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## ***Thermo VG PQ EXCELL™ INDUCTIVELY COUPLED PLASMA MASS SPECTROMETER***

### **TECHNICAL DESCRIPTION**

The VG PQ ExCell is a quadrupole based inductively coupled plasma mass spectrometer (ICP-MS) designed for the determination of trace elements in a wide range of sample types. The spectrometer is suitable for both routine and research applications. The VG PQ ExCell is fully automated and is operated using the PlasmaLab™ ICP-MS software suite in the Windows NT™ operating environment. The system includes as standard a number of unique features of real analytical benefit to the user and is available with optional collision cell technology (CCT). Key features include: rugged design for operation in a routine environment, innovative Infinity Lens System for ultralow backgrounds, Peltier cooled, inert sample introduction system with low memory effects, PlasmsScreen™ technology, TechConnect remote diagnostics. Available options include user selectable Collision Cell Technology, choice of detector options to suite the application, additional 4th gas supply with mass flow controller, organic matrix sample option and the proven S-Option interface technology for enhanced sensitivity. The VG PQ ExCell is fully integrated through PlasmaLab™ with a wide range of sampling accessories (including the VG MicroProbe II laser ablation system) which further enhance the capabilities of the system.

### **SYSTEM SPECIFICATION**

#### **ICP ION SOURCE**

Peristaltic Pump - The peristaltic pump provided with the VG PQ ExCell is computer controlled for flexibility of speed selection and has ten counter rotating rollers for pulse dampening and extended pump tubing lifetime. Further, it has four channels enabling complete control of sample introduction both during and between sample acquisitions. Channels one and two of the pump provide sample delivery to the nebulizer and continuous draining of the spray chamber. The third channel delivers wash solution to the auto-sampler probe rinse position. The fourth channel is provided for use with other sample introduction systems or for automated addition of internal standards. Finally, the pump can be switched off automatically upon system shutdown.

Peltier Cooled Pneumatic Nebulisation System – The nebulizer provided is a high precision concentric-type with zero dead volume fitting which exhibits excellent aerosol stability as well as exceptional tolerance to dissolved solids. The spray chamber is a conical impact bead design for low memory effects and is constructed of inert polymeric material for use with all mineral acids, including HF. The spray chamber is cooled and precisely temperature controlled by a Peltier device and exhibits excellent stability and minimum polyatomic ion formation (e.g. ArO+, MO+, etc.). A one-piece quartz torch is provided as standard and the entire sample introduction system is mounted on a removable cassette for easy changeover.

Precision Gas Control - Three high precision, computer controlled mass flow controllers are provided with the VG PQ ExCell.

This configuration results in superior stability of the coolant, auxiliary and nebulizer gas flows helping to ensure excellent short and long term precision. Like other instrument operating parameters, all gas flows can be stored and recalled in an analytical method.

The VG PQ ExCell is supplied with a high stability, solid-state RF generator. This generator operates at a crystal stabilized frequency of 27.12 MHz and has a maximum forward power of 2.0 kW. It is configured with on-board diagnostics and, like all other instrument parameters on the VG PQ ExCell, is controlled through PlasmaLab software. The solid-state technology utilized in the design of this generator has the advantage of eliminating all "normal wear" components and unlike RF power tube driven designs does not require periodic replacement of power tubes as the generator ages. The VG PQ ExCell employs a sophisticated, high speed, dynamic tuning system which automatically adjusts to optimize the ICP for change in sample type with no measurable change in energy coupling efficiency (e.g. when changing to mixed aqueous/organic solvent solutions, etc.).

Plasma ignition, operating power and shutdown are computer controlled and again, are parameters that can be stored and recalled in an analytical method.

Precision Torch Adjustment - ICP torch position is computer controlled in the x, y and z sampling directions to ensure the highest data integrity (maximum analyte sensitivity, minimum oxide and double charged ion levels and best precision). Torch position adjustment can be carried out manually or automatically through PlasmaLab software and like other parameters can be stored in an analytical method.

PlasmaScreen Torch - The VG PQ ExCell is equipped with PlasmaScreen technology that provides the analyst with the capability of determining elements such Na, K, Ca, and Fe at ppt levels. Operation of the PlasmaScreen Torch is fully automated and controlled through PlasmaLab software.

Sample Introduction Options – A variety of options and nebulizers are available to further enhance the applications capability of the VG PQ ExCell. The Additional Gas Kit consists of a 0-500ml/min mass flow controller for mixed gas plasmas or sweep gas work with low flow nebulizers. Used in conjunction with the Additional Gas Kit, the Organics Kit includes a Peltier cooled quartz spray chamber, semi-demountable torch, alumina injector, low flow concentric glass nebulizer and isoversinic tubing necessary for the analysis of trace element in organic matrices.

### **ION SAMPLING INTERFACE**

High Performance Ion Sampling Interface - The standard ionsampling interface supplied with the VG PQ ExCell is VG's patented High Performance Interface (HPI). This interface is supplied with patented Nicone™ sample and skimmer cones.

