Piezo-electric inlet system for atmospheric descent probe

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Abstract

An inherent challenge with Spaceflight Mass Spectrometers (SMSs) is the introduction of the material being sampled (gas, solid, or liquid) into the instrument interior, which operates at vacuum. Especially, if being employed in an Atmospheric Descent Probe, SMSs typically require a specially designed sample inlet system which ideally provides highly chocked, nearly constant mass-flow intake, despite ambient pressure variations. In addition to being sufficiently low in conductance, an inlet leak for SMS must also be chemically inert, must not distort the gas composition being sampled by adsorbing or reacting with sampled gases differentially, and must have a reasonably fast response time (on the order of seconds or less). Finally, it must be simple, robust and operable over a wide temperature range. Past methods of producing such inlet systems have included pulled glass[1], crimped metal tubes[2,3], porous frits, micro-machined leaks[4-7] and pulsed piezoelectric valves[8,9]. So far none of these methods have produced an inlet system that would satisfy all the conditions mentioned above and be able to finely regulate sample mass-flow in a continuous fashion in wide pressure interval.

At JPL we have recently produced a miniature (MEMS), fast reacting (less than a ms), and low power valve of variable conductance, capable of continuous regulation of mass-flow in very fine steps in the environment where external pressure can reach up to 100bar, based on a piezo-electric actuator. The valve is going to be coupled with JPL's existing Quadrupole Ion Trap Mass Spectrometer (QITMS)[10], today's smallest SMS, a compact, wireless instrument, with a mass of only 7.5 kg, capable of detecting a complete inventory of atmospheric chemical species at high speed (50 full- range mass spectra per sec), with high sensitivity (up to 1E14 counts/mbar/sec) and high resolution (m/m =20000 @ 40Da). The combination of the miniature piezo-electric valve and a QITMS will result in extremely powerful instrument suitable for atmospheric descent probe missions. For example, a compact instrument based upon the QITMS design would have a sensitivity high enough to reach the precision on isotope ratios (*e.g.* better than 1% for 129,131-136Xe/130Xe ratios)[11] necessary for a scientific payload measuring noble gases collected in the Venus atmosphere.

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