NEWS

Glass Expansion Newsletter | June 2010 | Issue 22

APPLICATION SPOTLIGHT

DEALING WITH HIGH SALT MATRICES

Introduction

In the very first issue of this newsletter in 2003, we focused on the analysis of high salt samples by ICP spectrometry. Since that time, there have been significant enhancements to both the spectrometers and the sample introduction systems that accompany them and so it is worthwhile to review this very common application. The challenges created by high salt samples are numerous.

- Elevated background levels for ICP-OES
- Space/charge interferences for ICP-MS
- Polyatomic spectral interferences for ICP-MS
- Matrix suppressions in general
- Easily ionizable element interferences for ICP-OES
- Devitrification of quartz components
- Salt deposits in nebulizers and injectors
- Reduced lifetimes of consumables
- Carryover and memory effects

In 2003, it was generally recommended not to exceed 0.1 or 0.2% total dissolved solids (TDS) on an ICP-MS. Now much higher concentrations are routinely analyzed, an indication of the evolution of ICP-MS. In this article, we will examine the challenges listed above with an eye toward describing the best solutions.

Elevated background levels for ICP-OES

From an accuracy standpoint, one of the most significant features provided by array detectors is the improved background correction afforded by the simultaneous measurement of both signal and background intensities. Previously with PMT based sequential spectrometers, not only did the spectrometer measure the analyte intensities sequentially but also the background correction point for each analyte was measured at a different time than the analyte intensity itself.

Even though simultaneous "direct readers" measured the analyte intensities at the same time, a feature such as a stepper motor was used to measure off-peak background intensity sequentially. The simultaneous background correction capability of array detectors increases the accuracy of measurement even when the background is elevated by the presence of high salt concentrations. Figure 1 shows an elevated background situation,[(1)] one in which simultaneous correction is advantageous. This graphic depicts an overlay of several scans on an iCAP6000 Series ICP (Thermo Scientific, Cambridge, UK) which utilizes a charge injection device (CID) array detector. The background points on the left and right of the peak are measured concurrently with the analyte peak itself.

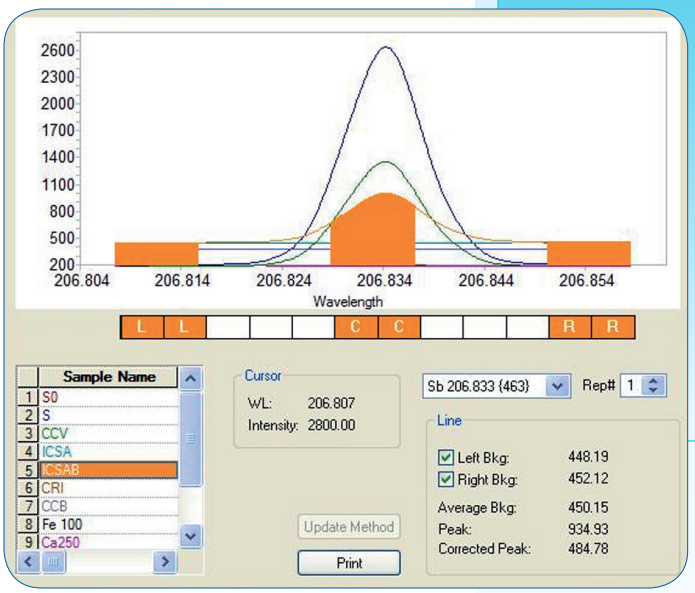

Figure 1: Effect of a complex matrix on an antimony peak at 206.833nm.

GE NEWS

JAIMA Show 2010

A full range of Glass Expansion products will be on display at the JAIMA Show, Tokyo, Japan, September 1 to 3, 2010 and Glass Expansion specialists will be on hand to assist you.

JAIMA EXPO:-2010

Applications Notes

To assist you with your applications, we have added a new Applications Notes section to our website. **Click here** to see the first Applications Notes. We will be adding more over time.

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GE GLASS EXPANSION
Quality By Design

Space/charge Interferences for ICP-MS

Space/charge interferences occur at the interface of the ICP-MS where larger mass ions can inhibit smaller ones from passing through. Although many commonly occurring salts are composed of relatively light atoms, there are situations where the salt is composed of heavier atoms as well. Also, the sheer volume of ions present at any mass can have a severe effect on the other analytes. Over the past few years, instrument manufacturers have optionally configured their sample introduction systems so that an auxiliary argon flow can dilute the sample aerosol before it reaches the interface region. Agilent, for example, refers to this option as the HMI (High Matrix Introduction) accessory. This allows for samples with much higher TDS concentrations to be more easily and accurately analyzed.[(2)]

