REVERSIBLE SAMPLE PREPARATION OF SMALL PARTICLES IN POTTED BUTTS FOR SIMS ANALYSES

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Introduction: With the return of Stardust samples the cosmochemistry community faced the novel challenge of conducting coordinated analyses on a suite of extraterrestrial samples that are simultaneously extremely tiny (nanogram to picogram), extremely limited, and extremely complex and fine-grained. This has required the development of novel techniques[1]. Current techniques generally make efficient use of the samples[2], but isotopic analyses have required a sample preparation technique that requires contact with the sample and modification of the potted butt. Here we describe an easily reversible sample preparation technique for SIMS measurements that facilitates multiple rounds of TEM, STXM and isotopic analyses, thus making full use of rare particles. We anticipate that this technique will be appropriate for Hayabusa samples from 25143 Itokawa, which share the same challenging properties as Stardust samples.

Silicon nitride window mounting protocols for SIMS: The most common sample-preparation protocol for Stardust samples is to embed particles in epoxy and to use an ultramicrotome to produce multiple 100nm-thick sections for TEM or STXM, and a potted butt that usually contains the remaining 70-90% of the original particle. Further rounds of ultramicrotomy can be done on the potted butt if it is preserved as a cylindrical "bullet". To achieve sufficiently high precision to place samples on the solar-system three-isotope oxygen plot, measurements must be made in the bulk grain in the potted butt. We developed a reversible SIMS sample preparation technique as part of our coordinated analysis of the particle Iris[3,4,5]. X-ray fluorescence microprobe analysis showed that Iris is a complex particle with several phases not uncovered in the first rounds of ultramicrotomy. This technique involves no physical contact with the sample or modification of the potted butt. The mount consists of two components: a Cameca ims 1280-compatible Al round which holds the potted butt at a fixed altitude, and a "buckler", which simultaneously surrounds the particle with a flat conductive plane, matching the altitude of the particle, and integrates a ring of 12 standards that closely match the known phases in the particle and that surround the particle. The buckler consists of a thin Al disk with embedded standards, polished to a mirror finish, with a central 3mm hole. We mounted a Au-coated, 500nm-thick Si_3N_4 membrane in which we had previously drilled a 300µm diameter hole using an ion mill, over the hole in Al disk. We used a motorized, encoded micromanipulator with 200nm resolution (Sutter MP-285) to integrate the complete assembly, since ~1-micron precision is required in the three-dimensional alignment of the Si_3N_4 window with the particle. Using San Carlos olivine standards in potted butts, we have shown that O-isotopes are measured with ~2‰ precision (2σ) in $\Delta^{17}O$ using this technique[5].

References: [1] Westphal A. J. et al. 2004. *Meteoritics & Planetary Science 39:1375.* [2] Zolensky, M. et al. 2000. *Meteoritics & Planetary Science 35:9.* [3] Gainsforth, Z. et al. 2011. *Meteoritics & Planetary Science 46:*this issue [4] Ogliore, R. et al. 2011. *Meteoritics & Planetary Science 46:*this issue. [5] Huss G. R. et al. 2011 *Meteoritics & Planetary Science 46:*this issue.