



Agilent ICP-MS Journal

May 2016 – Issue 65

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Agilent Technologies

Quantitative Analysis of Trace Elements in High Purity Copper using Laser Ablation-ICP-MS

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Laser Ablation-ICP-MS (LA-ICP-MS) is used for the elemental analysis of solid samples and pressed powders, including geological materials, ceramics, biological tissue and forensic samples. Calibration can be problematic though, because of the lack of solid standards to permit accurate quantitative analysis. Preparing calibration standards for the analysis of solids is more difficult than it is for liquid sample analysis, and matrix-matched solid calibration standards are rarely available. In a few cases, such as the metals industry, well-characterized, matrix-matched standards may be available, since established analytical techniques such as Arc/Spark or Glow Discharge (GD) Optical Emission Spectroscopy (OES) already require solid standards.

An alternative approach is to calibrate using existing solid Certified Reference Materials (CRMs) of a different composition, that is, non-matrix matched standards. This approach has the potential drawback that ablation yield and elemental fractionation during the ablation process may differ between the CRM and the sample, causing significant error in quantification. In this work, we report accurate and precise quantitative LA-ICP-MS data for trace elements in high purity copper, using certified copper standards for

Table 1. LA-LCP-MS operating parameters

ICP-MS parameter	Unit	Value
RF power	W	1550
Sampling depth	mm	8
Carrier gas flow rate	L/min	1.15
He (laser) gas flow rate	L/min	0.8
Extraction 1 lens	V	-15
Extraction 2 lens	V	-180
KED	V	3
H ₂ cell gas flow rate	mL/min	3.8
Data acquisition mode		spectrum
Integration time	s / mass	1
Number of sweeps		50
Scan lines		5
Replicates per scan line		3
LA parameter	Unit	Value
Fluence	J/cm ²	3
Spot size	μm	200
Scan pattern		line
Scan rate	μm/s	10
Pre-ablation		on
Warm-up time	s	10
On delay time	s	20

calibration, and compare these results with those obtained using a non-matrix-matched standard.

Plug-in Module for ICP-MS MassHunter

A NWR 213 (ESI, California, USA) deep UV Nd:YAG laser with a wavelength of 213 nm and pulse duration of 4 ns was coupled to an Agilent 7900 ICP-MS. The ICP-MS was operated in hydrogen mode to remove matrix argide interferences such as ArAr⁺, ArO⁺ and CuAr⁺, which are more problematic for laser ablation (dry plasma) than the oxide interferences typically encountered in solution mode.

Using the MassHunter plug-in developed by ESI, the LA system was controlled directly from the ICP-MS MassHunter 4.2 software for fully integrated sample analysis. The scan-pattern was set up in the LA system and then loaded into MassHunter where the run was controlled using the MassHunter plug-in. NIST 612 Trace Elements in Glass was used to tune the LA-ICP-MS system. LA-ICP-MS operating conditions are given in Table 1.

Matrix-matched Calibration

Two copper CRMs (BAM-M385 and BAM-M383b) were analyzed as unknown samples using spiked solid

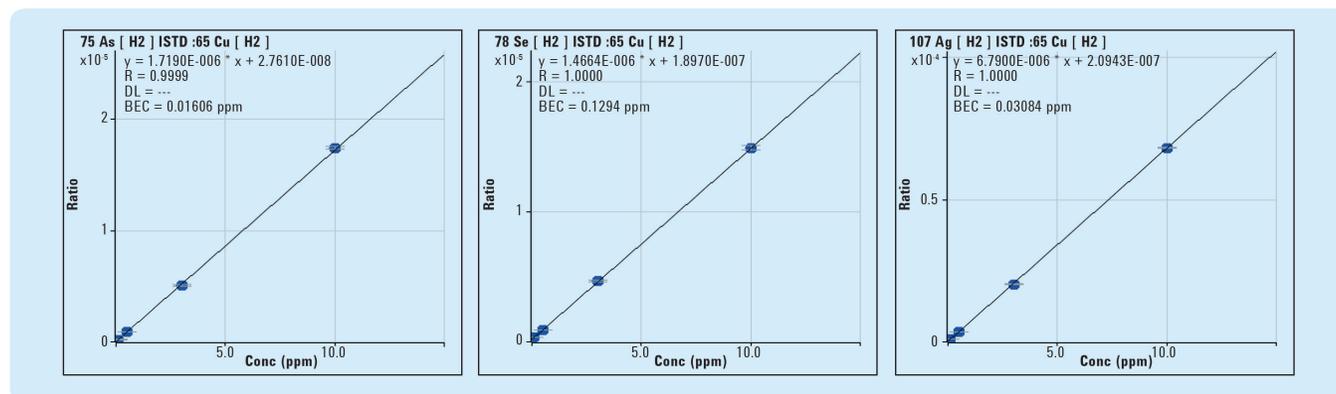


Figure 1. Matrix-matched calibration curves for As, Se and Ag using copper matrix standards

