TEM observations of sulfide and enstatite dust particles sampled by the Stardust mission

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The Stardust mission of NASA collected cometary dust particles during a flyby operation through the tail of comet 81P/Wild2. The dust particles were captured in an aerogel collector at a speed of 6.1 km/s, producing deep tracks along which dust particles are distributed. The samples were returned to Earth in 2006 and are since then under study by an international consortium of scientists [1,2]. In this context we have studied dust particles from tracks 32, 35, 41 and 69 of the collector, using transmission electron microscopy.
Monosulfides are ubiquitous in tracks 35 and 41 but most of them were melted during the capture process due to the high post-shock temperatures. These sulfides occur as droplets forming a foamy mantle around a core of metallic FeNi. This structure may be established during the capture process. Besides this, the tracks 35 and 41 do also contain two sulfide grains, which are apparently unmelted. Electron diffraction reveals that these grains are stoichiometric troilite. The two dust particles from track 32 are terminal grains of enstatite with $En_{85}Fs_{13}Wo_2$ and $En_{89}Fs_8Wo_3$ compositions; traces of Cr and Mn were detected as well. Both grains pervasively contain clinoenstatite lamellae parallel to (100) of orthoenstatite and few dislocations in glide configuration.
The occurrence of enstatite and sulfide grains substantiate the conclusion that the Wild 2 dust particles formed in the inner part of the solar nebula and were then transported outward into the Kuiper belt.
[1] Brownley D et al. (2006) Comet 81P/Wild 2 under a microscope. Science 314: 1711–1716.
[2] Zolensky ME et al. (2006) Mineralogy and petrology of comet 81P/Wild 2 nucleus samples. Science 314:1735–1739.

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