THE CARBON-13 POCKETS IN AGB STARS AND THEIR FINGERPRINTS IN MAINSTREAM SIC GRAINS.

N. Liu[1,2], A. M. Davis[1,2,3], R. Gallino[4], M. R. Savina[1,5], S. Bisterzo[4], F. Gyngard[6], N. Dauphas[1,2,3] and M. J. Pellin[1,2,3,5]. [1]Chicago Center for Cosmochemistry. [2]Department of the Geophysical Sciences, [3]Enrico Fermi Institute, University of Chicago, Chicago, IL. [4]Dipartimento di Fisica, Universitá di Torino, Torino, Italy. [5]Materials Science Division, Argonne National Laboratory, Argonne, IL. [6]Laboratory for Space Sciences, Washington University, St. Louis, MO. E-mail: lnsmile@uchicago.edu.

Introduction: Asymptotic giant branch (AGB) stellar model predictions suffer from uncertainties in the major neutron source, $^{13}C(\alpha,n)^{16}O$. It is unclear what process(es) are responsible for mixing protons from the bottom of the convective envelope into the He-intershell to form the ^{13}C-pocket [1]. Thus, the concentration and profile of ^{13}C nuclei within the ^{13}C-pocket, as well as the ^{13}C-pocket mass are poorly known [1]. AGB model predictions for $^{88}Sr/^{86}Sr$, $^{138}Ba/^{136}Ba$, and $^{92}Zr/^{94}Zr$ ratios strongly depend on the ^{13}C-pocket adopted in AGB models, because: 1) neutron-magic nuclei (^{88}Sr and ^{138}Ba) behave as bottlenecks in the *s*-process path due to their low Maxwellian-averaged neutron-capture cross sections (MACS) [2, 3]; and 2) the ^{92}Zr MACS deviates from $1/v_T$ rule, while the ^{94}Zr MACS closely follows the rule at relevant AGB temperatures [4]. Thus, Sr, Zr, and Ba isotope ratios in mainstream SiC grains from low-mass AGB stars can provide stringent constraints on the ^{13}C-pockets.

Results: Acid-cleaned presolar SiC grains from Murchison were used for Ba, and correlated Sr and Ba isotope measurements with CHARISMA at Argonne National Laboratory [2, 3]. Carbon and Si isotopes were measured afterwards by NanoSIMS.

Discussions: We compared mainstream grain data with AGB model with varying ^{13}C-pockets. We found that although small ^{13}C-pockets with flat ^{13}C profiles can explain some unusual $^{138}Ba/^{136}Ba$ and $^{92}Zr/^{94}Zr$ ratios in mainstream SiC grains, in most of the cases, it is impossible to distinguish the effect of ^{13}C-pocket mass from that of ^{13}C concentration using only one isotope tracer [2, 4]. We therefore simultaneously measured Sr and Ba isotope ratios in mainstream SiC grains [3]. Comparison of AGB model calculations with the grain data shows that $^{88}Sr/^{86}Sr$ predictions strongly depend on the ^{13}C concentration, while $^{138}Ba/^{136}Ba$ predictions depend on both the ^{13}C concentration and the ^{13}C-pocket mass. Correlated $^{88}Sr/^{86}Sr$ and $^{138}Ba/^{136}Ba$ ratios allow us for the first time to resolve the effect of ^{13}C-pocket mass from that of the ^{13}C concentration within the pocket, which points towards the common existence of large ^{13}C-pockets with relatively dilute ^{13}C concentrations in parent AGB stars. Formation of such large ^{13}C-pockets requires occurrence of multiple mixing processes, which could be caused by overshoot, gravity waves and/or magnetic buoyancy [e.g., 5, 6, 7] along the boundary between the bottom of the convective envelope and the He-intershell in AGB stars, perhaps related to rotation rate [8].

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