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MEMS pirani pressure sensor for the Mars Organic Molecule Analyzer (MOMA) of the ExoMars Mission

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The Mars Organic Molecule Analyzer, MOMA is a collaborative mission by European Space Agency, and NASA Goddard Space Flight Center. MOMA is a key analytical instrument aboard the ExoMars rover, set to launch in 2018. The rover will search for past and present evidence of martian life The twin rovers Spirit and Opportunity have confirmed that water was long standing on the surface of Mars long ago. The Curiosity rover found aromatic, organic compounds in the mudstone at the bottom of a possible ancient lake. Mars Science Laboratory scientists found that chlorobenzene was formed during the reactions inside the Sample Analysis (SAM) instrument from martian chlorine and carbon during the heating of perchlorates known to be present in martian soil. The ExoMars rover will sample martian soil/rock at depths of up to 2 meters, deeper than any instrument before it. The rover collect the sample and analyze them by MOMA. The MOMA has two operation modes: Gas Chromatograph-Mass Spectrometry (GC-MS); and Laser Desorption-Mass Spectrometry (LD-MS). (Please see the image) LD-MS employ laser desorption ionization to avoid the need to heat the sample, thereby preventing perchlorate reactions, which complicate identification of compounds in the sample. GC-MS will identify the chirality of organic molecules, improving understanding of how these molecules were formed.

The MEMS (microelectro-mechanical system) pirani pressure sensor is a critical component that will be used to ensure the ion trap mass spectrometer/s time sensitive operation in the LD-MS mode. It employ a high voltage for ionizations, and knowing the pressure of the MS chamber by miliseconds time scale is critical. The pressure data is used for the telemetry of the MS operation. Also the pirani pressure sensor has a critical function that pressure changes as a discontinuous inlet and pump work together to sample the Mars atmosphere in LD-MS mode. It also has to work at ambient temperatures varying from -20 to 80 degrees Celsius and be calibrated for both carbon dioxide for sampling martian atmosphere and helium during use of the gas chromatograph. The MEMS pirani sensor provides better than 0.1 mtorr accuracy over the critical pressure range from 1 mtorr to 0.1 mtorr and has a usable pressure range from 0.1 mtorr to 0.1 torr. This paper will focus on the characterization of the pirani sensor and its electrical interface and modeling ideas of a next generation of MEMS pressure sensor for future planetary and space missions.

Keywords: Robotic Rover Mission on Mars, MEMS pirani pressure sensor, Organic molecule analysis, Ion Trap, Laser Desorption Mass Spectroscopy, Gas Chromatograph Mass Spectroscopy