



Mass Spectrometers for Surface Analysis

MASS SPECTROMETERS

for Surface Analysis

Hiden Analytical have been designing and developing the highest quality quadrupole mass spectrometer based systems for over 35 years. We have built a reputation for delivering instruments with superior sensitivity, accuracy and reproducibility together with a first class global service and applications support network.

Hiden surface analysis products are available as complete systems, sub-assemblies and individual components. The products combine high performance and ease of use with unparalleled flexibility. Hiden can provide customisation for specific research needs or process monitoring requirements, ensuring optimised performance tailored to your application.

The range of ion guns and spectrometers provides for static SIMS (secondary ion mass spectrometry), depth profiling SIMS and SNMS (sputtered neutral mass spectrometry) as well as offering mass and energy resolved detection for low energy ISS (ion scattering spectroscopy).



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AutoSIMS

SIMS INSTRUMENTS

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- ▶ SIMS WORKSTATION
- ▶ SIMS WORKSTATION^{PLUS}

COMPACT SIMS – A Design Breakthrough in Surface Analysis

AUTOSIMS – Automatic Surface Analysis System

SIMS COMPONENTS

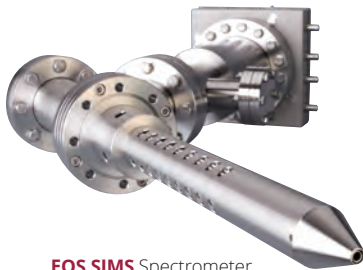
EQS – SIMS Detector

PRIMARY ION SOURCES – Optimised for Surface Analysis

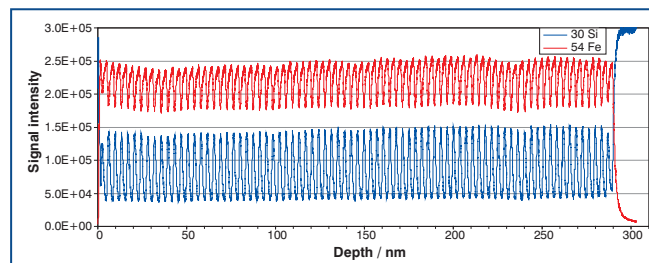
- ▶ IG20 – A 5 keV Caesium Ion Gun
- ▶ IG5C – A 5 keV Argon or Oxygen Ion Gun

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SOFTWARE – Control for SIMS



EQS SIMS Spectrometer



High depth resolution 1.8 nm layers

SIMS WORKSTATION SERIES

UHV Surface Analysis for Thin Film Depth Profiling

The **SIMS Workstation** is a family of instruments based around a large multi-function UHV chamber. The instrument is designed to be flexible, both in terms of function and cost, so features can be added or upgrades made as required. However, as a guide there are three standard configurations:

- ▶ **Foundation SIMS Workstation**
- ▶ **SIMS Workstation**
- ▶ **SIMS Workstation^{Plus}**

The **Foundation SIMS Workstation** has the main chamber and IG20 argon/oxygen source together with the 9 mm MAXIM spectrometer, a simple manipulator and an electron gun for charge compensation. This can be expanded with the addition of a full X-Y manipulator and load lock to create the standard **SIMS Workstation**. The **SIMS Workstation^{Plus}**

is the fully featured instrument with the IG5C caesium ion gun, liquid nitrogen cold trap and oxygen flood. It is, of course, possible to specify other options on all of the instruments.

The Workstation chamber is specifically designed to allow access through the top port for an XPS spectrometer and a port on the front of the chamber is optimised for a non-monochromated x-ray source.

CUSTOM SIMS

The Hiden SIMS components are available separately to enable SIMS to be added to an existing tool or to other instrumentation. A particularly useful customisation is the Modular SIMS where an ion gun, spectrometer, electron gun and light/camera are mounted on a single DN150 or larger flange.



