THE MARS SCIENCE LABORATORY ORGANIC CHECK MATERIAL. P. G. Conrad[1], J. E. Eigenbrode[1], C. T. Mogensen[2], M. O. Von der Heydt[3], D. P. Glavin[1], P. M. Mahaffy[1] and J. A. Johnson[3], [1]NASA Goddard Space Flight Center, Code 699, Greenbelt, MD 20771 Pamela.G.Conrad@nasa.gov, [2]Grundfos Management A/S, Bjerringbro, Denmark, [3]Jet Propulsion Laboratory, Pasadena, CA 91109.

Introduction: The Organic Check Material (OCM) has been developed for use on the Mars Science Laboratory mission to serve as a sample standard for verification of organic cleanliness and characterization of potential sample alteration as a function of the sample acquisition and portioning process on the Curiosity rover. OCM samples will be acquired using the same procedures for drilling, portioning and delivery as are used to study martian samples with The Sample Analysis at Mars (SAM) instrument suite [1, 2] during MSL surface operations. Because the SAM suite is highly sensitive to organic molecules, the mission can better verify the cleanliness of Curiosity's sample acquisition hardware if a known material can be processed through SAM and compared with the results obtained from martian samples.

SAM possesses internal calibrants and the OCM is not designed for this purpose, however the OCM material, an amorphous SiO_2 glass, is doped with fluorinated hydrocarbons) (3-fluoro-phenanthrene and 1-fluoro-Naphthalene in order to ensure that the lack of other detectable molecules is indeed due to their absence rather than a sample delivery failure.

There are five OCM samples, each one a cylindrical brick individually encapsulated in a hermetically sealed can. The five cans are accommodated on the front of Curiosity and the OCM sample will be acquired by puncturing the top of a can and drilling a brick in place, just as a natural martian rock is to be sampled. An important difference distinguishes the OCM sample process from the sampling of unknowns on Mars: the CheMin powder X-Ray diffractometer will not ingest and analyze the OCM samples. CheMin does not detect organic molecules and the amorphous silica brick material was chosen to minimize the potential for interference with X-Ray diffraction patterns.

OCM Matrix Material: The ceramic bricks had to meet several materials requirements:

- they must have a compressive strength < 230 MPa (the upper limit tolerated by the Curiosity drilling hardware)
- the material should be as amorphous as possible
- certain chemical elements should not be detectable at more than 1 wt % by CheMin after a two-hour integration: Ni, Zn, Cr, K, Y, Sr, and Mn at 0.3 wt %.
- material must be stable under conditions of launch and entry-descent-landing (EDL) loads, and thermal conditions of cruise and two years of seasonal and diurnal fluctuations on Mars
- must be suitable for doping with a fluorinated hydrocarbon marker.

Eleven materials from six different vendors were evaluated, including the MACOR ceramic used by the Phoenix Mars mission as an organic free blank [3]. Six materials underwent testing with respect to their chemical and physical properties, and a porous silica ceramic, FS-120a, H. P. Technical Ceramics in Sheffield, England, was selected as the best fit. This material can be fabricated with variable porosity up to thirty percent of the total volume and has a compressive strength of ~12 up to 20 MPa, depending upon porosity. We conducted a continuity test early in the selection process to determine that the pores were interconnected, by allowing a brick to soak up a liquid dye. In less than 15 minutes, a 66mm (L) x 56 mm (dia) was completely saturated. The interconnected network of pore spaces is a requirement for distributing the organic dopant on the interior surfaces as homogeneously as possible. Such a distribution ensures that small differences in drilling angle would not affect the amount of dopant in any given sample. Three bricks were analyzed on a Bruker D-8 Discover powder X-Ray diffractometer to verify a satisfactory lack of crystalline structure (Fig 1)

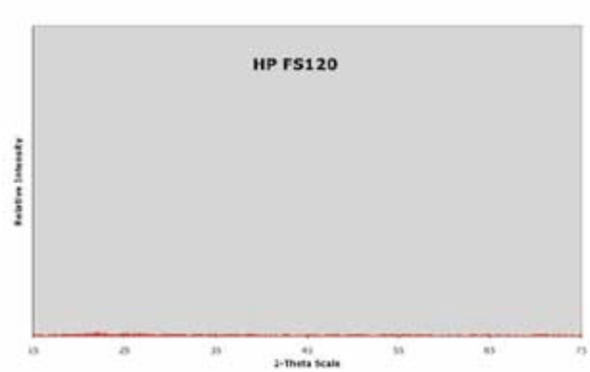

Fig. 1 Powder pattern of HP FS120A ceramic. Note absence of defined peaks. Source: CuKα (λ= 0.1542 nm)

The ceramic was subsequently drilled with an engineering model bit of the MSL rotary percussive drill to determine particle size distribution of the powders. With a penetration rate of ~6.23 cm/min., 41 % of the powders were in a particle size range of 50 – 150 µm and 49.6% of the powder particles were > 150 µm. 9.4% of the grains were < 50 µm in diameter. Testing with a high fidelity EM of Curiosity's drilling mechanism under analog Mars environment is ongoing.

