COORDINATED STEM AND NANOSIMS ANALYSIS OF ENSTATITE WHISKERS IN INTERPLANETARY DUST PARTICLES.

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Introduction: Enstatite whiskers (<10 μm length, <200 nm width) occur in chondritic-porous interplanetary dust particles (CP IDPs) [1], an Antarctic micrometeorite [2] and a comet 81P/Wild-2 sample [3]. The whiskers are typically elongated along the [100] axis and contain axial screw dislocations, while those in terrestrial rocks and meteorites are elongated along [001]. The unique crystal morphologies and microstructures are consistent with the enstatite whiskers condensing above ~1300 K in a low-pressure nebular or circumstellar gas [1]. To constrain the site of enstatite whisker formation, we carried out coordinated mineralogical, chemical and oxygen isotope measurements on enstatite whiskers in a CP IDP.

Sample and Methods: The IDP sample, L2055N1 (8 μm in size) from cluster #7 of comet 26P/Grigg-Skjellerup dust stream collection was embedded in epoxy and 70 nm thick sections were obtained. Following the mineralogical and chemical identifications using a JEOL 2500SE field-emission scanning TEM (FE-STEM), the sample was analyzed for O isotopic compositions by isotopic imaging with the JSC NanoSIMS 50L ion microprobe.

Results: L2055N1 is a typical anhydrous IDP dominated by very porous fine grained aggregates. No well-developed magnetite rims on mineral grains were observed, suggesting little heating during atmospheric entry. L2055N1 contains abundant GEMS (glass with embedded metal and sulfides) grains, and 20 – 200 nm sized enstatite and sulfide grains bound together by carbonaceous material. An enstatite whisker occurs in two thin sections. In one section the whisker is 1.4 μm long and 0.1 μm wide and in the adjacent section it is 0.5 μm long. Both fragments are composed of En100 and display a fine-scale intergrowth of clino- and ortho-enstatite with stacking disorder along [100]. O isotopic images revealed that enstatite whiskers have $\delta^{17}O$ = -75±101 ‰, $\delta^{18}O$ = -117±37 ‰ (1σ), whereas the bulk IDP is very near the terrestrial value: $\delta^{17}O$=15±14, $\delta^{18}O$=6±11‰.

Discussion: The O isotopic composition of the whisker falls within the range of Solar System materials. However, the $\delta^{18}O$ value (-117±37‰) is consistent with a ^{16}O-enrichment at a level comparable to refractory inclusions in meteorites and comet Wild-2 samples [4]. If this is the case, the whisker may have also formed in the inner solar system. The O isotopic data for most other sub-μm grains in the IDP do not have resolvable O isotopic anomalous, and the bulk IDP composition indicates that the remaining silicate material in the IDP (mineral and GEMS grains) are not similarly ^{16}O-rich. Enstatite whiskers are observed only in the primitive dust particles – their absence in meteorites is likely due to destruction during parent body thermal/ aqueous alteration.

References: [1] Bradley J.P., Brownlee D.E. & Veblen D.R. (1983) *Nature* **301**, 473-477 [2] Noguchi T. et al. (2008) *MAPS* 43, abst.# 5129 [3] Ishii H.A. et al. (2008) *Science* 319, 447-450 [4] McKeegan et al. (2006) Science, 314, 1724-1728.