MASS SPECTROMETERS

FOR RESIDUAL GAS ANALYSIS - RGA

HIDEN ANALYTICAL

MASS SPECTROMETERS

for Residual Gas Analysis - RGA

A range of residual gas analysers for vacuum diagnostics, process monitoring and UHV science applications

Residual gas analysers (RGA) provide a unique window into the vacuum environment providing for contamination monitoring, leak detection and analysis of the species of interest within the vacuum chamber, water vapour for example. The Hiden residual gas analysers are quadrupole mass spectrometers configured in a broad range of products to address applications in vacuum processing, science and technology.

Hiden residual gas analysers are equipped with software that is intuitive and multi level offering simple fail safe* operation for a novice user whilst incorporating a broad range of useful and advanced features for the vacuum expert.

The vacuum residuals routinely analysed include:

Hydrogen, measured at mass 2, and of specific interest in UHV where outgassing can be the limiting factor for achieving ultimate vacuum.

Helium, measured at mass 4, and used as a search gas for leak detection. Hiden residual gas analysers include a dedicated leak detect mode, for fast response analysis of helium.

Water Vapour, measured at mass 18, is the most difficult residual to pump to UHV level without baking or pumping the vacuum chamber for extended periods.

Nitrogen and Oxygen, measured at mass numbers 28 and 32, with additional peaks measured for confirmation at mass numbers 14 and 16. The measurement of significant signal for the 'air peaks' is often the first indication of a chamber leak.

Hydrocarbons are analysed at several masses across a mass scan and typically can be identified at mass numbers 69 and 71, 55 and 57, 41 and 43, and 15 for alkanes and alkenes. The residual gas analyser broad mass scan with high sensitivity allows the user to get detailed information regarding the contamination level of the chamber.

Volatile Organic Compounds, measured at species specific masses including mass 78 for benzene, 91 for toluene, 31 for ethanol, and 45 for isopropyl alcohol.

Hiden's residual gas analysers analyse the above species with a real time data display to give the vacuum user immediate and updated information about the health and trends of the partial pressure of the key vacuum residuals. Data is used for routine vacuum chamber monitoring, leak detection, for analysis of vacuum processes, and for advanced research studies.

What our customers say:

"...I strongly feel (based on experience) that, products supplied by Hiden can be fully relied upon for their quality and reliability and equally well for the support from the Hiden family, right from the point of planning to the point of implementation."

* On board safety features include overpressure protection for both filament and detector by internal measurement as well as connection for an external over pressure protection device.

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CONTENTS

RGA SERIES

Residual Gas Analysis

All Hiden residual gas analysers are application tested and calibrated to provide the highest quality performance, and they are backed by a 3 year warranty and lifetime service support.

The Hiden RGA series includes three specification levels:

HALO - for residual gas analysis

Suitable for vacuum fingerprint analysis, leak detection and trend analysis

3F - triple filter mass spectrometers for analytical applications

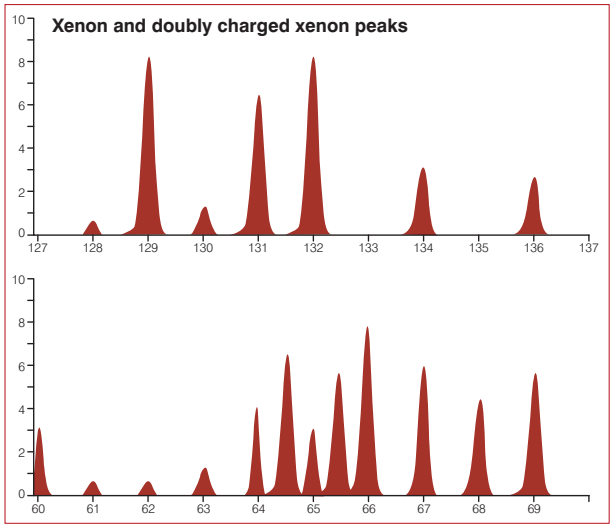
Triple filter technology provides extended mass range, increased mass resolution, enhanced sensitivity and improved contamination resistance for more demanding analytical applications

3F PIC - pulse ion counting detection for fast event studies

Ultra-fast pulse ion counting detection provides seven decade continuous dynamic range with optimum sensitivity at UHV/XHV

RGA

RGA series



3F performance includes enhanced sensitivity for high mass species and increased resolution capabilities

- **vacuum diagnostics**
- **leak detection**
- **contamination analysis**
- **semiconductor production**
- **vacuum process analysis**
- **reactive sputtering closed loop control**
- **vacuum furnace monitoring**
- **molecular beam studies**
- **UHV/XHV surface science**
- **UHV TPD**

FEATURES/OPTIONS:

- **mass range options: 50, 100, 200, 300, 510 amu**
- **very high sensitivity**
- **ultra-fast data acquisition - up to 500 measurements per second**
- **twin burnout-resistant oxide coated iridium filaments**
- **real time background subtract**
- **embedded web server with *net*MASsoft Java applet - enables simplified RGA operation from a web browser**
- **range of ion source and shroud options**
- **integral mass library**

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ION SOURCE OPTIONS

Standard and UHV low profile sources

Standard and UHV low profile gold sources

Laser cross beam source

FEATURES:

standard filament material is oxide coated iridium

other materials available on request

ion source options are interchangeable

open and closed sources available

range of cross beam sources available

standard and low profile options available

Hiden Analytical produces a wide variety of ion source types which can be fitted to our full range of RGAs. Ion source types are crucial to the performance of a RGA and having the ability to specify which source you require ensures our RGAs are custom configured for specific applications.

