X-RAY ABSORPTION NEAR-EDGE SPECTROSCOPY OF SUPERNOVA CARBONACEOUS GRAINS.

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Introduction: Transmission electron microscopy and Raman spectroscopy have been previously used with great success to characterize presolar carbonaceous grains and infer useful astrophysical information about their formation conditions [1-3]. Here, we report the first application of synchrotron transmission X–ray microscopic (STXM) techniques to meteoritic graphitic grains with isotopic compositions indicating a presolar formation in Type II supernovae.

Samples and Methods: We analyzed ultramicrotome slices of two presolar graphites: KE3-e6, from Murchison [2], and OR1d5m-G15 (ORG15), from Orgueil. STXM measurements were performed at beamline 5.3.2.2 of the Advanced Light Source (Lawrence Berkeley National Lab). X-ray Absorption Near-edge Spectroscopic (XANES) analyses were made in "image stack" mode, wherein the sample is moved in a raster pattern under the <50nm X-ray beam and a complete absorption spectrum is acquired at each pixel. XANES stacks were acquired at the C, N and O K-edges and the Ti $L_{2,3}$ edge.

Results and Discussion: Isotopic analyses of the two graphite grains indicate a SN origin, *e.g.*, ^{18}O, ^{15}N and ^{28}Si excesses. TEM analysis of the analyzed slice of KE3-e6 indicates a turbostratic graphite morphology and several Ti-rich sub-grains. The C-edge XANES spectrum for this grain shows typical graphite features at 285.2 and ~291 eV, due to 1s π^* and σ^* transitions, respectively, as well as a small feature at 288.6 eV. This is probably due to C=O bonding (also seen in the O K-edge spectrum), suggesting that the observed O is bonded to the graphene layers as a lactone. N-XANES spectra reveal significant N contents and an absorption feature at ~401 eV, possibly indicating amide-type bonding. Ti- and O-XANES spectra of five Ti-rich sub-grains indicate that one is most likely TiO_2, and the rest TiC. However, the spectra suggest the presence of some O (and N) even in the TiC grains, as previously inferred from SIMS measurements of other supernova grains [4]. The STXM data for grain ORG15 indicate a "cauliflower-like" morphology and a C-XANES spectrum slightly different from that of KE3-e6. Rather than a single sharp 1s π^* feature at 285.2 eV, ORG15 shows features at 284.8, 285.4 and to a lesser extent at 287.5 eV. Most likely, this grain consists of a composite of graphitic C with some smaller, well-organized PAH-like material. In contrast, the N-edge spectrum for ORG15 is similar to that of KE3-e6. Our preliminary results demonstrate the utility of XANES analysis of graphitic presolar grains. In future studies, we will probe the chemistry of Fe-rich sub-grains and the C-edge structure of grains for which Raman spectra indicate a strongly disordered nature [3].

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