Polyatomic Spectral Interferences in ICP-MS

There are numerous examples of overlap of mass/charge species in ICP-MS. Table 1 shows some examples of those that would be common in the presence of certain high salt concentrations.[(3)]

Element/Isotope	Interference
^{75}As	$^{40}Ar^{35}Cl^{+}$
$^{51}V^{+}$	$^{35}Cl^{16}O^{+}$
$^{63}Cu^{+}$	$^{40}Ar^{23}Na^{+}$
$^{56}Fe^{+}$	$^{40}Ca^{16}O^{+}$
$^{57}Fe^{+}$	$^{40}Ca^{16}OH^{+}$
$^{64}Zn^{+}$	$^{48}Ca^{16}O^{+}$

Table 1

Although most of these can be resolved with a high resolution ICP-MS system such as a multi-collector or magnetic sector spectrometer, these systems are typically much more expensive than a quadrupole spectrometer. For quadrupole spectrometers, these potential interferences can often be effectively dealt with through the use of collision or reaction cells. In a collision cell, the interfering molecular ions are broken down into non-interfering species through kinetic interaction with a non-reactive gas such as helium. In a reaction cell, a reactive gas such as ammonium or oxygen is added to react with the interfering species to form non-interfering ions.

Matrix Suppression

High TDS samples can affect a number of liquid-related properties including viscosity, surface tension, and droplet formation, all of which in turn affect the resultant signal at the detector. In addition, the presence of high salts in the plasma often creates a greater load on the plasma, decreasing the amount of energy available for efficiently exciting and/or ionizing analyte atoms. Internal standardization can be a good way of correcting for these types of interferences, as long as the internal standards are wisely selected. For ICP-OES, an internal standard line should be selected such that the state (ion or atom) matches that of the analytes. For ICP-MS, several internal standard masses should be selected to cover the range of masses in the analyte suite. Even with these considerations, variations in response will exist between the internal standard and the analytes, such that large signal suppressions require dilution for truly accurate measurements.

In order to guarantee the accuracy of addition of the internal standard and to avoid contamination, many analysts prefer to add the internal standard automatically in-line. Figure 2 depicts an in-line addition accessory (Trident In-line Addition accessory, Glass Expansion P/N 60-808-1185). With this kit, the rigid glass tee has a built-in mixing chamber to assure intimate mixing of the internal standard and sample.

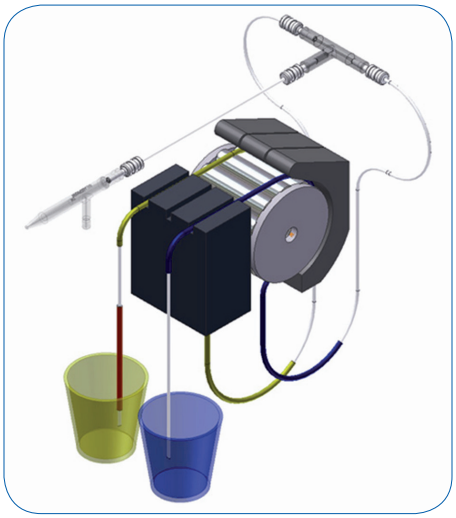


Figure 2: Trident in-line reagent addition accessory schematic

Easily ionizable element interferences in ICP-OES

Easily ionizable elements such as sodium and potassium are commonly present in salts. The presence of these elements can affect the signal of all easily ionizable elements by altering the ion/atom ratio. This effect is more pronounced in axially viewed plasmas since a much wider range of plasma height is viewed. The most commonly used approach to compensate for this potential interference is to dose the plasma with a high concentration of an easily ionizable non-analyte element (typically cesium) so that sample to sample variations are minimized. This can be easily and automatically accomplished by adding this element to the container of internal standard used to compensate for other matrix effects.

Devitrification of quartz components

When salts deposit on hot quartz, a process called devitrification occurs. It is observed as small cracks in the surface of the torch and eventually will cause the outer tube to break. Devitrification can also affect the intermediate tube and the injection tube but to a lesser degree. Figure 3 shows some examples of torch devitrification.

