Detecting Organics with the Mars Organic Molecule Analyzer (MOMA) on the 2018 ExoMars Rover.

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Introduction: The Mars Organic Molecule Analyzer (MOMA) is a combined pyrolysis gas chromatograph mass spectrometer (GC-MS) and laser desorption mass spectrometer (LD-MS). It will be the key instrument of the ESA Roscosmos ExoMars 2018 mission to search for extinct and extant life. Additionally the instrument should detect the organic background for example delivered by meteorites to Mars. The drill system on board ExoMars is capable to provide a drill core from down to 2 m depth. Underground samples should be partially protected from degradation derived from cosmic radiation.

Laser desorption-Mass Spectrometry: Laser desorption-mass spectrometry is a method to detect large organic molecules without degrading them during the volatilization step. This method needs a laser source in the UV-range. The method has never been used on a space mission.

Fig. 1 Laser head housing in the front and the internal optical elements in the back. The laser head contains the laser crystal and the two frequency doubling stages.

In the MOMA instrument a solid-state laser source generates UV light of 266 nm wave-lengths with a 1 ns pulse width, repetition rate up to 100 Hz and maximum output energy of 250 μJ. A miniaturized linear ion trap mass spectrometer similar to a Thermo LTQ ion trap is used to detect the generated ions.

Fig. 2 MOMA-MS Engineering and Test Unit (ETU).

A crushed sample from the drill is moved under the laser and the mass spectrometer. The laser pulses generate plumes of ions which are injected into the mass spectrometer via gas flow and electrostatic voltages through the aperture valve and capillary ion inlet. After closing of the valve the pressure in the MS is reduced to the working conditions of the linear ion trap mass spectrometer and the ions are analyzed.

Gas Chromatography-Mass Spectrometry: The use of pyrolysis and derivatization GC measurements to determine the volatile and the highly functionalized less volatile compounds from an sample is a well-established and has been a facility on several missions, for example Curiosity and Rosetta.

The MOMA instrument is capable to submit the sample to a derivatization process, consisting of the reaction of the sample components with specific reactants (MTBSTFA, DMF-DMA or TMAH) which increase the volatility of complex organic species.

In the pyrolysis mode the sample material can be heated to above 900°C. In this step most of refractory organic compounds break down and can be analyzed by the GC-MS.