MURCHISON PRESOLAR GRAPHITE OF DIFFERENT DENSITY FRACTIONS: A RAMAN PERSPECTIVE.

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We have previously reported Raman measurements on individual presolar graphite grains from the Murchison separate LFC1, and found correlations between the surface morphology of individual grains (termed "onions" and "cauliflowers") and the degree of crystallinity as manifested in their Raman spectra [1]. These early measurements, however, were 1) made with a first-generation single-channel Raman microprobe (it took up to 8 hours to obtain a single spectrum, and thus the sample experienced a lot of laser-induced heating), and 2) were not done on density-separated grains. Here we revisit the Raman analyses of presolar Murchison graphite grains. We now have more knowledge and experience with presolar grains as well as better instruments and analytical protocols.

Before the grains were studied in the NanoSIMS (isotopic results have been reported in [2]), we Raman analyzed 103 individual grains from three density fractions: KFA1 (2.05-2.10 g/cm^3), KFB1 (2.10-2.15 g/cm^3) and KFC1 (2.15-2.20 g/cm^3). We observe a strong correlation between density and morphology. Most low-density KFA1 grains are "cauliflowers", whereas most high density KFC1 grains are "onions", with ambiguous in-between structures (termed "caulionions" [2]) occurring in all 3 density fractions. Few of the grains (2 or 3 of each density fraction) have kerogen-type Raman spectra with extremely wide 1st-order and no 2nd-order peaks (they are not further addressed here). The vast majority of the grains, however, have spectra with very narrow 1st- order peaks (D and G) and very strong 2nd- order peaks; their D/G intensity ratios can be used to infer the graphitic in-plane crystallite size or "structural order". Different density fractions of Murchison grains have different Raman spectra. The majority of KFA1 grains (19 of 21) are either so-called "glassy carbon" with D>G, or have very strong D peaks indicative of large structural graphitic disorder (or small size of ordered crystallographic domains); KFA1 D/G = 0.87 ± 0.31 (n=21). On the other hand, the KFC1 fraction is dominated by grains that have Raman spectra indicative of fairly well ordered graphite; KFC1 D/G = 0.35 ± 0.26 (n=38). The KFB1 grains are mixed, both in terms of their morphology and their Raman spectra but are closer to KFC1 than to KFA1 grains; KFB1 D/G = 0.44 ± 0.26 (n=41).

Our Raman findings for density-separated Murchison grains agree with our previous results for density-separated presolar Orgueil grains [3,4]: Low-density presolar sp^2-bonded carbon is very disordered or even amorphous (i.e., "glassy" in Raman spectroscopy lingo), whereas high-density presolar carbon is indeed well crystalline graphite. It is our hypothesis that those differences in bonding/crystallinity are due to the fact that low- and high-density grains come from different stellar sources [5,6].

References: [1] Zinner E. *et al.* (1995) *Meteoritics* 30, 209-226. [2] Xu Y. C. *et al.* (2012) *LPS* XLIII, Abstract #1094. [3] Wopenka B. *et al.* (2011) *LPS* XLII, Abstract #1162. [4] Wopenka B. *et al.* (2011) *MAPS* 46, A252. [5] Zinner E. *et al.* (2006) *Proceedings of Science* (NIC-IX) 019. [6] Amari S. *et al.* (2012) *LPS* XLIII, Abstract #1031.