COORDINATED TEM/STXM/IMS ANALYSIS OF A TYPE IIA CHONDRULE FRAGMENT FROM COMET 81P/WILD2 STARDUST TRACK C2052,2,74

Z. Gainsforth[1], A. L. Butterworth[1], L. Bonal[2], D. E. Brownlee[3], G. R. Huss[2], D. Joswiak[3], R. C. Ogliore[1], M. Telus[2], T. Tylic-zszak[4], A. J. Westphal[1], [1]U. C. Berkeley, USA, [2]Hawaii Institute of Geophysics and Planetology, University of Hawaii at Manoa, USA. [3]Astronomy Dept., University of Washington, USA, [4]Advanced Light Source, Lawrence Berkeley National Laboratory, USA

Introduction: We have conducted coordinated analyses by Synchrotron X-Ray Fluorescence Microscopy (SXRF), Scanning Transmission X-ray Microscopy (STXM), and Transmission Electron Microscopy (TEM) on a single 10 µm x 20 µm grain named Iris returned by NASA's Stardust mission (track C2052,2,74)[1].

Analysis: Iris consists of olivine, low-Ca clinopyroxene, mesostasis glass, chromite and iron sulfide. We have determined the composition of the chromite as 46 wt% Cr_2O_3, 28 wt% FeO, 17 wt% Al_2O_3, 6 wt% MgO, 1.5 wt% TiO_2, 0.8 wt% MnO, 0.6 wt% V_2O_3. From the stoichiometry we estimate $Fe^{3+}/\sum Fe \approx 20\%$. Near edge spectra of the chromium $L_{2,3}$ absorption edge shows evidence for partial reduction from the nominal Cr^{3+} to Cr^{2+} which supports oxidation of Fe^{2+} to Fe^{3+} to maintain stoichiometry[2]. V and Mn values could not be attained via EDX because of interference in V Kα from Ti Kβ and Mn Kα from Cr Kβ. However, V $L_{2,3}$ and Mn $L_{2,3}$ absorption edges had no such interferences and we were able to obtain accurate values using STXM[3]. We determined the olivine to be Fo_{64} with composition 42 wt% SiO_2, 29 wt% MgO, 29 wt% FeO, 0.7 wt% MnO and 0.2 wt% CaO; Cr was below the detection limit (<0.1 wt % Cr_2O_3). Fo number, V, Mn, and oxidation states of the chromite and olivine can be used to constrain the oxygen fugacity of the environment in which Iris formed. We find that $\log(fO_2) \approx$ IW[4]. The presence of the low-Ca clinopyroxene and mesostasis glass indicates fast cooling[5]. The above suggests that Iris is a fragment of a type IIA or AB chondrule.

Isotopes: Oxygen isotope analysis will tell us whether Iris resides on the TF or CCAM line, or if perhaps Kuiper belt material shows evidence for non-solar isotopic signature[6]. We have developed a sample preparation technique that enables high-precision isotopic analysis on small grains, several microns in size, in potted butts. The method has been tested on a grain of San Carlos olivine in a potted butt of comparable size and prepared using the same sample preparation methods as Iris. The test indicates that we can measure the oxygen composition of Iris with an uncertainty of ±2‰ (2σ). We will proceed with measurements on Iris within a few months.

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References: [1] Brownlee et al. 2006. Science vol. 314 pp. 1711. [2] Nell and Pollak. 1998. Hyperfine Interactions vol. 111 pp. 309-312. [3] Gainsforth et al. 2010. 41st LPSC, 2698 [4] Benedix et al. 2005 Geochimica et Cosmochimica Acta, vol. 69 (21) pp. 5123-5131 [5] Smyth. 1974. American Mineralogist vol. 59 pp. 345-352 [6] Huss. 2006 Nature vol. 440 pp. 751.