Ion Source Options

Standard RGA A radially symmetric configuration for general applications.

UHV Low Profile Optimised for UHV TPD studies enabling closer proximity of the ion source to the evolution surface.

Closed Source For high pressure studies with direct gas input used in conjunction with a differential pumping stage for the analyser.

XBS Cross Beam The XBS Cross Beam is configured specifically for MBE deposition rate monitoring and control.

Basic Cross Beam The Basic Cross Beam source is used for analysis of molecular beams, where the beam may be liable to condense on ioniser surfaces. The source features an unobstructed pathway through the ionising region of the source. External shrouds are available to protect the quadrupole mass filter from condensing species.

Laser Cross Beam Source The Laser Cross beam source includes two orthogonal unobstructed pathways for laser photon ionisation within the source cage region, providing an alternative to electron impact and electron attachment ionisation.

4 Lens Ion Optics with Integral Ioniser Additionally enables analysis of low energy positive and negative ions generated externally to the analyser. For electron, photon and laser stimulated desorption studies.

Platinum Ion Source This source is configured for improved operation in reactive gases. Radially symmetric, UHV compatible.

Gold Plated Ion Source This source is configured to minimise the effects of source outgassing. Radially symmetric, UHV compatible. Available as Standard or Low Profile options.

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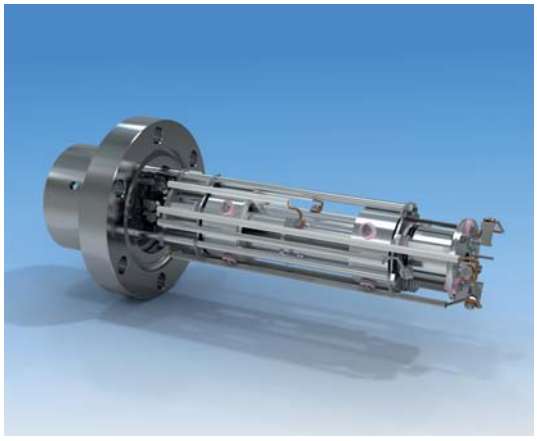
HMT

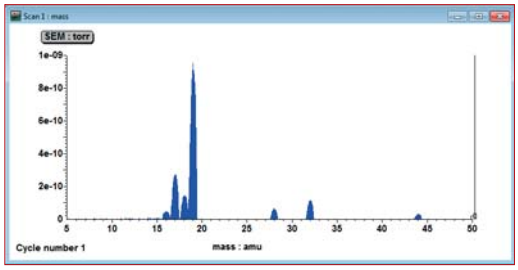
High Pressure Residual Gas Analyser

The Hiden HMT quadrupole mass spectrometer is a unique dual mode RGA system capable of operating at pressures up to 4 x 10^{-3} mbar without the need for differential pumping. Operation at this pressure is achieved using a specially designed ion source/ quadrupole filter combination and software which corrects for abundance non-linearity. The unique high pressure specification makes the HMT ideal for process monitoring applications.

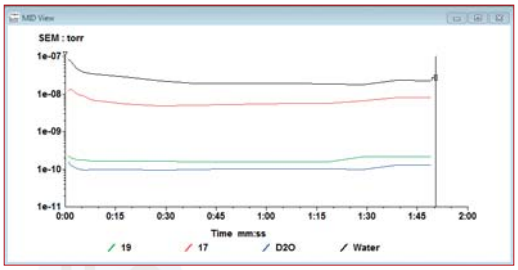
The HMT can also operate in RGA mode in the same way as a traditional quadrupole RGA. Dual Faraday, electron multiplier detectors provide partial pressure sensitivities in the 10^{-13} mbar range.



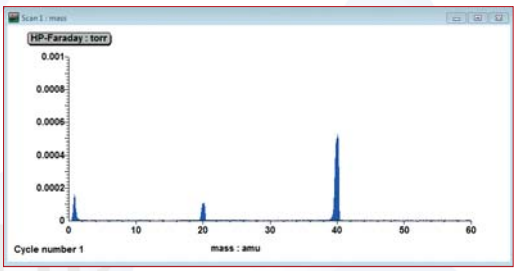
HMT



Profile mass scanning in RGA high sensitivity mode



Multi-component trend analysis



Profile mass scanning in high pressure HMT mode

FEATURES:

- **HMT mode for high pressure operation to 4 x 10^{-3} mbar**
- **RGA mode for high sensitivity operation to 10^{-13} mbar**
- **100 amu mass range**
- **stability better than +/- 1% over 24 hours**
- **fast access mixed mode scanning**
- **real time background subtraction**

RGA FOR UHV: HAL 201 RC

for Demanding UHV Applications

Gold plated ion source

The Hiden RGA for UHV are designed and configured for residual gas analysis in demanding UHV applications where critical measurements at UHV are required.