copper standards as a matrix-matched calibration. Four COPPERSPEC standards, 001, 005, 030, and 100, spiked with 11 elements at 0.1, 0.5, 3, and 10 ppm respectively, were used for the calibration. ^{65}Cu was used as the internal standard (ISTD) to correct for any variation in the LA system, ablation yield, and signal suppression/drift of the ICP-MS. Representative calibration curves for three elements (As, Se, and Ag) demonstrated good linearity, as shown in Figure 1.

Table 2 shows the measured results (average \pm standard deviation of five separate ablation lines) and certified concentrations for the 11 calibrated elements in the two copper CRMs. The measured concentrations are in good agreement with the certified values; almost all were within the uncertainty (given error range) of the CRMs.

The same analysis was repeated on three different days, with good reproducibility. Figure 2 shows the percent recovery of the measured average concentrations compared to the certified value on the three days. The results for BAM-M383b have higher variability due to the much lower concentrations of trace elements in this CRM (single- or sub-mg/kg for most elements), but the data show that the LA-ICP-MS method is suitable for quantitative analysis of trace elements at the low ppm level in solid copper, with accuracy typically better than $\pm 10\%$.

Non-matrix Matched Calibration

The use of matrix-matched copper calibration standards allowed

Table 2. Measured (average of 5 ablation lines) and certified concentrations of representative elements in two copper CRMs: BAM-M383b and BAM-M385

Element	BAM-M383b		BAM-M385	
	Certified mg/kg	Measured mg/kg	Certified mg/kg	Measured mg/kg
Fe	3.60 \pm 0.60	3.92 \pm 0.13	45.4 \pm 1.4	43.5 \pm 0.1
Ni	1.43 \pm 0.18	1.59 \pm 0.02	11.9 \pm 0.8	12.0 \pm 0.1
Zn	9.30 \pm 0.40	9.69 \pm 0.15	57.9 \pm 4.0	61.6 \pm 0.4
As	2.80 \pm 0.40	3.05 \pm 0.16	11.4 \pm 0.8	11.7 \pm 0.3
Se	1.17 \pm 0.28	1.43 \pm 0.13	7.20 \pm 0.50	7.37 \pm 0.64
Ag	10.60 \pm 0.40	10.72 \pm 0.36	28.6 \pm 0.8	29.2 \pm 0.4
Sn	0.80 \pm 0.40	0.66 \pm 0.04	18.0 \pm 0.9	17.6 \pm 0.5
Sb	1.69 \pm 0.16	1.71 \pm 0.13	19.9 \pm 0.8	20.8 \pm 0.6
Te	5.70 \pm 0.90	5.94 \pm 0.69	10.0 \pm 0.4	10.1 \pm 0.4
Pb	1.01 \pm 0.17	1.03 \pm 0.09	11.3 \pm 0.5	12.6 \pm 0.4
Bi	1.85 \pm 0.21	1.98 \pm 0.21	5.81 \pm 0.17	6.18 \pm 0.22

accurate analysis of trace elements in copper CRMs within $\pm 10\%$ of the certified values. However, in many applications of LA-ICP-MS, known or certified standards are not available and cannot easily be made. In these cases, non-matrix matched calibration can be used, based on a common, commercially available and well-characterized CRM, such as NIST 612 Trace Elements in Glass.

Three different metal CRMs were analyzed by LA-ICP-MS using NIST 612 as a non-matrix matched calibration standard to assess the accuracy of the method. BAM-M385 (pure copper), CRM-191-2 (dynamo-steel) and BAM-310 (98.5% Al, 1% Mg) were analyzed as samples, and trace element concentrations were calculated against a semi-quantitative calibration, using NIST 612 as the semi-quant standard. The major elements, Cu, Fe and Al were used as

internal standards in the analysis of BAM-M385, CRM-191-2 and BAM 310, respectively. The results obtained in the metals standards, using NIST 612 as the non-matrix matching calibration standard, were almost all within $\pm 50\%$ of the certified values.

