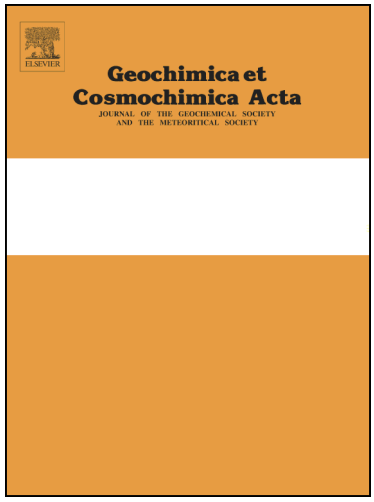

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Correlated XANES, TEM, and NanoSIMS of Presolar Graphite Grains

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Abstract

We report correlated XANES, TEM, and NanoSIMS measurements of twelve presolar graphite grains extracted from primitive meteorites and for which isotopic data indicate predominantly Type-II supernovae origins. We find continued evidence for isotopic heterogeneities in presolar graphite grains, including the first observation of a radial gradient in the inferred initial $^{26}Al/^{27}Al$ within a presolar graphite grain. The XANES spectra of these samples show a variety of minor absorbances near the C K-edge, attributable to vinyl-keto, aliphatic, carboxyl, and carbonate molecules, as well as possible damage during sample preparation. Each sample exhibits homogeneous C K-edge XANES spectra within the graphite, however, showing no correlation with isotopic heterogeneities. Gradients in the isotope ratios of C, N, O, and Al could be due to both processes during condensation, e.g., mixing in stellar ejecta and granular transport, and post-condensation effects, such as isotope dilution and exchange with isotopically normal material in the early Solar System or laboratory, the latter of which is a significant issue for high-density presolar graphite grains. It remains unknown whether the mechanisms behind isotope exchange would also affect the local chemistry and therefore the XANES spectra. Ti L-edge XANES from most Ti-rich subgrains match standard spectra for TiC and potentially TiCN. A rare rutile (TiO_2) subgrain has been identified, though it lacks the lowest energy L_3 peak typically seen in standard spectra. Ca has also been identified by EDXS in TiC subgrains, likely due to the decay of live ^{44}Ti at the time of formation. Future NanoSIMS measurements will determine the variability of initial ^{44}Ti in TiC subgrains, an important constraint on mixing in the ejecta of the grains' parent supernovae.