The HAL analyser includes, as standard, gold plated versions of all ion source types. The gold plated ion source is provided to minimise source outgassing, suited for applications where total pressure is < 5 x 10^{-10} mbar.

EPICS is the standard instrument control software used in many light sources around the world and the Hiden HAL system is fully compatible with EPICS software drivers.

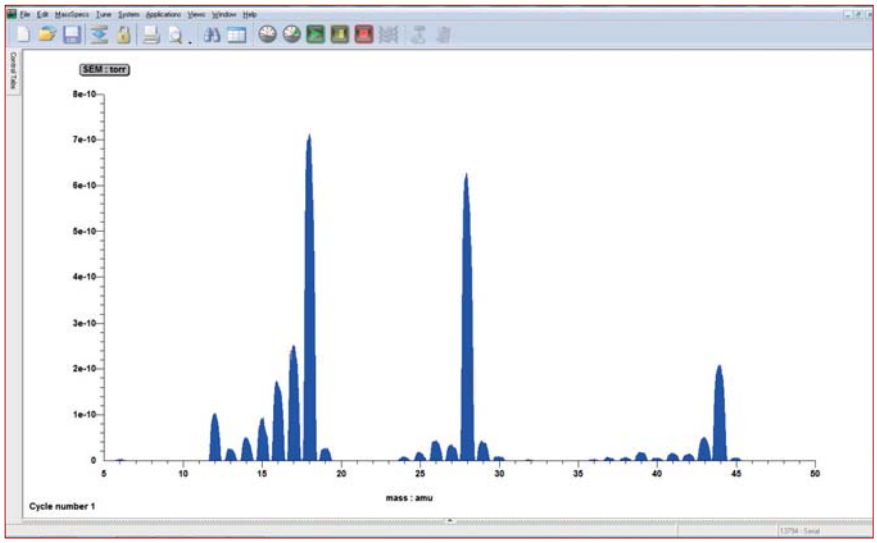
beam lines

Tokamaks/Torus facilities

particle accelerators

synchrotrons

UHV chambers



Typical profile spectra for HAL system

FEATURES/OPTIONS:

gold plated ion sources to minimise source outgassing

electron impact ioniser with twin oxide coated iridium filament

dual Faraday/channeltron electron multiplier detector

minimum detectable partial pressure of 5 x 10^{-14} mbar

maximum operating pressure of 1 x 10^{-4} mbar

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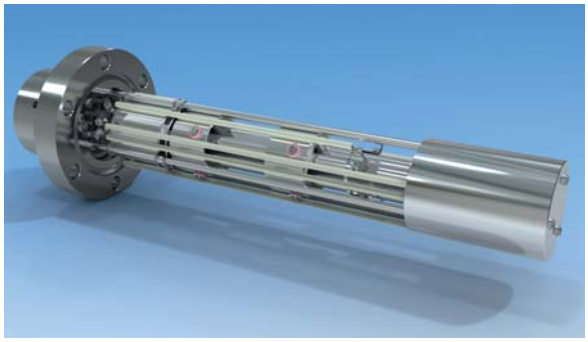
RGA FOR MBE: HALO 201 MBE

for Molecular Beam Epitaxy Applications

The Hiden HAL systems are designed for RGA, gas analysis and process monitoring applications including leak detection, trend analysis and vacuum survey.

The MBE specific analyser is constructed from compatible materials and designed for prolonged use in MBE environments and includes, as standard, molybdenum wiring in place of copper and a contamination resistant ion source shroud.