SIMS Workstation^{Plus}



Modular SIMS

COMPACT SIMS

A Design Breakthrough in Surface Analysis



Compact SIMS

The Hiden Compact SIMS tool is designed for fast and reliable characterisation of layer structures, surface contamination and impurities with sensitive detection of positive ions being assisted by the oxygen primary ion beam and provides isotopic sensitivity across the entire periodic table. The ion gun geometry is chosen to provide nanometre depth resolution and near surface analysis. The instrument is self-contained requiring only a standard electrical outlet for operation. Although designed for routine lab use, the Compact SIMS runs the same software and is based on the same components as the Workstation series instruments allowing advanced users to access the feature-rich environments of these devices.

The manual stage and visible internal structures make the Compact SIMS ideal in an educational environment and the clean lines and simple operation ensure that it fits well in any laboratory.

FEATURES:

- ▶ Oxygen IG20 primary Ion Gun and 6 mm MAXIM spectrometer with positive ion detection
- ▶ Manual rotary stage for high reliability and ease of use
- ▶ Self-contained system (requires single phase 2 kW power supply)
- ▶ Static and dynamic SIMS with 3D imaging
- ▶ Optional electron gun and negative ion detection

AUTOSIMS

Automatic Surface Analysis System

The AutoSIMS is built around the same source and analyser as the Compact SIMS but with the addition of a large sample holder and automated stage. This allows it to perform automated analysis batches, running 24/7 and potentially making hundreds of analyses per day. Of course, it can also be run in full manual mode where the precision of the stage and large sample area make it a very attractive instrument for the expert user.

Capable of static and dynamic SIMS the AutoSIMS fits well in a busy production environment and its small footprint allows rapid installation. Fitting an electron gun (Hiden EG500) allows analysis of insulators and the integrated camera makes navigation around the large sample holder very easy.

FEATURES:

- ▶ Fully automated, unattended, SIMS analysis
- ▶ Large X-Y stage (70 x 100 mm) with customisable loading cassette
- ▶ Oxygen primary ion gun for sensitive analysis
- ▶ Parameter entry by spreadsheet
- ▶ Modular servicing for high up-time
- ▶ Nanometre depth resolution

APPLICATIONS:

- ▶ Thin film failure analysis / product verification
- ▶ Corrosion and tribology investigations
- ▶ Static and dynamic SIMS
- ▶ Large area investigations

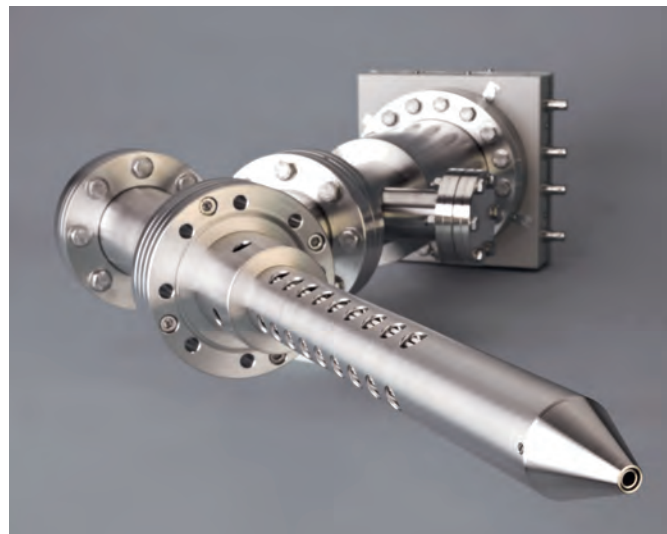


EQS SIMS Detector

The Hiden EQS is a high transmission quadruple secondary ion mass spectrometry, SIMS, detector including a 45 degree electrostatic sector for simultaneous ion energy analysis. Ions are collected on the axis of the device with a low potential screened extraction field which makes it very popular for fitting as an after-market detector to a wide variety of surface analysis instrumentation. The EQS has been fitted to focussed ion beam (FIB) microscopes and XPS tools.

