MICROSTRUCTURE OF A PRESOLAR HIBONITE GRAIN.

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Introduction: Thermodynamic equilibrium calculations of dust condensation in oxygen-rich stellar outflows predict that corundum (Al_2O_3) is the first phase to condense, followed by hibonite ($CaAl_{12}O_{19}$) [1]. Microstructural studies of presolar grains provide the possibility to test these predictions, and help constrain circumstellar condensation conditions. For Al_2O_3, the available structural data from two grains support the thermodynamic models [2], but no data from $CaAl_{12}O_{19}$ grains have been available. Comparison of the range of oxygen isotope values of the approximately 20 known presolar $CaAl_{12}O_{19}$ grains to those of the several hundred Al_2O_3 grains indicates that the two grain populations sample similar stellar source populations [3], and thus likely similar circumstellar condensation conditions. We report herein the first structural data from a presolar $CaAl_{12}O_{19}$ grain and confirm the structural phase identification as hibonite.

Methods: The hibonite grain was prepared as an acid residue of the Krymka ordinary unequilibrated chondrite (LL3.1) [3]. It was identified as presolar based on oxygen isotope measurements made with the Cameca ims 6f at the Carnegie Institution of Washington, and the identification was confirmed by measurements made with the Washington University NanoSIMS. We used the Nova 600 Dual Beam focused ion beam (FIB) workstation at the Naval Research Laboratory to prepare a thin section (200 nm x 150 nm across x 100 nm thick) of the 1-μm grain, which we characterized using a JEOL 2200FS transmission electron microscope (TEM) equipped with a Noran Vantage energy dispersive x-ray spectroscopy (EDS) system.

Results: The oxygen isotope data ($\delta^{17}O$ = 900, $\delta^{18}O$ = -300) indicate that the grain belongs to Group 1, i.e, it originated in an O-rich asymptotic giant branch (AGB) star, with a mass approximately 1.5 $M_{\odot}$ and 0.9 x solar metallicity. Electron diffraction patterns obtained from the [10 4 -3] and [10 11 1] zones confirm that the grain has the hexagonal hibonite crystal structure. Some of the primary diffraction spots exhibit satellite spots, which indicate that the crystal is twinned. The grain composition determined by EDS using default k-factors is within experimental error (3%) of stoichiometric $CaAl_{12}O_{19}$. The thin section shows no evidence for subgrains, but we cannot rule out the possibility of subgrains in the remainder of the hibonite grain.

Discussion: Our measurements confirm that well-crystallized hibonite condenses in the outflows of O-rich AGB stars, in agreement with equilibrium thermodynamic calculations. Our results suggest that hibonite may contribute to features in the infrared spectra of some O-rich AGB stars. Analyses of additional grains are planned in order to address the compositional range of presolar hibonite and any relationship to pre-existing Al_2O_3 grains or other possible subgrains.

References: [1] Lodders K. 2003. *Astrophysical Journal* 591:1220–1247. [2] Stroud R. M. et al. 2004. *Science* 304:1455-1457. [3] Nittler L. R. et al. 2005. Abstract #2200. 36th Lunar & Planetary Science Conference.