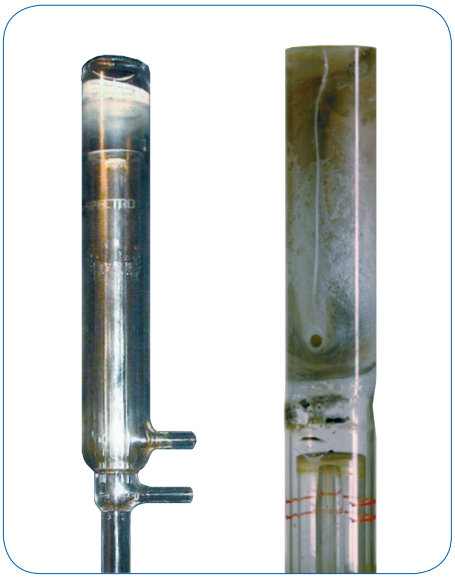


Figure 3: Examples of devitrification of quartz torches

The presence of high TDS in samples can shorten torch life from several months to only a few weeks and is therefore a concern with respect to a laboratory's operating budget. Recently, Glass Expansion introduced a new line of torches called the D-Torch to combat this problem (Figure 4). The D-Torch is equipped with a ceramic intermediate tube and quartz outer tube but can be configured with a ceramic outer tube as well. Having replaceable quartz outer tubes significantly reduces the cost of replacing torches while using a ceramic outer tube extends the torch life, reducing down time and maintenance as well.

Figure 4: D-Torch for the PerkinElmer Optima 7300V

Salt deposits in nebulizers and injectors

As the dry argon used to generate an aerosol from the sample carries the sample through the nebulizer, spray chamber, and torch, opportunities for drying the salts and forming deposits abound. A simple way to decrease the likelihood of salt deposits is to humidify the argon before it comes in contact with the sample. Glass Expansion designed the Capricorn argon humidifier for this purpose (Figure 5). Since it has a glass component that is under pressure, it is encased in a rugged plastic housing to ensure safe operation. Also, it can be optionally configured with a bypass switch so that the operator can turn humidification on and off without connecting or disconnecting any tubing.

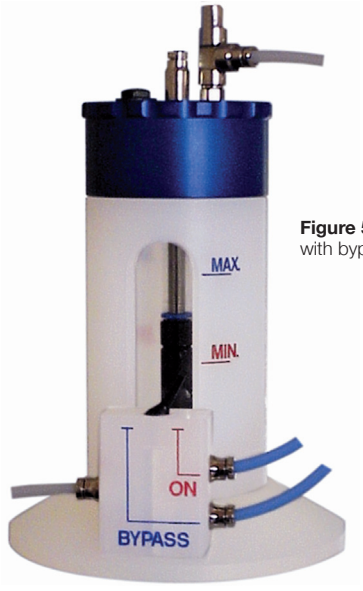


Figure 5: Capricorn argon humidifier with bypass switch

Furthermore, it is important to select the proper nebulizer and injector when aspirating high TDS samples. Glass Expansion's SeaSpray nebulizer is designed to be self-washing at the tip and is therefore capable of handling quite high concentrations of dissolved solids, up to 20% for most common salts. With respect to the injector tube, it is important to avoid a sharp pressure change near the hot tip of the injector. In fact, we recommend a straight bore (with no taper) injector for high TDS applications. Still it is a good idea to increase the auxiliary argon flow to lift the plasma higher off the injector.

Reduced lifetimes of consumables, carryover and memory

Not only does the presence of high TDS shorten the life of quartz torches, it also adversely affects other consumables such as nebulizers, injector tubes, and interface cones for ICP-MS. Another related problem is carryover, which can result if you are measuring a salt containing an element that is present at high concentrations in only some of the samples. Memory is different from carryover in that it can be caused by the presence and carryover of an element (or elements) that are not of analytical importance but affect the signals of analytes. To lessen these effects, an accessory can be employed which decreases the amount of time that sample comes in contact with the sample introduction system. Such a device is the Niagara Plus, which consists of an eight port valve and a fast draw positive displacement pump and the software to control it (Figure 6). The function and benefits of this accessory were fully described in the previous (February 2010) issue of this newsletter. In short, it typically allows the analyst to cut the sample exposure time in half without affecting the analyte measurement time.

Figure 6: Components of the Niagara Plus accessory

Conclusion

Although high TDS samples pose many challenges to the ICP analyst, the technology is available to circumvent these and achieve accurate analyses with a robust system.

References

1. Graphics courtesy of Thermo Scientific.
2. Steve Wilbur, Agilent Technologies, Bellevue WA, Wim Proper, Eurofins Analytico, Barneveld, Netherlands, Noriyuki Yamada and Naoki Sugiyama, Agilent Technologies, Hachioji, Japan, *Direct Analysis of Undiluted Soil Digests Using the Agilent High Matrix Introduction Accessory with the 7500cx ICP-MS*, Agilent Applications Note #5989-7929EN, February, 2008.
3. Robert Thomas, *Practical Guide to ICP-MS*, 2nd Edition, CRC Press, NY, 2008.

