

Impact of Calcium perchlorate on the TMAH thermochemolysis reaction: application to SAM and MOMA

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Abstract

The Mars Organic Molecule Analyzer (MOMA) experiment onboard the ExoMars 2020 rover (Rosalind Franklin) will analyze the content in organic molecules present in samples collected at the surface and subsurface (down to 2 meters) of Mars. MOMA has two

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complementary analytical modes: Laser Desorption/Ionization-Mass Spectrometry (LDI-MS) and Pyrolysis-Gas Chromatography-Mass Spectrometry (Pyr-GC-MS). In addition to the pyrolysis analysis, three types of derivatization reagents which can be used to make the analysis of refractory and very polar compounds by increasing their volatility and protecting the labile chemical groups: N-methyl-N-tert-butyldimethylsilyl-trifluoroacetamide – MTBSTFA; dimethylformamide dimethyl-acetal - DMF-DMA; and tetramethylammonium hydroxide TMAH. TMAH works as a methylation agent boosting the cleavage of macromolecules, thereby methylating the products released from sample pyrolysis, and giving rise to improved detection by GC-MS. TMAH thermochemolysis can provide complementary informations about organic compounds such as amino acids, aliphatic and aromatic carboxylic acids, ect.. TMAH derivatization can increase the volatility of the nucleobases by decreasing the polarity of the labile molecules, which makes it easier to identify nucleic acids in the complex mixtures. However, we know perchlorate are present at the subsurface of Mars and could oxidize and degrade organic molecules at high temperature during the pyrolysis. Then, the effect of perchlorate on the derivatization reagent TMAH, needs to be studied. The products of TMAH pyrolysis with and without calcium perchlorate at different heating rate (flash pyrolysis and ramp pyrolysis (at a heating rate of 35 °C/min) up to 600°C) were analyzed. What's more, the reaction mechanism of TMAH pyrolysis with perchlorate was studied by step pyrolysis. Results showed that the products of TMAH at flash pyrolysis and MOMA ramp are different. In addition, the calcium perchlorate has low effect on the pyrolysis of TMAH when the content of calcium perchlorate less than 5 wt. %. Therefore, TMAH seems a good derivatization solvent for the detection of organic compounds on MOMA.