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Passive measurement of dust particles on the ISS (MPAC): Third report on aerogel dust collectors

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The Micro-Particles Capturer (MPAC) is a particle-capture experiment consisting of three identical units (numbered #1 to #3), each containing aerogel, polyimide foam and an aluminium witness plate, and deployed on the exterior of the Russian Service Module (SM) of the International Space Station (ISS). A more detailed description of this experiment, together with impact flux and chemical data of impactor residues are given by Neish et al., 2005. In this paper we focus on the results of impact feature morphology and track analysis in MPAC #1 aerogel, based on hypervelocity impact experiments on aerogels (calibration shots), and provide first inspection results of MPAC #2 aerogel. SM/MPAC#1 (315 daysĄEexposure): After removal of all aerogel tiles from the frame, 24 aerogel tiles (exposed area: 37m m x 37 mm per tile) were inspected as follows: a) each tile was scanned individually with the aid of a 150x CCD optical scope; b) when an impact feature was located, a photograph and/or sketch was taken of the feature; c) track length, depth, and inclination to the surface were measured; particle remnants were searched for; d) SEM, EDS, and Raman spectroscopic analyses were carried out to obtain chemical composition of residues left in the tracks. Very elevated flux levels have been noted on the Ram and Wake faces of one aerogel tile which could be due to 1) uncertainties in MASTER-2001, 2) interception of a dust cloud, 3) contaminants emitted from the ISS, Soyuz or the Shuttle, or 4) secondary debris. Consideration of the conditions in orbit currently favours 3) as the origin of the Wake impacts. On the Ram face any of causes 1), 2), 3) and 4) is plausible. However small tracks, measuring approximately 50 μmĄE00μm in diameter or length, are low-velocity impact features ($<$ 1km s-1) (Kitazawa, et al., 1999), and the tracks are predominantly from one direction. These results suggest a likelihood of 3) as the origin. SM/MPAC#2 (865 daysĄEexposure): Visual inspection of the entire surface of

SM/MPAC&SEED#2, including aerogel tiles was completed using the 8x magnifying glass. At this time, track diameters of 200 μm or larger were detectable on the aerogel surface: the number of the tracks found is about 3 times (13 tracks) that of SM/MPAC #1. Under the 150x microscope, many porous bubbles (or pock-marks) become visible, with diameters in the range of several to hundreds of microns, and near a depth of about 100 μm; in addition, numerous jellyfish-like white objects approximately 100 μm in diameter can be seen. There are on average approximately 4,000 of these objects per tile. The existence of these features could complicate the search for smaller impact features, and consequently the contamination issue could be relevant factor in planning future exposure experiments and designing external equipment on the ISS. The Wake surfaces of both MPACs #1 and #2 have changed colour and texture as a result of contamination; in addition the Ram surfaces of MPAC #2 have undergone strikingly different changes from the Wake surfaces. When viewed with the naked eye, exposed Ram surfaces appear a milky colour. SM/MPAC#3 was retrieved around October 2005 (about 4 years'exposure). We discussed analysis results of SM/MPAC#3 in the full paper. MPAC experiment is also scheduled for the Japanese Experimental Module (Kibou).