

STARDUST CURATION AT JOHNSON SPACE CENTER: PHOTO DOCUMENTATION AND SAMPLE PROCESSING OF SUBMICRON DUST SAMPLES FROM COMET WILD 2 FOR METEORITICS SCIENCE COMMUNITY. K. Nakamura-Messenger¹, M.E. Zolensky², R. Bastien¹, T.H. See¹, J.L. Warren¹, T.J. Bevill¹, F. Cardenas¹, L.F. Vidonic², F. Horz², K.M. McNamara², C.C. Allen², A.J. Westphal³, C. Snead³, H.A. Ishii⁴ and D. Brownlee⁵ ¹ESCG ²NASA Johnson Space Center, Houston, TX 77058 ³Univ. of California at Berkeley, Berkeley, CA94720 ⁴Lawrence Livermore National Laboratory, Livermore, CA94550 ⁵Univ. of Washington, Seattle, WA98195 (keiko.nakamura-1@nasa.gov).

Introduction: Dust particles released from comet 81P/Wild-2 were captured in silica aerogel on-board the STARDUST spacecraft and successfully returned to the Earth on January 15, 2006. STARDUST recovered thousands of particles ranging in size from 1 to 100 micrometers. The analysis of these samples is complicated by the small total mass collected (< 1mg), its entrainment in the aerogel collection medium, and the fact that the cometary dust is comprised of submicrometer minerals and carbonaceous material. During the six month Preliminary Examination period, 75 tracks were extracted from the aerogel cells, but only 25 cometary residues were comprehensively studied by an international consortium of 180 scientists who investigated their mineralogy/petrology, organic/inorganic chemistry, optical properties and isotopic compositions [1-7]. These detailed studies were made possible by sophisticated sample preparation methods developed for the STARDUST mission [8,9] and by recent major advances in the sensitivity and spatial resolution of analytical instruments.

The STARDUST curation team at ARES/ NASA Johnson Space Center assumed a major role in the photo documentation and sample preparations of these precious samples, as detailed below.

Photo Documentation: Four levels of photo documentation were undertaken that differ in resolution, viewing geometry and purpose:

Level 1: This photography was part of the collector deintegration procedure and provides a low resolution record of each individual aerogel cell in its most pristine, "as received" condition. It employed a tripod-mounted still camera (Nikon D200).

Level 2: High resolution, plan view mosaics of aerogel (typically 50 frames/cell) and foil specimens (typically 35 frames). This photography used the Primary Scanning System (PSS: a Leica MZ16A Stereo Microscope hosting a DFC 320 digital camera, and a pair (x/y) of Texonics Precision Positioning devices on a vibration isolation optical table). This photography resulted in

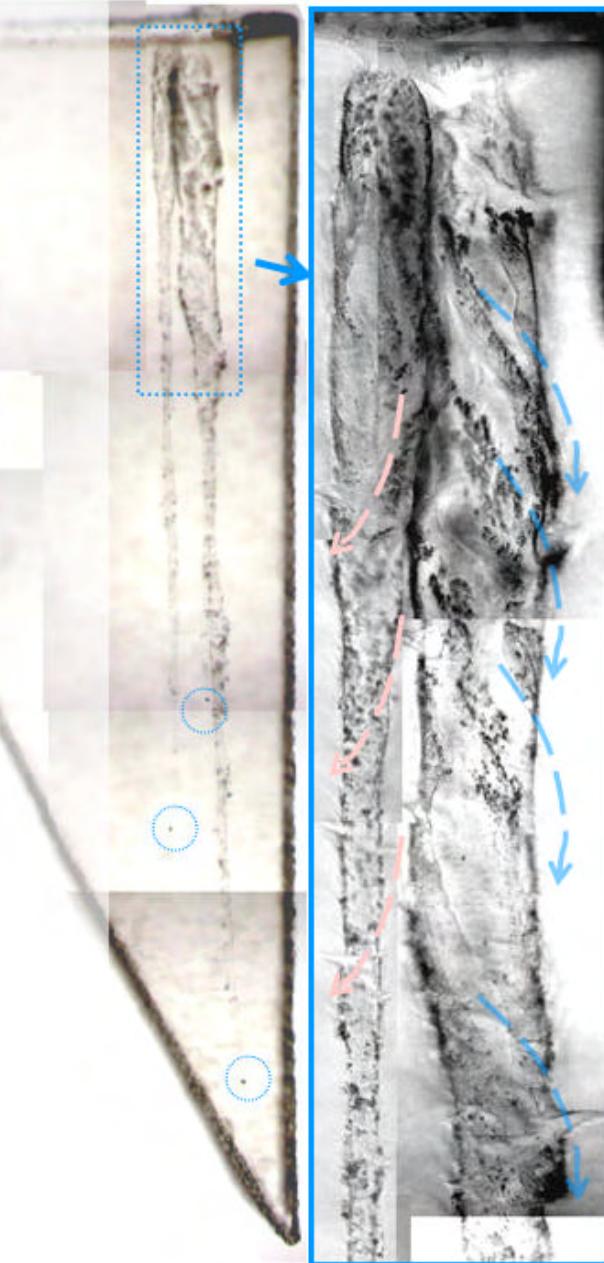


Fig. 1a (left): Optical microscope image of a 8.5mm-long keystone using transmitted light. The keystone consists of Track#99 (shorter carrot on left, 7mm-long) Track#100 (longer carrot on right, 8mm-long). Both tracks contain significant terminal particles and sub-grains in the blue circles (~10um in size.) Blue-line boxed area is magnified on the right. **Fig. 1b (right):** compound microscope image of boxed area of Fig.1a under reflected light condition. Both tracks shows spiral features (arrowed) indicating that the dust particle produced track#100 (right) was spinning counter clockwise and the one for track#99 (left) spinning clockwise toward the sample collector.

an overview of all impact features accumulated by either individual aerogel cells or Al-foils, and recorded their positions in a cell-specific reference frame.