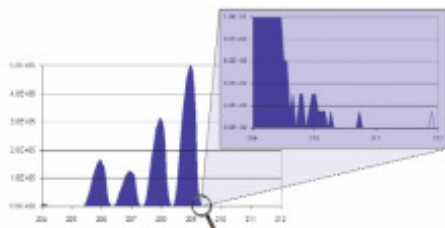
The role of the HPI is to transmit ions from the atmospheric pressure ICP ion source into the ion-focusing region of the VG PQ ExCell. The patented design of this interface provides higher sensitivity, more uniform mass response and superior dissolved solids handling capability than any other ion-sampling interface. These analytical characteristics simplify both system optimization and sample analysis. Water cooling of the interface extends cone lifetime and ensures negligible contribution of orifice ions into the background spectrum. The standard Ni sampler and skimmer cones are tolerant to a wide variety of sample matrices, however; for applications that demand superior corrosion resistance, optional platinum tipped cones are available.

S-Option Ion Sampling Interface – Available as an option for applications that demand the ultimate in sensitivity. The S-Option Ion Sampling Interface is suitable for solution work and small spot laser applications. This interface is designed to provide sensitivities in excess of  $200 \times 10^6$  cps/ppm for mid-high mass elements, without degrading other analytical figures of merit such as background, stability, MO+, M2+, etc. This level of sensitivity can be attained using standard pneumatic nebulization and without resorting to inordinately long integration times. Switching from the S-Option back to the standard high performance interface is achieved through the PlasmaLab software, providing the ultimate in dynamic range and application flexibility.

### **VACUUM SYSTEM AND MASS SPECTROMETER**

Vacuum Isolation Valve - A pneumatically actuated slide valve isolates the high vacuum region of the VG PQ ExCell when the instrument is not in use. This allows the VG PQ ExCell to reach a stable operating pressure in less than a minute after switching the system on from overnight standby.

Infinity™ Lens System – Unique to the VG PQ ExCell, this comprises of a high efficiency ion guide and an innovative chicane deflector coupled to an advanced off-axis quadrupole mass analyzer. This unique configuration reduces the background noise to levels previously unattainable on any quadrupole based ICP-MS system.



Low background achieved with VG PQ ExCell

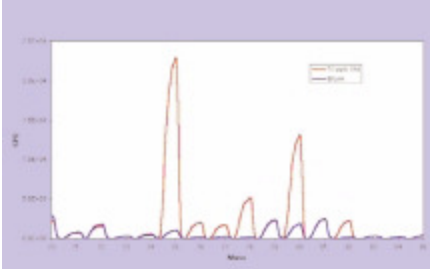
This low background, typically <math><0.5\text{cps}</math>, is routinely obtained at both low and high mass whilst maintaining the exceptionally high sensitivity expected of an ICP-MS instrument from VG. (Typical signal/noise ratios of  $300 \times 10^6$  can be achieved).

The inherently high and uniform ion transmission (across the mass range) means there is no necessity to vary the ion lens voltages or quadrupole resolution settings during an acquisition. For instrument tuning, optimization of the voltages applied to the ion lens system can be performed either manually or automatically using the intelligent auto-tuning routines PlasmaLab software. The high abundance sensitivity quadrupole used in the VG PQ ExCell has been specifically designed for use in ICP mass spectrometry.

In addition to the resolution, TJA Solutions has paid particular attention to the sensitivity, abundance sensitivity and peak shape characteristics of the analyzer. A solid-state RF generator ensures excellent stability and reliability, further; unlike power tube based designs that require regular power tube replacement, the solid-state design used in the VG PQ ExCell virtually eliminates the need for routine maintenance. High thermal stability ceramic rectification circuits ensure excellent mass calibration stability, better than  $0.05 \text{ amu/day}$  and  $0.1 \text{ amu/month}$ . Should the mass calibration ever need to be reset, it can be easily performed from PlasmaLab software. The process takes approximately one minute, including aspiration of a standard solution.

Collision Cell Technology (CCT) – As an option, the VG PQ ExCell may incorporate the innovative, user selectable collision cell technology. The option compliments the PlasmaScreen and may be purchased either at the same time as the VG PQ ExCell or at a later date as an upgrade. Using CCT it is possible to selectively attenuate many of the polyatomic ions that have previously limited quadrupole-based ICP-MS analysis. Naturally, when fitted with the CCT option, the VG PQ ExCell may be still operated in the normal, non-pressurized mode (non CCT), depending upon the application requirements. In CCT the ion beam is injected into a pressurized collision cell containing a gas, e.g.  $\text{H}_2$ , He,  $\text{N}_2$  etc.

When polyatomic ions collide with the reaction gas, they are dissociated into their component atoms or ions. As a result, there is a significant attenuation of the polyatomic interference ions, while transmission of the analyte ions is less affected. Since the plasma operates at normal power when operating with CCT, the degree of ionization is very high, such that the high analyte sensitivity of the VG PQ ExCell is maintained. Spectral interferences, e.g.  $^{40}\text{Ar}^+$ ,  $^{40}\text{Ar}^{160+}$ ,  $^{40}\text{Ar}^{35}\text{Cl}^+$  and  $^{80}\text{Ar}^{2+}$  are significantly reduced, resulting in significantly lower detection limits for K, Fe, As and Se without the matrix-induced limitations of 'cool' or mixed gas plasmas or the need for hydride generation.



