

Sample Introduction Accessories for the PlasmaQuant[®] MS

1. INTRODUCTION

One of the main advantages of Inductively Coupled Plasma–Mass Spectrometry (ICP–MS) is the ability to quickly and accurately measure a full suite of elements across a large concentration range. The safe and unattended operation of ICP–MS also makes it attractive for overnight analyses with the potential to analyze hundreds, even thousands of samples on a daily basis.

The need for handling large sample numbers has resulted in the regular use of autosamplers for loading and presenting of solutions to the ICP–MS. The ASPQ 3300 autosampler offered by Analytik Jena is well suited to most routine applications in industries including environmental, geological, food, metals, chemicals and petrochemical. Other common 3rd party autosamplers similarly available from Analytik Jena and fully supported in the ASpect MS software include the ASX-560 from Cetac Technologies and Elemental Scientific's SC-4 DX model.

Autosampler enclosures are available for all models and are recommended for minimizing sample contamination. Purged systems are preferred as they create a positive pressure within the autosampler compartment, thereby eliminating dust particles from the local environment.



General purpose range of autosamplers from Analytik Jena, Cetac Technologies and Elemental Scientific

2. HIGH CAPACITY AUTOSAMPLERS

As the demand for analyzing more samples by ICP-MS grows each day, so does the need for autosamplers that can handle larger sample numbers. This demand, particularly from the environmental, food, petrochemical and mining industries, has resulted in the emergence of high capacity autosamplers, capable of holding in excess of 700 samples at a time. Fully supported on the PlasmaQuant® MS series, a range of high capacity autosamplers are available from 3rd party suppliers.

| Company | Model name | Comment |
|----------------------|------------------------------------|--|
| Cetac Technologies | XLR-8 Extended Rack Autosampler | Holds up to 730 solutions |
| Elemental Scientific | SC-8 DX High Capacity Autosampler | Holds up to 730 solutions (10mL) and 40 Calibration/QC (50mL) |
| | SC-14 DX High Capacity Autosampler | Holds up to 1310 solutions (10mL) and 12 Calibration/QC (50mL) |



High capacity autosamplers from Cetac Technologies and Elemental Scientific

3. LOW VOLUME AUTOSAMPLERS

In some industries, very small sample volumes are regularly handled and require a specialized autosampler. For example, blood samples taken from newborn babies where only microliter amounts can be extracted and diluted to a final volume of less than 1ml. Also semi-conductor applications involving quality control analysis of reagents and products often involves the determination of impurities in minute volumes, including concentrated hydrofluoric acid solutions that are corrosive to glass components and dangerous to handle. Contamination-free environments are essential in the semi-conductor industry with instruments often confined to a 'clean room' laboratory environment and autosampler enclosures regularly utilized.

| Company | Model name | Comment |
|----------------------|---|---|
| Cetac Technologies | ASX-110/112FR Flowing Rinse Micro Autosampler | For sample volumes 0.5-15mL. Dual flowing rinse stations, PFA sample path with integrated enclosure hood |
| Elemental Scientific | SC-μDX micro autosampler | Supports low volume vials and 96 well-plates (0.5-1.0mL) with optional enclosure and ULPA air filter |



Low volume autosamplers from Cetac Technologies and Elemental Scientific

4. ULTRA-CLEAN AUTOSAMPLERS

The extremely low detection limits of ICP-MS are often defined by the quality of reagents used during sample preparation and the cleanliness of the laboratory environment. Hence the need for costly clean-room facilities used by semi-conductor manufacturers, where ultra-low detection of contaminants is essential to production quality. While this may be overkill for most routine laboratories, clean room conditions can be emulated by installing laminar-flow, sample-preparation areas and storage cabinets and by the use of ultra-clean sample introduction systems.

