MICROSTRUCTURAL ANALYSIS OF SUBGRAINS IN SIC GRAINS OF TYPE AB

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Introduction: SiC AB grains comprise ~5% of the total SiC population and are defined as having $^{12}C/^{13}C < 10$ [1]. These low C ratios, along with the wide range of $^{14}N/^{15}N$ ratios measured in AB grains ($40 \leq {}^{14}N/^{15}N \leq 10{,}000$) [2], are difficult to explain with standard nucleosynthesis models for asymptotic giant branch (AGB) stars. In addition, some AB grains have s-process enrichments of 3-5 times solar abundances, while others have solar abundances of s-process elements [3], suggesting AB grains most likely originated in two distinct types of astrophysical sources: J stars and born-again AGB stars [1]. Detailed microanalysis with the transmission electron microscope (TEM), coupled with isotopic analysis, can yield important insights into grain formation conditions as well as possible differences between AB grains and other types of SiC. Only a few AB grains have previously been structurally analyzed and none have been analyzed for their chemical compositions or for internal grains [4]. Here we report structural, chemical, and isotopic data on six AB grains, as well as on their internal subgrains, including observations of a new presolar phase.

Experimental: AB grains from the Murchison meteorite [5] were analyzed for their C, N, and Si isotopes in the NanoSIMS. Six grains were subsequently sliced to a ~70 nm-thickness with a diamond ultramicrotome for TEM analysis.

Results: All of the SiC grains in this study have $^{12}C/^{13}C$ and $^{29,30}Si/^{28}Si$ ratios typical of AB grains. Four grains have $^{14}N/^{15}N < 272$, while two have significantly higher $^{14}N/^{15}N$ ratios. Each AB grain was composed of epitaxially aligned crystal domains ranging in diameter from ~0.15-1.50 μm. Most of the domains are the 3C polytype, although one large crystal domain was consistent with the 2H polytype and another with a 2H-3C intergrowth. This is in agreement with a previous study of over 500 presolar SiC grains of all types, in which only the 3C and 2H polytypes were observed, with 3C being the most abundant [4]. Subgrains in the AB grains were identified by EDXS and microdiffraction. Five AB grains contained multiple TiC subgrains in a single slice of SiC. Although not previously directly observed in AB grains, isotopic and TEM studies of SiC grains indicate that TiC subgrains are common in all types of SiC except X grains, which originate in supernova outflows [6, 7]. Only one subgrain showed evidence of s-process enrichments, with a concentration of approximately $Ti_{94}Zr_6C$, indicating an s-process enrichment of over 10 times solar (relative to Ti). In addition to TiC subgrains, one AB grain also contained five subgrains that are compositionally consistent with CaS (oldhamite). While CaS is a predicted stable condensate in AGB stars [e.g., 8], it has not been previously observed in presolar grains. Three Fe-Ni-rich subgrains were also found in this AB grain, and in each case were located within ~50 nm of a CaS subgrain. Further investigation on the phases and crystallographic relationships of these subgrains is ongoing.

References: [1] Amari S. et al. 2001. *ApJ* 559:463. [2] Hynes K.M. and Gyngard F. 2009. *LPSC* Abstract #1198. [3] Amari S. et al. 1995. *Meteoritics* 30:679. [4] Daulton T.L. et al. 2003. *GCA* 67:4743. [5] Amari S. et al. 1994. *GCA* 58:459. [6] Gyngard F. et al. 2006. *MAPS* 41:A71. [7] Bernatowicz T.J. et al. 1992. *LPSC* XXIII 23:91. [8] Lodders K. and Fegley B., Jr. 1995. *Meteoritics* 30:661.