STANFORD RESEARCH SYSTEMS

Closed Ion Source Gas Analyzers

Closed Ion Source Gas Analyzers

CIS100/1 ... $7250

CIS200/1 ... $8000

CIS300/1 ... $9500 *(All prices U.S. list)*

- *100, 200 and 300 amu systems*
- *1 ppm detection*
- *1 mTorr operation*
- *Real-time RGA Windows® software*
- *Multi-head operation*
- *Field replaceable electron multiplier and filament*
- *RGA and CIS mode*

Introducing the new Closed Ion Source Gas Analyzers (100, 200 and 300 amu mass range) from SRS. With better than 1 ppm detection limit, direct sampling at mTorr pressure and a user friendly real-time Windows software package, the CIS systems will satisfy your most demanding applications. On-line process monitoring and control, verification of process gas purity at the point of use, high vacuum residual gas analysis, and process equipment leak checking are some of the areas where these systems will prove indispensable.

Compact Design

The probe consists of a quadrupole mass spectrometer with a CIS ionizer mounted inside a 2.75” Conflat Tee (CIS Cover Tee). The control unit mounts directly on the probe’s feedthru flange and contains all the necessary electronics for operating the instrument. The side port of the CIS Cover Tee provides a connection for the differential pumping system that keeps the quadrupole, filament and detector at high vacuum. The system can be connected directly to a process chamber through its standard CIS Mounting Flange (2.75” CF connection). The unit is self-aligning, with a simple, robust design. You can clean and reassemble the probe, and replace the filament and electron multiplier in the field, without ever calling the factory!

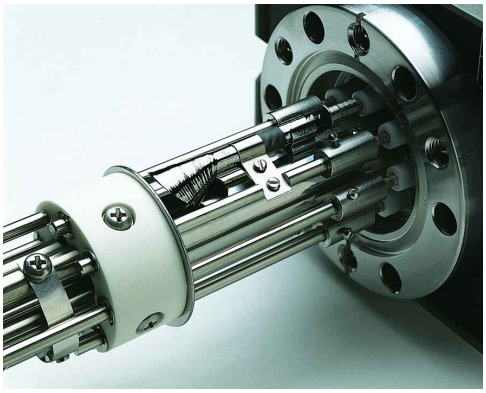
Gold plated ionizer

The entire ionizer is made of gold plated stainless steel. This reduces outgassing and background signals in the ionization region, improves the long-term stability and permits operation while exposed to reactive and corrosive gases. A Tungsten

filament is used, which resists corrosive and reactive gases like WF_6 and silane, and leads to extended lifetime. The closed (gas tight) design of the ionizer prevents commonly interfering species from back-streaming into the ionization volume. This produces spectra free of spectral overlap.

Choice of Detectors

The CIS series analyzers come standard with both Faraday Cup detector (10 ppm detection) and Continuous Dynode Electron Multiplier (1 ppm detection). The software allows you to easily switch between detectors.



Versatility

The CIS systems can also be used in a so-called “RGA mode”. In this mode, the unit has a lower minimum detectable partial pressure, but a lower maximum operating pressure as well. The RGA mode is used, for example, in the first stage of a sputtering process when the chamber is evacuated to a low pressure and the quality of the vacuum is checked for leaks and harmful contaminants. The unit can then be switched to a CIS mode, for sampling directly at higher pressure.

Complete programmability

A standard RS-232 interface is provided along with a complete programming reference. All probe parameters can be controlled and monitored, and data can be acquired for use in custom applications.

Windows software

The CIS systems are supported with a real-time Windows® software package that runs on IBM compatible PCs (486 or greater). The intuitive graphical user interface allows measurements to be made quickly and easily. The program is fully interactive giving the user complete control of the graphical display. Screens can be split for dual mode operation, scales can be set to linear or log format, and data can be scaled manually or automatically. Data is captured and displayed in real-time or scheduled for acquisition at a given interval for long term data logging. Features include user selectable units (ppm, Torr, mBar, Pascals and Amps), programmable audio and visual alarms, and comprehensive, on-line help. The software also allows complete CIS head control with easy mass scale tuning, sensitivity calibration, ionizer setup and electron multiplier gain adjustment. For further analysis, data files can be saved in ASCII format for easy transfer into spreadsheets. Graphic images can be saved as META files or copied to the clipboard for importing into other Windows® programs. The software also provides password protection for locking out head parameters so that casual users can’t alter important settings.

