IRON AND NICKEL ISOTOPIC COMPOSITIONS OF PRESOLAR SiC Z GRAINS AND A MYSTERIOUS SiC GRAIN OF UNKNOWN ORIGIN

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Introduction: Approximately 1% of presolar SiC grains are of Type Z, characterized by comparatively large $^{30}Si/^{29}Si$ ratios [1]. These grains are thought to have formed in the ejecta of low-metallicity AGB stars, and as such represent good tracers of Galactic Chemical Evolution. Here we report new isotopic measurements of the Fe-Ni compositions of three Z grains, as well as one accidentally measured SiC grain of unknown type with the largest Fe isotopic anomaly ever observed.

Experimental: A residue (IH6) composed mostly of SiC and Si_3N_4 grains from the Indarch enstatite chondrite (EH4) was automatically mapped [2] for $^{12,13}C$, $^{12}C^{14}N$, $^{12}C^{15}N$, and $^{28,29,30}Si$ isotopes in multi-collection with the Carnegie NanoSIMS 50L. After SEM imaging, candidate Z grains were selected for further studies based on their physical separation from nearby grains. Two instrumental setups (consisting of two magnetic field steps each) were used to measure the Fe-Ni isotopic compositions. In the first, $^{54,56,57}Fe$ and $^{58,60,61,61}Ni$ were measured in one magnetic field step, and ^{52}Cr and $^{28}Si_2$ (for locating the grains) in the other step. The other setup consisted of ^{28}Si, ^{52}Cr, $^{54,56,57}Fe$, and $^{58,60}Ni$ in the first magnetic field step and $^{61,62}Ni$ in the second.

Results: The candidate Z grains chosen for study were selected based on their enrichments in ^{30}Si relative to the mainstream correlation line, as has been done previously [3-5]. Due to extreme difficulty in re-locating many of the grains in the NanoSIMS, only three Z grains were able to be successfully analyzed for their Fe-Ni compositions. Two of the grains have isotopically normal Fe and Ni, within 2σ uncertainties. This is not unexpected as many Z grains analyzed previously [5] have shown no anomalies in Fe and Ni, though this may be simply due to poor statistics from low Fe-Ni elemental concentrations. Z grain f3-2-14-6 has a large enrichment in ^{54}Fe ($\delta^{54}Fe/^{56}Fe = 620 \pm 230$ ‰) – its Ni (as well as other Fe) isotopic compositions are normal. As observed before [5, 6], ^{54}Fe excesses are unexpected; grains believed to come from low-metallicity stars are predicted to have ^{54}Fe deficits [6]. In an attempt to locate and measure a Type C SiC grain (e2-3-4 [7]), we inadvertently measured a nearby SiC grain that had not been analyzed for its C, N, or Si isotopic compositions; however, it has an Fe composition of $\delta^{54}Fe/^{56}Fe = 2200 \pm 150$ ‰ and $\delta^{57}Fe/^{56}Fe = 1860 \pm 230$ ‰. The grain's Ni isotopic composition is solar within 2σ errors. This grain was not measured during the automated measurements; yet, re-analysis of the overview ion image taken of the area containing the grain during automated scanning reveals it to have a $^{12}C/^{13}C$ ratio of ~30. Unfortunately, its N and Si compositions are not diagnostic enough to definitively assign it to a given grain type, due to low count rates in the ROI of the grain. More measurements of Z grains and the Type C grain are planned for the future.

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