Presolar SiC Grains of Type AB with Isotopically Light Nitrogen: Contributions from Supernovae?

P. Hoppe[a], M. Pignatari[b] and S. Amari[c]

[a]*MPI for Chemistry, Mainz, Germany,* [b]*University of Hull, UK,* [c]*Washington University, St. Louis, USA*

Primitive solar system materials contain small concentrations of presolar grains that formed in the winds of evolved stars and in the ejecta of stellar explosions [1]. Presolar SiC is the best studied presolar mineral. Among them are so-called Type AB grains which have low ^{12}C/^{13}C ratios of $\leq$ 10. This population of presolar SiC grains appears to originate from multiple types of stellar sources, namely, supernovae (SNe) for grains with isotopically heavy N (^{14}N/^{15}N $<$ 440) [2], and born-again AGB stars [3] and in particular J-type carbon stars for grains with isotopically light N (^{14}N/^{15}N $\geq$ 440) [4].

Here, we report on high resolution ($<$ 100 nm) measurements of C-, N-, Mg-Al-, Si-, and S-isotopic compositions of 10 SiC AB grains from Murchison separate KJD (median size 0.81 μm) [5] conducted with the NanoSIMS ion probe at MPI for Chemistry with Cs and Hyperion O ion sources. Except for one grain with the highest ^{12}C/^{13}C ratio we find good correlations between ^{12}C/^{13}C, ^{14}N/^{15}N, and ^{26}Al/^{27}Al. There is an almost perfect 1:1 correlation between Al and N concentrations, suggestive of AlN and low levels of contamination. Magnesium is essentially monoisotopic ^{26}Mg from ^{26}Al decay (half life: 0.72 Myr). Sulfur isotope anomalies are generally small and Si-isotopic compositions plot along the SiC mainstream line. Four of our AB grains have light N with ^{14}N/^{15}N up to 1000. The correlations between C-, N-, and Al-isotopic ratios are well explained by the 25 $M_{\odot}$ SN model 25T-H of [6] when matter from the O/nova zone, which experienced explosive H burning, and above (6.847-13.3 $M_{\odot}$) is mixed with matter that experienced only partial H burning, taken from the outer layers in the 12 $M_{\odot}$ model of [7], as suggested by [2], and if the ^{12}C/^{13}C ratio in the 25T-H model is decreased by a factor of 3. The comparison of our data with model 25T-H suggests that SNe might have contributed not only AB grains with heavy N but also some of those with light N.

References

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