

STUDY OF AEROGEL SURFACE EXPOSED TO THE PARTICLE FLUX OF COMET WILD 2: AN UPDATE. D. Rost, T. Henkel, A. King and I. Lyon, The University of Manchester, SEAES, Williamson Bldg. Oxford Rd., Manchester, M13 9PL, UK, detlef.rost@manchester.ac.uk.

Introduction: During the January 2004 encounter of the Stardust space probe with comet 81P/Wild 2, a collector containing aerogel tiles was exposed to the cometary particle flux and returned to Earth in January 2006 [1–3]. Most studies so far focused on the millimeter long cavities or tracks in the aerogel, produced by micrometer sized cometary particles [3]. Cometary material has been identified in form of terminal particles at the end of the tracks as well as sub-micrometer sized grains dispersed in the track walls. Organic compounds (e.g., PAHs) from the comet have been identified on track walls [4] and have been putatively found in the adjacent aerogel [4,5].

This report is an update on our study [6] of aerogel surface that is not associated with optically recognizable impact tracks. By this approach, a potential direct deposition of organic compounds from the coma of Wild 2 can be identified on exposed aerogel surface. Furthermore, micrometer sized impact structures might be found, probably accompanied by local enrichments of cometary matter including organic compounds.

High resolution ($\sim 2 \mu\text{m}$) and high mass ($< 800 \text{ u}$) chemical mapping was applied to aerogel surface that was exposed to the cometary particle flux is compared with inward pointing flight aerogel surface that was not exposed ('blank' from now on).

Samples: C2005,2 is a $\sim 10 \text{ mm} \times 15 \text{ mm} \times 5 \text{ mm}$ aerogel chip, which was part of the top surface that fell off while tile C2005 was removed from the cometary collector tray. This sample is devoid of (visible) impact tracks. C2052,8 is a $\sim 10 \text{ mm} \times 10 \text{ mm} \times 5 \text{ mm}$ aerogel chip dissected from the bottom of tile C2052.

Experimental: In 2007, we equipped one of our time-of-flight secondary ion mass spectrometry (ToF-SIMS) instruments [7,8] with a 40 kV C_{60} primary ion gun from Ionoptika Ltd [9] and a 20 kV post-acceleration detector from Kore Technology Ltd. Compared to other primary ion species, especially mono-atomic ones, C_{60} bombardment results in a more gentle and more effective desorption of larger molecules [10,11], which is highly beneficial for the detection of organic compounds.

Measurements can be routinely performed with a lateral resolution of $\sim 2 \mu\text{m}$. Sub-micrometer resolution is possible although at the expense of intensity. Uncoated/pristine insulating samples like, e.g., aerogel, can be analyzed by parallel operation of an electron flood gun to prevent charging. Since installation, we developed elaborate software tools that allow for cor-

recting instrumental drift and varying mass calibrations throughout the measurement as well as depth profiling, that is following the intensities of selected ion species throughout the measurement.

Results and discussion: Many organic compounds increase in intensity throughout the measurement, probably because of $\text{C}_n\text{H}_m\text{SiO}_2$ -cluster formation. Some organics, however, show decreasing secondary ion signals. It was reported [12] that C_{60} bombardment is hardly destroying sub-surface organics. If this holds for aerogel samples as well, those organics must be concentrated close to the outmost surface. The most striking example is found at m/z 279 and is most likely Pentacene (or Picene) + H. Being a likely contamination, it is not clear if acquired pre-, post-, or during flight (out-gassing of space craft). In general, no statistical relevant difference between exposed aerogel and blank has been found so far.

Results from the chemical mapping of the exposed aerogel surface are shown in Figure 1. Some potential local enrichments in Mg, Ca and Fe are found. This might indicate micrometer-sized impact structures with residual cometary material. Unambiguous identification should be possible with follow-up measurements of higher mass resolution. The widely abundant and heterogeneous Na is most likely caused by contamination, either pre- or post-flight.

References: [1] Brownlee D. E., et al. (2003) *JGR*, 108, 8111. [2] Tsou P., et al. (2003) *JGR*, 108, 8113. [3] Brownlee D., et al. (2006) *Science*, 314, 1711–1716. [4] Sandford S. A., et al. (2006) *Science*, 314, 1720–1724. [5] Stephan T., et al. (2008) *MAPS*, 43, 233–246. [6] Rost D., et al. (2008) *LPSC*, 39, #2110. [7] Braun R. M., et al. (1998) *Rapid Commun. Mass Spectrom.*, 12, 1246–1252. [8] Henkel T., et al. (2007) *Rev. Sci. Instrum.*, 78, 055107. [9] Hill R., et al. (2006) *Appl. Surf. Sci.*, 252, 7304–7307. [10] Weibel D., et al. (2003) *Anal. Chem.*, 75, 1754–1764. [11] Fletcher J. S., et al. (2006) *Anal. Chem.*, 78, 1827–1831. [12] Fletcher J. S., et al. (2006) *Appl. Surf. Sci.*, 252, 6513–6516.