More Information

For further details on the accuracy achieved using this non-matrix matched approach, see *Quantitative analysis of high purity metals using laser ablation coupled to an Agilent 7900 ICP-MS*, Agilent publication 2015, 5991-6156EN.

See page 8 for more information on Agilent's Software Developer's Kit, designed to guide third party developers through the process of creating MassHunter plug-ins for their devices.

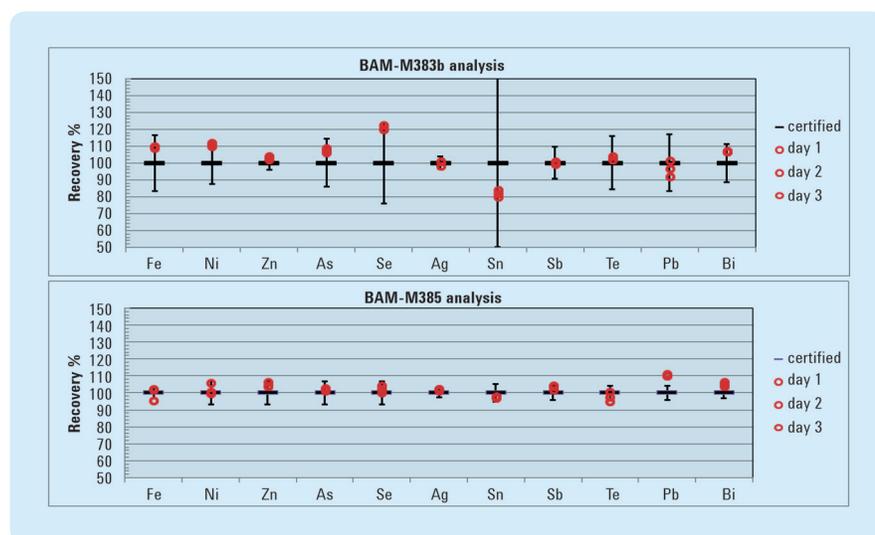


Figure 2. Recovery of selected elements on three different days.

Simultaneous Speciation of Arsenic and Selenium using CE-ICP-MS

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Introduction

Arsenic (As) is known to be toxic and carcinogenic to humans even at very low levels of exposure. Selenium (Se) is an essential element for biological systems at trace levels, but toxic at high doses, with a narrow range between human dietary deficiency (<40 µg/day) and excess levels (>400 µg/day) [1]. The toxicity of both elements is affected by their chemical form and oxidation state. Inorganic As species arsenite (As(III)) and arsenate (As(V)) are more toxic than the methylated organic species, such as MMA and DMA, with As(III) being the most toxic species.

The major Se species in environmental matrices include two inorganic species selenite (Se(IV)) and selenate (Se(VI)) and some selenoamino acids (seleno-cysteine (SeCys), seleno-methionine (SeMet), and S-e-methyl-seleno-cysteine (MeSeCys)), with Se(IV) being the most toxic species. Selenoamino acids are considered to be less toxic than the inorganic forms. Furthermore, an antagonistic effect between arsenic and selenium has been found to cause detoxification in biological systems [2, 3]. To understand the different aspects of these elements in biological samples, a simple, rapid, and sensitive speciation method is needed.

Capillary electrophoresis (CE) coupled to inductively coupled plasma mass spectrometry (ICP-MS) was investigated for the simultaneous separation and determination of As and Se species in environmental, biological and food samples.

Compared to other chromatographic techniques, CE provides relatively gentle separation conditions and can therefore preserve the integrity of complex molecules. CE also has the advantage of high separation efficiency and low sample volume requirements, making it more suitable

for elemental speciation of samples that are only available in limited volumes, such as biological samples. Furthermore, CE's rapid separations and minimal buffer consumption combine to reduce the volume of solvents and salts that are introduced into the ICP-MS, compared to other separation techniques.

The combination of CE with ICP-MS as the detector provides a very selective, highly sensitive, multi-element method for the determination of elemental species in aqueous samples and sample digests.

Experimental Instrumentation

An Agilent HP3D CE was interfaced to an Agilent 7500ce ICP-MS by connecting the CE/MS electro-spray sprayer to the ICP-MS's low-volume spray chamber via an Agilent CE/MS spray kit interface (G1607A). The CE separation was performed using a fused silica capillary (Yongnian Optical Fiber Company, Hebei, China). As and Se were measured using time resolved analysis (TRA), monitoring the signals at m/z 75 and 82 for ^{75}As and ^{82}Se , respectively. Optimized CE-ICP-MS operating parameters are given in Table 1.

