High-density graphite grains from the Murchison meteorite

SACHIKO AMARI[1], ERNST ZINNER[1] AND ROBERTO GALLINO[2]

[1]McDonnell Center for the Space Sciences and Physics Department, Washington University, St. Louis, MO 63130, USA (sa@physics.wustl.edu)

[2]Dipartimento di Fisica, Università di Torino, I-10125 Torino, Italy (gallino@ph.unito.it)

Presolar grains are defined as grains that formed in the outflow of stars or in stellar ejecta, remained intact, and were incorporated into meteorites [1]. Studies of presolar grains have yielded vast information on nucleosynthesis, mixing in stellar ejecta, and the Galactic chemical evolution [1, 2]. Two major stellar sources of presolar grains are asymptotic giant branch (AGB) stars and core-collapse supernovae.

Presolar graphite grains have been extracted from Murchison (CM2) [3] and Orgueil (CI) [4], and analyzed for grains' isotopic ratios using noble gas mass spectrometry, and secondary ion mass spectrometry [5-7]. Murchison graphite grains exhibit a range of density (1.6 – 2.2 g/cm^3), and analyses of these grains show that isotopic properties depend on density [6]. Although $^{12}C/^{13}C$ ratios of these grains span for more than 3 orders of magnitude, from a few to a few thousand, the distribution of $^{12}C/^{13}C$ ratios of low-density grains (1.6 – 2.1 g/cm^3) show a broad distribution, while those of high-density graphite grains (2.1 – 2.2 g/cm^3) show two distinct peaks, one around 10 and the other around 400 – 630, many grains belong to the second peak. These high $^{12}C/^{13}C$ ratios (> 100) and Kr isotopic ratios of a bulk noble gas analysis indicate that high-density grains formed in AGB stars with metallicity (Z: mass fraction of elements heavier than He, $Z_{sun} = 2 \times 10^{-2}$) ranging from 3×10^{-3} to 6×10^{-3} [6].

Although it is not clear how much AGB stars with low-metallicity contributed to the solar system, high-density graphite grains give us a unique opportunity to probe into building blocks of the solar system.

[1] Lodders K. and Amari S. (2005) Chem. Erde **65**, 93-166. [2] Zinner E. (1998) Ann. Rev. Earth Planet. Sci. **26**, 147-188. [3] Amari S. *et al.* (1990) Nature **345**, 238-240. [4] Jadhav M. *et al.* (2006) New Astron. Rev. **50**, 591-595. [5] Amari S., Lewis R. S., and Anders E. (1995) Geochim. Cosmochim. Acta **59**, 1411-1426. [6] Amari S., Zinner E., and Gallino R. (2014) Geochem. Cosmochim. Acta **133**, 479-522. [7] Jadhav M. *et al.* (2013) Geochem. Cosmochim. Acta **113**, 193-224.