STUDY OF ASYMPTOTIC GIANT BRANCH STARS AND TYPE II SUPERNOVAE VIA NM-SCALE ISOTOPIC ANALYSES OF PRESOLAR SILICON CARBIDE BY ATOM-PROBE TOMOGRAPHY.

J. B. Lewis[1] C. Floss[1], D. Isheim[2], and D. N. Seidman[2] [1]Laboratory for Space Sciences, Physics Department, Washington University in St. Louis, St. Louis, MO, USA. jlewis@physics.wustl.edu, [2]Northwestern University Center for Atom-Probe Tomography (NUCAPT), and Department of Materials Science and Engineering, Northwestern University, Evanston, IL, USA.

Introduction: Four distinct types of mainstream silicon carbide (SiC) grains from asymptotic giant branch (AGB) stars have been identified [1], in addition to A and B SiC, which may also be from AGB stars [2]. A small fraction of presolar SiC grains are from core-collapse supernovae (SNII). These presolar SiC grains carry information about the processes active in the stars and stellar atmospheres in which they form. In AGB stars, third dredge-up influences the C/O ratio, which affects if and in what manner SiC condenses. He burning creates s-process isotopes, and cool bottom processing, hot bottom burning, and He core flash mixing create isotopic heterogeneities, which are incorporated into some SiC grains. For SNII, initial mass and metallicity, degree of zone mixing, and thermodynamic properties of the different zones in the expanding nebula affect the contents of SNII SiC. Solar wind at various energies during the AGB and subsequent white dwarf/planetary nebula stage [2], and, for SNII, shocks and reverse shocks [3,4], will implant ionized, sometimes fractionated isotopes into grains. Subgrains may co-condense with SiC, or form internally from elements in solid-solution [5]. Nanometer-scale spatially resolved analysis of presolar SiC can probe these phenomena, via analyses of the distributions of implanted and co-condensed noble gases, minor isotopes, and trace elements, including s-process isotopes, especially ^{138}Ba, ^{88}Sr, and noble gases Kr and Xe, as well as assessment of subgrains, grain boundaries, and Fe, Ti, Al, and Ni in solid-solution, and, for grains that have not been processed in acids, surface alteration [6].

Methods: Building on our previous tests [7–9], we are studying SiC grains using atom-probe tomography (APT) *in situ* and after acid separation from the matrix of carbonaceous chondrites. For APT we prepare samples at the apex of <100 nm diameter nanotips using focused ion beam (FIB) milling, and field-evaporate the sample ion by ion using high voltage and thermal pulsing from an ultraviolet laser, collecting 3-D position and time-of-flight spectral data with a 77% of the material from the analysis region. *In situ* studies have the potential to gather important information about surface alteration and initial grain size. The low-density fine-grained matrix causes, however, field-evaporation instabilities during APT analyses of average-sized (100–300 nm diameter) SiC grains [10]. Acid-separated grains can be embedded in a metal matrix that is more stable during field-evaporation using sputter- or metal-organic-precursor –deposition. Previous development of APT analysis of meteoritic nanodiamonds required a large amount of trial and error work; we are in the process of testing sample preparation and analysis methods for the SiC grains.

Results and Outlook: Initial attempts of APT analyses of 100–300 nm presolar SiC grains *in situ* collected data on olivine and pyroxene in small regions of fine-grained matrix material, but missed the SiC grains, revealing (1) the challenges with targeting ~100 nm-sized grains while FIB milling into an APT needle without backscatter contrast for identification of the grain; and (2) field-evaporation instability of the olivine/pyroxene matrix under APT analysis. We are in the process of implementing solutions: (1) including targeting meteoritic regions that are less altered by previous IB imaging and FIB liftouts, and using improved fiduciary markers for tracking the regions of interest. Potential solutions to (2) include coating the nanotip with different metals for improved thermal and electrical conductivity and using higher laser pulsing energies and base temperature for reducing mechanical stresses during APT analysis. In addition, we plan on preparing larger and smaller SiC grains for APT analyses and compositional comparison. Larger grains can be more easily prepared *in situ* or after separation. Multiple smaller grains can be deposited in a layer, similar to the methodology used for meteoritic nanodiamonds.

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