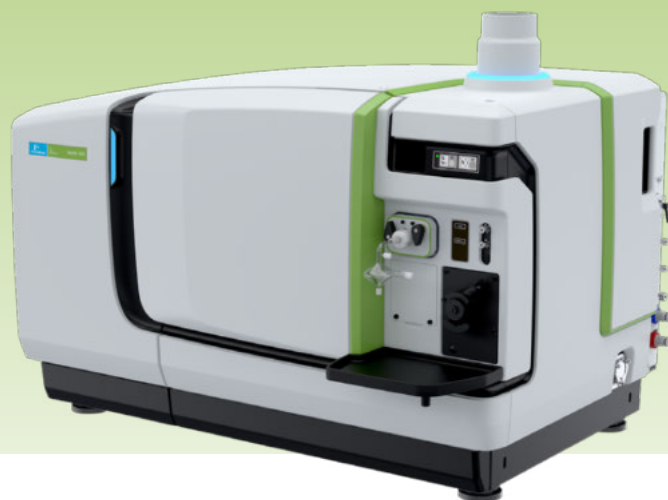


ICP - Mass Spectrometry

**Key Features:**

- Ultimate interference removal
- Outstanding background equivalent concentrations (BECs)
- Unparalleled plasma robustness
- Ease of use
- SEMI S2/S8, regulatory and safety compliance

NexION 5000 Multi-Quadrupole ICP Mass Spectrometer

Introduction

The NexION® 5000 is a multi-quadrupole-based instrument innovatively designed to remove the most complex interferences in ICP-MS analysis, ideal for applications in semiconductor (SEMI S2/S8 compliant with upgrade

kit), biomonitors and other industries. From the robust, highly sensitive interface and customizable sample introduction system to the detector, this system has been designed to exceed your ICP-MS expectations.

The NexION 5000 ICP-MS provides a host of proprietary technologies that come together to deliver the ultimate in spectral interference removal:

- Triple Cone Interface with OmniRing™ which can operate in extraction or focusing modes for outstanding sensitivity and detection limits;
- 90 degree Quadrupole Ion Deflector (Q0) that selectively focuses ions, maximizing signal sensitivity and eliminating neutral species and photons;
- A full-sized Resolving Quadrupole (Q1) to remove the matrix ions from the ion beam, ensuring that a tightly focused beam of ions of the same m/z reaches the Universal Cell;
- The Universal Cell (Q2), a true quadrupole which is able to accommodate gases that react with either the analyte or interferent in a controlled and reliable manner, efficiently removing interferences and preventing side reactions from taking place. The ions then pass to the full-sized Analyzer Quadrupole (Q3) for mass separation, followed by detection.

Every aspect of this instrument has been meticulously constructed to address all of your needs, from a robust plasma for changing sample matrices, ultra-low detection limits (DLs) in hot plasma conditions, semiconductor-compliant VCR gas fittings and an easy upgrade to meet SEMI S2 and S8 requirements. Moreover, with the intuitive Syngistix™ software, you can count on accurate, reliable results every time.

Ultimate Interference Removal – Outstanding BECs

The NexION 5000 is a multi-quadrupole system providing the best ion beam control within this instrument class, capable of suppressing and eliminating spectral interferences found in complex samples, ensuring the best BECs in both hot and cold plasma conditions and outstanding detection limits.

Where the use of miniature quadrupoles in some systems have limited mass-resolving capabilities and impact the ability to effectively resolve interferences, the full-length quadrupoles found in the NexION 5000 ensure that <0.7 amu mass resolution can be achieved while also ensuring high ion-transmission efficiency. This excellent mass resolution is able to guarantee exceptional detection limits, outstanding analyte signal-to-noise ratios and provide absolute confidence in the results.