Ultra-clean autosamplers are manufactured from high-purity, inert polymer materials that are metal-free and corrosion-resistant to strong acids and organic solvents. Integrated enclosures eliminate contamination from air-borne dust while dual rinse stations minimize carry-over between samples.

| Company | Model name | Comment |
|----------------------|---|--|
| Cetac Technologies | ASX-110/112FR Flowing Rinse Micro Autosampler | Dual flowing rinse stations, PFA sample path with integrated enclosure hood |
| Elemental Scientific | SC-2 DX semiconductor autosampler prepFAST S semiconductor sample preparation system | PTFE sample deck, Ultem probe with 2 independent rinse valves |
| | | Direct sampling from PFA bottles and inline dilution with automated solution preparation |

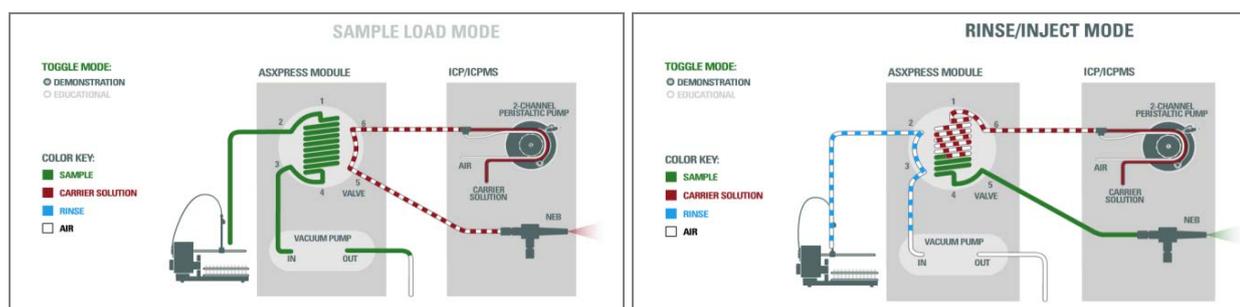


Ultra-clean autosamplers from Cetac Technologies and Elemental Scientific

5. PRODUCTIVITY ENHANCING ACCESSORIES

Various companies, including Analytik Jena, offer a range of productivity enhancing accessories that significantly improve sample throughput and reduce washout times. Thereby, allowing more samples to be measured in a single day and lowering operating costs by reducing batch analysis times. This is achieved through the combination of automated switching valves and high speed pumping systems to reduce the time it takes to present the sample for measurement and to rinse out the sample from the introduction system.

Basic productivity enhancing accessories provide instantaneous rinsing of the sample introduction system upon completion of a measurement and directs excess sample immediately to waste and away from the system. More advanced systems include a fast uptake pump that pre-loads a set volume of the following sample into a sample loop for even greater productivity gains and reduced memory effects.



Typical operation of an advanced productivity enhancing accessory

Some advanced productivity enhancing accessories also offer the additional capability of real-time dilution of samples and calibration standards using a series of syringes to accurately and precisely collect, dilute and inject the solution into the ICP-MS, including the automatic addition of internal standard solution. Completely automated, these accessories are perfect for high throughput laboratories analyzing high matrix sample types that would otherwise require manual dilution, saving valuable preparation time.

6. DILUTION SYSTEMS

Inline dilution

While ICP-MS offers an exceptionally large linear dynamic range, exceeding 10 orders of magnitude and allowing the accurate measurement of concentrations from sub part per trillion (ppt) to percent (%) levels, inline dilution systems have gained acceptance as they offer many advantages, including:

1. Automatic, real-time dilution of high total dissolve solids (TDS) samples
2. Accurate preparation of multiple calibration standards from a bulk standard source
3. Increased productivity through faster sample uptake and washout
4. Improved precision by eliminating peristaltic pump noise
5. More efficient handling of sample solution, reducing contamination and memory effects

Inline dilution systems remove the need for manual dilutions by laboratory personnel for sample types such as seawater, brine solutions, effluents, soils and sediments, metals and mining samples that often exceed the TDS limit of ICP-MS. Real-time, in-line dilution also means sample analysis times are constant, independent of dilution factor.