Analytical Performance

Six arsenic compounds (AsB, AsC, As(III), DMA, MMA, As(V)), and five selenium compounds (SeMet, MeSeCys, SeCys, Se(IV), and Se(VI))

Table 1. CE-ICP-MS operating parameters

ICP-MS parameters	
Plasma power	1550 W
Sampling depth	8 mm
Carrier gas	1.05 L/min
Make up gas	0.10 L/min
CE parameters	
Capillary	75 µm id × 60 cm
Buffer	NaH ₂ PO ₄ (6 mM), H ₃ BO ₃ (9 mM), pH 9.0
Voltage	25 kV
Temperature	25 °C
Sample Injection	Hydrodynamic 50 mbar, 10 s
Pre-analysis rinse	0.1 M NaOH (2 min) Deionized water (2 min) Running buffer (2 min)
Post-analysis rinse	0.1 M NaOH (2 min) Deionized water (2 min)

were measured using CE-ICP-MS. All compounds were baseline-separated within 10 minutes, as shown in Figure 1. Excellent linearity was achieved for the As and Se species in the range of 5-200 µg/L and 10-400 µg/L respectively. Detection limits (3σ, based on the peak height measurement) ranged from 0.11 µg/L to 0.37 µg/L for the As compounds and 1.27 µg/L to 2.31 µg/L for the Se compounds. Significantly lower detection limits can be achieved for Se, if the more abundant ^{78}Se isotope is measured, utilizing collision reaction cell conditions to reduce the backgrounds

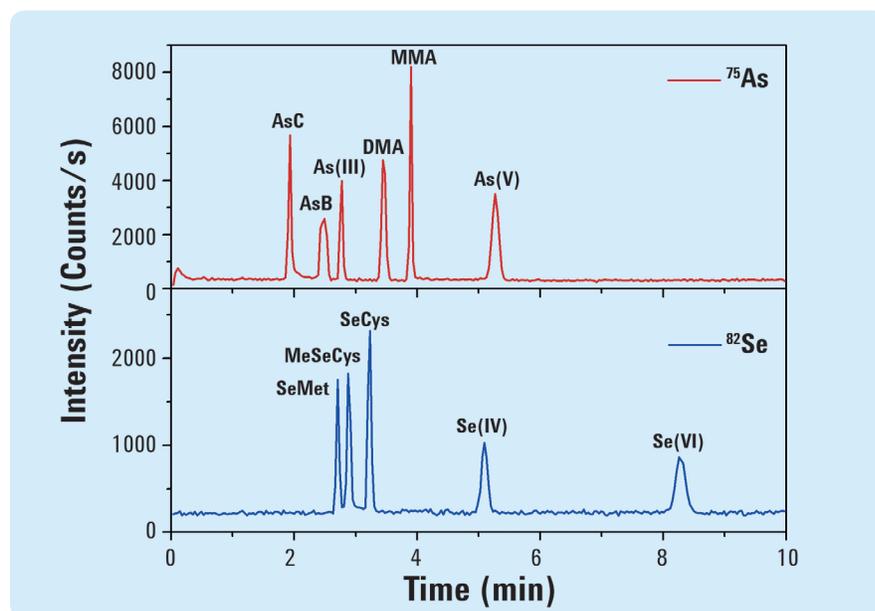


Figure 1. A typical electropherogram of the six arsenic species at 100 µg/L and five selenium species at 200 µg/L level

