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8900 ICP-QQQ Applications



Agilent Technologies

Determination of Ultra Trace Elements in High Purity Sulfuric Acid and Hydrogen Peroxide using ICP-QQQ

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Manufacturers of semiconductor devices strive to reduce contamination within the manufacturing process, as particle, metallic, or organic contaminants degrade the quality and reliability of the final product. Organic materials, such as photoresist polymer patterns, must be thoroughly removed from the surface of the silicon wafer following ion implantation; this cleaning step is performed using a mixture of sulfuric acid (H_2SO_4) and hydrogen peroxide (H_2O_2). Ensuring a low level of metal impurities in these chemicals is vital to ensure that contamination of the wafer surface is avoided at this critical stage.

Why ICP-QQQ?

The semiconductor industry standard method for monitoring trace element contaminants is ICP-MS, but the drive for ever-smaller device architectures and improved device performance has led to demands to monitor a greater number of contaminant elements at lower concentrations. Current industry requirements therefore require analytical methods capable of achieving single- or sub-ng/L (ppt) level background equivalent concentrations (BECs) for a wide range of trace elements. Compared to conventional quadrupole ICP-MS, ICP-QQQ offers a more reliable and consistent approach to resolving spectral interferences, since ICP-QQQ has an additional quadrupole mass filter (Q1) in front of the collision/reaction cell (CRC). This tandem mass spectrometer layout enables ICP-QQQ to operate in MS/MS mode. Q1 controls the ions that can enter the cell, ensuring that the reaction processes in the cell are consistent, and thereby minimizing the risk of non-target product ions being formed from the matrix elements or other analyte ions. This control of reaction processes not only ensures more consistent results, but also

allows the use of highly reactive cell gases, without the risk of creating inter-element product ion overlaps.

For example, using MS/MS, Ti can be analyzed in a sulfur matrix using NH_3 reaction gas mode by measuring a suitable ammonia cluster product ion that is free from the matrix-based SO^+ polyatomic ion interference. Also, the new axial acceleration technology of the 8900 ICP-QQQ ORS⁴ cell raises the energy of cell-formed product ions, increasing sensitivity for the Ti/ NH_3 cluster ions.

In this article, we illustrate two extreme semiconductor applications: a) The analysis of sub-ppt level trace elements in a very difficult matrix, sulfuric acid; b) The measurement of ultra-trace level contaminants in a high-purity “clean” reagent, hydrogen peroxide.

Experimental

A standard Agilent 8900 ICP-QQQ #200 Semiconductor configuration instrument was used. The 8900 #200 is fitted with a PFA-100 nebulizer, Peltier cooled quartz spray chamber, quartz torch, platinum-tipped sampling and skimmer cones, and s-lens. The nebulizer was operated in self-aspiration mode to minimize the potential for sample contamination from peristaltic pump tubing.

In advanced semiconductor applications, the key requirement is to achieve the absolute lowest possible detection limit for every analyte. To achieve this, laboratories measuring ultra-trace levels of contaminants can use a multi-tune method, where several tuning steps are applied sequentially during the measurement of each solution. This approach allows the tuning conditions to be optimized for the removal of different types of interferences, while maintaining maximum sensitivity for the analytes.

In this work, several cell gases were used (He, H_2 , O_2 and NH_3) as appropriate for the large number of analytes: 42 analytes were measured in H_2SO_4 and 52 elements (including the 23 listed in SEMI C30-1110 Grade 5 specifications [1]) were determined in H_2O_2 . Cool plasma conditions were applied for the elements where this mode provides the lowest BECs. Tuning and acquisition parameters are provided in the respective application notes [2, 3].

H_2SO_4 Sample Preparation and Results

High purity 98% H_2SO_4 (TAMA Chemicals Co. Ltd. Japan) was diluted ten-fold with UPW. Multi-element standard solutions were prepared from XSTC-331, XSTC-7, XSTC-8 (SPEX CertiPrep, USA) and a Si single element standard (Kanto Chemical Co., Inc., Japan).

As is typical for high-purity semiconductor samples, calibration for both chemicals was by the Method of Standard Additions (MSA). Representative standard addition calibration curves in 9.8% H_2SO_4 are shown in Figure 1. Good linearity was observed for all analytes ($R > 0.9995$), and sub-ppt detection limits were achieved for all elements apart from Si (44 ppt), P (3 ppt), and Zn (1.5 ppt). The quantitative results of the analysis of 9.8% H_2SO_4 are shown in Table 1. The DLs were determined from 10x replicate measurements of the blank 9.8% H_2SO_4 . Recoveries and RSDs were determined from 10 replicate measurements of a 20 ng/L spiked solution of 9.8% H_2SO_4 . Excellent performance was achieved for all elements, including Ti, V and Zn, indicating the effective suppression of S-based matrix interferences.