Multiple-head operation

The software supports multiple head operation when more than one CIS is needed. Up to eight ECUs can be monitored from the software.

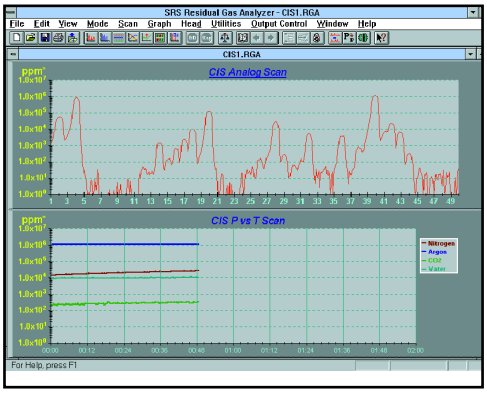
Pumping Requirements

The CIS100/200/300 requires connection to a pumping system with a pumping speed of at least 40 L/s and a base pressure of $<10^{-9}$ Torr. The connection port is a 2.75" Conflat flange. Option O100TDP provides a turbo pump which mounts directly to the CIS head along with a diaphragm roughing pump. When this option is ordered the entire analyzer including the quadrupole spectrometer and pumps are assembled, tested, and calibrated at the factory. Users can provide their own pumping station; however, it is the user’s responsibility to ensure that the pumping system does not damage or limit the performance of the instrument.

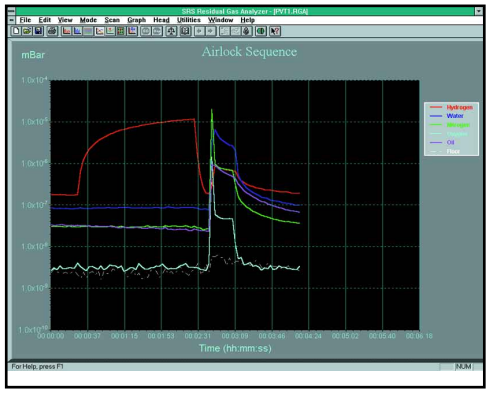
Affordable performance

The SRS CIS systems offer state-of-the-art performance for a fraction of the cost of competing models. Standard systems include faraday cup detector and Windows software. Options include electron multiplier, built-in power module, complete computer systems and a pumping package with a turbomolecular pump and diaphragm pump. Additional details are available at our web site at www.srsys.com.

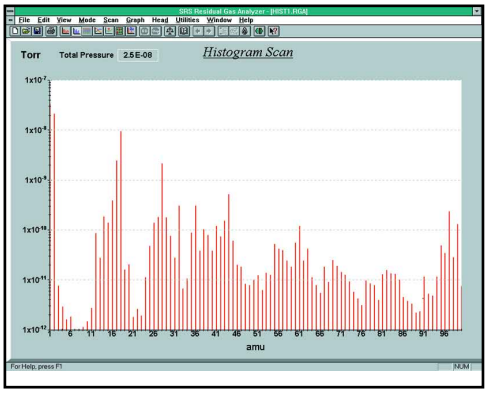
For more information, or to place an order, call SRS at 408 744-9040.



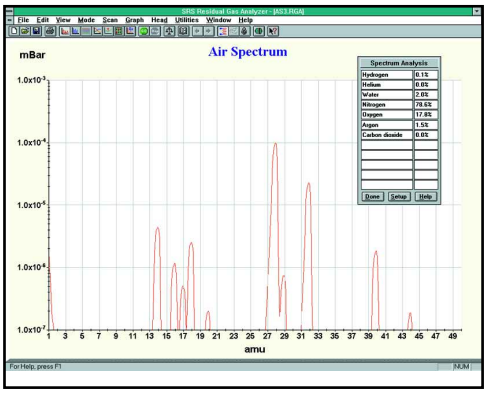
Analog mode *provides a line graph representation of the acquired mass spectrum (partial pressure vs. mass number). Data can be viewed in ppm units relative to a major peak or to total pressure. The CIS system has enough dynamic range to detect 1 ppm of water in process environments.*



