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Wild 2 grains characterized combining MIR/FIR/Raman micro-spectroscopy and FE-SEM/EDS analyses

M. Ferrari[1,2], A. Rotundi[1,2], F.J.M. Rietmeijer3 V. Della Corte[1], G.A. Baratta[4], R. Brunetto[5], E. Dartois[5], Z. Djouadi[5], S. Merouane[5], J. Borg[5], J.R. Brucato[6], L. Le Sergeant dHendecourt[5], V. Mennella[7], M.E. Palumbo[4], P. Palumbo[1]

[1] Dip. Scienze e Tecnologie, Università degli Studi di Napoli "Parthenope", Centro Direzionale I C4, 80143 Napoli, Italy
[2] INAF-IAPS, Istituto di Astrofisica e Planetologia Spaziali, Area di Ricerca di Tor Vergata, via del Fosso del Cavaliere, 100, 00133, Rome, Italy
[3] Dept. of Earth and Planetary Sciences, MSC03 2040, 1-University of New Mexico, Albuquerque, NM 87131-0001, USA
[4] INAF-Osservatorio Astrofisico di Catania, Via Santa Sofia 78, 95123 Catania, Italy
[5] Institut d'Astrophysique Spatiale, CNRS, UMR-8617, Université Paris Sud, bâtiment 121, F-91405 Orsay Cedex, France
[6] INAF-Osservatorio Astrofisico di Arcetri, Largo E. Fermi 5, 50 125 Firenze, Italy
[7] INAF-Osservatorio Astronomico di Capodimonte, Via Moiariello 16, 80131 Napoli, Italy

Abstract.

We present the results of the analyses Rotundi et al. (2014) of two bulk terminal particles (TPs), C2112,7,171,0,0 (TP2) and C2112,9,171,0,0 (TP3), derived from the Jupiter-Family comet 81P/Wild 2 returned by the NASA Stardust mission Brownlee et al. (2006). Each particle, embedded in a slab of silica aerogel, was pressed in a diamond cell. Aerogel is usually cause of problems when characterizing the minerals and organic materials present in the embedded particles. We overcame this common issue by means of the combination of FE-SEM/EDS, IR and Raman μ-spectroscopy, three non-destructive analytical techniques, which provided bulk mineralogical and organic information on TP2 and TP3. This approach proved to be a practical solution for preliminary characterization, i.e. scanning particles for chemical and mineralogical heterogeneity. Using this type of bulk characterization prior to more detailed studies, could be taken into account as a standard procedure to be followed for selecting Stardust particles-of-interest. TP2 and TP3 are dominated by Ca-free and low-Ca, Mg-rich, Mg,Fe-olivine. The presence of melilite in both particles is supported by IR μ-spectroscopy and corroborated by FE-SEM/EDS analyses, but is not confirmed by Raman μ-spectroscopy possibly because the amount of this mineral is too small to be detected. TP2 and TP3 show similar silicate mineral compositions, but Ni-free,

low-Ni, sub-sulfur (Fe,Ni)S grains are present only in TP2. TP2 contains indigenous amorphous carbon hot spots, while no indigenous carbon was identified in TP3. These non-chondritic particles probably originated in a differentiated body. The presence of high temperature melilite group minerals (incl. gehlenite) in TP2 and TP3 reinforces the notion that collisionally-ejected refractory debris from differentiated asteroids may be common in Jupiter-Family comets. This raises the question whether similar debris and other clearly asteroidal particles could be present in Halley-type comets and, if so, which fraction of the dust in these comets is truly represented by non-processed silicates and organic material. The work done for Stardust samples is important to understand the similarities and differences among comets. In fact, the results of this study are relevant also for the ROSETTA mission that encountered the Jupiter-Family (J-F) comet 67P/Churyumov-Gerasimenko in August, 2014. At the time this mission was launched, our ideas of comet dust were biased by the findings of the Halley missions. The Stardust mission showed an unexpected richness of dust that originated from the inner solar system. Rosetta is confirming these results but also adding information, in particular on the presence of a primitive and unprocessed dust component Fulle et al. (2015).

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