A TRANSMISSION ELECTRON MICROSCOPE STUDY OF INTERNAL SUBGRAINS IN SIC-X GRAINS.

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Introduction: SiC-X grains comprise approximately 1% of the total presolar SiC population. Based on their isotopic compositions, these rare grains are thought to have a supernova origin [1]. While over 500 SiC grains have been studied by transmission electron microscopy (TEM), these grains were primarily mainstream grains and most have not been studied for their isotopic compositions [2]. Microstructure and phase information have been obtained for only two known SiC-X grains and there have been no previous reports of internal subgrains in them [3]. Here we present preliminary results from TEM studies on four SiC-X grains.

Experimental: SiC-X grain candidates from the KJG fraction (3 μm average size) from the Murchison meteorite were located by ion imaging (with the IMS-3f) and subsequently analyzed for their C and Si isotopic ratios with the NanoSIMS to confirm their origin. Four of these grains were then selected for TEM studies. The grains were placed in resin and sliced into ≤100 nm sections with a diamond ultramicrotome and subsequently studied in a JEOL 2000FX TEM equipped with a NORAN Energy Dispersive X-ray Spectrometer (EDXS).

Results: The four selected grains all have large ^{28}Si excesses (-309‰≤δ^{29}Si≤-187‰; -436‰≤δ^{30}Si≤-329‰), as well as ^{12}C/^{13}C ratios greater than solar (111‰≤^{12}C/^{13}C≤250‰). EDXS analysis shows that three of the grains have significant amounts of Mg, with Mg/Al ratios of up to ~0.67. The Mg and Al appear to be distributed uniformly, in agreement with previously studied SiC-X grains [3]. Because an insignificant amount of Mg typically condenses within SiC during formation (Mg/Al<0.05 in mainstream SiCs [4]), the Mg is likely radiogenic ^{26}Mg from the decay of ^{26}Al. The polytypes observed thus far in the SiC-X grains are the same as those found in mainstream SiC [2]. Most of the crystal domains analyzed in the SiC-X grains are consistent with the 3C-SiC polytype (79% of mainstream SiC), with a preponderance of ∑=3 twins. Also observed was one case of an intergrowth between the 3C-SiC and the 2H-SiC polytypes (17% of mainstream SiC). Unlike mainstream grains, which are predominantly single crystal domains [2], the SiC-X grains are composed of multiple small crystal domains, ranging in size from ~70-200 nm. Five subgrains were found within one of the SiC grains. Three of the subgrains are mainly Fe, with Ni/Fe ratios of 0.21 ± 0.07, 0.19 ± 0.03, and 0.18 ± 0.06. Significant Ti is seen in the third subgrain, although it is unclear at this time if the Ti is uniformly distributed or is in a separate subgrain. The other two subgrains are Ni-rich, with Ni/Fe ratios of 1.889 ± 0.279 and 0.41 ± 0.05. Preliminary TEM diffraction data from the Ni-rich subgrains do not appear to be consistent with the metal phases previously observed in subgrains found within presolar graphite [5]. Due to the SiC background, we cannot rule out the presence of Si in these subgrains, and silicides are, indeed, a possibility. Further investigation on the phases of these subgrains is ongoing.

References: [1] Amari S. et al. 1992. *ApJ* 394:L43-L46. [2] Daulton T. L. et al. 2003. *GCA* 67:4743-4767. [3] Stroud R. M. et al. 2004. *MAPS* 39:5039. [4] Amari S. et al. 1995. *Meteoritics* 30:679-693. [5] Croat T. K. et al. 2003. *GCA* 67:4705-4725.