Self-Sealing Wet Chemistry Cell for Field Analysis

Analysis of soluble species in field samples is required in agriculture, soil science, and biomedical applications.

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In most analytical investigations, there is a need to process complex field samples for the unique detection of analytes, especially when detecting low-concentration organic molecules that may identify extraterrestrial life. Wet chemistry based instruments are the techniques of choice for most laboratory-based analysis of organic molecules due to several factors including less fragmentation of fragile biomarkers, and ability to concentrate target species resulting in much lower limits of detection. Development of an automated wet chemistry preparation system that can operate autonomously on Earth and is also designed to operate under Martian ambient conditions will demonstrate the technical feasibility of including wet chemistry on future missions. An Automated Sample Processing System (ASPS) has recently been developed that receives fines, extracts organics through solvent extraction, processes the extract by removing non-organic soluble species, and delivers sample to multiple instruments for analysis (including for non-organic soluble species). The key to this system is a sample cell that can autonomously function under field conditions.

As a result, a self-sealing sample cell was developed that can autonomously hermetically seal fines and powder into a container, regardless of orientation of the apparatus. The cap is designed with a beveled edge, which allows the cap to be self-righted as the capping motor engages. Each cap consists of a C-clip lock ring below a crucible O-ring that is placed into a groove cut into the sample cap. As the capping motor pushes the cap down onto the cell, the lock ring engages a small groove cut into the cell body. When the C-clip engages, the cap locks onto the sample cell. The seal is created through the O-ring, which is pushed down the body of the cell, resulting in a clean seal that has not leaked during multiple tests with 2,000 psi (≈13.8 MPa) of pressure.

The sample cells allow solvent to be inserted into the cell through a high-pressure check valve at the bottom of the cell. The spring-loaded back end also comes with a 5-μm sintered metal filter that removes particulates as the solvent and analyte are removed from the cell and delivered to the analytical instrumentation for analysis. Additionally, the check valve is nominally closed so that any residual solvent remains in the cell and does not contaminate other instruments.

This type of technique is vital for *in situ* chemical analysis on future flight missions. The current commercial benchtop model that performs this type of operation weighs well over 60 kg, and needs to be loaded by hand, including a consumable filter. The new cells are completely reusable with the only consumables being a C-clip and two O-rings, and have been demonstrated to be reusable over 50 times in laboratory testing.

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