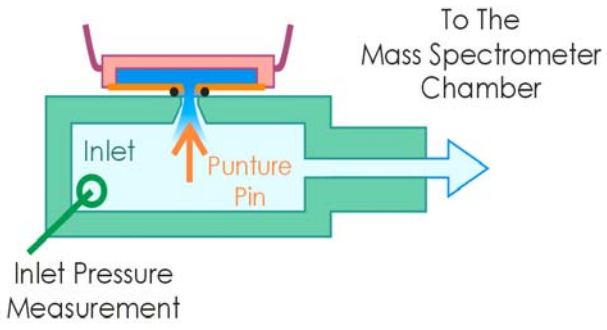
ONEIDA RESEARCH SERVICES, INC.

INTERNAL VAPOR ANALYSIS (IVA™) TEST SEQUENCE

The most widely accepted method for evaluating internal gas content is Internal Vapor Analysis (IVA) via mass spectrometry.

The mass spectrometric method for IVA involves the ionization and separation of gas molecules as they flow from the package cavity followed by a measurement of their relative abundance as a function of their mass-to-charge (m/e) ratio. Most commercially available IVA systems employ quadrupole mass spectrometers and are configured for either Batch testing or single sample testing (aka Rapid Cycle Testing). Batch Systems utilize a larger test chamber that can accommodate several samples on one central carousal. Once loaded, the test chamber is vacuum baked for 16 to 24 hours to reduce background levels of moisture prior to testing. A Rapid Cycle System type system, as used at Oneida Research Services, Inc. is designed to load and test one device at a time and, due to the reduced size of the test chamber, requires only a couple minutes vacuum bakeout to achieve suitable background levels prior to testing.

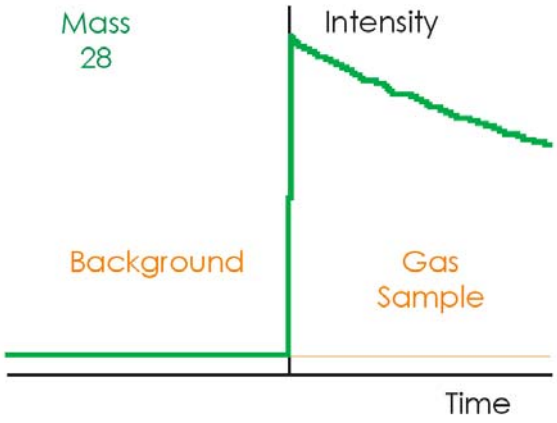
The test sequence begins by loading a single sample into the test chamber where the lid of the sample is sealed against a Viton™ O-ring. It is through the center of this O-ring that the puncture



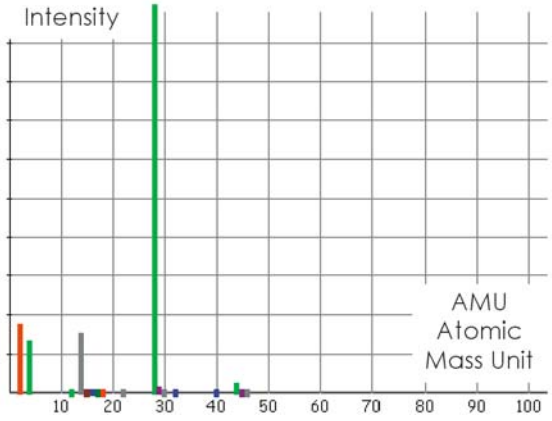
pin will be driven to pierce the package lid. This mounting procedure places most of the sample outside the realm of the mass spectrometer analyzer, thus minimizing the effect of the exterior of the package as one of the major adsorption variables. A temperature-controlled cover is placed over the sample forming a small oven which is maintained at 100°C ±5°C. A turbomolecular pump maintains the mass spectrometer inlet and analyzer at about 1x10-8 torr. Maintaining the inlet and analyzer vacuum via turbomolecular pump assures that the background level of gases remaining in the analyzer are too low to cause any interference with the measurement of gases in the sample cavity. Once an adequate background level is achieved, a background scan is collected and the package lid is punctured releasing the internal gases into the mass spectrometer analyzer. A controlled orifice allows the gases to leak into the analyzer at a predetermined rate. As the gases flow into the analyzer, they are ionized via collisions with electrons generated by a hot Rhenium or Tungsten filament. Once ionized, the gas molecules can be manipulated by electrical attraction and repulsion. A series of electronic lenses use this attraction to accelerate the ions into the quadrupole mass filter. By sequentially scanning RF and DC voltages around a set of four rods, the ions spiral down a pathway at the center of the rod group. For any given collision on the rods, only one mass-to-charge ratio (the mass of the atom or molecule divided by its total ionic charge) can pass all of the way through to the detector. Any other ion would spiral eccentrically and strike one of the rods causing it to lose its charge and be pumped away as a neutral gas molecule.

The relative ionic abundance or intensity is detected over several scans over a set Atomic Mass Unit (AMU) range. The detector is an Electron Multiplier that employs a series of charged dynodes to create a cascade effect of electrons after an ion impacts on the first dynode. This cascade effect produces a

measurable signal that is detected by an electrometer and passed through an amplifier. The intensity of the signal is roughly equivalent to the amount of gas analyzed. The voltage on the quadrupole rods at the time the signal is measured is used to identify the gas.



The analog signal generated is then digitized to form a raw data file.



This raw data is corrected from the background effect to form the mass spectra of the gas sample (peak intensities for each detected AMU). The next step consists in associating these peaks with individual gases, taking into account the interfering spectral peaks and instrument sensitivity. The final quantitation is calculated in % or ppm by volume concentration.

Every molecule exhibits a spectral signature with a primary peak and secondary peaks. The key aspect of the mass spectra is the stability of the ratios of the secondary peaks to the primary peak. Once these spectra are known for all the substances, we are able to use them to determine the different spectra (substance) constituting the analysis. The delicate part of this operation is to manage the masses (peaks) generated by more than one substance.

For substance recognition we are using a small library which contains the most common substances found in hermetic micro-electronic packages (constituents of air, common solvents and cleaning agents, leak testing substances, ...).

After the standard substance recognition step some residual peaks may remain. Any significant peaks that remain may be identified with the assistance of a NIST mass spectra database containing more than 140,000 substances. This feature allows us to characterize unusual substances with the help of the manufacturer. Understanding the manufacturing process and materials used can help determine the residual spectra.

A crucial step in data analysis and quantitation is to determine the response or sensitivity factor for identified substances. Sensitivity factors are then used to correct each quantitative measurement from the instrument raw signal. A calibration system that reproduces the test procedure of a typical device is a key factor in providing repeatable and accurate results. The best method is to use fixed single volume calibrators that are mounted on the test chamber and punctured in the same manner a real samples. Known single calibration volumes range run from 0.01cc to infinite volumes (evaluated at 1 atmosphere). Volumes as low a 0.0001cc are available on ORS' High Resolution IVA system for very small volume and vacuum sealed devices. The Moisture calibration requires the use of a moisture generator associated with a dew point hygrometer. Room air and other precise gas mixtures are used to calibrate for other standard gases.