Presolar Graphite: Insight into Redox Conditions in CO Nova Ejecta

P. HAENECOUR[1], J. Y. HOWE[1,2], T. J. ZEGA[1], P. WALLACE[1], S. AMARI[3], C. FLOSS[3], K. LODDERS[3], K. KAJI[4], T. SUNAOSHI[4] AND A. MUTO[2].

[1]The University of Arizona, Tucson, AZ, USA.
[2]Hitachi High-Technologies America Inc., Clarksburg, USA.
[3]Washington University in St. Louis, St. Louis, MO, USA.
[4]Hitachi High-Technologies Corp., Hitachinaka, Japan.

Several studies have suggested that a small fraction of presolar grains (< 0.01%), characterized by unusual isotopic compositions, may have originated from nova ejecta [1-6], consistent with other estimates that dust from ONe and CO novae contributed only a small fraction (0.1%) of the dust in the interstellar medium (ISM) [7]. While all previously reported putative nova grains are believed to have formed in ONe novae, a recent study reported a presolar graphite spherule, LAP-149, with isotopic compositions (e.g., C, N, Si, S) consistent with an origin in a low-mass CO nova ejecta [3]. Here we report on a detailed elemental and microstructural study of an O-rich inclusion inside of graphite grain LAP-149.

Using the Hitachi SU9000 30kV SEM/STEM and HF5000 200kV TEM/STEM at the University of Arizona, we carried out energy-dispersive X-ray spectroscopy (EDS), electron energy-loss spectroscopy (EELS) and selected-area electron-diffraction (SAED) analysis of grain LAP-149.

Our new TEM data indicate that the surface of the graphite grain is coated with a mixture of amorphous carbonaceous material and ferromagnesian silicate. Because LAP-149 was identified *in-situ* in a thin-section of the pristine chondrite, LAP 031117 [3], this rim does not reflect laboratory or parent body processing, but likely reflects pre-accretionary grain surface processing in the ISM or in the solar nebula.

STEM imaging and EDS maps also reveal the presence of a composite O-rich incusion inside LAP-149 that has heterogeneous distributions of Si and O, with both Mg-silicate and Fe-Al oxide present. SAED indicates that the inclusion is crystalline. While refractory inclusions were reported in presolar SiC and graphite [8], to our knowledge, this is the first confirmed identification of silicate and oxide grains inside of a presolar graphite grain. The identification of an O-rich inclusion composed of both Mg-silicate and Fe-oxide indicates spatial or temporal variations in redox conditions in the CO nova ejecta.

[1] Amari et al. (2001) *ApJ* 551, 1065. [2] José et al. ApJ 612, 414-428. [3] Leitner et al. (2012) *ApJL* 754, L41. [4] Haenecour et al. (2016) *ApJ* 825, 88. [5] José (2016) *CRC Press*. [6] Iliadis et al. (2018), submitted (arXiv). [7] Gehrz (1989) *Interstellar Dust*, 445-453. [8] Croat et al. (2014) Elements 10, 441-446.