Fast Pressure Prediction with a MEMS Pirani Sensor for Protection of MOMA-MS

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The 2018 joint ESA-Roscosmos ExoMars rover mission will seek out signs of past or present life in the near-surface environment of Mars. To do this, the Mars Organic Molecular Analyzer (MOMA) employs a linear ion trap (LIT) developed to sample ions formed by an electron ionization or laser desorption ionization (LDI) source. In LDI mode, an aperture valve opens to pull in ions entrained in the Mars gas causing the pressure in the LIT to rise to 100 mtorr before the valve closes and pressure drops to 0.5 mtorr in 1 second. The pressure must be tracked to avoid damage to the high voltage supplies for the dynode, Channeltron electron multiplier, and rods of the LIT. Pressure sensing must also accommodate ambient temperature variations from -20 to 80 °C and varying gas composition. Fortunately, a new type of MEMS pirani pressure sensor as small as a T039 transistor package, which consumes only a few hundred microwatts, developed by Heimann Sensor GmbH, can track pressures from atmosphere to lower than 1E-4 torr.

Pirani sensors work by monitoring the heat conducted away by the pressure of gas surrounding a heated resistor. To satisfy the critical precision and accuracy requirements of pressure predictions needed by MOMA, calibrations were done on each pirani sensor tested to determine their physical parameters and subtract out power losses not due to gas conduction. Due to the roughly 10 second thermal equilibration time of the pressure sensitive membrane, an algorithm was developed to speed up response by accounting for its heat capacity. To prepare the gauge for flight, power cycling, life tests at extreme temperatures, shock treatments, and radiative exposure were investigated to optimize sensitivity without compromising sensor lifetime. Such sensors could facilitate development of portable mass spectrometers and provide measurements of pressure into the microtorr regime.