The flight tube transfer lens system allows insertion lengths up to 750 mm to be achieved with high transmission and the system can be supplied with either 6 mm or 9 mm triple stage quadrupole mass filters. With over 6 orders of magnitude dynamic range the EQS is ideally matched to SIMS depth profiling and outputs are provided for direct connection to the IG20 and IG5C ion guns.

The EQS is available with a differential pumping option allowing operation at chamber pressures of up to $1E-5$ mbar which is suitable for use when oxygen flooding to enhance ion yield or to maintain planar surface topography.



EQS SIMS Spectrometer

FEATURES:

- ▶ 45 degree energy analyser with resolution to 0.2 eV
- ▶ +ve and -ve secondary ion detection
- ▶ Optional differential pumping
- ▶ SNMS option
- ▶ Integrated residual gas analysis
- ▶ Standard and custom lengths to 750 mm insertion
- ▶ Mass range options of 50, 300, 510 and 1000 amu
- ▶ 6 mm or 9 mm triple quadrupole analyser
- ▶ Slim fitting for crowded sample regions
- ▶ Can be mounted on a 50 mm or 100 mm z-drive retraction system

APPLICATIONS:

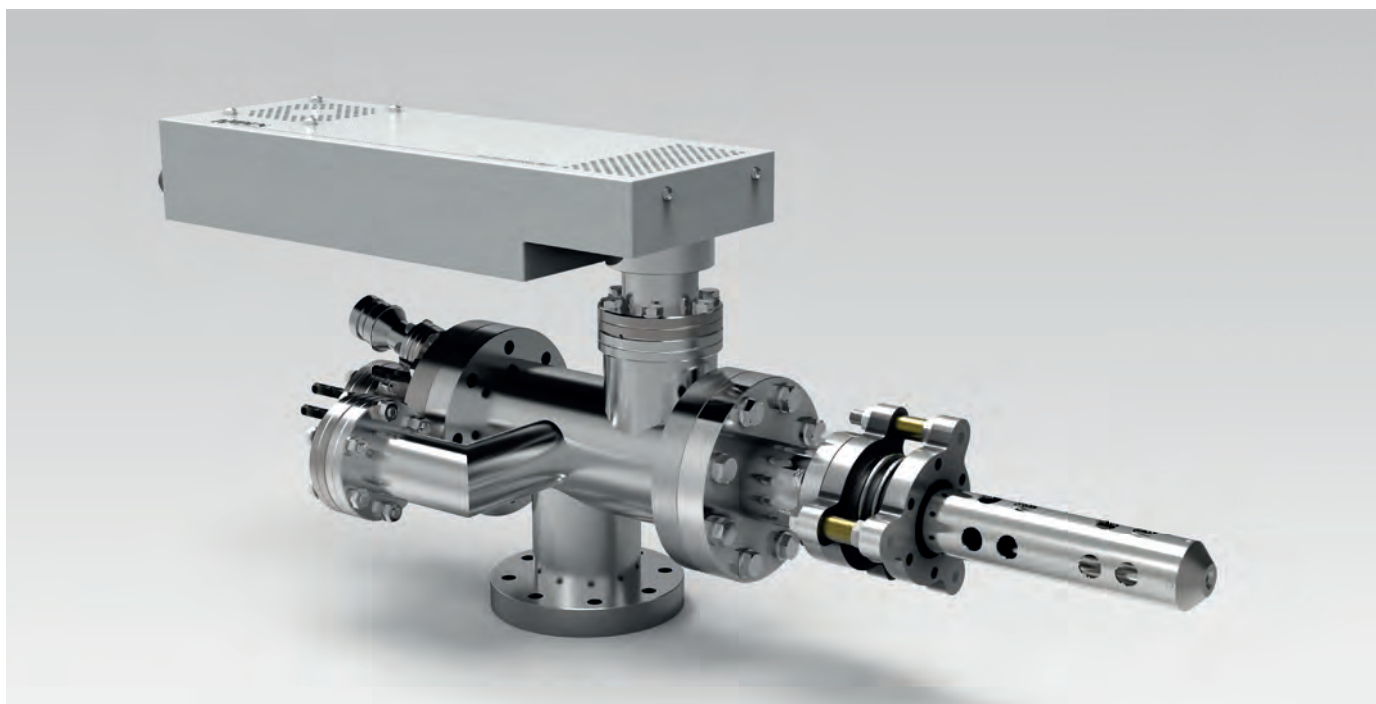
- ▶ Static and dynamic SIMS analysis
- ▶ FIB-SIMS
- ▶ Sputtered ion and neutral mass/energy analysis
- ▶ Routine materials science sputter depth profiling
- ▶ High performance "bolt-on" SIMS/SNMS