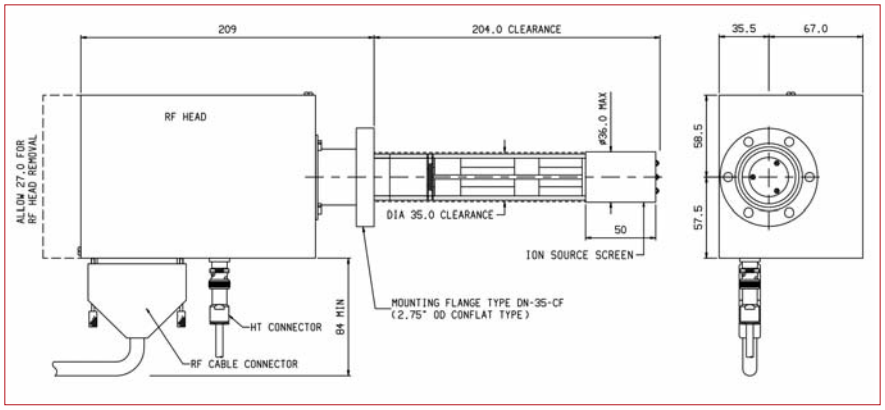
HALO 201 MBE analyser

semiconductor

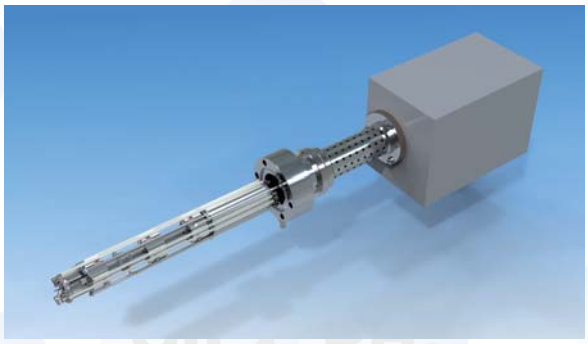
oxides

nitrides

solar cells



HALO 201 MBE analyser and RF head



HALO 201 MBE with thermal extender option

FEATURES/OPTIONS:

molybdenum wiring in place of copper wiring to improve RGA system lifetime in MBE environments

contamination resistant ion source shroud

dual Faraday/channelplate electron multiplier

minimum detectable partial pressure of 1 x 10^{-11} mbar (Faraday) up to 2 x 10^{-13} mbar (channelplate)

thermal extender option for RGA operation during bakeout

XBS DEPOSITION RATE MONITOR

for Molecular Beam Analysis and Deposition Control

XBS probe

XBS probe with water-cooled shroud and Z-drive

The Hiden XBS system is a quadrupole mass spectrometer designed for monitoring multiple beam sources simultaneously and uniquely offers beam acceptance through a 70° cone. Species-specific analogue signals are used for beam intensity output to the users' source control modules.

Beam acceptance apertures are configured individually for each specific process chamber source position, manufactured as replaceable plug-in elements to enable retrospective modification in event of chamber alteration. Purpose-designed with high contamination resistance for monitoring evaporating components and fragments in MBE processes. Manufactured with a triple stage mass filter and water-cooled fully-shrouded probe to protect the probe from the radiant heat sources and to inhibit probe contamination.

monitor and control in MBE processes

molecular beam studies

multiple beam source analysis

photoionisation studies

desorption/outgassing studies

monitor and diagnostics of contaminants in the process chamber

high performance RGA with high-sensitivity helium leak check mode for vacuum quality verification

FEATURES:

high sensitivity - minimum detectable partial pressure 2.5 x 10^{-14} mbar

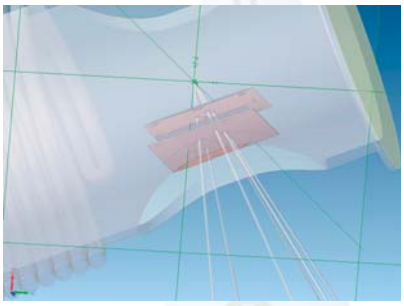
mass range: 320 or 510 amu

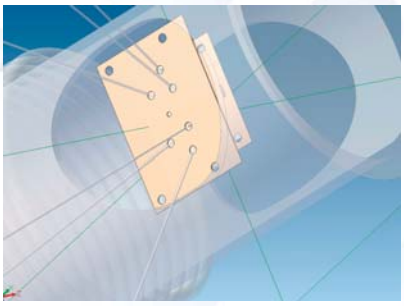
crossbeam ion source, beam acceptance through +/- 35° to transverse axis

beam acceptance apertures configured for beam source positions

growth rate determination typically < 0.01 Å s^{-1} (species dependent)

optional water-cooled shroud





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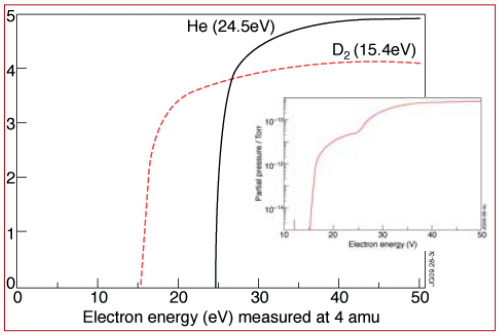
qRGA FOR ADVANCED RESEARCH

for Tokamak/Torus Fusion Research

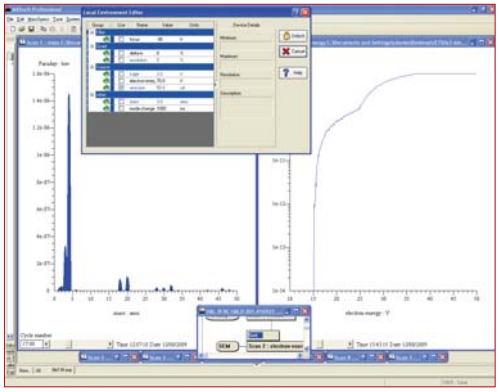
At nuclear fusion research facilities, spectral analysis of the vacuum conditions within Tokamaks is challenging due to complex interactions of hydrogen isotopes within the Tokamak. Typically, gas purity is assessed by using RGAs and obtaining a conventional mass spectrum[1]. Validation of fusion fuel purity is complicated due to D_2 and ^4He occupying the same atomic mass, 4 amu (mass separation 0.0254 amu), rendering fuel validation purity problematic using conventional mass spectrometry RGA techniques.