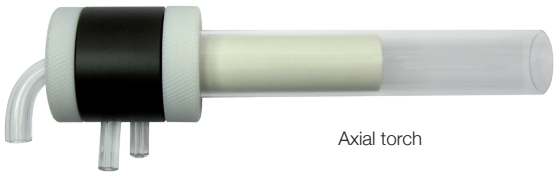
NEW PRODUCTS

D-Torch for Varian 700-ES and Vista

The D-Torch is a new demountable torch design that provides the benefits of a fully demountable torch at a significantly lower cost. We have previously released the D-Torch for the PE Optima 2/4/5/7000 Series, PE Elan, Thermo iCAP 6000 and the Spectro SOP. D-Torches are now available for the Varian Vista and 700-ES Series. At present, the Varian Axial D-Torch is only available with a quartz outer tube but we expect to have a ceramic outer tube available at a later date. The Varian Radial D-Torch is available with both quartz and ceramic outer tubes.

Part No.	Description
KT-1094	D-Torch with Alignment Tool for Varian Vista or 700-ES Axial
30-808-3052	D-Torch for Varian Vista or 700-ES Radial

The D-Torch is a cost-effective alternative to the standard fixed torch or semi-demountable torch. It will save money for any laboratory with a moderate workload. In most cases, when the torch wears, you will only need to replace the outer tube instead of replacing the entire torch. You will realize a saving after replacing the outer tube three or four times. In addition, interchangeable injectors are available to suit samples with organics, high solids or HF.

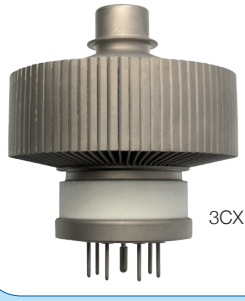


Axial torch

RF Power Tubes

Glass Expansion is now offering cost-effective replacement RF power tubes for a variety of ICP-OES and ICP-MS models. We have tubes for the Thermo Iris, AtomScan and 61E Trace, PerkinElmer Optima 3000 and Elan, and all of the Varian ICP models. As is the case with all Glass Expansion products, the power tubes are guaranteed for 100% satisfaction. Furthermore, they come with a full one year warranty.

Part No.	Description	ICP Model
3CX1500A7	RF Power Tube	Thermo Iris, Atomscan, 61E Trace
3CX1500D3	RF Power Tube	Varian – all models PerkinElmer Optima 3000 series, Elan series



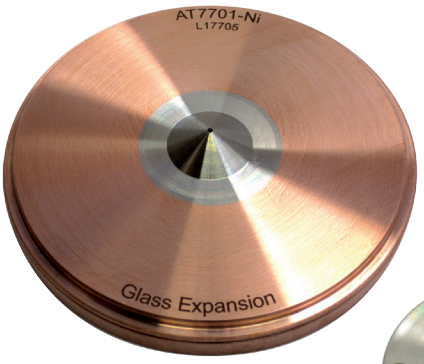
3CX1500A7

3CX1500D3

Consumables for Agilent 7700 ICP-MS

The Agilent 7700 was released in 2009, replacing the 7500. We can now supply a range of consumables for this model, including nebulizers, torches and the most common cones. We will be adding other cones shortly. Please contact us if the item you require is not on the list below.

Part No.	Description
AR35-1-USS04EX	SeaSpray U-Series nebulizer 0.4mL/min
AR35-1-FM04EX	MicroMist Nebulizer with EzyFit 0.4mL/min
30-807-0556	Quartz Torch with 2.5mm injector for Agilent 7700
30-807-0557	Quartz Torch with 1.5mm injector for Agilent 7700
30-807-0558	Quartz Torch with 1.0mm injector for Agilent 7700
AT7701-Ni	Nickel Sampler for Agilent 7700
AT7702X-Ni	Nickel Skimmer for Agilent 7700x
AT7702S-Ni	Nickel Skimmer for Agilent 7700s
AT7704	Retaining Ring for Agilent 7700 Sampler Cone
AT7703	Graphite Gasket for Agilent 7700 Sampler Cone (PKT 3)



AT7701-Ni

AT7702X-Ni

INSTRUMENT NEWS

From PerkinElmer – Launch of NexION 300 ICP-MS

PerkinElmer, Inc announced the launch of the NexION™ 300 ICP-MS at PITTCON® 2010. "The NexION 300 platform advances trace element analysis, and its introduction is perfectly timed to help address global problems ranging from contamination of our air, water and food, to the integrity of pharmaceuticals and nutritional supplements, as well as the safety of emerging nanomaterials," explained Martin Long, Vice President, Spectroscopy, Analytical Sciences and Laboratory Services, PerkinElmer.