Pressure vs. time *presents a strip chart of partial pressures for selected masses and provides a complete time history of your data. You have complete scrolling and zoom control - even while data is being acquired. This mode is most often used for monitoring trends in your process.*

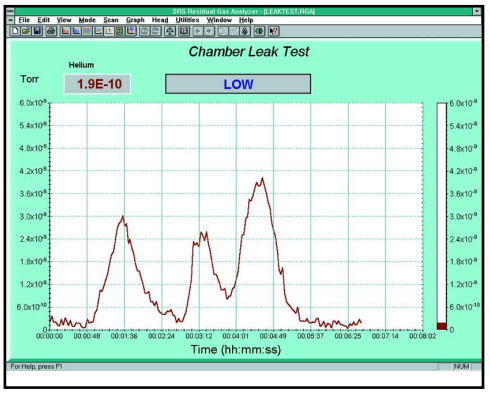


Histogram mode *displays a bargraph of partial pressure vs. mass allowing the spectrum to easily be interpreted. This mode is often used for quick and easy vacuum analysis. The screen can always be split for viewing two modes of operation simultaneously.*

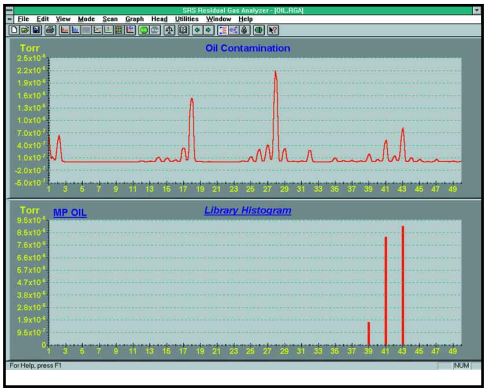


Analysis untility *provides a fast and accurate way of evaluating the composition of gases being monitored by the CIS. Using a regression technique, the utility evaluates the residual gas and gives the best approximation to its composition. Since more than one gas can contribute to a particular amu's partial pressure, the analysis mode is extremely useful in determining the make-up of complex gases. Up to 12 common gases can be selected for the analysis.*

Annunciator mode *is provided for conveniently monitoring up to 10 masses. The screen is large enough to be seen from across the room. If a particular mass has tripped its preset alarm, the large box will turn red indicating a problem. An audible alarm will also be present until the mass falls back within its preset limits. This mode is most often used for Go/No-Go testing.*



Leak detection mode *monitors a particular mass number (not just Helium) over time, and combines many features of the previous modes. A vertical bar graph provides a visual reference for viewing changes in intensity from a distance. A programmable audible tone that changes pitch as the partial pressure of the detected mass fluctuates is useful in detecting the location of a leak. A large numeric read-out and visual alarm are also provided.*



Library mode *contains a comprehensive list of gases that can be used to compare against the current spectrum. A search mode allows you to select up to 12 masses and identify and display (numerically and graphically) the intensity of all gases that contain these masses.*

CIS Parameter	*Full range*	*CIS mode*	*RGA mode*
Electron emission current (mA)	**0 to 1**	**0.05**	**0.5**
Electron energy (eV)	**25 to 105**	**70 or 35 eV**	**70 eV**
Ion energy (eV)	**4 or 8**	**4 or 8**	**4 or 8**
Extraction Voltage (V)	**0 to -150**	**-50 typical**	**-50 typical**
Sensitivity (for N2 @ 28 amu)		**10^{-6} A/Torr**	**10^{-5} A/Torr**
Linear range upper limit (Torr)		**2 x 10^{-3}**	**10^{-4}**
MDPP (Torr)		**10^{-8}**	**10^{-9}**

Notes:

1. The CIS tests were performed with a 70 l / s hybrid turbomolecular pump, backed by a high performance diaphragm pump, attached to the side port of the CIS Cover Tee.
2. The RGA mode sensitivities reported were calculated for N_2 at $<10^{-5}$ Torr.
3. The CIS mode sensitivities were calculated for N_2 at 1-5 x 10^{-4} Torr.
4. MDPP (Minimum Detectable Partial Pressure) is determined by measuring baseline levels for FC detection in the presence of $^{28}N_2$ at 10^{-5} (RGA mode) and 10^{-3} Torr (CIS mode). Up to 3 orders of magnitude improvement in detectability is possible when the CDEM is turned on.

