

# Semiconductor Fabrication

## Bulk Gas Purity Fast Facts

Vacuum Lithography

Plasma Etch and CVD

MB Epitaxy

Scrubber Efficiency

**Ultra-pure gases are a necessity for semiconductor device fabrication and the continuous monitoring of bulk gas purity can ensure maximum production.**

**Contamination is costly.** Semiconductor manufacturers need the ability to continuously verify the purity of process gases in real-time and detect trace contamination at concentrations in the low parts-per-trillion (ppt).

### Extrel Application Highlights

- Confident supply of UHP production gases
- One analyzer for all contaminants
- Fully automated, real-time contamination alerts
- Reliable 24-7 process protection
- Maximized wafer yields

Ultra-high purity gas analyzers from Extrel have the speed, sensitivity, and ease-of-use to continuously monitor Nitrogen, Argon, Helium, Oxygen, and Hydrogen supply streams and rapidly report ppt-level contamination to protect the electronics fabrication process.

The Extrel VeraSpec™ APIMS combines Atmospheric Pressure Ionization (API) technology with a high-performance mass spectrometer optimized over five decades in industrial gas analysis.

Extrel is the only mass spectrometer manufacturer in the world that utilizes a 19mm, tri-filter quadrupole mass filter in semiconductor gas analysis for the very best performance, reliability, and uptime.

Air Separation Unit



Bulk Gas Storage



Gas Purification

Continuous Online Purity Monitoring



Fabrication Environment and Process Tools



VeraSpec APIMS for Continuous Semiconductor Bulk Gas Purity Verification

## Fast, Accurate Analyzers that Give You More Information

Atmospheric pressure ionization is a technique that gives a mass spectrometer the very highest sensitivity for trace gas analysis in UHP samples.

A corona discharge needle is used to ionize the molecules of the bulk gas sample (Figure 1). These ions readily transfer this charge to contaminant molecules with lower ionization potentials. The approach yields ionization efficiencies approaching 100%, ensuring exceptional detection limits (Table 1).

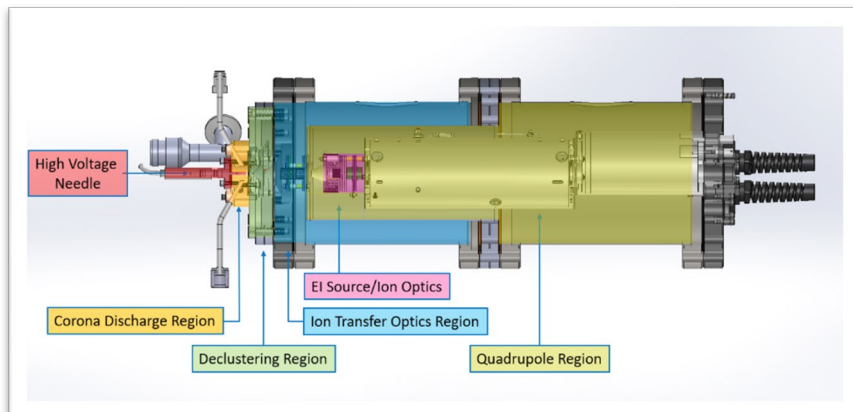


Figure 1. The critical components of APIMS

While APIMS allows for high ion currents, resulting in low detection limits, the technique is limited to species whose ionization energy is less than that of the bulk gas, or components with sufficient proton affinity to be ionized. The VeraSpec APIMS system combines both EI and API ionization sources. Having two ionization techniques allows for the complete analysis of all components in the pure gas sample with one system.

Table 1. Typical VeraSpec APIMS Low Detection Limits by Contaminant and Bulk Gas

Trace Contaminant*	Bulk Gas				
	N2	Ar	He	H2	O2
Oxygen (O <sub>2</sub> )	10 ppt	10 ppt	10 ppt	10 ppt	n/a
Methane (CH <sub>4</sub> )	10 ppt	10 ppt	10 ppt	10 ppt	10 ppt
Water (H <sub>2</sub> O)	10 ppt	10 ppt	10 ppt	10 ppt	10 ppt
Carbon Monoxide (CO)	*	10 ppt	10 ppt	10 ppt	10 ppt
Carbon Dioxide (CO <sub>2</sub> )	5 ppt	5 ppt	5 ppt	5 ppt	5 ppt
Ammonia (NH <sub>3</sub> )	500 ppt	500 ppt	500 ppt	500 ppt	500 ppt

\*Additional contaminants are available, i.e. argon, nitrogen, etc. Testing is currently underway to measure these specific LDLs. Further details are available upon request.

### Extrel VeraSpec APIMS Features

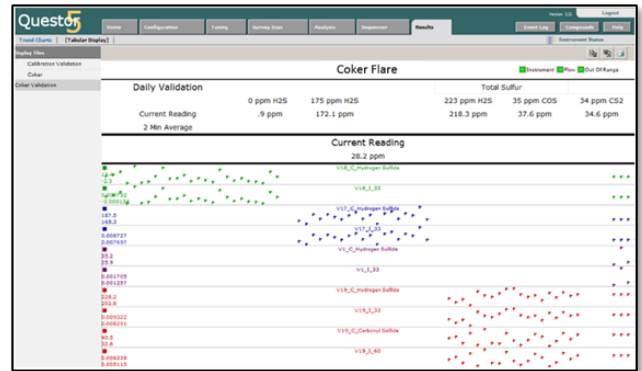
Additional features of the VeraSpec APIMS make the difference, every day, over years of intuitive, low-maintenance operation.