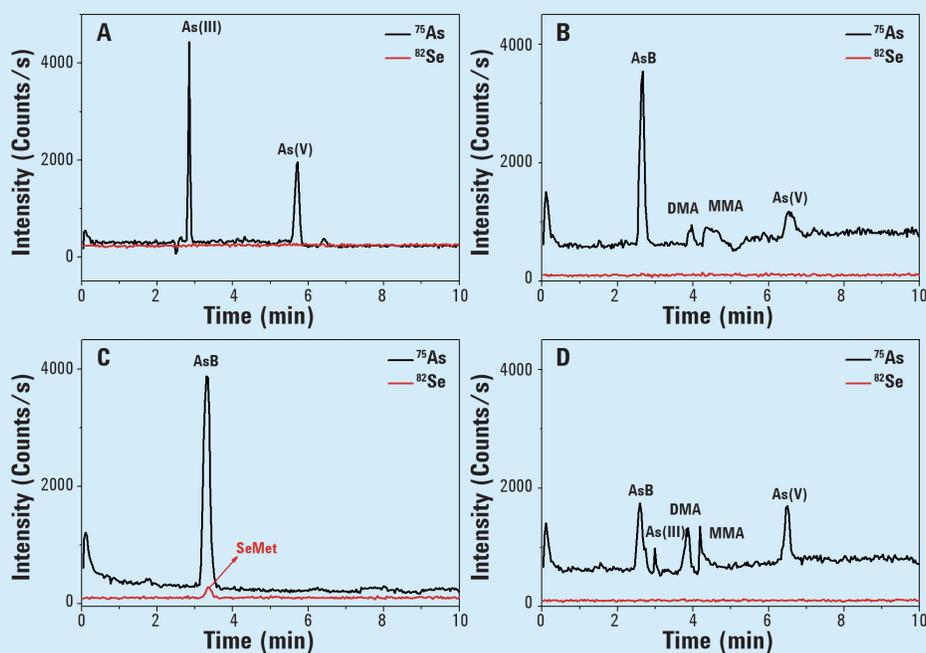


Figure 2. Electropherograms of arsenic and selenium species obtained by CE-ICP-MS in environmental samples: (A) Ground Water-1, (B) DORM-3, (C) Fish-1 and (D) Urine sample.

at m/z 78. The absolute detection limits (fg) were based on a 72.6 nL sample injection. Reproducibility of the method expressed as the relative standard deviations (RSD, $n=6$) of both migration time and peak area were better than 2.68% for As compounds and 3.28% for Se compounds.

Samples & Sample Preparation

The two groundwater samples were obtained from separate tube wells in Shanyin (Shanxi province, China) and the tap water was collected in the laboratory (Beijing, China). The urine sample was collected from a volunteer living in Shanyin. The two groundwater samples, tap water sample and urine sample were filtered through a 0.22 μm nylon filter to remove particulates. The fish samples analyzed included DORM-3 fish protein Certified Reference Material (CRM) obtained from National Research Council, Canada, Fish-1 (collected from Dalian, Liaoning province), and Fish-2 (collected from the Tibetan plateau). These samples were lyophilized and homogenized before extraction in deionized water. All extracted solutions were diluted with running buffer solution before analysis by CE-ICP-MS.

Sample Analysis

CE-ICP-MS was used for the speciation

of As and Se species in water, urine, and fish samples including the CRM DORM-3. Typical electropherograms of the samples are shown in Figure 2. Since the groundwater samples were collected from Shanyin, Shanxi province, China, which is an area seriously affected by arsenic contamination, inorganic arsenic was the predominant species in these samples, as shown in Figure 2A. Recovery tests were performed by spiking 100 $\mu\text{g/L}$ arsenic and 200 $\mu\text{g/L}$ selenium species in groundwater-1 and excellent recoveries were achieved.

The sum concentration of individual arsenic species measured in DORM-3 (6.31 ± 0.13 $\mu\text{g/g}$) agreed reasonably well with the ICP-MS measured value for total arsenic (6.73 ± 0.13) and the certified value (6.88 ± 0.3 $\mu\text{g/g}$), giving confidence in the results. Selenium compounds were only detected in the Fish-1 sample. Spike recovery tests were conducted by spiking 50 $\mu\text{g/L}$ As and 100 $\mu\text{g/L}$ Se species in DORM-3. All recoveries were in the range of 96.2%–106.3% for As species and 93.7%–105.8% for Se species.

To test the method in a high chloride matrix sample, the urine sample was analyzed. Five As species were found, including high levels of inorganic As species. No Se species were detected.

Spike recoveries for As and Se species were in the range of 94.9%–110.2% and 93.3%–110.1%, respectively.

Conclusions

Six arsenic species and five selenium species were determined in a range of samples, using a single rapid separation by CE-ICP-MS. All species were baseline separated in less than 10 minutes with detection limits in the range of 0.11–0.37 $\mu\text{g/L}$ for the As species and 1.33–2.31 $\mu\text{g/L}$ for the Se species. Arsenic species were detected in all of the samples measured, with high concentrations of toxic inorganic As (sum of As(III) and As(V)) found in the two groundwater samples taken from a contaminated region. High levels of As were also found in the urine sample of a resident of the same region. Only Fish sample 1 was found to contain any of the Se species measured.

