ON THE STELLAR SOURCES OF HIGH-DENSITY PRESOLAR GRAPHITE GRAINS.

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Introduction: Low- and high-density presolar graphite grains have different stellar origins as revealed by their isotopic compositions [1]. Low-density grains have ^{15}N, ^{18}O, and ^{28}Si excesses as well as large inferred $^{26}Al/^{27}Al$ ratios, and some grains show evidence for the initial presence of ^{44}Ti. These isotopic signatures have been interpreted as evidence for an origin in Type II supernovae [2]. The stellar origin of high-density (HD) grains is less well understood. They generally do not have N and O isotopic anomalies and lack evidence for initial ^{26}Al and ^{44}Ti. Most HD grains have high $^{12}C/^{13}C$ ratios and this and $^{29,30}Si$ excesses in some grains have been taken to indicate an origin in low-metallicity AGB stars [3, 4]. However, this applies at best for the majority of the grains. A few grains show evidence for ^{44}Ti and must have a SN origin. Another few HD grains have low $^{12}C/^{13}C$ ratios and extremely large excesses in $^{42,43}Ca$ and $^{46,49,50}Ti$. It has been proposed that these signatures indicate an origin in so-called born-again AGB stars, of which Sakurai's object is an example [5].

Investigation: We compare the Ca and Ti isotopic ratios measured in the HD graphite fraction OR1f from the Orgueil carbonaceous chondrite [6 and unpublished data] with theoretical models of the isotopic compositions in the envelope and the He shell of AGB stars with a range of masses and metallicities. He-shell compositions could explain the Ca and Ti isotopic compositions of grains for which a born-again AGB origin had been proposed. Such stars have lost most of their envelope and the Ca and Ti isotopic ratios on the surface reflect those of the He-shell. A sizeable fraction of the remaining grains have Ca and Ti anomalies that, while being smaller than those of the born-again grains, are much larger than those predicted for the envelope of AGB stars with masses 2, 3 and 5 $M_\odot$ and metallicities Z down to 1/6 the solar value. $^{42,43,44}Ca$ excesses in quite a few grains are within the range predicted for the He-shell of $M=3M_\odot$ and $Z=Z_\odot$ or $M=2M_\odot$ and $Z=1/6Z_\odot$ AGB stars. On the other hand, predictions of these models are larger than the $^{46,47,49,50}Ti$ excesses measured in the grains, which are better matched by $M=2M_\odot$ and $Z=Z_\odot$ models. However, most of these grain have high $^{12}C/^{13}C$ ratios, whereas Sakurai's object has a low ratio and models of born-again AGB star also predict a low ratio [7]. It is quite unlikely that a fairly large fraction of presolar graphite grains are from born-again AGB stars. Type II SN models also predict large Ca and Ti anomalies [8]. However, the HD grains with Ca and Ti anomalies lack the N, O, Si and Al isotopic SN signatures shown by LD grains. Furthermore, certain ratios such as $^{49}Ti/^{46}Ti$ are not well matched by SN models. The stellar origin of HD grains with intermediate Ca and Ti anomalies remains enigmatic.

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