The qRGA provides a solution to this problem as it can also operate in a mode allowing complete control of the energy of the electrons emitted within the ionisation source, resulting in each species having a unique fingerprint that can be determined by qRGA. This mode of operation is known as Threshold Ionisation Mass Spectrometry (TIMS).

qRGA



qRGA, real time TIMS data taken at JET, UK. D_2 and ^4He (with threshold ionisation energies at 15.4 eV and 24.5 eV respectively) are easily separated and quantifiable



qRGA, real time TIMS data taken at JET, UK. Spectra show scans at 3 amu, separating ^3He from HD. Mass separation of ^3He and HD: 0.0058 amu (difficult for any mass spectrometer to resolve in conventional mass mode), is a routine measurement for qRGA

FEATURES:

real time quantitative gas analysis in a mass range 1-200 amu

sub PPM detection levels

qRGA operates in both conventional mass analysis and TIMS modes

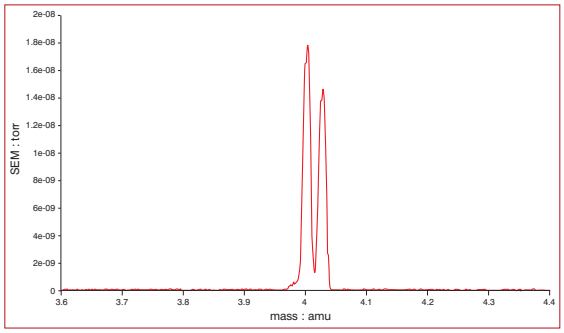
0.5 eV electron energy resolution over the range 0-150 eV

low cost multi unit solution with radiation and magnetic shielding solutions

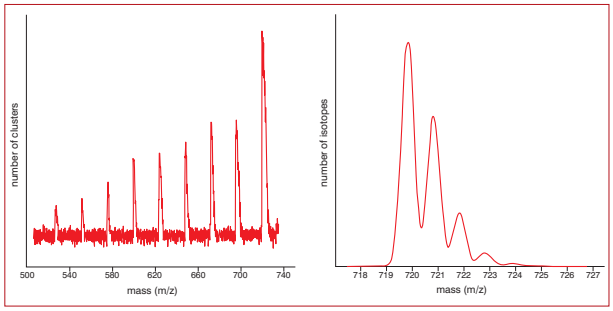
[1] *Coyne. T, RGAs Used at JET, **RGA-8**, Culham (2008)*

3F SERIES 1000/2000 RGA

for High Precision Scientific and Process Applications



High mass resolution: HAL 1000 series 1-50 amu. Allows effortless separation of overlapping masses such as helium/deuterium at 4 amu (0.025 amu) in fusion research

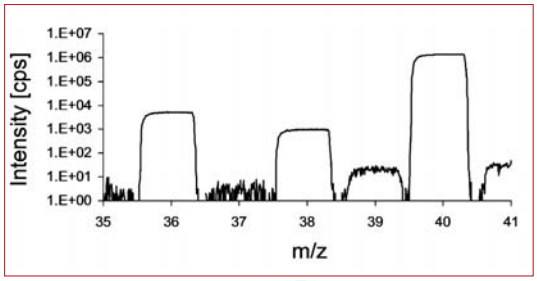


High mass transmission: Fullerene (C_{60}) vapour isotope fragment analysis

The HAL 3F RC systems are designed for gas analysis in high precision scientific and process applications.

The triple filter quadrupole minimises contamination from unwanted ions, where the pre and post RF only filters work at different selected frequency from that of the main mass filter. In combination with the longer mass filter and wider rod diameter of 9 mm/12 mm, this results in increased: mass resolution, ion sensitivity, stability for precision/ratio measurements and high mass transmission.

HAL 3F 1000/2000 series



High stability for precision isotope ratio measurements: $^{40}Ar/^{39}Ar$ geochronology research[1]

FEATURES:

mass range 1-1000/2500 amu, 9 mm/12 mm molybdenum rod design

increased mass resolution, high mass transmission, and ion stability

full electron energy control 0-150 eV for complementary TIMS analysis mode

available with SEM or PIC detection or optional dual Faraday/SEM or Faraday/PIC models

HAL 1000 series 9 mm: Researchers[1] concluded that the Hiden system outperformed their expectations, and is comparable to the magnetic sector instrument they routinely use in this field of research.