The NexION 300 instrument features the patented Universal Cell Technology™ (UCT) and is the only instrument of its kind with three modes of interference removal – Standard, Collision and Reaction. These three modes allow scientists to choose the appropriate technique for their particular application, based on the complexity of the problem to be solved.

NexION's Standard mode can be used for simple and routine analyses. Collision mode is effective for semi-quantitative analyses, environmental sample monitoring and testing unknown samples. Reaction mode, using patented DRC™ technology, provides the best detection limits available, for even the most difficult elements and matrices such as semiconductor testing.

The NexION 300 system can be integrated with chromatography systems for effective speciation analysis to enable customers to accurately separate and measure the toxicity, bioavailability, metabolism and environmental mobility of elements.

From Spectro – A New Era In ICP Mass Spectrometry

With the SPECTRO MS, SPECTRO presents the first fully simultaneous measuring mass spectrometer with inductively coupled plasma in the world. The SPECTRO MS records the entire elemental spectrum between lithium and uranium for every analysis. Users achieve a greatly increased sample throughput rate and much better precision and accuracy compared to using a sequential mass spectrometer.

"The SPECTRO MS will change mass spectrometry forever. The option of being able to measure simultaneously will create a revolution on the market similar to the one created by the optical emission spectrometers several years ago," reports Manfred Bergsch, SPECTRO's Managing Director. "The SPECTRO MS delivers not only much more precise and reproducible results than a conventional mass spectrometer, but also measures a great deal faster; opening new perspectives and applications for laboratories."

Simultaneous recording of the entire spectrum is enabled by a series of newly designed high-end components:

- A novel ion optic that is extremely efficient in transporting ions from the plasma into the mass spectrometer
- A double focusing sector field mass spectrometer with a Mattauch-Herzog design.
- An extremely powerful Direct Charge Detector with 4,800 channels is placed in the focal plane of the mass spectrometer, recording simultaneously the entire mass spectrum from lithium to uranium with an average of 20 channels per isotope.
- With the innovative sleep-mode, the robust and user-friendly vacuum system features very low energy consumption.

From Teledyne Leeman Labs – New Application Note on the Analysis of Oil Additives

Teledyne Leeman Labs has announced the publication of a new application note on the ***Analysis of Oil Additives using the Prodigy High Dispersion ICP***. Nearly all commercially available motor oils contain additives. Oil additives are used to modify various properties of the oil to improve its performance. Some motor oils contain additional additives to modify the viscosity of the oil or to prevent the buildup of acids.

This application note demonstrates the ability of the Prodigy High Dispersion ICP to determine a range of elements in two oil additive sets. The Prodigy ICP provides high sensitivity and dispersion which, combined with appropriately chosen wavelengths and background correction points, can be used to provide accurate and reliable results for a suite of elements in oil additive samples using a radial plasma.

To receive a copy of technical note 1060, "***The Analysis of Oil Additives using the Prodigy High Dispersion ICP***", email: **LeemanLabsinfo@Teledyne.com** or visit our website at **www.LeemanLabs.com**.

From Thermo Fisher Scientific – Thermo Fisher Scientific Ships 2000th iCAP 6000 Series ICP Emission Spectrometer

Thermo Fisher Scientific Inc has announced that Bormioli Rocco, a producer of glass and plastic pharmaceutical packaging, glass containers for perfumery and foodstuffs and glass tableware, has purchased and deployed the 2000th Thermo Scientific iCAP 6000 Series inductively coupled plasma (ICP) emission spectrometer. The company relies on ICP emission spectrometry to ensure that alkaline metal concentrations in their glass materials conform to current European legislation. Since deployment, Bormioli Rocco has increased lab productivity while lowering its costs.

Bormioli Rocco selected the Thermo Scientific iCAP 6300 Duo ICP for its flexibility and exceptional performance capabilities, which ensure accurate, precise analytical results and higher productivity. Also important was the small footprint of the system, which makes it easier to transport and install, an important benefit for modern labs where bench space is increasingly limited.

Gareth Jones, product group director, Trace Elemental Analysis, Thermo Fisher Scientific, comments: "Our iCAP 6000 Series delivers outstanding performance, ease-of-use and low cost-of-ownership, all in a uniquely compact instrument. These benefits are possible because of the expertise, hard work and commitment that goes into producing such a superior analytical solution. Achieving the 2000th-order milestone clearly demonstrates that customers value the instrument's quality and reliability."

For more information on the Thermo Scientific iCAP 6000 Series ICP emission spectrometers, please email **analyze@thermofisher.com** or visit **www.thermo.com/icap**.