Ba and Sr in Mainstream SiCs: Condensation or Implantation?

N. Liu[1,2], A. M. Davis[1], M. R. Savina[2], R. Gallino[3], N. Dauphas[1] and M. J. Pellin[1,2]

[1]Dept. of the Geophysical Sciences, Univ. of Chicago, Chicago, IL 60637 (lnsmile@uchicago.edu)
[2]Materials Science Div., Argonne National Laboratory, Argonne, IL 60439
[3]Dip. di Fisica, Univ. di Torino, Torino I-10125, Italy

Grain size-dependent trends of concentration and isotopic composition have been observed for a number of refractory elements, among which, Sr and Ba, in aggregates of SiC grains with different sizes (e.g., [1, 2]). It has been proposed that the cause of these trends is ion implantation into SiC grains and that the implantation efficiency of a nuclide depends on its ionic radius and ionization potential (IP) [3]. Consequently, this model would predict that Cs and Ba were coimplanted into SiCs. We obtained abundances of the two *p*-process isotopes, ^{130}Ba and ^{132}Ba, in 12 mainstream SiCs. By comparing their abundances with respect to that of ^{135}Ba, we conclude that there is no measurable decay of ^{135}Cs to ^{135}Ba ($t_{1/2}$=2.3 Ma) in individual SiC grains, indicating condensation of Ba, but not of Cs, which would allow ^{135}Cs to decay into SiC grains.

In a study of correlated Sr and Ba isotopes in single acid-cleaned mainstream SiC grains using Resonance Ionization Mass Spectrometry (RIMS) [4], we obtained Sr/Ba atomic and isotopic ratios in ~90 SiCs (all the isotopes of the two elements were measured simultaneously). Both Sr and Ba were well saturated with the laser intensities used in this study, which indicates that they have the equal relative sensitivity factors in this analysis and can be compared quantitatively.

The maximum Sr/Ba ratio measured in the grains (~25) matches the predicted ratio (~30) in the convective envelope of AGB stars, indicating that both elements were incorporated into the SiCs by the same process, condensation. However, the grains show a range of lower Sr/Ba ratios extending down to ~0.3, suggesting lower condensation efficiency of Sr (e.g., lower condensation temperature) into SiC grains than that of Ba. On the other hand, Sr and Ba both belong to Group 2 elements (alkaline metals) and therefore have similar ionic radii. If Sr were implanted into SiC grains, Ba would be implanted with even higher efficiency because of its lower IP. The range and maximum of Sr/Ba ratios observed favor condensation into SiCs rather than implantation.

[1] Podosek *et al* (2004) *ApJ*, **605**, 960; [2] Zinner *et al* (1999) *ApJ*, **382**, 47; [3] Verchovsky *et al* (2003) *ApJ*, **607**, 611; [4] Liu *et al* (2014) *45 LPS*, **#2049**