They measured the precision ratio of the $^{40}Ar/^{39}Ar$ isotopes over a two year period and concluded:

"Over two years the position of the flat peak centre did not move significantly even after maintenance events. For a ^{40}Ar beam size of 1 x 10^6 cps, peak width is 0.9 amu at 10 cps and 0.84 amu at 5 x 10^5 cps, clearly separating it from neighbouring masses. The stability of the Hiden QMS compares favourably to the MAP215-50. Air standard $^{40}Ar/^{36}Ar$ of the Hiden QMS 257.9±1.3 (n=34 since July 2006) compares to 293.1±3.3 (n=739) measured with the magnetic sector mass spectrometer instrument since the beginning of 2007."[1]

[1] *Björn Schneider et al. 2009 Quaternary Geochronology* ***4*** *Pages 508-516*

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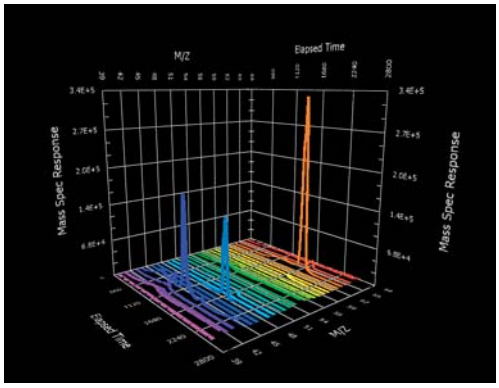
3F PIC FOR UHV TPD

RGA for Advanced Research

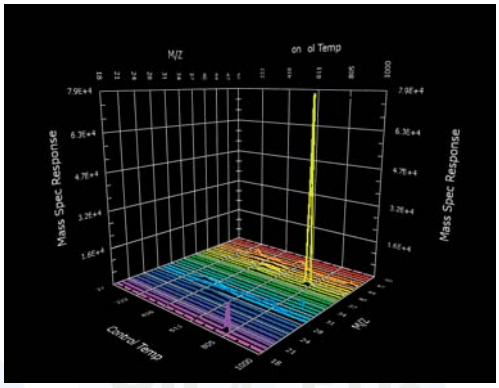
Hiden's 3F PIC Series quadrupoles are high precision triple filter analysers with digital detectors for ultimate sensitivity and time resolution in fast event studies such as UHV TPD. 3F PIC Series analysers are available with UHV compatible mass filter shrouds and low profile ion source for close positioning to the desorption surface.

Application specific software enables the user to control temperature ramp profiles and collect data in the same program (TPDsoft) or to simply collect MS data and temperature in the same program (EGAsoft).

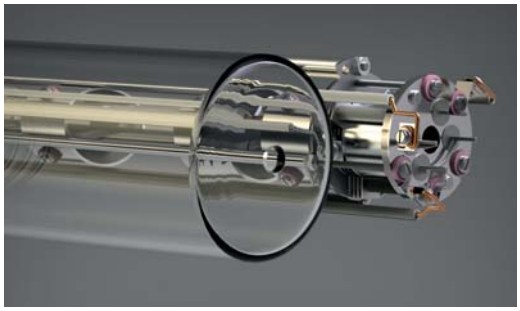
Both analogue and digital inputs are provided for synchronous acquisition start and sample temperature data display alongside mass channel data.



3D bar data view in TPDsoft



Display MS response vs. temperature



HAL 3F PIC and quartz shroud

Range of shrouds

FEATURES:

low profile ion source

range of shrouds available

fast data acquisition

500 data points per second

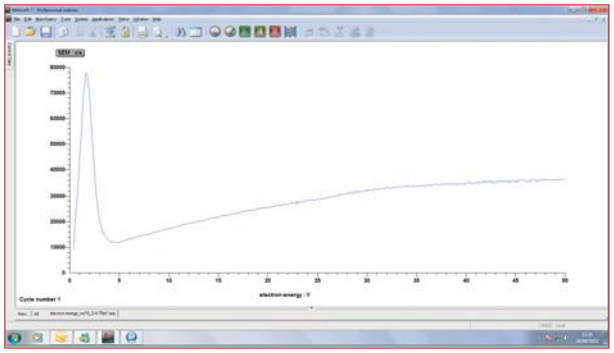
wide dynamic range

7 decade continuous log scale

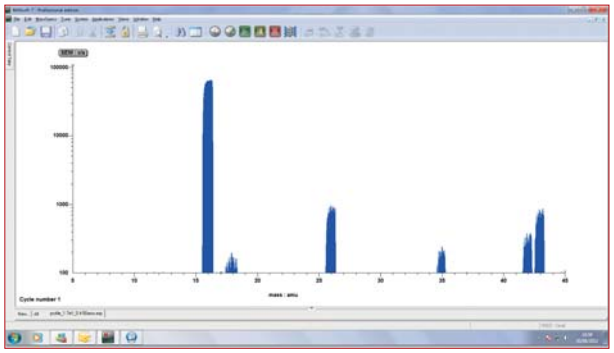
gating input for pulsed gas studies down to 100 ns gating resolution

EPIC and IDP

for Scientific Applications



O^- ions formed by dissociative electron attachment
$e + N_2O \rightarrow N_2 + O^-$



Mass spectrum of negative ions formed by low energy electron attachment

The Hiden EPIC and IDP have all the features of high performance RGAs - but with the addition of pole bias mid-axis potential and negative ion capability making them outstanding research grade mass spectrometers.