Closed vs. Open Ion Source Gas Analyzers

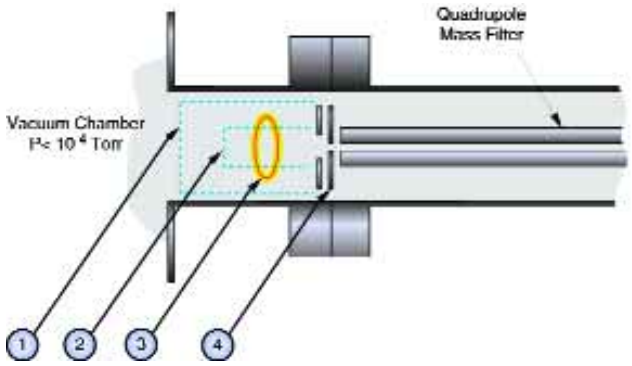
The SRS Residual Gas Analyzer (RGA) uses an Open Ion Source (OIS) configuration (Figure 1) for ionization of the gas molecules. The OIS extends into the process chamber and is "open" to all the gaseous molecules in the vacuum environment. The pressure in the ionizer is the same as in the rest of the surrounding vacuum and also the same as in the quadrupole mass filter and ion detector. The upper pressure limit for the operation of an OIS gas analyzer is 10^{-4} Torr; however, the pressure range can be shifted to higher levels (i.e. 10^{-3} to 10 Torr) with the help of a differentially-pumped pressure reducing gas inlet system (PPR) consisting of a restriction and a vacuum pump package. OIS gas analyzers have the sensitivity and dynamic range required to detect part-per-million (PPM) level contaminants. However, interferences from process gases and background outgassing from the sensor itself (i.e. from the quadrupole and detector assembly) can make the detection of PPM levels of some common residual impurities, such as water, difficult in practice.

In applications requiring the measurement of pressures between 10^{-4} and 10^{-2} Torr, the problem of background and process gas interferences with the mass spectra can be significantly reduced by replacing the traditional OIS PPR configuration described above with a Closed Ion Source (CIS) gas sampling system. Diagrams of the two systems are shown.

The CIS Ionizer sits on top of the quadrupole mass filter replacing the OIS used in conventional RGAs. It consists of a short, gas-tight tube with two very small openings for the entrance of electrons and the exit of ions. Ions are produced by electron impact directly at the process pressure (i.e. mTorr range) while, at the same time, a differential pumping system keeps the filament and the rest of the quadrupole assembly at pressures below 10^{-5} Torr through differential pumping (i.e. two decades of pressure reduction). Because the sampling pressure in the CIS is typically two decades higher than that of the rest of the sensor's vacuum system, the signal-to-background ratio is significantly increased relative to the OIS PPR configuration. This is particularly important when measuring common residual gases, such as water. The combination of direct sampling and differential pumping provides the potential for PPM and sub-PPM detection limits for even the most pervasive residual gases. For other common interferences, such as organic contaminants or reaction by-products of the filament, the gas tight design of the source reduces the visibility of the ionization region to those gases providing a very clean residual gas spectrum, free of many of the spectral overlaps that are common in OIS PPR setups.