More Information

Anal. Chem., 2014, 86 (16), pp 8167–8175

References

1. Lenz, M. et al., Environ. Sci. Technol. 2012, 46, 11988–94.
2. Levander, O. A. Environ. Health Persp. 1977, 19, 159–164.
3. Gailer, J. et al, Am. Chem. Soc. 2000, 122, 4637–4639.

US FDA Proposes New Limit for Inorganic Arsenic in Infant Rice Cereal

April 2016: The U.S. Food and Drug Administration (FDA) is proposing a maximum concentration or “action level” of 100 parts per billion (ppb) for inorganic arsenic (iAs) in infant rice cereal. This is in line with the European Commission (EC) limit for iAs in rice, but the EC standard applies to rice intended for the production of food for infants and young children, whereas the FDA’s proposed action level relates to the rice cereal foodstuff itself. FDA testing found that the majority of infant rice cereals currently on the market either meet, or are close to, the proposed action level.

Basis for Proposed Limit

The proposed limit stems from a 2016 FDA risk assessment that analyzed scientific studies showing an association between iAs exposure and adverse pregnancy outcomes and neurological effects in early life. This assessment was considered together with the results of extensive testing of rice and non-rice food products, and an evaluation of the feasibility of reducing iAs in infant rice cereal.

The FDA has released data showing the levels of iAs in 76 samples of rice cereals for infants (Table 1). The FDA’s data show that nearly half (47 percent) of infant rice cereals sampled from retail stores in 2014 already met the agency’s proposed action level of 100 ppb iAs, while over three-quarters (78%) were at or below 110 ppb iAs.

Table 1. Extract from FDA’s published data: Inorganic arsenic in infant/toddler foods

Product Category: Cereal - Infant/Toddler	Range of Inorganic Arsenic (ppb)	Number of Samples
Rice	20.8 - 176	76
Multigrain	22.2 - 49.6	6
Non-rice	3.5 - 68.3	30

To assess overall sources of iAs in infant foods, the FDA also tested more than 400 samples of other foods commonly eaten by infants and toddlers. The agency found all

the non-rice foods contained well below 100 ppb iAs, showing that low-arsenic alternatives are available to be incorporated into a well-balanced diet.

Find out more at:

<http://www.fda.gov/Food/FoodborneIllnessContaminants/Metals/ucm319870.htm>

Speciation Measurement

To measure iAs alone, the two main forms arsenite (As(III)) and arsenate (As(V)) must be separated from the other, organic forms of As using chromatography, usually HPLC, as used by the FDA in their study of iAs levels in infant/toddler foods.



Agilent 1260 Infinity LC coupled to an Agilent 7900 ICP-MS

Agilent ICP-MS and ICP-QQQ instruments link seamlessly with Agilent HPLC and GC systems through optimized interfaces. The coupled system is setup and operated directly from the ICP-MS MassHunter software, giving fully integrated control. Figure 1 shows an overlay of iAs chromatograms in five rice cereals measured using an Agilent LC-ICP-MS system.

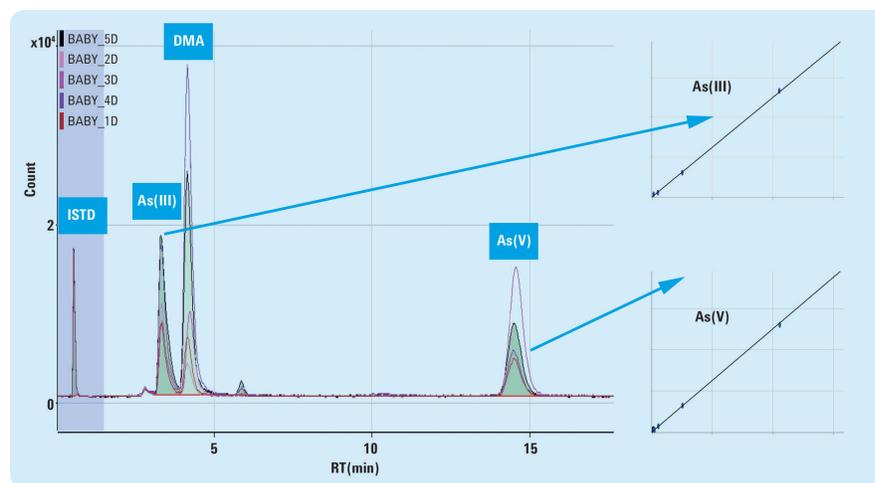


Figure 1. Overlaid chromatograms showing As species in five infant rice cereals. See Agilent publication 5991-2568EN

Agilent has been providing robust and reliable solutions for the measurement of iAs in foods and beverages for many years – including collaborating with many leading external research groups. With the FDA’s new proposed limit and ongoing public concern about food contamination, demand for routine monitoring of iAs in foods is expected to increase.