HIDEN EQS (top left) on a Zeiss Auriga 60 FIB-SEM Instrument

IG5C

A 5 keV Caesium Ion Gun



IG5C - A 5 keV Caesium ion gun for UHV surface analysis applications

The IG5C is a self-contained caesium ion gun designed for dynamic and static SIMS applications. The high brightness miniature surface ionisation source uses a safe caesium salt to generate an intense beam which is focussed via a two lens column onto the target. Thermal management of the source is an integrated feature of the Ion Gun Controller software allowing unattended starting and stopping, including ioniser regeneration at shutdown. With a minimum spot size of under 30 μm it makes an excellent ion gun for imaging.

Caesium is a very useful ion source for general analysis and mixed materials where the CsM^+ mode can be used to great effect. Quantitative depth profiling with nanometre depth resolution of thin dielectrics and layers formed by deposition and corrosion is possible.

FEATURES:

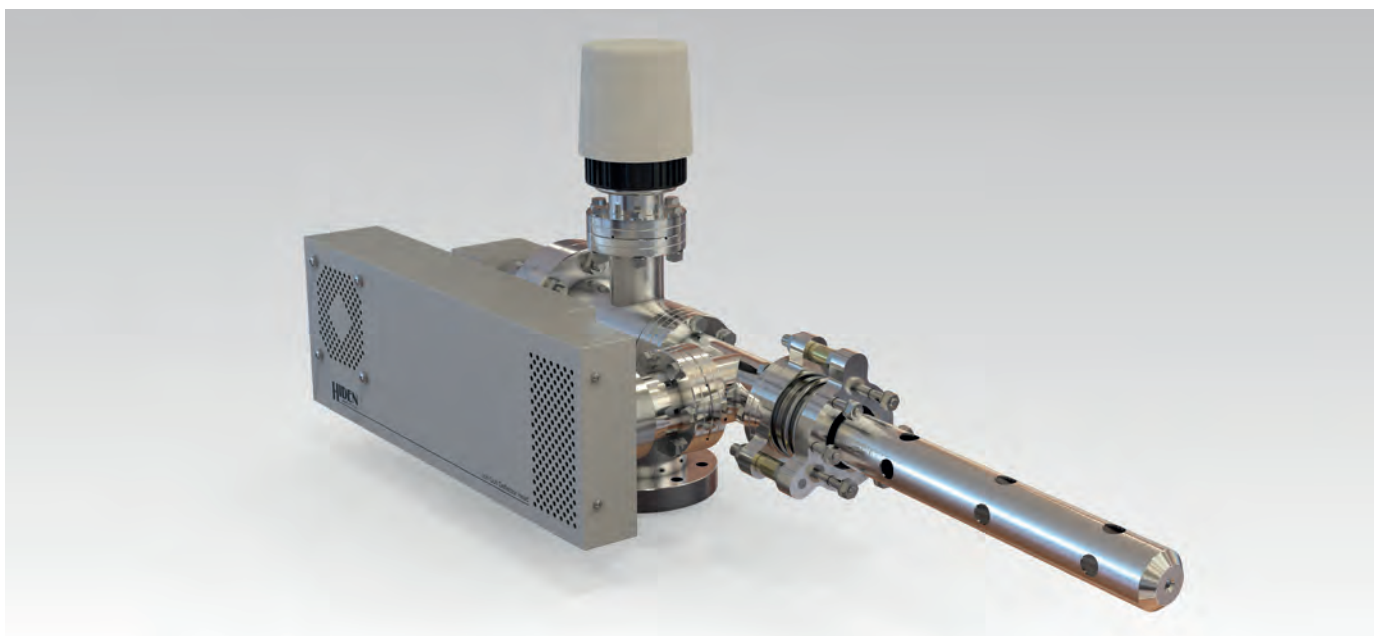
- ▶ 1 keV to 5 keV ion energy
- ▶ Spot size from < 30 μm to > 1 mm
- ▶ Current 1 pA to > 100 nA
- ▶ Easily changed, self-aligning ion source
- ▶ Two lens column
- ▶ Easily changed beam forming aperture
- ▶ Differentially pumped