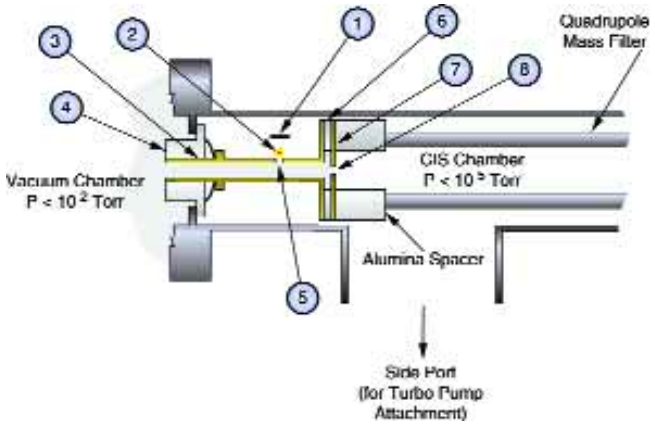
The ability of the CIS Quadrupole Gas Analyzer to sample gases directly in the mTorr range and to provide PPM level detectability across its entire mass range makes it ideal for semiconductor processing applications such as PVD, CVD and etching. The higher pressure limit of operation of the CIS is achieved at the cost of an increased (i.e. two decades typical) minimum detectable partial pressure (MDPP) level relative to an OIS PPR. A PPR system should be considered as an alternative to the CIS Analyzer for applications requiring routine leak testing and analysis of high vacuum environments at base pressures, and where the detection of PPM level contaminants is not necessary.

Figure 1: Cross section of the SRS Open Ion Source (OIS)



1) *Repeller*
2) *Anode grid*
3) *Filament*
4) *Focus plate*

Figure 2: Cross section of the SRS Closed Ion Source (CIS)



1) *Repeller*
2) *Filament*
3) *Ionization Tube (anode)*
4) *Alumina insulator and seal*
5) *Emission slit*
6) *Alumina insulator and seal*
7) *Exit plate*
8) *Exit aperture*

Specifications

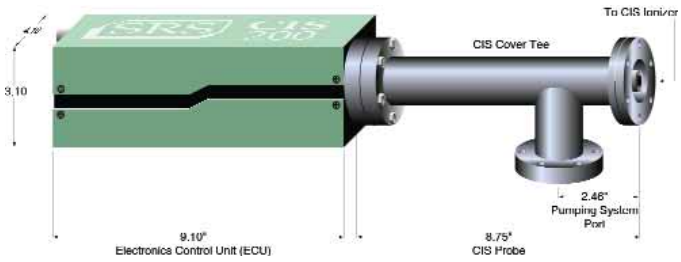
Operational

Mass range	
CIS100	1 to 100 amu
CIS200	1 to 200 amu
CIS300	1 to 300 amu
Mass filter type	Quadrupole
Detector type	Faraday cup (FC) Electron multiplier (CDEM)
Resolution (per AVS std. 2.3)	Greater than 0.5 amu @ 10% peak height. Adjustable to constant peak width throughout the mass range.
Bakeout temperature	350 °C (without ECU)

Ionizer

Design	Closed ion source. cylindrical symmetry, electron impact ionization.
Material	Gold plated SS304

Figure 3



Filament	Tungsten with firmware protection. Field replaceable. Optional: Thoriated Iridium filament.
Electron energy	25 to 105 V, programmable.
Ion energy	4 or 8 V, programmable.
Focus voltage	0 to 150 V, programmable.
Electron emission current	0 to 1 mA, programmable.

General

Probe dimensions	See Figure 3.
Probe mounting flange	2.75" CF
ECU dimensions	9.1" x 4.1"x 3.1". Easily separated from the probe for bakeout.
LED indicators	Power ON/OFF, filament ON/OFF, Elec. mult. ON/OFF, RS-232 Busy, Error, Overpressure, Burnt Filament.
Computer interface	RS-232C, 28,800 Baud with high level command set.
Software	Windows® based application. Requires 486 or better.
Power Requirement	24 VDC @ 2.5 Amps. Male DB9 connector. Optional 120-240 VAC adapter.
Weight	6 lbs.
Warranty	One year parts and labor on materials and workmanship.

Ordering Information

(All prices U.S. list)

CIS100 / 1

100 amu system w/ software and electron multipier $7250

CIS200 / 1

200 amu system w/ software and electron multipier $8000

CIS300 / 1

300 amu system w/ software and electron multipier $9500

Options

Opt 02	Built-in power module (AC line operation)	$ 250
O100HJC	200°C Heater jacket for CIS head	$ 395
O100RFW	Replacement Tungsten filament (qty. 5)	$ 100
O100RFT	Replacement ThO_2/Ir filament (qty. 2)	$ 125
O100EM	Replacement electron multiplier	$ 1000
O100RIC	Replacement ionizer kit (includes filament)	$ 900
O100TDP	Turbo pump and diaphragm pump	$ 9975

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