The four quadrupoles of the NexION 5000 are outlined as follows:

- First: Quadrupole Ion Deflector (Q0) directs ions to the entrance of the first mass filter;
- Second: Transmission Analyzer Quadrupole 1 (Q1, full-sized for <0.7 amu mass resolution), can act as a mass filter or as an ion guide to direct ions to the Universal Cell;
- Third: Quadrupole Universal Cell (Q2) empowered by dynamic bandpass tuning which creates a controlled environment for effective interference removal and analyte mass differentiation through dynamic reactions with reactive gases or collisions using non-reactive gases;
- Fourth: Transmission Analyzer Quadrupole 2 (Q3, full-sized for <0.7 amu mass resolution), can act as a mass filter or as an ion guide to direct ions to the detector.

Q0 Quadrupole Ion Deflector

The Quadrupole Ion Deflector (QID) is an electrostatic analyzer that turns the analyte ion beam 90 degrees. A software-controlled scanning voltage is applied to the QID to enhance the transmission of selected ions into the first analyzing quadrupole (Q1), thereby improving sensitivity and eliminating the transmission of photons and neutral species to the mass spectrometer via the vacuum.

Since the ion beam is narrowly focused through the use of the hyper-skimmer cone, analyte ions and neutral species never touch any surfaces of the ion deflector, ensuring cleanliness and no maintenance beyond the cones, as well as superior stability and robustness.

Q1 Transmission Analyzer Quadrupole 1

A full-length Transmission Analyzer Quadrupole (Q1) has been engineered to deliver <0.7 amu mass resolution and is driven by a high-frequency 2.5 MHz power supply. Its carefully-designed rods produce a perfect hyperbolic field, delivering optimal resolving power and ion-transmission efficiency. This quadrupole can work in mass filtering or ion guide modes. In triple quad mode, the mass filtering ability of Q1 allows only ions of a specific m/z to be passed through to the Universal Cell, while all other ions from the matrix, solvents and plasma are removed. This ensures that a “clean” beam of tightly focused ions with the same m/z enter the cell. In ion guide mode, all ions are allowed to proceed to the Universal Cell.

Q2 Quadrupole Universal Cell

The Universal Cell is a true quadrupole-based cell which predictively removes spectral interferences through reactions or collisions, allowing different modes of analysis to be run within the same method. The NexION 5000 ICP-MS is generously equipped with a 4-channel cell gas control manifold that allows the introduction of either a single gas or a mixture of gases which can be mixed on the fly using proprietary mass flow controllers. The key strength of this cell is its ability to prevent side reactions from taking place by rapidly destabilizing any neutral species which may have been introduced into the cell via cell gases, a unique feature only available in quadrupole cells. Moreover, the versatility of the Universal Cell to handle pure reaction gases, including 100% ammonia (NH₃) is often required for the complete elimination of complex interferences, ensuring predictable and reproducible clusters for cluster-forming ions such as Ti, Zn, Ge etc., all of which contributes to better results and lower BECs.

The modes are summarized as follows:

- Reaction (DRC) with selection of up to four reaction gases at typical flows <1 mL/min
- Collision (KED) with selection of up to four neutral gases
- Standard mode (no gas)

Reaction (DRC) mode is ideal for applications demanding the best performance and an unprecedented level of interference removal. Highly reactive gases – such as ammonia, oxygen, hydrogen or methane – can be introduced into the cell, creating predictable chemical reactions with either the analyte or interferent. Reaction byproducts are instantly removed through dynamic bandpass tuning using frequency modulation. This unique technology, which is essential for full confidence in the results, rapidly destabilizes and ejects the undesired by-product ions from the cell before they react with any residual neutral species that could have found their way to the cell (e.g. water vapor, gas impurities, etc.)

For the removal of unknown spectral polyatomic interferences, Collision mode is especially useful. In this mode, non-reactive gases, such as helium, can be introduced into the cell to collide with the ions that are travelling through it. Since interfering ions tend to have larger diameters (collisional cross section), they will be subject to more collisions than the analyte ions. These extra collisions mean that the interfering ions lose more kinetic energy and, as such, are removed through kinetic energy discrimination (KED).