Acknowledgement: This work is part of the UK Stardust Consortium and was supported by the Science and Technology Facilities Council, through its UKCAN programme and through a rolling grant. The University of Manchester is thanked for major SRIF and other funding for equipment. The authors express their gratitude to D. Blagburn, B. Clementson and B. Gale for essential construction and maintenance work.

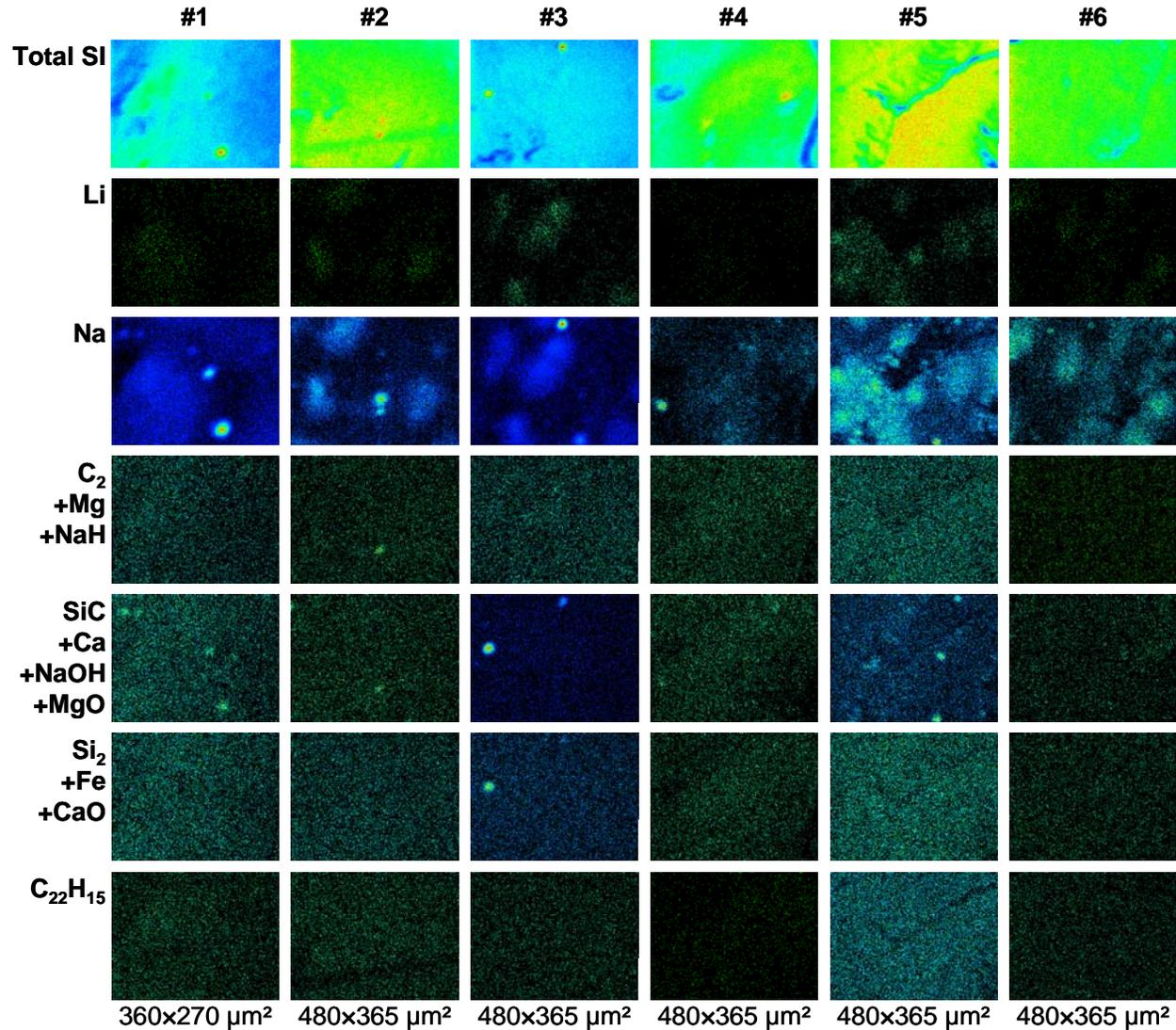


Figure 1. C_{60} -ToF-SIMS analyses of Stardust aerogel surface exposed to the particle flux of comet Wild 2. All 6 measurements have 256×256 pixels and the same number of primary ion shots. Intensities are normalized to maximum and color-coded (0=black, blue, green, red=maximum). Displayed are total secondary ion images (m/z 1-800) as well as selected mass intervals (at $m/z \sim 7, 23, 24, 40, 56, 279$). Because of limitations in mass resolution, several ion species contribute to some of the intervals, the most likely ones are indicated to the left. C and Si distributions (not shown) indicate that C_2 , SiC and Si_2 are only responsible for the featureless, noisy background in their respective images. Therefore, area #1 probably contains several Ca-rich spots, #2 one MgO- or NaOH-rich spot, #3 two Ca, Fe- or CaO-rich spot, and #5 several Ca-rich spots. Li and Na distributions are heterogeneous (but mostly correlated) in all analyzed areas, including blank measurements (not shown).