APPLICATIONS:

- ▶ SIMS depth profiling of electronegative elements
- ▶ SIMS depth profiling using the CsM^+ mode
- ▶ Efficient static SIMS analysis
- ▶ Quantitative analysis of oxides and nitrides

IG20

A 5 keV Argon or Oxygen Ion Gun



IG20 - A 5 keV Argon or Oxygen ion gun for UHV surface analysis applications

The IG20 is an easy to use gas ion gun with an electron impact ion source ideal for SIMS, Auger and XPS applications. Whilst most frequently used with oxygen (to enhance secondary ion emission for SIMS) the IG20 will produce beams of many gases, including all noble gases and even hydrogen. The gun features two independent, switchable, filaments so that analysis can continue even when one filament reaches the end of its life, typically in excess of 500 hours – replacement can then be made at the user's convenience.

The ion gun will produce beams from 1 keV to 5 keV with a spot size of under 100 μm at higher energy. An optional large lens ion source is available for high dynamic range work and this can also be fitted with noble metal parts for enhanced beam cleanliness.

The low gas usage of the source means that the gun can be run from small laboratory bottles (supply the gas at 0.3 bar) and a manifold can be supplied to quickly clean and purge gas lines for rapid changes in the ion species.

The gun uses the Hidden Ion Gun Controller software that stores and retrieves previous settings, provides timed start and stop features and can internally generate rasters and lines for use in stand-alone applications.

FEATURES:

- ▶ 1 keV to 5 keV ion energy
- ▶ 10 pA to 600 nA beam current
- ▶ < 100 μm to > 1 mm spot size
- ▶ Twin filament, long life, electron impact ion source
- ▶ Reliable and easy control using Hidden IGC software
- ▶ Differential pumping to reduce chamber load

APPLICATIONS:

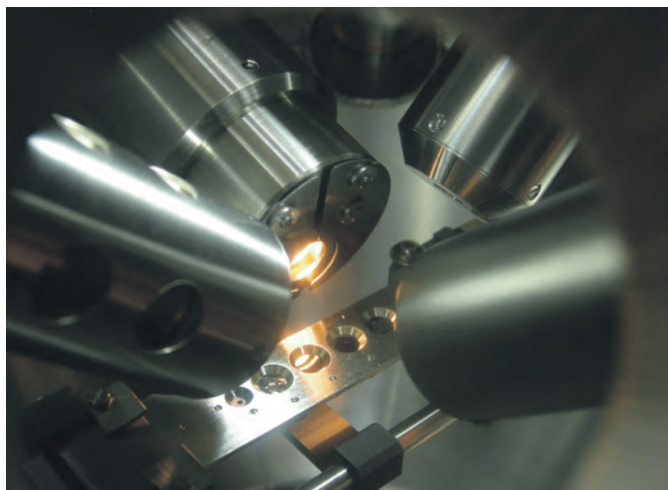
- ▶ SIMS, dynamic and static (using O_2 , Ar and Xe)
- ▶ Sample cleaning and depth profiling for XPS and Auger
- ▶ Fundamental studies of ion-solid interaction
- ▶ Local area milling and surface modification