Q3 Transmission Analyzer Quadrupole 2

The Transmission Analyzer Quadrupole 2 is driven by a high-frequency 2.5 MHz power supply, delivering a perfect hyperbolic field which provides optimal resolving power and ion-transmission efficiency. Both the Q1 and Q3 are designed using state-of-the-art alloy materials, exhibiting negligible thermal expansion. This guarantees rigid structural integrity along the entire length of the rod, ensuring exceptional mass calibration stability. All rods are carefully inspected prior to assembly and aligned to ensure maximum ion transmission for greater sensitivity.

Ultimate Interference Removal – Outstanding BECs (continued)

The NexION 5000 ICP-MS is engineered to achieve the best BECs in hot and cold plasma. A number of other features complement the complete removal of interferences in the NexION 5000, further lowering BECs, and are outlined as follows:

Triple Cone Interface

The Triple Cone Interface is easy to remove and clean without opening the vacuum chamber. The cone materials are made of high-purity platinum and nickel for robustness against tough matrices. The ability to apply voltage to the cones allows operation in extraction or focusing modes. The details of the cones are provided below:

- Sampler: platinum tipped cone, grounded. Used to sample ions from the plasma;
- Skimmer: platinum tipped cone, grounded. Used to maximize signal stability and minimize cone clogging during extended, high total dissolved solid (TDS) sample runs;
- Hyper-skimmer: nickel cone, charged. Used to produce a tightly focused beam of ions that helps the QID in filtering out neutrals and photons.

OmniRing

The proprietary OmniRing technology applies a voltage behind the hyper-skimmer to optimize ion flow from the plasma, enhancing sensitivity and allowing analysis to take place in either extraction or focusing modes. The unique design of OmniRing guarantees no required cleaning of this component.

Target Lens

When an application calls for the best BECs, the proprietary Target Lens in the NexION 5000 ICP-MS can help to further improve the signal to noise (S/N) ratios. Traditionally, to maximize ion transmission efficiency, multiple lens structures, such as Einzel lenses, are often used to enable a focusing field at the expense of an increased ion path length and vacuum chamber volume. In contrast, the NexION's Target Lens is a compact, planar structure which projects a focusing electric field onto the ion path at the exit of the QID. This helps to focus the ion beam entering the first quadrupole mass filter for improved S/N and consequently better BECs. Since the QID filters neutrals and photons, these never make contact with the Target Lens, thus this component requires no cleaning.

Detector

The highly sensitive and stable electron multiplier detector ensures low electronic background while offering up to 10^{12} orders of linear dynamic range when used in combination with the NexION's unique Extended Dynamic Range (EDR) functionality, which is able to attenuate the analyte signal in the cell. This allows both low and high concentration analytes to be quantified within a single analytical run, resulting in fewer re-runs and less chemical consumption while ensuring longer detector lifetimes.

Unparalleled Plasma Robustness

The NexION 5000 ICP-MS has been carefully designed to deliver the most stable plasma on the market, which is essential to be able to quickly adjust to changing sample matrices. It does this using the proprietary techniques listed as follows:

PlasmaLok Interface

PlasmaLok™ stabilizes energy distribution even when the sample matrix drastically changes, such as going from a wet-sample aerosol (conventional nebulization) to a dry-sample aerosol (laser sampling), from robust plasma to cold plasma, and from aqueous solutions to organics. It also prevents uncontrolled arcing between the plasma and cones without the need to use a plasma shield, which is a consumable that instruments with unbalanced RF drive sources have to use. Consequently, deposition on the cones and high double-charged signals are reduced, guaranteeing excellent signal precision and long-term stability

Robust and Reliable, Fire-and-Forget Plasma Generator

The state of the art 34 MHz, free-running solid-state RF generator with PlasmaLok offers a trouble-free user experience, featuring adjustable power with 1 watt increments from 400 to 1600 watts. The accurate impedance matching of this system allows the plasma to quickly adjust to changing sample matrices, ensuring that sensitivity is maintained. The plasma is generated by the unique LumiCoil™ RF load coil. This innovative design is unique in that it is air cooled by the extraction and requires no additional infrastructure for water or gas cooling. LumiCoil eliminates the need for replacement of plasma load coils as is often needed with copper RF coils.

