MICROSTRUCTURE OF A SUPERNOVA SILICATE GRAIN

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Introduction: The mineralogy of dust from red giant and AGB stars is well studied both astronomically and among presolar grains. In contrast, much less is known about the nature and abundance of dust from supernovae (SNe). Hundreds of carbonaceous SN stardust grains have been identified and the microstructures of many have been determined. In contrast, fewer than 20 O-rich SN grains have been identified [1 and references therein] and only one SN oxide and one SN silicate has been mineralogically characterized in detail [2,3]. Here we present detailed chemical and mineralogical studies of a recently discovered supernova silicate grain.

Experimental: Presolar silicate grains were identified among sub-µm matrix grains from the Acfer 094 meteorite by O and Si isotopic imaging with the JSC NanoSIMS 50L. Isotopically rare grains were subsequently analyzed for Mg isotopes after removal of surrounding grains to enable uncontaminated measurements [1]. One presolar silicate (2_4) was targeted for mineralogical and chemical characterization by transmission electron microscopy (TEM). An electron transparent grain cross-section was prepared by focused ion beam (FIB) milling.

Results and Discussion: Presolar silicate grain 2_4 has isotopic compositions consistent with condensation in a 15M⊙ SN with the majority of material coming from the H envelope [4] ($\delta^{17}O$=1495‰, $\delta^{18}O$=2435‰, $\delta^{25}Mg$=-175‰, $\delta^{26}Mg$=360‰, $\delta^{29}Si$=-5, $\delta^{30}Si$=105). TEM analysis of this grain showed that it is structurally amorphous and stoichiometric $MgSiO_3$ (trace Fe, with Ca and Al below detection limits). In contrast, SN silicate B10A [2] was comprised of an aggregate of Fe-bearing olivine crystals (Fo83) with more Fe than silicate 2_4. B10A is also much more enriched in ^{18}O and is highly depleted in ^{17}O, requiring more material from the He/C zone than grain 2_4. Carbonaceous and Si_3N_4 SN grains, which form even deeper in the SN, also tend to be aggregates of sub-µm crystals [5-8]. On the other hand, the SN hibonite, with similar O and Mg isotopic composition to 2_4, is a single crystal [2].

The amorphous structure of grain 2_4 is unique among SN dust grains found so far. However, recent *Spitzer* observations of several supernova remnants [9,10] suggest amorphous $MgSiO_3$ as a significant dust component. Silicate 2_4 may have condensed as an amorphous grain, but subsequent alteration from a crystalline state is perhaps more likely. The different microstructures of SN dust reflect the strongly varying chemical compositions and physical conditions in different SN regions.

References: [1] Nguyen A. N. et al. 2010. Abstract #2413. 41st Lunar & Planetary Science Conf. [2] Stroud R. M. et al. 2008. Abstract #1778. 39th Lunar & Planetary Science Conf. [3] Messenger S. et al. 2005. *Science* 309:737-741. [4] Rauscher T. et al. 2002. *Astrophys. J.* 576:323-348. [5] Stroud R. M. et al. 2004. *Meteorit. Planet. Sci.* 39:A101. [6] Hynes K. M. et al. 2009. Abstract #1398. 40th Lunar & Planetary Science Conf. [7] Stroud R. M. et al. 2006. *Meteorit. Planet. Sci.* 41:A5360. [8] Croat T. K. et al. 2003. *Geochim. Cosmochim. Acta* 67:4705-4725. [9] Rho J. et al. 2008. *Astrophys. J.* 673:271-282. [10] Rho J. et al. 2009. *Astrophys. J.* 700:579-596.