MAXIM

SIMS/SNMS Detector

The MAXIM SIMS spectrometer provides high transmission in a compact unit designed specifically for routine materials analysis. A parallel plate energy filter is used to reject high energy ions that would affect mass resolution whilst permitting a wide bandwidth of optimally filtered ions to enter the triple filter quadrupole analyser – which can be either 6 or 9 mm pole diameter. The MAXIM extracts ions from 30 degrees below its inlet aperture thus it is mounted “off axis” which can be useful to free space beneath the sample. An electron impact ioniser is positioned at the front of the MAXIM, subtending the largest solid angle available, to permit analysis of sputtered neutral atoms. Sputtered neutral mass spectrometry (SNMS) is more quantitative than SIMS in regions of matrix variation and is a valuable tool in high concentration analysis, especially of metal alloys. The MAXIM provides excellent imaging over a large area and reproducible quantification – an important factor in a production environment.

The exceptionally low screened extraction field (3V/mm) reduces perturbation of low energy primary ion beams and also allows easier electron beam charge compensation.



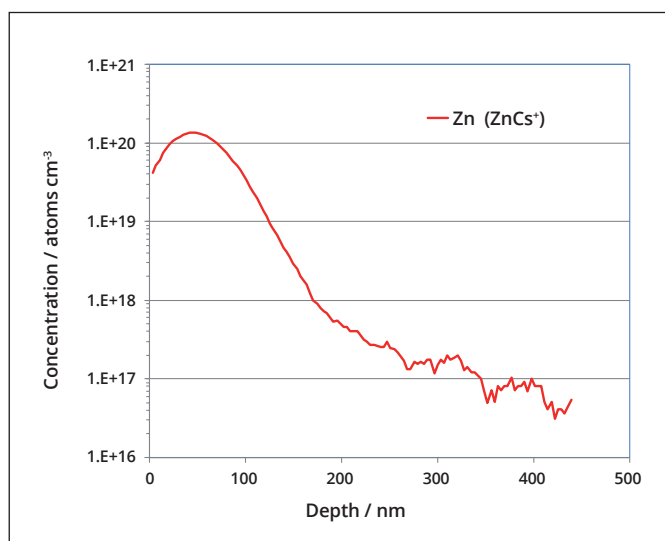
MAXIM SIMS/SNMS Spectrometer

FEATURES:

- ▶ 30 degree collection angle
- ▶ +ve, -ve and neutral detection
- ▶ Integral energy filter
- ▶ Electron impact ioniser
- ▶ Mass range options of 50, 300, 510 and 1000 amu
- ▶ Wide field of view – 6 x 6 mm
- ▶ Low extraction field

APPLICATIONS:

- ▶ Static and dynamic SIMS
- ▶ Sputtered neutral mass spectrometry (SNMS)
- ▶ Materials analysis
- ▶ Routine SIMS for production control
- ▶ Integration into compact, dedicated, instruments



Depth profile of Zinc in GaAs using CSM*

SOFTWARE

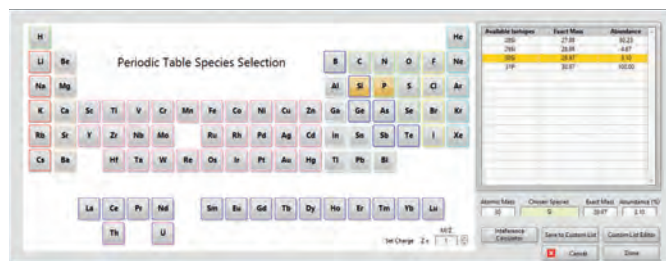
Control for SIMS

All SIMS spectrometers can be run using the standard Hiden MASsoft software suite. This permits auto-tuning of the secondary column as well as collection of mass spectral, depth profile and diagnostic data.