Ease of Use

A streamlined user experience is achieved via several product enhancements. The following features aim to create a simple and guided user experience, as well as providing the best in detection limits:

Refined, User-Friendly Software

Syngistix for ICP-MS software (v. 3.0 or higher) enables users to quickly harness the powerful analytical capabilities of the NexION 5000 ICP-MS. The contemporary user interface encapsulates the complexity of the triple-quad ion optics into an easy-to-understand workflow. With just a few mouse clicks, the user can quickly access and complete a suite of automated optimizations which tune the instrument to reach optimal performance. Also included with the software are a number of tried and tested methods, allowing users to get up and running quickly.

Sample Introduction System

The sample is introduced into the plasma at a constant rate using a self-aspirating perfluoroalkoxy polymer (PFA) nebulizer, greatly improving measurement precision and long-term stability. The sample introduction system comes standard with a SilQ one-piece torch and a fixed 2 mm injector, ensuring excellent performance in different matrices. Also supplied is a baffle-type cyclonic ultra-high purity quartz (SilQ) spray chamber with an All Matrix Solution (AMS) port, enabling >100x *in situ* aerosol dilution of the sample or the introduction of oxygen to burn off excess carbon. This allows users to run samples with high TDS (such as seawater: >3.5%; brine: >25%) and organic solvents (IPA, NMP etc.) without the need for manual dilution, saving on preparation time as well as reducing cone maintenance. Optional extras include a Peltier cooler (-10 °C to 80 °C), which facilitates the analysis of organic solvents. Also optional is a kit with a PFA spray chamber, demountable SilQ torch, and demountable platinum injector for those working with hydrofluoric acid.

User-Friendly Torch and Torch Mount

The one-piece standard torch is interchangeable with demountable torches, where the injector can be chosen to fit the application. A variety of torch cassettes are available, whereby each torch cassette is color-coded according to the application, taking the guesswork out of the sample introduction component selection. The tool-free removal of the torch mount cassette allows the sample introduction system to be changed with minimal downtime and has fully remote-controlled and automated X, Y, Z torch positioning (+/- 3 mm with 0.05 mm reproducibility), ensuring that maximum ion transmission is achieved thereby enhancing sensitivity.

Status Lighting

Visible from afar, the NexION 5000 system has incorporated status lighting which provides visibility to the state of the instrument and facilitates the quick response to and diagnosis of issues.

Clear Plasma View

A true reflection, full-color plasma view window allows for careful, unobstructed and real-time visual inspection of the cones, torch, load coil, sampling depth, and plasma color without needing to extinguish the plasma. This feature simplifies the optimization of gases when running organic matrices and allows troubleshooting, promoting the early diagnosis and quick response to issues via plasma observations.

4-Channel Peristaltic Pump

The NexION 5000 ICP-MS comes equipped with a fully remote-controlled, high-precision peristaltic pump with four channels. The 36 mm peristaltic pump head has 12 rollers, improving flow consistency and reducing pulsations while also supporting a variety of different speeds from 0-100 rpm.

Safety: SEMI S2/S8 Compliant and Protected Against Earthquakes

The NexION 5000 is the first multi-quadrupole ICP-MS in the industry which meets the strict regulatory requirements of SEMI S2/S8 standards (available as an optional upgrade kit). This kit ensures conformance to the stringent Environmental, Health and Safety (EHS) standards applicable to the semiconductor equipment manufacturing industries and semiconductor laboratories. An important part of S2/S8 standard compliance is the assurance that the NexION 5000 system is equipped with a number of unique features which help to protect against collateral damage caused by earthquakes. Consequently, the NexION 5000 is the ideal ICP-MS solution for semiconductor laboratories located in active seismic zones.

Regulatory and Safety Compliance

The NexION 5000 ICP-MS carries the CE Mark and fully meets the safety and regulatory standards below:

- SEMI S2/S8 (with upgrade kit)
- EN 61010-1:2010 and EN 61010-2-081 Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use
- European EMC Directive 2014/30/EU and referenced standards EN 61326-1:2013
- WEEE Directive 2012/19/EU
- RoHS 2