

**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<sub>2,3</sub> edge.

**Results and Discussion:** Isotopic analyses of the two graphite grains indicate a SN origin, e.g., <sup>18</sup>O, <sup>15</sup>N and <sup>28</sup>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  $\pi^*$  and  $\sigma^*$  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<sub>2</sub>, 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  $\pi^*$  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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**References:** [1] Bernatowicz T. J., et al. (1996). *Astrophysical Journal*, 472, 760-782. [2] Croat T. K., et al. (2003). *Geochimica et Cosmochimica Acta*, 67, 4705-4725. [3] Zinner E., et al. (1995). *Meteoritics*, 30, 209-226. [4] Stadermann F. J., et al. (2005). *Geochimica et Cosmochimica Acta*, 69, 177-188.