle separation procedure [5].

Acid Residue (AR) Grain Results: Four acid residue grains of between 1 and 2 microns deposited sparsely on high purity gold foil were analysed by TOF-SIMS using a pulsed (3-4ns) Ga primary ion gun rastered over a 3-5 micron area. The entire mass spectrum is stored for each pixel of the image so that any area of interest in the image may be analysed offline. Measurements require typically 1-4 hrs due to the low duty cycle of the

instrument. Several measurements were taken of each grain after thorough cleaning, to get rid of contamination from handling the sample in air. Individual measurements of both positive and negative secondary ions were made. Although most elements form positive secondary ions atoms such as the halogens more easily form negative ions due to their high electron affinity. Figure 1a and 1b show SEM images of two of the grains analysed.

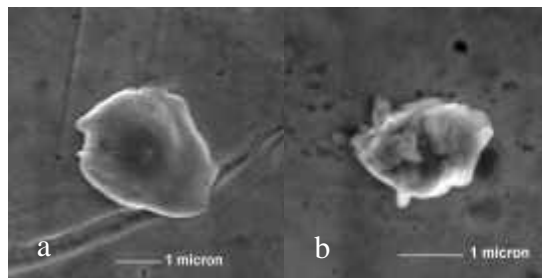


Figure 1a and 1b – SEM images of two of the acid residue grains studied

Figure 2 shows the elemental abundances relative to Si in each of the grains studied. Among these Li, B and Al show high variations of more than two orders of magnitude whereas Mg, Ca, Cr and Cu show only small variations of less than one order of magnitude. Most elements have trace atomic abundances below 1% relative Si except B (see below), Al and Cu. Na and K are very strongly correlated showing that they are from the same source and very likely contamination from handling the sample in air despite thorough cleaning and are therefore not discussed further.

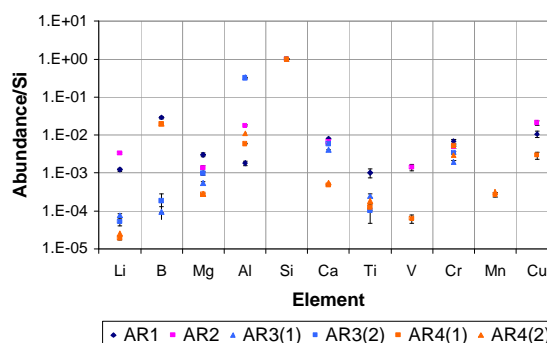


Figure 2. Elemental abundances of 4 acid residue presolar grains relative to silicon. Multiple measurements are numbered and are indicated by the number in brackets.

Mg and Ca fall in the range of 0.3 - 8 permil relative to Si, which is in agreement with previous studies. Al data mostly agrees with previous studies although one grain (AR3) displays unusually high content at ~33 atomic-% relative to Si. Chromium abundance is also unusually and consistently high ranging from 2-7 permil. None of the grains

showed isotopic anomalies in Cr. This may be explained as contamination from the $\text{Cr}_2\text{O}_7^{2-}$ used in the grain extraction process.

Boron shows a range in abundance of more than two orders of magnitude from trace amounts in two grains to 2-3 atomic-% relative to silicon in the other two grains. The $\delta(^{10}\text{B})$ -value for grain AR1 is 20 ± 180 and for grain AR4 is 70 ± 130 (measurement 1) and -70 ± 130 (measurement 2), respectively. The boron isotope ratios are terrestrial within one-sigma errors. However the large variability in abundance between the different grains is hard to explain as a contamination from the extraction process as that should effect all grains similarly therefore boron may be indigenous to the grain.

Further Work: These preliminary results show some interesting variations in elemental abundances between SiC grains. Further measurements and data processing are hoped to

help tie down any effects of the acid treatment separation process. Comparison of acid treated grain measurements with future measurements on grains separated by our new gentle separation method may help to distinguish between contamination in separation processes and reveal signatures of delicate accreted outer layers to the presolar grains.

Acknowledgements: This work is supported by PPARC who also provided a studentship for JMT. The major funding for the TOFSIMS instrument was provided by the University of Manchester through SRIF.

References: [1] Lewis R. S. et al. (1987) *Nature*, 326, 160-162. [2] Amari S. et al. (1994) *GCA*, 58, 459-470. [3] Henkel T. et al. (2001) *M&PS*, 36, A78. [4] Bernatowicz T. J. et al. (2003) *GCA*, 67, 4679-4691. [5] Tizard J. et al (2005) *M&PS*, in press.