

JUST HOW MANY TYPES OF INTERSTELLAR CARBON?; P. Hoppe¹, S. Amari^{1,2}, E. Zinner¹ and R. S. Lewis², ¹McDonnell Center for the Space Sciences and Physics Department, Washington University, St. Louis, MO 63130, ²Enrico Fermi Institute, University of Chicago, Chicago, IL 60637.

Previous single grain C-isotopic studies of two carbon density fractions, KFA1 and KFC1 (see Fig. 1) from the Murchison carbonaceous chondrite indicate that C α , the carrier of Ne-E(L), consists of at least two types of round grains that differ in their density, C-isotopic composition, Ne-E(L) release temperature and trace element concentrations [1-3]. We have extended these studies by analyzing C and N isotopes in round carbon grains from two additional density fractions, KE1 and KFB1 (see Fig. 1); Mg and Si-isotopes were also measured in selected grains from KFA1 and KFB1. With the additional data (the fraction of round grains in KE1 is very small and only few could be measured) there now appear at least 4 different groups of carbon grains according to the C-isotopic composition (Fig. 1): 1) A cluster around $^{12}\text{C}/^{13}\text{C} = 10$ with densities between 2.10 and 2.20 g/cm³. 2) A cluster with $^{12}\text{C}/^{13}\text{C}$ from 20 to 60 and $\rho = 2.05 - 2.10$ g/cm³. These grains have higher ^{15}N excesses than grains in the other groups (Fig. 2), 3) Grains with C close to normal and $\rho = 2.05 - 2.15$ g/cm³. At least some of these grains must be interstellar as they have extremely high $(^{26}\text{Al}/^{27}\text{Al})_0$ ratios and/or large Si-isotopic anomalies (Figs. 3 and 4). 4) Isotopically light grains with $\rho = 2.10 - 2.15$ g/cm³. At present it is still unclear whether this group is subdivided any further since contamination with small amounts of isotopically normal carbon tends to reduce the measured $^{12}\text{C}/^{13}\text{C}$ ratio. Noble gas analysis by laser heating show that single grains of groups 1, 3 and 4 contain Ne-E(L) [4]; no members of group 2 have been measured so far. In view of the large range in C-isotopic compositions N-isotopic variations are surprisingly small (Fig.2). Except for a few extreme points the largest deviations are shown by grains of group 2, most of which have heavy N. It is unlikely that terrestrial N dominates the N-isotopic analyses since the grains with the largest N-isotopic anomalies don't have exceptionally high N contents and the N concentrations roughly correlate with Si concentrations. In their C- and N-isotopic compositions the carbon grains differ from interstellar SiC [5]. Grains with ^{13}C and ^{15}N excesses could possibly be from novae although the enrichments in these two isotopes fall by far short of theoretical expectations from these sources [6]. Grains with light C show the characteristics of He burning and could have formed from the He-burning shell either of pre-supernova stars or of Wolf-Rayet stars at the WC stage that had lost their H-burning envelope [7]. 11 out of 54 grains have fossil ^{26}Mg with inferred $(^{26}\text{Al}/^{27}\text{Al})_0$ ratios ranging up to 0.086 (Fig. 3); for the rest we obtained only upper limits. Members of all groups appear to have ^{26}Al although the highest $(^{26}\text{Al}/^{27}\text{Al})_0$ ratios are shown by grains with close to normal C and grains with very light C gave only upper limits.

Most grains have Si-isotopic compositions compatible with terrestrial within rather large uncertainties (a result of the low Si concentrations). The only grains whose Si-isotopic compositions differ from normal by more than 3σ are shown in Fig. 4. One of them (grain A) plots in the area occupied by unusual SiC grains sobriquet grains X [8]. While this carbon grain also has a $^{26}\text{Al}/^{27}\text{Al}$ ratio similar to those of grains X (0.1-0.6), its C and N isotopic compositions are significantly different ($^{12}\text{C}/^{13}\text{C} = 90$ compared to 170-2540 in grains X and $^{14}\text{N}/^{15}\text{N} = 238$ compared to 12-160 in grains X). We do not know whether the Si in carbon grain A is present in the form of SiC subgrains similar to TiC found in another graphite grain [9].

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