The brick shape is cylindrical with machined chamfers to minimize the potential for cracking and abrading of edges (Fig 2):

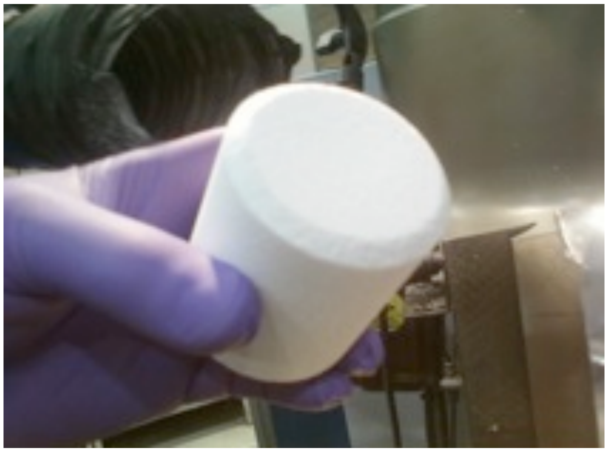

Fig. 2 The OCM bricks have chamfered edges at the top of the cylinder and a positioning groove machined into the base as an anti-rotation feature while drilling. (Photo James Pura).

Organic Dopant: Each OCM brick is doped with a 1:1 mixture of 3-fluoro-phenanthrene (3FP) and 1-fluoro-naphthalene (1FN) to serve as a detectable, yet non-naturally occurring marker. Several dopant candidates were evaluated on the basis of their chemical properties. The marker material must meet several requirements:

• must be "sticky" enough to withstand the drilling, portioning and delivery process, yet SAM must be able to bake it out of its gas processing system, mass spectrometer and gas chromatograph

• must be soluble in a solvent delivery medium that can be driven off so it does not remain in the bricks after doping, but must have sufficient volatility to distribute evenly throughout the brick pore network

• must be resistant to degradation under Mars conditions during the length of the MSL primary mission.

The SAM investigation has included the OCM matrix material as well as the 3FP and 1 FN dopants among its internal calibration materials and will be able to compare the delivered OCM sample chromatograms against internal standards.

Encapsulation: Each brick is individually contained in a hermetically sealed canister so that a pristine OCM brick can be sampled at each use. The canisters are sealed with a welded lid and are doped through inlet and outlet ports, which are pinched off and capped after the doping process is complete and the cans evacuated to martian ambient pressure. Several sealing strategies were studied and the welded foil "lid" was judged the best approach for maintaining the cleanliness of the OCM bricks as well as minimizing the chance for degradation in the martian environment.

The number of canisters to be accommodated was determined by the available space on the front of Curiosity; each sample had to be accessible by the drill on the end of the robotic arm. Hardware and accommodation of the OCM will be more fully described in a separate report.

Organic Cleanliness: The bricks are baked at 550 °C for four hours in air to remove any potential contaminants that may remain from the manufacturing process. They are then handled according to MSL contamination control guidelines, and the hardware is precision-cleaned to the same standards. A high temperature bake out is incompatible with the materials properties of the canisters and nickel gland assemblies comprising the inlet and outlet ports.

Usage: The Organic Check Material is a mission resource as are all of the investigations, so the decision to sample an OCM brick will be made by consensus of the project's science operations working group (SOWG). Possible scenarios for use could include one sample immediately after observing any organics in martian samples. Perhaps an OCM sample may be acquired if no organics are observed to test if reduced carbon phases are not robust to the drilling, portioning and delivery process. An OCM sample could be characterized very early in the mission to determine if the launch or EDL processes have contaminated the sampling hardware.

Five identically produced and encapsulated OCM units will be maintained at the SAM test bed at NASA Goddard and they will be analyzed with the SAM test bed at the same time in the mission as the OCM units on Mars are sampled.

References: [1] Mahaffy, P.R., (2008) Space Sci. Rev. **135**, 255. [2] Mahaffy, P.R. (2009) Geochem. News, **121**. [3] Ming, D. W., et al (2008) JGR, **113**.

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