Further reading:

- The FDA Elemental Analysis Manual <http://www.fda.gov/downloads/food/foodscienceresearch/laboratorymethods/ucm479987.pdf>
- ICP-MS Journal Article: Fast arsenic speciation for food and urine analysis, 5991-6586EN
- Application note: Speciation of inorganic arsenic in baby rice cereals using HPLC-ICP-MS, 5991-2568EN
- Application note: Rapid determination of five arsenic species in polished rice using HPLC-ICP-MS, 5991-5933EN
- Application note: Accurate and sensitive analysis of arsenic and selenium in foods, 5991-5860EN
- Application note: High throughput determination of inorganic arsenic in rice using hydride generation-ICP-MS, 5991-6055EN
- Application brief: Low-level analysis of inorganic arsenic in apple juice by LC-ICP-MS, 5991-2049EN
- Application note: Arsenic speciation analysis in apple juice using HPLC-ICP-MS with the Agilent 8800 ICP-QQQ, 5991-0622EN

ICP-MS MassHunter and Agilent's Best Ever Software Maintenance Agreement

Edward Guthrie, Software Services Product Manager, Agilent Technologies, USA

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When you purchase an Agilent ICP-MS MassHunter software product, a 1-year Agilent Software Maintenance Agreement (SMA) is included. The SMA provides 1-year subscription access to free software updates and upgrades via either download or media, as well as unlimited telephone based software support. The Agilent SMA protects your ICP-MS MassHunter investment, keeps the software running at its highest level, and provides access to the knowledge of Agilent software experts. At the end of the first year, the SMA may be renewed on an annual basis, ensuring cost effective software update management over the life of the ICP-MS instrument and software.

Effectively Manage Software Costs

An Agilent SMA is an excellent way to manage software update costs and avoid costly surprises. For example, it is common for laboratory or corporate IT departments to mandate transition of all computers on the corporate network to the newest revisions of Windows as earlier revisions go out-of-support. In this case, laboratory instruments running out-of-support versions of Windows would need to be disconnected from the network. Alternatively, since Agilent MassHunter software is always written for current revisions of Windows, simply upgrading the

instrument software to the current revision allows the instrument to comply with IT standards, all without any unexpected software update costs. Note however, that some very old instruments may not be supported by the most current MassHunter revisions.

Activating the SMA

Agilent's SubscribeNet portal is a web based service which provides registered software users 24x7 access for software and SMA license management.

Registering your ICP-MS MassHunter software in Agilent's SubscribeNet web portal automatically activates the 1-year SMA. Registration is quick & easy:

1. Locate the authorization code in your ICP-MS software package:



2. Save the authorization code for future reference (see Figure 1)
3. Follow the directions contained in the ICP-MS software package or visit the Agilent SubscribeNet portal:
<https://agilent.subscribenet.com>
4. If you are already a registered Agilent SubscribeNet user, simply log into your account.
5. If you are not a registered Agilent SubscribeNet user, click on the New User link at the bottom of the login page.
6. Once you have logged into your Agilent SubscribeNet account, select the "Register Software" tab on the side menu.
7. Enter your authorization code.

Your Agilent ICP-MS MassHunter software is now registered and your SMA is active.

If you purchased ICP-MS MassHunter software and have not completed the software registration process, it is never too late to do so. If you cannot locate your software registration authorization code and you have not registered the software, you may obtain a replacement code by contacting your local Agilent representative.

Stay Up-To-Date for Maximum Productivity

When you register your ICP-MS MassHunter software, the SMA is



Figure 1. Keep your authorization code safe – peel the label off the product packaging and place it on the Software Entitlement Certificate supplied with your instrument/software

activated and ICP-MS MassHunter software updates and upgrades are immediately available via download or media request. Both services are absolutely free to owners of current SMAs. All software users who are registered in SubscribeNet may also elect to receive automatic email notifications regarding new software version availability, bug fixes and security updates, as well as SMA contract expiration and renewal information. Maintaining your ICP-MS software on the latest version provides access to new software features as they become available and maintains maximum software and instrument efficiency.