Level 3 documentation refers to the most detailed documentation of individual aerogel tiles following extraction from the tray and portrays individual tracks from the side. Each cell was scanned via high-resolution mosaics at depth intervals of 2 mm, resulting in a 3-dimensional rendition of the track population. Cometary track length, track types, and terminal particle sizes may be investigated in this imagery..

Level 4 photo documentation refers to the documentation of individual tracks that have been extracted from their host-cell by either the keystone system [8] or the ultrasonic microblades [9]. Level 4 identifies microscale tracks and particle features in highest detail. Careful examination of particles with crossed-polarized light has been effective for distinguishing amorphous from crystalline grains (Fig. 3). We recently identified a paired-track with unusual spiral features as shown in Fig.1. It appears that the dust particle which produced track #100 (right) was spinning counter clockwise and the one for track #99 (left) rotated clockwise during the initial phase of penetration.. This level of documentation is time consuming, but it provides essential information that may be lost once the residues are extracted and processed for analysis .

On-line Catalog is now available at:

<http://curator.jsc.nasa.gov/stardust/>

this is a public-domain access website with all the curatorial information associated with a given particle, track, or tile, including allocation history, analytical summary (when available) and various photo documentations acquired during the curation process. The purpose behind this online catalog and the care and effort being applied to this sample suit by the JSC Curatorial staff is to provide the scientific community with information such that interested investigators can make intelligent sample request. How to make such request can also be found on the above mentioned website, along with a great deal of other information related to the Stardust mission and sample suits.

References: [1] Brownlee D. et al. (2006) *Science*, 314, 1711-1716. [2] Zolensky M.E. et al. (2006) *Science*, 314, 1735-39. [3] Horz F. et al. (2006) *Science*, 314, 1716-1719. [4] Keller L.P. et al. (2006) *Science*, 314, 1728-1731. [5] Flynn G.J. et al. (2006) *Science*, 314, 1731-1735. [6] Sandford S.A. et al. (2006) *Science*, 314, 1720-1724. [7] McKeegan K.D. et al. (2006) *Science*, 314, 1724-28. [8] Westphal A.J. et al. (2004) *Meteoritics & Planet. Sci.*, 39, 1375-1386. [9] Ishii H.A. et al. (2005) *Meteoritics & Planet. Sci.*, 40, 1741-1747.

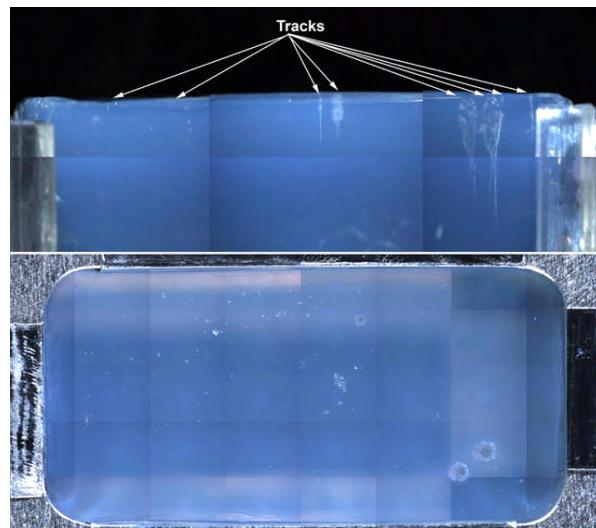


Fig. 2: Level 2 (bottom, aerogel collector surface view) & Level 3 (top, aerogel side view) photo documentations on cometary cell C2027. These photo mosaics of cometary cell C2027 consist of at least 48 individual digital image files that may be accessed individually. (These images are available at:

http://curator.jsc.nasa.gov/stardust/sample_catalog/Level2/images/C027-01.jpg)

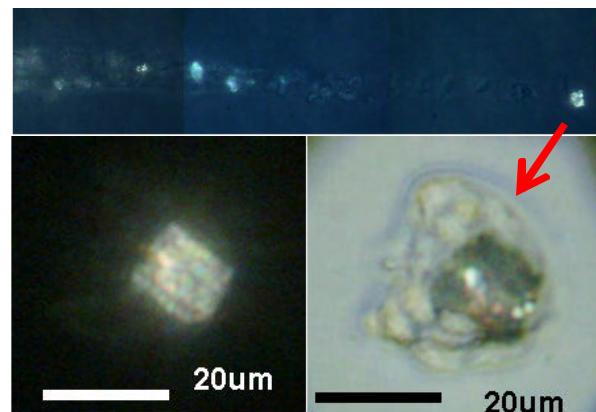


Fig.3a (top): Dark-field image of a cometary track (Track#48 from cell C2027) in a compound microscope (x50 objective). The terminal particle (~20 μ m) is on the right side. Crystalline grains along the track are brighten up in the dark-field distinguished from compressed aerogel. **Fig.3b (bottom right):** Bright-field image under reflected light of the Track#48 terminal particle after extraction, still surrounded by remaining aerogel. **Fig.3c (bottom left):** Dark-field image of the same field of view of Fig.3b. In the dark field image, only the particle (crystalline) is visible.