FIRST SYSTEMATIC TEM/NANOSIMS COORDINATED STUDY OF CRYSTAL STRUCTURE AND ISOTOPIC COMPOSITION OF PRESOLAR SILICON CARBIDE

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Introduction: Submicron- to micron-sized presolar grains of SiC are ubiquitous in the matrices of primitive chondrites. While numerous studies have measured the isotopic compositions in primary and trapped elements of individual presolar SiC grains [1], providing information on their stellar sources, there have been few detailed studies of their microstructure. Grain microstructures provide important information on mechanisms of grain formation, physical conditions at sources of formation, and metamorphic processing subsequent to formation. The value of isotopic and microstructural measurements on presolar SiC grains would be increased if those data sets were correlated to one another on an individual grain basis.

Results: Suspensions of SiC isolated by acid dissolution from Murchison (KJB residue) [2] were deposited on transmission electron microscopy (TEM) grids. Crystal structure of randomly selected grains was determined by TEM; three SiC polytypes or stacking sequences (cubic 3C, hexagonal 2H, and disordered) along with their intergrowths and a range of defect and twin microstructures were identified [3,4]. The locations on the TEM grid of 48 TEM-characterized grains of the following structure types, hexagonal 2H SiC (3% of Murchison SiC population); intergrowths of cubic 3C and hexagonal 2H SiC (17% of population); and disordered SiC (1% of population), were determined for use in subsequent isotopic measurement by NanoSIMS.

Forty randomly selected grains on the TEM mount, presumably mostly 3C SiC (79% of population), were analyzed by NanoSIMS as a control, and they exhibited a range of isotopic compositions similar to those measured in far larger presolar SiC populations [1]. As a group, the 2H, 2H/3C intergrowth, and disordered SiC structure types are isotopically anomalous and exhibit a greater scatter in both $\delta^{29}Si$ and $\delta^{30}Si$ in comparison to the predominantly 3C SiC set of randomly selected grains. All three measured 2H grains are isotopically mainstream. Of the 42 SiC 2H/3C intergrowth grains analyzed, one has $^{12}C/^{13}C = 8.7 \pm 0.8$ (i.e., < 10) and is identified as type A+B; two exhibit small enrichments in ^{28}Si and are possibly type X; one has $^{12}C/^{13}C = 110.3 \pm 2.3$ (i.e., > 100) with Si isotopes on the ^{30}Si-enriched side of the mainstream distribution and is identified as type Y; two have mainstream $^{12}C/^{13}C$ with Si isotopes on the ^{30}Si-enriched side of the mainstream distribution as well as $\delta^{29}Si < 0$ and are identified as type Z. We also confirm our earlier inference that one-dimensionally disordered SiC [3,4] is a presolar grain type. Interestingly, all three disordered grains analyzed have very similar isotopic compositions in $\delta^{29}Si$ (46 to 63‰), $\delta^{30}Si$ (34 to 57‰), and $^{12}C/^{13}C$ (51 to 60). Although the statistics are limited, the probability of three disordered grains clustering as observed in Si isotopes is $< \sim 3\%$, suggesting disordered SiC might be associated with a specific type of stellar source.

References: [1] Meyer B. S. and Zinner E. 2006. in *Meteorites and the Early Solar System II*, Lauretta D. and McSween Jr. H. Y. (eds) U. of Arizona Press. [2] Amari S. et al. 1994. *GCA* 58, 459-470. [3] Daulton T. L. et al. 2002. *Science* 296, 1852-1855. [4] Daulton T. L. et al. 2003. *GCA* 67, 4743-4767.