- Easy-change Corona Discharge Needle
- Dual Source (API/EI) ionization functionality
- All-metal system and fittings design
- Dry, oil-free pumping configuration (single backing pump setup)
- 1-500 amu standard configuration (multiple mass ranges available)
- Pulse-counting electron multiplier
- Analog and Digital I/O included
- Simple maintenance (<1/year)

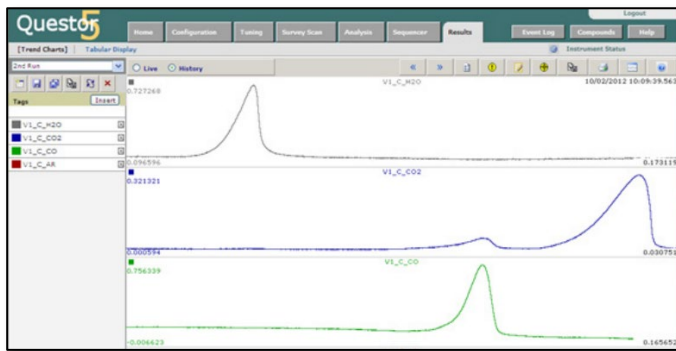
## Questor5 Process Control Software

The Questor5 process control software that drives the VeraSpec APIMS System is designed for continuous gas monitoring in a process environment.

The intuitive web-based interface allows the user to check instrument status, review data, or run an acquisition from anywhere on the network, while maintaining government and industry security standards for login and electronic record keeping.



Analysis routines and data displays are fully customizable



Simultaneously trend high precision measurements of multiple contaminants

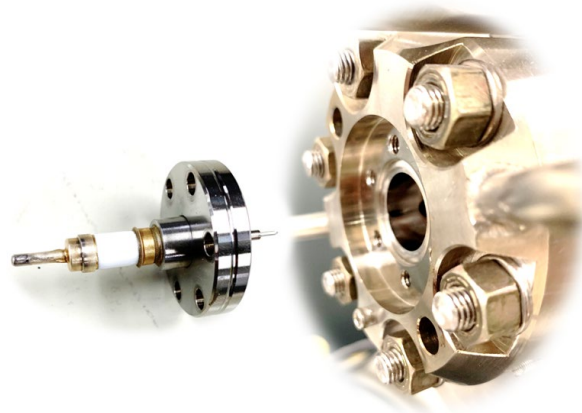
## Questor 5 Software Features

- Manual or automated calibration
- Automated sample selector options available
- Unlimited configurable data tags and alarms
- Analysis can be triggered by external devices
- Automatic removal of spectral overlap
- Full Network Accessibility
- Security: 21 CFR Part 11
- Security levels: Administrator, User, Viewer
- Comprehensive spectral library included - NIST MS database and spectrum matching software upgrade, optional
- External communications - Ethernet, Modbus serial, digital I/O, analog I/O, OPC

## VeraSpec APIMS Use and Maintenance

The innovative design of the VeraSpec APIMS makes it easy to use and maintain for maximum uptime and utility.

- *Easy-change needle replacement flange*
- *A single, dry backing pump eliminates the need to maintain messy oil pumps*
- *The Questor5 software is designed for automated, continuous industrial gas analysis*
- *The inclusion of an additional Electron Ionization (EI) source allows the analyzer to be used for full sample characterization, leak checking, and looking for unexpected compounds at concentrations up to 100%.*
- *The 19mm, tri-filter, quadrupole mass filter transmits more sample ions to the detector than a smaller quadrupole can, allowing for greater precision, less cleaning, and better long-term stability.*



### Analyzer Specifications

Dual Ionization Source	Atmospheric Pressure Ionization (API) / Electron Ionization (EI)
API Source Background	Less than 1 ppt
Mass Range Options	1-500 amu
Quadrupole Tri-Filter Rod Diameter	19 mm
Detector	Pulse Counting Electron Multiplier
Detection Noise	< 3 counts in 10 <sup>6</sup>
Detection Limit	< 5 ppt (component dependent)
Analysis Time	< 1 Second per Component
Sample Switching Time	15 Minutes to < 1 ppb
Bulk Gas Suitability	H <sub>2</sub> , N <sub>2</sub> , He, O <sub>2</sub> , Ar
Impurities Monitored	CO, CO <sub>2</sub> , H <sub>2</sub> O, O <sub>2</sub> , CH <sub>4</sub> , Kr, NH <sub>3</sub> , Xe (other impurities available)
Dimensions	49" (H) x 47" (W) x 24" (D) (1.2 m x 1.2 m x 0.6 m)
Maximum Number of Components	Unlimited
Maximum Number of Peaks	Unlimited
Maximum Number of Derived Values	Unlimited
Maximum Number of Alarms	Unlimited
Maximum Number of Methods	Unlimited
Maximum Number of Sequences	Unlimited
Maximum Number of Analog I/O	20 (standard) Unlimited available
Maximum Number of Digital I/O	16 (standard) Unlimited available
Maximum Number of Trend Windows	Unlimited
Communication Protocols	Modbus, Profibus, OPC