HRTEM ANALYSES OF STARDUST SAMPLES AND THEIR COMPARISON WITH TOF-SIMS RESULTS.

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Introduction: Recent analyses of Stardust samples reveal that there are a wide variety of unexpected and seemingly unusual minerals found in the samples collected from comet 81P/Wild 2 [1, 2]. In addition, a wide range of olivine (Fo_4 – Fo_{100}) and pyroxene (En_{52} – En_{100}) compositions are observed in the samples [e.g., 1]. Indeed, it was unexpected to discover such a broad range of compositions and exotic refractory minerals, including CAI-like particles, suggesting that comets may incorporate materials from a greater cross-section of the early protoplanetary disk than previously thought, thus requiring significant large-scale mixing [1, 2]. No confirmed carbonates or phyllosilicates have been found thus far, which indicate that Wild 2 may not have been affected by aqueous alteration [1, 3].

As the multi-approach analysis of Stardust cometary samples continues, we now have the opportunity to compare different types of data collected from individual cometary grains. One advantage of this approach is that we can correlate elemental analyses with high sensitivity by time-of-flight secondary ion mass spectrometry (TOF-SIMS) with elemental and mineralogical analyses of very high spatial resolution by high resolution transmission electron microscopy (HRTEM). As a result, it is possible to gain greater insight into the nature of Wild 2 materials.

Sample C2004,1,44,4,5,#47: So far, in this study, one sample has been characterized by both TEM and TOF-SIMS techniques. This sample is similar to some other samples already characterized by TEM methods [e.g., 1, 3]. It is approximately 9 µm × 20 µm in size and is composed of a variety of different mineral grains, intermingled with vesicular glass, which mainly consists of melted aerogel. Iron sulfide and metal grains, which are all smaller than 100 nm, are randomly distributed throughout the melted aerogel and correspond to the generally homogeneous distribution of S- and Ni-rich pixels as seen in TOF-SIMS secondary ion images [4].

At one end of the sample are several dark (electron-opaque) mineral grains, the largest of which measures 1.6 µm × 0.5 µm and is composed of a subhedral core with darker surrounding material. This grain exhibits very high Ca content along with O and some C, as seen with both EDX [this work] and TOF-SIMS [4] analyses. Several smaller grains having the same elemental composition surround the larger grain. One small tabular grain is possibly a Ca, Fe-silicate. Many of the grains exhibit well-defined diffraction patterns and resolvable lattice patterns using HRTEM imaging, which will help to specifically identify these phases. In particular, it is possible that some of the grains are carbonates, but further analyses are needed to answer this important question.

Further results from additional particles analyzed using both HRTEM and TOF-SIMS techniques will be presented.

References: [1] Zolensky M. et al. 2007. *Science* 314:1735-1739. [2] Brownlee D. et al. 2007. *Science* 314:1711-1716. [3] Mikouchi T. et al. 2007. Abstract #1946. 38th Lunar & Planetary Science Conference. [4] Stephan T. et al. *Meteoritics & Planetary Science*, submitted.