Elemental Scientific 'prepFAST' and Glass Expansion 'Assist CM' inline dilution systems

Overrange (Online) dilution

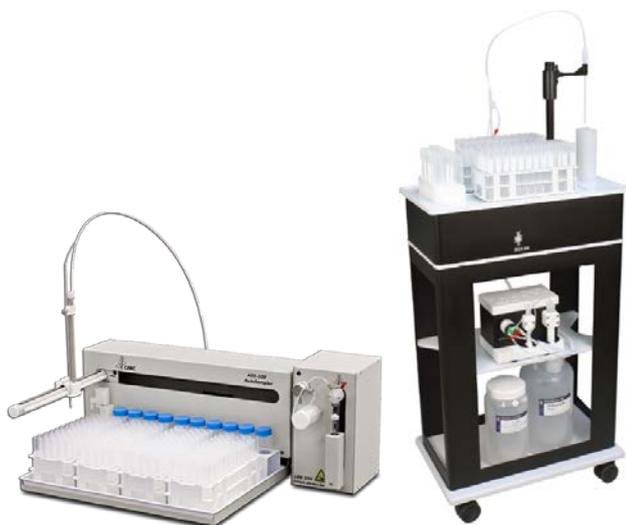
Online dilution systems are designed for automatic dilution when measured elements exceed the calibration concentration range during the analysis of a sample. When overrange concentrations are detected, the sample is automatically diluted and re-sampled until all overrange elements fall within the valid calibration range. The results are then automatically updated by the instrument controlling software to account for the dilution factor and the next sample is analyzed. This frees valuable personnel from time-consuming, manual sample handling and eliminates the need for additional work upon completion of the analysis.



The Cetac Technologies ADX-500 Online Autodilution Accessory with ASX-520 autosampler

Offline dilution

Offline dilution systems are programmable dilution systems that automate the preparation of calibration standards and samples prior to analysis by ICP-MS. Using a purpose-built software platform, method programs are developed for preparing sample batches, instructing the sampler and auto-dilution system on the volume of sample to be collected, the location of the awaiting dilution tube, which reagents to mix and the final dilution volume required for each sample. The preparation of calibration standards from bulk standards and the addition of internal standard to each solution are also possible. Preparation work is typically done offline with a dedicated PC and without being directly connected to the ICP-MS. Labor intensive sample preparation is greatly reduced for routine applications without sacrificing accuracy and precision, requiring only the transfer of prepared solution racks to the ICP-MS autosampler for analysis.



The Cetac Technologies 'SDS-550' and Elemental Scientific 'prepFAST', Offline Sample Dilution Systems

| Company | Model name | Comment |
|----------------------|---|--|
| Analytik Jena | iQprep range | Basic and advanced productivity enhancing accessories well suited to the Analytik Jena ASPQ 3300 autosampler |
| Cetac Technologies | ASXpress Plus Rapid Sample Introduction | Advanced productivity enhancing accessory for the ASX autosampler platform |
| | ADX-500 Online Autodilution Accessory | Automatic overrange (online) dilution accessory for the ASX-5X0 autosampler (not supported) |
| | SDS-550 Offline Sample Dilution System | Programmable offline dilution accessory for the ASX-5X0 autosampler |
| Elemental Scientific | oneFAST range | Advanced range of productivity enhancing accessories for the SC-DX autosampler platform. Also supported on the Analytik Jena ASPQ 3300 autosampler |
| | prepFAST range | Advanced range of productivity enhancing accessories with automatic inline and offline dilution for the SC-DX autosampler platform. |
| Glass Expansion | Niagara CM | Basic productivity enhancing accessory |
| | Niagara Plus CM | Advanced productivity enhancing accessory |
| | Assist CM | Advanced productivity enhancing accessory with automatic inline dilution |

7. FURTHER INFORMATION

For further updates, applications and other literature, please visit the Analytik Jena website at www.analytik-jena.com.

Pictures by courtesy of Teledyne CETAC Technologies <http://www.cetac.com>, Elemental Scientific <http://www.icpms.com>, and Glass Expansion <http://www.geicp.com>