

Preliminary Examination of Al Foil I1061N,1 from the Stardust Interstellar Collector. C. Floss (floss@wustl.edu), C. Allen, S. Armes, S. Bajt, A. Ball, R. Bastien, H. Bechtel, J. Borg, F. E. Brenker, J. C. Bridges, D. E. Brownlee, M. J. Burchell, M. Burghammer, A. Butterworth, R. Chater, P. Cloetens, G. Cody, A. Davis, R. Doll, T. Ferroir, G. Flynn, D. Frank, Z. Gainsforth, E. Grün, P. R. Heck, J. Hillier, P. Hoppe, F. Hörz, L. Howard, B. Hudson, G. R. Huss, J. Huth, A. T. Kearsley, B. Lai, M. Landgraf, J. Leitner, L. Lemelle, H. Leroux, L. Nittler, R. Ogliore, F. Postberg, M. C. Price, S. Sandford, S. Schmitz, G. Silversmit, A. Simionovici, R. Srama, F. J. Stadermann, T. Stephan, R. Stroud, S. Sutton, R. Toucoulou, M. Trieloff, J. Trigo-Rodriguez, P. Tsou, A. Tsuchiyama, T. Tyliczszak, B. Vekemans, L. Vincze, J. Warren, A. J. Westphal, and M. E. Zolensky. The Stardust Interstellar Preliminary Examination Team (affiliations are at <http://ssl.berkeley.edu/~westphal/ispe>).

Introduction: The interstellar tray of NASA's Stardust mission collected particles during its exposure to the interstellar dust stream. In addition to aerogel capture cells, the tray contains Al foils that make up ~15% of the total exposed collection surface [1]. Interstellar dust fluxes are poorly constrained, but suggest that ~12-15 particles may have impacted the total exposed foil area of 15,300 mm², with 2/3 of these less than ~1 μm in size [2]. Below we outline the automated high-resolution imaging protocol we have established to locate these small, rare craters in the Stardust interstellar foils.

Protocol and Discussion: Scanning was done with a JEOL 840a SEM equipped with Noran System Seven software for automated image acquisition. We experimented with various test shot foils to determine measurement conditions that would allow us to locate craters of the appropriate sizes (~300 nm or larger) while minimizing contamination to the foils. Our final optimized scanning protocol consists of mapping individual images of 106 x 80 μm (2048 x 1536 pixels at 16 bit grayscale) at 15 kV, 5nA for 10 sec per frame, providing a resolution of ~52 nm/pixel with a dwell time of 0.002 sec/μm². Under these conditions, C contamination during scanning is negligible [e.g., 3].

The actual scanning procedure is automated: after defining the four corners of the foil, the foil area is divided into multiple grids, each ~0.25 mm² in size. Following manual z-axis focusing in the centers of these regions, each grid is further divided into areas of the appropriate size. A minimal amount of image overlap (5%) is incorporated into both steps to ensure that no portion of the foil is omitted. The entire array is then imaged automatically in sequence and each image is saved with a unique label identifying its position on the foil.

Using the protocol noted above, our imaging of interstellar foil I1061N,1 resulted in 329 grids, each with 30 areas, for a total of 9870 high-resolution images. Complete mapping of this long ('N') foil required about four days of SEM time and resulted in ~100 GB of raw image data. The images are currently being examined manually at Washington University, and remotely via a modified stardust@home [4] approach; automated searching may be implemented in the future [5]. To date, one unambiguous crater (~750 nm in diameter) and numerous other candidate features have been identified.

References: [1] Tsou P. et al. (2003) JGR 108, 8113; [2] Westphal A. et al. (2008) LPSC XXXIX, #1855; [3] Kearsley A. T. et al. (2010) LPSC XLI, #1593; [4] Westphal A. et al. (2007) LPSC XXXVIII, #1457; [5] Ogliore R. et al. (2010), this volume.