Access to Agilent Software Experts

An Agilent SMA provides ICP-MS MassHunter software users access to unlimited telephone based software support. The service provides access to MassHunter software experts who can quickly answer software related questions. Expert help reduces support calls, reduces instrument downtime, helps users learn how to use the ICP-MS MassHunter software to its greatest advantage, keeps the system running at peak efficiency, and allows the software users to focus on analytical results.

Agilent ICP-MS MassHunter Goes “Open Platform” with Agilent Software Developer’s Kit (SDK)

Agilent strives to develop, design and manufacture the world’s best ICP-MS instruments. The wide range of our customers’ applications means that some require special sample introduction devices that may not be directly available from Agilent. These include laser ablation systems, specialized autosamplers, process monitoring systems, VPD scanners etc.

Historically, these devices could be used with Agilent ICP-MS instruments, but would require some level of customization and frequently two, independently operating software packages.

Our goal is to facilitate simple, seamless integration of high quality, high demand third party sample introduction systems into ICP-MS MassHunter, eliminating the need for compromised solutions.

To this end, ICP-MS MassHunter revision 4.1 and later have been created as “open platform” software, which allows third party developers to fully integrate their device control into MassHunter in the same way that Agilent peripherals are integrated. To support this, we have created a Software Developer’s Kit (SDK), designed to guide third party developers through the process of creating MassHunter plug-ins for their devices.

We have also dedicated support resources to help with the process of development and testing new integrated device plug-ins. In order to insure that integrated devices meet Agilent’s strict quality standards, we carefully review all proposals from third party manufacturers and license only those products we feel will meet our customers’ needs with well designed, well manufactured hardware and software solutions.

To date, we have licensed seven companies to develop MassHunter plug-ins for their devices and progress is encouraging. As new devices become available and are in high demand, we will continue to support making these available to our users.

This information is subject to change without notice.

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Printed in the U.S.A. May 13, 2016
5991-6885EN



Conferences. Meetings. Seminars.

The 8th Nordic Conference on Plasma Spectrochemistry, June 5-8, Loen, Norway, www.nordicplasma.com
ASMS, June 5-9, San Antonio, TX, US, www.asms.org/
Goldschmidt, June 26–1 July, Yokohama, Kanagawa, Japan, <http://goldschmidt.info/2016/>
Interphex, June 29-1 July, Tokyo, Japan, www.interphex.jp/en/home/
BNASS 2016, The 18th Biennial National Atomic Spectroscopy Symposium, July 4-6, Liverpool, UK, www.rsc.org/events/
32nd International Conference on Environmental Geochemistry and Health, July 4-8, Brussels, Belgium, <http://segh-brussels.sciencesconf.org/>
13th European Workshop on Laser Ablation, July 12-15, Ljubljana, Slovenia, <http://ewla2016.ki.si/>
68th American Association for Clinical Chemistry, July 31-August 4, Philadelphia, PA, USA, www.aacc.org/
252nd American Chemical Society National Meeting, August 21-25, Philadelphia, PA, USA, www.acs.org
JASIS 2016, Sept 7-9, Makuhari Messe International Exhibition Hall, Chiba, Japan, www.jasis.jp/en/
TraceSpec 2016, Sept 4-7, Gdansk, Poland, www.chem.pg.edu.pl/tracespec
34th National MS Conference of China, Sept 9-13, Xining, China www.cmss.org.cn/?action=viewevent&nid=207
Ilmac 2016, Sept 20-23, Basel, Switzerland, www.ilmac.ch/en-US.aspx

Agilent ICP-MS Publications

To view and download the latest ICP-MS literature, go to www.agilent.com/chem/icpms

- **Application note:** Accurate analysis of neptunium 237 in a uranium matrix, using the exceptional abundance sensitivity provided by MS/MS on the Agilent 8800 ICP-QQQ 5991-6905EN
- **Application note:** Resolution of ¹⁷⁶Yb and ¹⁷⁶Lu interferences on ¹⁷⁶Hf to enable accurate ¹⁷⁶Hf/¹⁷⁷Hf isotope ratio analysis using an Agilent 8800 ICP-QQQ with MS/MS, 5991-6787EN

Agilent ICP-MS Journal Editor

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