The EPIC system is factory-upgradeable for inclusion of an energy filter, either the Bessel box or Hiden 45° sector field type, ensuring compatibility with the Hiden plasma/SIMS series including the EQP, EQS, PSM and SIM probes.

The Hiden IDP is for the direct analysis of low energy ions and neutrals from UHV surface science techniques. Applications include electron stimulated desorption, photon stimulated desorption and thermal desorption studies.

UHV surface science

electron stimulated desorption

photon stimulated desorption

thermal desorption studies

radical analysis

energy and biofuels

time resolved studies

EPIC FEATURES:

pole bias mid-axis potential

positive and negative ion detection

Electron Attachment Mass Spectrometry (EAMS)

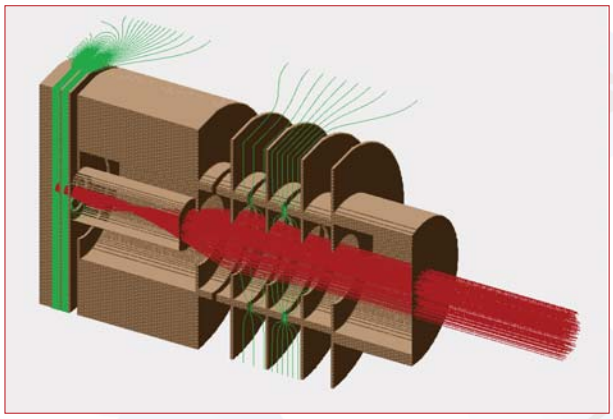
IDP FEATURES:

pole bias mid-axis potential

positive and negative ion detection

Electron Attachment Mass Spectrometry (EAMS)

4 lens ion optics



Simulation showing the focussing properties of IDP 4 lens ion optics

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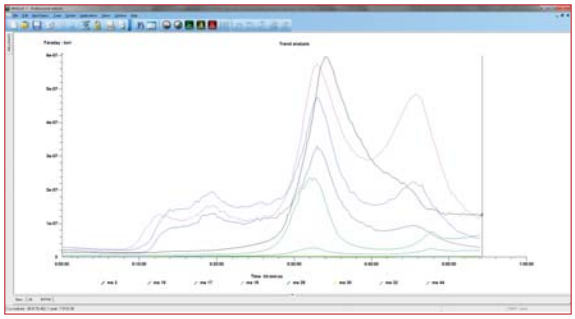
RGA CONTROL SOFTWARE

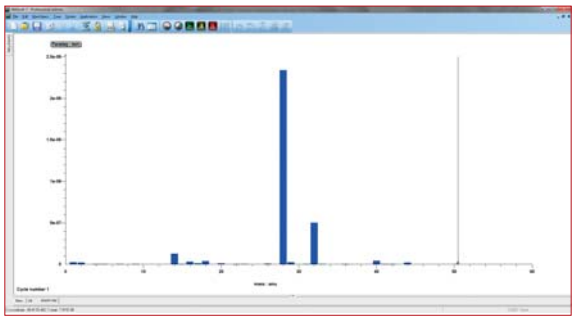
MASsoft Professional and *net*MASsoft

All Hiden Residual Gas Analysers are supplied with MASsoft mass spectrometer PC control software and *net*MASsoft.

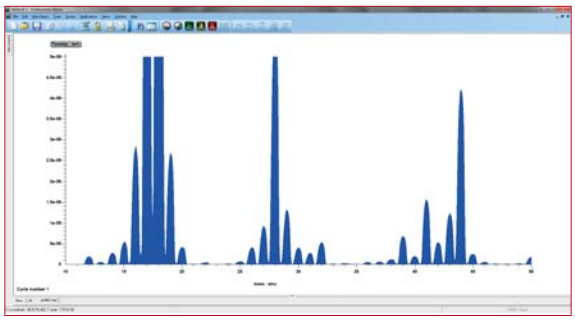
MASsoft Professional software is intuitive and multi level offering simple operation for a novice user whilst incorporating a broad range of useful and advanced features for the vacuum expert.



Trend analysis



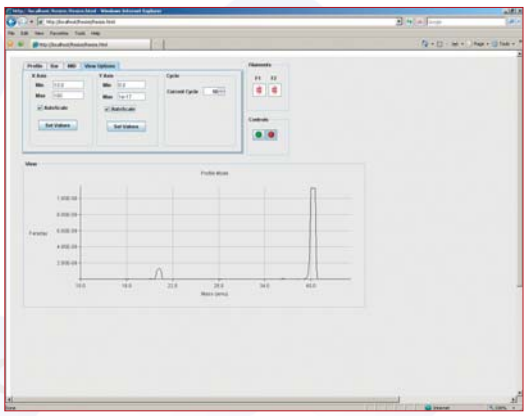
Mass scan - histogram



Mass scan - profile

Scan gallery - scan selector mode

***net*MASsoft** is a Java application for RGA operation through your web browser.



netMASsoft - a Java application for RGA operation directly from within your web browser

www.HidenAnalytical.com

SOFTWARE FEATURES:

