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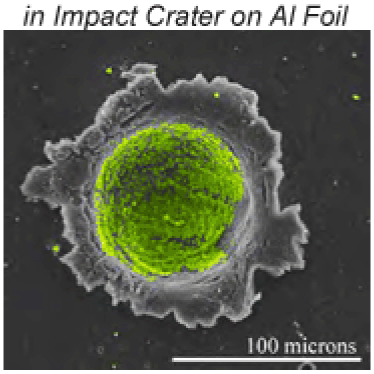
Shooting Iron Sulfides into Aluminum Foil to Better Understand Comet Wild 2

When NASA's Stardust mission returned samples from comet 81P/Wild 2 to Earth in 2006, researchers found particles in the aerogel collector-cells as well as in the aluminum (Al) foil, which wrapped the cells and facilitated the safe removal of the aerogel from the collector frame. These Al-foil pull tabs, though not the primary collecting material, captured a bonus assortment of cometary grains. But did the impacts into the Al foil change the Wild 2 grains? Teams of scientists have been hard at work in the laboratory to answer that question by simulating impacts into Stardust Al foil using a light gas gun to shoot powders of the major minerals found in cometary dust.

Lab Result of Mineral Residue in Impact Crater on Al Foil



(Wozniakiewicz, *et al.* LPSC XXXVIII,1579.)

They are studying the impact craters on the Al foils and what's left of the impacting particles, the residues, that coat the crater surfaces. Whether or not the original chemical composition of the impacting particle is preserved in the residue is a key question to examine in the laboratory, as the answer bears on how accurately the researchers can determine the original chemistry of the cometary grains from Wild 2.

Penelope Wozniakiewicz (Lawrence Livermore National Lab and the Natural History Museum, London) and colleagues from the U.S., U.K., and Australia recently reported on iron sulfide residues from their experiments with pyrrhotite [$Fe_{0.85}S$] and pentlandite [$(Fe,Ni)_{1.04}S$] grains, which were crushed and sieved to make buckshot in the diameter range of 10–53 µm. The team shot the minerals, one at a time, into targets of Stardust flight-spare aluminum foil that they had wrapped around a 1-millimeter-thick square aluminum alloy plate, to simulate mounting on the Stardust collector. The figure shows a backscattered electron (BSE) image overlaid by an iron x-ray map that reveals what the pyrrihotite residue (displayed in green) looks like inside the crater after one experimental impact. Wozniakiewicz and coauthors investigated the extent of alteration of pyrrhotite and pentlandite by comparing scanning and transmission electron microscope analyses of preimpact powder and postimpact residues in craters >50 µm in diameter. They found that the pyrrhotite projectile was mostly preserved, compositionally and structurally, after impact. But they also saw evidence of melting, segregation and loss of sulfur, mixing with molten aluminum, and new phases with increased iron content possibly due to incorporation of iron-rich inclusions that are randomly distributed in the Al foil. The pentlandite projectile was completely altered by impact. It melted, segregated, and mixed with molten Al foil (though the residue retained the original nickel to iron ratio of the projectile). Upon cooling, new alloy components crystallized and, in some areas, captured exsolved sulfur. The team found that the Al foils were unable to collect iron sulfides without alteration and some loss of sulfur, yet they speculate that identifying the original, preserved iron sulfides may be possible in Al-free areas of residue (if they exist). This knowledge and data from laboratory experiments of other impact residues help researchers make informed interpretations of comet Wild 2 composition.

See: Wozniakiewicz, P. J., Ishii, H. A., Kearsley, A. T., Burchell, M. J., Bland, P. A., Bradley, J. P., Dai, Z., Teslich, N., Collins, G. S., Cole, M. J., and Russell, S. S. (2011) Investigation of Iron Sulfide Impact Crater Residues: A Combined Analysis by Scanning and Transmission Electron Microscopy, *Meteoritics and Planetary Science,* v. 46(7), p. 1007-1024., doi: 10.1111/j.1945-5100.2011.0126.x. [***NASA ADS entry***] and ***Stardust: A Mission with Many Scientific Surprises*** by

Donald Brownlee (Stardust Principal Investigator) and the PSRD article ***Wee Rocky Droplets in Comet Dust***.

Written by Linda Martel, Hawai'i Institute of Geophysics and Planetology, for ***PSRD***.

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http://www.psrd.hawaii.edu
psrd@higp.hawaii.edu