TRACE ELEMENTS IN PRESOLAR SIC GRAINS: CONDENSATION Vs IMPLANTATION

K. K. Marhas[1,2], P. Hoppe[2] and U. Ott[2]. [1]Laboratory for Space Sciences and Physics Department, Washington University, St. Louis, MO 63130, USA. E-mail: kkmarhas@wuphys.wustl.edu. [2] MPI für Chemie, Becherweg 27, D-55128 Mainz, Germany.

Introduction: Trace elements in various individual presolar grains serve as a tool to understand the chemical and physical conditions during the formation of presolar grains (in expanding envelope/ejecta of stars). Two scenarios that have been discussed to incorporate trace elements within the forming presolar SiC grains are: (a) condensation of trace elements as solid solutions [1, 2]. The abundances will be a function of C/O ratio, pressure, volatility and crystal structure; and (b) ion implantation of trace elements into the SiC grains. In this case abundances depend on the ionization potential of the respective element [3]. Noble gas data for presolar SiC grains indicate that ion implantation plays an important role. Quantifying the fraction of implanted trace elements might give a better idea on the physical conditions under which SiC condensation takes place.

Experimental: We have measured 32 individual mainstream SiC grains, 7 SiC-agglomerates and 17 single X-grains from the Murchison and Murray meteorites using the NanoSIMS at Max-Planck-Institute for Chemistry at Mainz for Ba isotopes (except ^{130}Ba, ^{132}Ba) along with the most abundant isotopes of selected trace elements (Sr, Zr, Cs, La and Ce) [4].

Results: The trace element characteristics (normalized to Si and CI) can be summarized as follows: (1) There is a spread of two orders of magnitude for the concentrations of all trace elements, except for Cs which varies by 7 orders of magnitude. The data obtained for bulk samples of Murchison KJA-KJG grains [1] for Ce, La, Sr, Zr are compatible with those of the mainstream grains analyzed in this work. (2) There is no systematic difference between the trace element concentrations of the 17 X grain and single mainstream grains and the agglomerates. (3) Normalized Sr abundances are on average lower than Ba by an order of magnitude. (4) Except for Cs and Zr, correlations exist between Ba and the other trace elements, that is, [Ba]-[La], [Ba]-[Ce] and [Ba]-[Sr]. (5) Zr, La, Ba and Ce are enriched relative to Si and CI, whereas most of the SiC grains are depleted in Sr. (6) There is a rough negative correlation between concentrations of Ce, Ba, La, and Sr and grain size. This trend even extends to the larger KJH grains (3.4-5.9 microns) studied by [1].

The existence of a negative correlation between grain size and trace element concentration implies that at least some fraction of the Ba and other trace elements were implanted into the mainstream SiC grains. It has been proposed that 60 % of the Ba in SiC was trapped by ion implantation [3] and that the rest co-condensed into the SiC grains. The ion implantation scenario is also favored by trace element data from ICPMS measurements on bulk SiC [5]. Clearly, more theoretical work needs to be done in order to get a better understanding on how the trace elements were incorporated in presolar SiC grains.

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