control architecture that allows for ruggedness and compactness. The combination provides both portability and battery operation on a simple camcorder battery for up to eight hours.

Optical detection of gaseous HF is confounded by the need for rapid sampling with minimal contact between the sensor and the environmental sample. A sensor is required that must simultaneously provide the required sub-parts-per-million detection limits, but with the high specificity and selectivity expected of optical absorption techniques. It should also be rugged and compact for compatibility with operation onboard spacecraft and submarines.

A new optical cell has been developed for which environmental sampling is accomplished by simply traversing the few-mm-thick cell walls into an open volume where the measurement is made. A small, low-power fan or vacuum pump may be used to push or pull the gaseous sample into the sample volume for a response time of a few seconds. The optical cell simultaneously provides for an enhanced optical interaction path length between the environmental sample and the infrared laser. Further, the optical cell itself is comprised of inert materials that render it immune to attack by HF. In some cases, the sensor may be configured so that the optoelectronic devices themselves are protected and isolated from HF by the optical cell. The optical sample cell is combined with custom-developed analog and digital control electronics that provide rugged, compact operation on a platform that can run on a camcorder battery.

The sensor is inert with respect to acidic gases like HF, while providing the required sensitivity, selectivity, and response time. Certain types of combustion events evolve copious amounts of HF, very little of other gases typically associated with combustion (e.g., carbon monoxide), and very low levels of aerosols and particulates (which confound traditional smoke detectors). The new sensor platform could warn occupants early enough to take the necessary countermeasures.

A Probabilistic Mass Estimation Algorithm for a Novel 7-Channel Capacitive Sample Verification Sensor

NASA's Jet Propulsion Laboratory, Pasadena, California

A document describes an algorithm created to estimate the mass placed on a sample verification sensor (SVS) designed for lunar or planetary robotic sample return missions. A novel SVS measures the capacitance between a rigid bottom plate and an elastic top membrane in seven locations. As additional sample material (soil and/or small rocks) is placed on the top membrane, the deformation of the membrane increases the capacitance. The mass estimation algorithm addresses both the calibration of each SVS channel, and also addresses how to combine the capacitances read from each of the seven channels into a single mass estimate. The probabilistic approach combines the channels according to the variance observed during the training phase, and provides not only the mass estimate, but also a value for the certainty of the estimate.

SVS capacitance data is collected for known masses under a wide variety of possible loading scenarios, though in all cases, the distribution of sample within the canister is expected to be approximately uniform. A capacitance-vs-mass curve is fitted to this data, and is subsequently used to determine the mass estimate for the single channel's capacitance reading during the measurement phase. This results in seven different mass estimates, one for each SVS channel. Moreover, the variance of the calibration data is used to place a Gaussian probability distribution function (pdf) around this mass estimate. To blend these seven estimates, the seven pdfs are combined into a single Gaussian distribution function, providing the final mean and variance of the estimate. This blending technique essentially takes the final estimate as an average of the estimates of the seven channels, weighted by the inverse of the channel's variance.

Low-Power Architecture for an Optical Life Gas Analyzer

A simple camcorder battery can be used for as long as eight hours.

John H. Glenn Research Center, Cleveland, Ohio

Analog and digital electronic control architecture has been combined with an operating methodology for an optical trace gas sensor platform that allows very low power consumption while providing four independent gas measurements in essentially real time, as well as a user interface and digital data storage and output. The implemented design eliminates the cross-talk between the measurement channels while maximizing the sensitivity, selectivity, and dynamic range for each measured gas. The combination provides for battery operation on a simple camcorder battery for as long as eight hours. The custom, compact, rugged, self-contained design specifically targets applications of optical major constituent and trace gas detection for multiple gases using multiple lasers and photodetectors in an integrated package.