- **template driven quick start operation**
- **multiple RGA operation over ethernet link**
- **real time data display with zoom feature**
- **mixed mode scanning including trend analysis view of selected species from broad mass scans**
- **statistical analysis and peak integration**
- **accessible data with copy/paste functions and automated data export**
- **auto mass alignment**
- **integrated mass spectral library**

RGA CONTROL SOFTWARE

Advanced Software Features

RC RGA interface

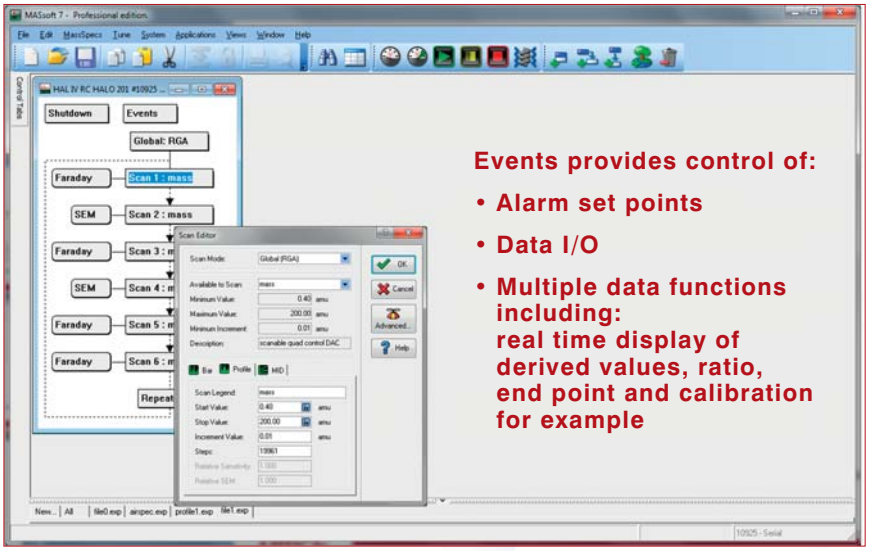
MASsoft Professional PC software provides for mass spectrometer data acquisition and control, providing a user friendly interface for the acquisition of mass spectrometer data. Behind the simplicity of the point and click automatic scan gallery are layers of flexibility allowing users to acquire, store and present mass spectrometer data in formats directly suited to their application.

background subtract - for real time comparison of vacuum quality

extract trend analysis for any mass peak(s) within the scan

4, 6 or 8 decade high dynamic range scan modes

derived data values for data presentation in % or PPM for example



MASsoft control - fully editable scan sequence with selectable: scan mode, detector and mass spectrometer parameters set individually for each scan in the sequence

RGA MASS SPECTROMETER INTERFACE INCLUDES:

ethernet TCP/IP, USB and RS232 communication links

I/O subsystem with: multi protocol RS485 links for external devices, mass flow controllers, CO analyser, total pressure gauges for example

5 channel TTL for process control/automatic start - stop trigger

analogue data input and output options

HIDEN ANALYTICAL

HIDEN APPLICATIONS

Hiden's quadrupole mass spectrometer systems address a broad application range in:

Gas Analysis

dynamic measurement of reaction gas streams

catalysis and thermal analysis

molecular beam studies

dissolved species probes

fermentation, environmental and ecological studies

Surface Science

UHV TPD

SIMS

end point detection in ion beam etch

elemental imaging - surface mapping

Plasma Diagnostics

plasma source characterisation

etch and deposition process reaction kinetic studies

analysis of neutral and radical species

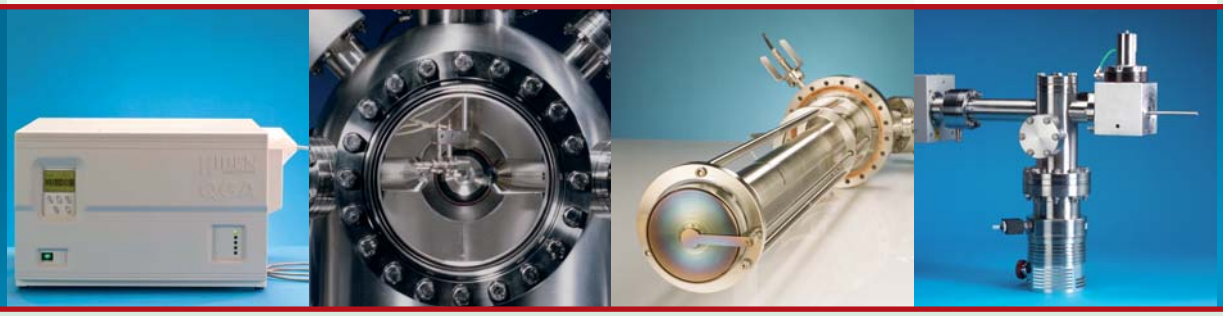
Vacuum Analysis

partial pressure measurement and control of process gases

reactive sputter process control

vacuum diagnostics

vacuum coating process monitoring



quadrupoles for advanced science

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