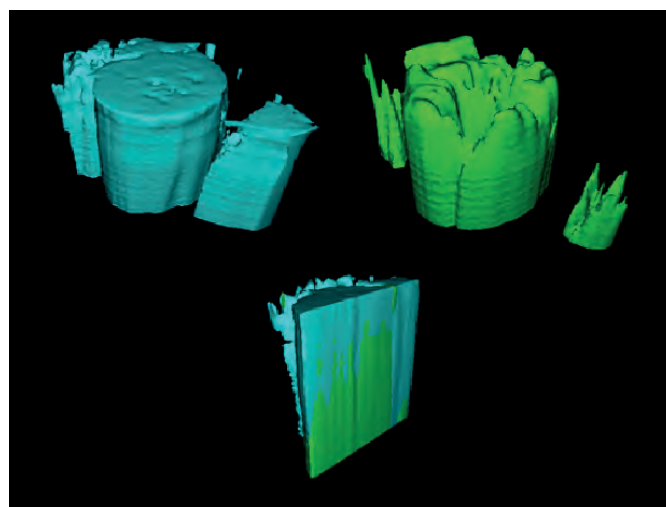
The **SIMS Mapper** software is an image based dedicated SIMS analysis tool. Depth profiles are collected as a stack of images from which local depth profiles and 3D reconstructions can be made after acquisition. By allowing gating after data acquisition, it is possible to maximise dynamic range and to choose to include or exclude specific features as well as to take multiple depth profiles from a single data set or to re-evaluate a data set in the future. Standard and custom export formats are available to enable the use of third party applications for image and data processing.

FEATURES:

- ▶ Easy choice of species directly from periodic table
- ▶ Integrated mass interference calculator
- ▶ Interactive image and depth profile gate control
- ▶ Stored templates for repeat and automated analysis
- ▶ Multiple export options (custom options available)
- ▶ 3D data view for easy interpretation
- ▶ Local mass spectrum tool for feature identification



SIMS Mapper species choice

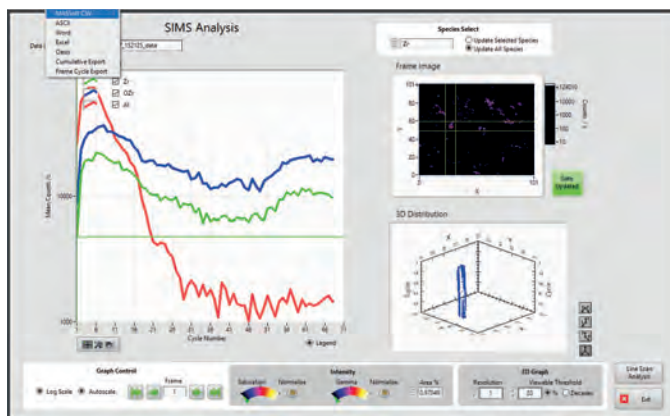


3D reconstruction showing carbon (blue) contamination of a gold (green) 1 mm diameter electrical contact

The **Ion Gun Controller** software allows tuning and measurement of the primary ion beam. Gun parameters may be stored and recalled for rapid operation and the beam profile can be observed in systems fitted with a Faraday cup. Tools are included for initial beam set-up (Beam Finder) and for correct source procedures such as thermal management of the caesium ion source.

FEATURES:

- ▶ Save and recall of ion gun parameters
- ▶ Integrated Faraday cup bias power supply and electrometers
- ▶ Clearly visible always-on diagnostics
- ▶ Ion source management tool set
- ▶ Ability to be controlled from external programs for high level of integration



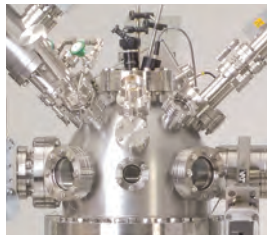
SIMS Mapper acquisition window

Hidden **APPLICATIONS**

Hidden'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 ANALYSIS

- ▶ UHV TPD
- ▶ SIMS
- ▶ end point detection in ion beam etch
- ▶ elemental imaging – 3D mapping

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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