**Vacuum Pumping System** - The vacuum system of the VG PQ ExCell is a three stage, differentially pumped design which utilizes 2 rotary vane and 2 turbo-molecular pumps to achieve its very low operating pressure of less than  $2 \times 10^{-6}$  mbar. The turbomolecular pumps are provided with high performance ceramic bearings that require virtually no maintenance and, therefore contribute to maximizing instrument up time. This exceptional vacuum performance promotes high ion transmission and good peak shapes as well as contributing to the excellent sensitivity and abundance sensitivity characteristics of this system. The exceptional abundance sensitivity of the VG PQ ExCell makes resolution switching (with associated degradation in ion transmission and sensitivity found on other systems) unnecessary. The VG PQ ExCell can therefore be operated at maximum sensitivity regardless of the application; another real-world benefit of the instrument not available on other commercial systems.

**Argon Backfill** - An automatic argon flush prevents atmospheric contamination of the vacuum chamber should the system need to be shutdown for any reason. This aids in a faster pump-down when the instrument is restarted.

**Wide Dynamic Range Ion Detection System**- The VG PQ ExCell can be equipped with one of two ion detection systems. Included as standard is the AutoRange Standard Detector System. Alternatively the VG PQ ExCell can be provided with the optional AutoRange Plus Simultaneous Detector System. Both systems permit the user to determine elemental concentrations over 8 orders of magnitude. With such wide linear dynamic range capability, the need for sample dilution is nearly eliminated. A description of the performance differences for each detector is provided below.

**AutoRange** - (Standard Detection System) The AutoRange ion detection system provided with VG PQ ExCell utilizes a discrete dynode electron multiplier. The multiplier is operated in both the analogue and pulse counting modes of operation for dynamic range extension. This detection system provides the capability of measuring solution concentrations of eight orders of magnitude from non-transient signals. This includes signals that arise from pneumatic, ultrasonic, low flow nebulization systems.

For applications that demand wide dynamic range measurements from transient signals, the detection system described below may be more appropriate.

**AutoRange Plus** - (Optional Detection System) The optional AutoRange Plus ion detection system also utilizes a discrete dynode electron multiplier which is operated simultaneously in the analogue and pulse counting modes to provide a linear dynamic range measurement which spans 8 orders of magnitude of concentration. AutoRange Plus eliminates the need for system pre-scans required to assign the appropriate detector mode (analogue or pulse counting) found in other detection systems. With either detection system cross calibration between modes and full detector over-range protection are provided automatically through PlasmaLab software.

## **DATA ACQUISITION SYSTEM**

**Instrument Control** – For ease-of-use, all major instrument operating parameters including ICP power and gas flows, plasma position, ion lens voltages, detector voltage, sample uptake rate, etc. are computer controlled. Once optimized, the settings are stored with each experiment and can be recalled for use at any time. VG PQ ExCell is controlled by an on-board 32 bit instrument controller which continuously monitors all services and instrument parameters. It is this controller (not the instrument PC) which is responsible for status monitoring of the system. With this configuration, in the unlikely event of a fault detection, the controller will maintain fail-safe operation of the instrument and also report the fault back to PlasmaLab (running on the instrument PC).

This system can be interrogated by the user and/or one of our ICP-MS specialists engineers either through the data systems or through TechConnect, our modem-based remote diagnostics facility. The heart of the VG PQ ExCell data acquisition system is a custom, high speed Multi-Channel Analyzer (MCA) providing data processing power that is unmatched in other ICP-MS instrumentation. During an acquisition, data is stored in the MCA and then transferred to the PC. This allows very high speed data capture, with dwell times as short as 80 micro-seconds and virtually no limits imposed on the mass range or number of channels per amu. With this data handling capability, the fast transient signals generated for example with, chromatography, ETV or single shot laser analysis, can be handled with ease. Scanning, split scanning, peak jumping and single ion monitoring are all available for both semi-quantitative and fully quantitative analysis. The MCA gives a continuous real time acquisition display, and a variety of user selectable tuning modes for added ease of system optimization.

## **PLASMALAB**

PlasmaLab is a Windows NT™, ICP-MS software suite that provides sophisticated and seamless control of TJA Solutions range of ICP-MS instruments and sample introduction accessories. PlasmaLab has been developed with extensive input from our ICP-MS user base to meet the demanding analytical requirements for both routine, high throughput and more specialized, research applications.

Unique new features in this powerful software suite that sets the standard for all ICP-MS software suites include:

- Full automation
- Intelligent, instrument optimization routines
- Dynamic, real-time, analytical parameter optimization
- Proprietary PICO Technology™ (PlasmaLab Intelligently Controlled Operation)
  - PICO Monitor
  - PICO Technician
  - PICO Acquisition
  - PICO Assistant
- Comprehensive analyte and matrix databases
- Multiple calibration techniques
- Spreadsheet data entry and report formats
- Mixed concentration unit reporting
- External triggers for accessory control and automated startup/shut-down
- Full, real-time LIMS capability



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