SURFACE STUDIES OF PRISTINE PRESOLAR GRAINS.
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Introduction: Presolar SiCs traversed the ISM and early solar system as solid objects, and surface alteration features from these environments may still be preserved on "pristine" grains (those extracted from meteorites without harsh chemical etching [1, 2]). Previous studies revealed C-rich amorphous surface coatings present on some pristine grains [1]. Prior NanoSIMS measurements on a coated grain showed indications of a ^{15}N-rich coating on a SiC grain with a bulk ^{14}N enrichment [3], which could conceivably result from low temperature interstellar chemistry [4]. We report results from ongoing SEM, Auger and NanoSIMS surface studies on pristine SiCs, which have revealed partial oxide layers on some uncoated SiCs.

Experimental Methods: Murchison matrix was extracted, ultrasonicated in an isopropanol-water mixture, and deposited on graphite planchets. Using x-ray spectral imaging, pristine SiCs were located based on high Si (and lower Mg and O) counts and grain size. Low-voltage field-emission (FE-SEM) images and Auger spectra (30-2300 eV) were acquired. NanoSIMS raster images of $^{12}C^-$, $^{13}C^-$, $^{16}O^-$, $^{12}C^{14}N^-$, $^{12}C^{15}N^-$ and secondary electrons were collected and analyzed as a function of depth.

Results and Discussion: All uncoated SiCs (those without visible amorphous coating in low voltage FE-SEM) showed bulk C and N anomalies consistent with mainstream SiCs ($58<^{12}C/^{13}C<78$ and $495<^{14}N/^{15}N<600$). Unlike a previously analyzed coated SiC [3], the N isotopic composition of the surface measurement layers were near normal, with bulk anomalies diluted towards solar values to varying degrees. The C and N isotopic ratios from the uncoated SiCs did evolve more quickly to the bulk values than those of coated SiCs, an indirect confirmation that the coated grains had surface material present that was isotopically distinct from the bulk. NanoSIMS ion images of 2 of 4 uncoated SiCs showed large surface regions (comprising ~25% of the SiC surface) with far higher O counts and solar C and N ratios. In both O-rich regions, the O enrichment and solar C and N ratios persisted through the entire measurement, suggesting a minimum thickness of ~100 nm. Pre and post-SIMS Auger spectra showed higher O content in these subregions. These O-rich regions were not visibly distinct in prior SEM images, which along with the above results suggests a true oxide layer (possibly SiO_2) on the SiC rather than an adhering matrix grain. In studies of SiC volatilization under solar nebula-like oxidizing conditions [5], partial SiO_2 layers (similar to our observations) were seen at lower oxygen fugacities (IW-6) but not at higher fugacities (IW-2.8) wherein continuous SiO_2 layers were seen. Our observations, combined with these experimental results, may thus constrain the oxidation conditions (e.g. O fugacity, temperature) to which these grains were exposed.

References: [1] Bernatowicz T.J. et al. (2003) *Geochim. Cosmochim. Acta* 67, 4679-4691. [2] Lyon I. C. et al. 2007. *Meteoritics & Planetary Science* 42:373-385. [3] Croat T. K. 2007. Abstract #1887. 40th Lunar & Planetary Science Conference. [4] Sandford S. A. et al. 2007. *Meteoritics & Planetary Science* 36:1117-1133. [5] Mendybaev R.A. et al. (2002) *Geochim. Cosmochim. Acta* 66, 661-682.