SILICON AND TITANIUM ISOTOPES IN SiC FROM AGB STARS;
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We are modelling the abundances in both the He-burning shells of
asymptotic-giant-branch (AGB) stars and in its envelope as shell material
is dredged up and mixed into it. The envelope mass is declining owing to
mass loss (prescribed at a standard but uncertain rate), and it is becoming
more carbon-rich as newly synthesized C is dredged up along with the
neutron-irradiated material. In this report we compare the calculated Si
isotopes in SiC particles with the anomalous compositions of those
particles as measured [1,2]. We take all nuclei in the He shell to receive the
same neutron fluence in each AGB pulse, probably in the range Δτ =0.05-0.2
n/mb. The fraction r of shell matter remaining for the next irradiation
probably lies in the range r=0.5-0.9 [3], and is sometimes taken to have a
constant value that can be varied as a parameter but which we determine
for each pulse by an astrophysical model of the AGB envelope and its mass
loss and shell mass primarily from published analytic models by Renzini
and Voli [4]. If these stars are also the dominant site of s-process
nucleosynthesis, then their composite must average an exponential
distribution exp(-τ/τ₀), where τ₀= -Δτ/ln(r); but we do not at this time
require that constraint because it cannot be asserted that the SiC particles
have sampled the average s process. For the Si isotopes we take neutron
cross sections advocated by the Karlsruhe team [5], namely 2.9mb1
7.8mb1
and 6.3mb for 28,29,30Si respectively.

Figure 1a shows the calculated evolution of the Si isotopes within the
He shell in a 3-isotope plot as the pulses proceed in a 5M₆ star in which it
is assumed that Δτ =0.071 n/mb per pulse; and Fig.1b shows the envelope
composition with our mixing prescription. That specific pulse and
dredgeup that first turns the atmosphere C-rich is shown as an asterisk along the
dotted evolution path. The line of unit slope is shown solid as an aid to the
eye. In Fig. 1a one sees that the initial slope in the shell is greater than
unity, similar to measurements [1,2], but only for those first few pulses
while the star is still O-rich. The star becomes C-rich only near the end of
this path in the 3-isotope plot, and the large number of subsequent pulses
move it very little more. We do not find the very 30Si-rich composition
calculated by Gallino et al.[3]. Of more relevance to the SiC particles, which
must form in the envelope in order that its carbon not be too 12C-rich, is
the evolution of that envelope. Fig.1b reveals that the dilution of the
dredged up Si by envelope Si greatly reduces the size of the anomalies and
lies near slope 1. The largest envelope anomalies occur after the transition
to C star, with 30Si =100-250 ppm. Such magnitudes are similar to those
measured [1,2] in SiC, but fall near the slope 1 line rather than a slope 1.4
line that is suggested by the measurements [1,2]. We continue to seek the sensitivity of this result to uncertainties in the model: $\Delta T$, $r$, mass, mass loss rate, etc.

![Graph showing Si isotopes in 5M$\odot$ thermally pulsing AGB star. Both overlap $r$ and mass loss are prescribed by astrophysical model [4]; $\Delta T = 0.071$ is chosen.](image)

Fig.1a,b. Si isotopes in 5M$\odot$ thermally pulsing AGB star. Both overlap $r$ and mass loss are prescribed by astrophysical model [4]; $\Delta T = 0.071$ is chosen.

A promising s-diagnostic of SiC may be sought in the isotopes of Ti, initially predicted [6] to be huge $^{50}\delta$, big $^{49}\delta$, large negative $^{48}\delta$, moderate negative $^{47}\delta$, and moderate $^{46}\delta$. This pattern seems to be now be discovered [7], after renormalizing the $^{48}$Ti deficiency to normal.

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