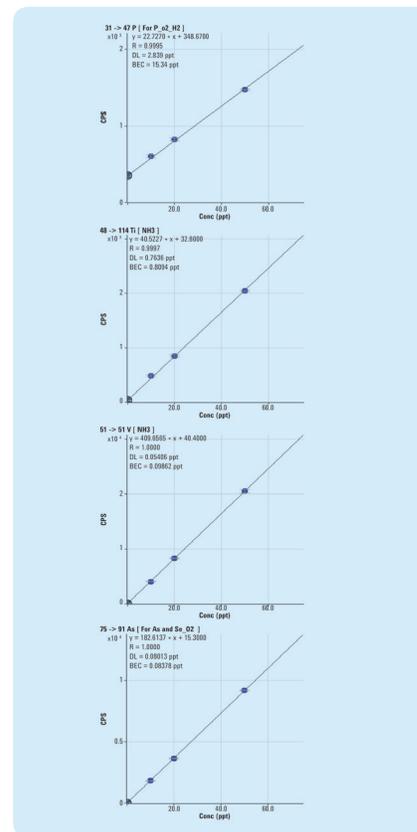


Figure 1. Calibration curves of P, Ti, V and As in 9.8% H_2SO_4

Table 1. Quantitative results for 42 elements in 9.8% H₂SO₄

Analyte	DL (ppt)	BEC (ppt)	Analyte	DL (ppt)	BEC (ppt)
Li	0.13	0.13	Rb	0.12	0.03
Na	0.37	0.73	Sr	0.02	0.004
Mg	0.15	0.05	Zr	0.03	0.005
Al	0.18	0.09	Nb	0.03	0.05
Si	44	480	Mo	0.19	0.12
P	2.8	15	Ru	0.19	0.10
K	0.36	0.66	Pd	0.04	0.004
Ca	0.57	0.18	Ag	0.16	0.15
Ti	0.76	0.81	Cd	0.16	0.04
V	0.05	0.10	In	0.02	0.008
Cr	0.51	0.37	Sn	0.35	0.33
Mn	0.16	0.11	Sb	0.09	0.03
Fe	0.40	0.28	Cs	0.10	0.17
Ni	0.12	0.02	Ba	0.03	0.007
Co	0.23	0.03	Ta	0.26	0.42
Cu	0.57	0.58	W	0.28	0.07
Zn	1.5	1.8	Au	0.41	0.30
Ga	0.08	0.01	Tl	0.09	0.07
Ge	0.40	0.24	Pb	0.56	0.93
As	0.08	0.08	Bi	0.03	0.004
Se	0.14	0.22	U	0.02	0.003

H₂O₂ Sample Preparation and Results

TAMAPURE-AA-10 hydrogen peroxide (35%) was used as the sample matrix. To stabilize the spiked elements, ultrapure nitric acid (TAMAPURE-AA-10) was added to the H₂O₂ samples at 1 part of 70% HNO₃ to 1000, giving a final acid concentration of 0.07%. A mixed multi-element standard solution (SPEX CertiPrep, NJ, US) was prepared and spiked into the blank H₂O₂ matrix at 10, 20, 30, 40 and 50 ppt to create the standard addition calibration solutions. Solutions were prepared just before the analysis.

Quantitative results and detection limits for the SEMI elements measured in H₂O₂ are shown in Table 2, including S and P. For the results of elements that are not specified in the SEMI standard, see reference 3. Each detection limit was calculated as 3-sigma of 10 replicate measurements of a blank H₂O₂ sample. Reproducibility between 1.0 – 8.1% RSD was obtained at the 10 ppt level (100 ppt for S) for the spiked analytes, for a high purity 35% H₂O₂ sample analysis sequence lasting 3 hours 40 minutes [3].

Conclusions

Using the Agilent 8900 ICP-QQQ, sub-ppt level DLs and BECs were obtained for 39 analytes in 9.8% H₂SO₄, demonstrating the effective removal of matrix-based interferences on many analytes. All 23 elements specified in SEMI C30-1110 were measured at sub-ppt to ppt levels in high purity 35% H₂O₂, including P, and S. For almost all elements, sub ppt quantitative results were obtained, with the remaining elements (except Si) having single-ppt detection limits.

The results demonstrate the suitability of the Agilent 8900 Semiconductor configuration ICP-QQQ instrument for routine analysis of the highest-purity semiconductor reagents and process chemicals.

Table 2. Quantification of trace elements and stability test results for SEMI specification elements in high purity 35% H₂O₂

	Conc. (ppt)	DL (ppt)	Stability ¹ RSD (%)
Li	< DL	0.003	4.7
B	7.7	0.69	8.1
Na	0.39	0.031	3.3
Mg	0.017	0.017	4.1
Al	0.39	0.071	2.9
P	4.2	0.89	3.3
S	190	5.1	7.8
K	0.21	0.11	2.2
Ca	< DL	0.23	1.9
Ti	0.097	0.045	2.6
V	0.067	0.027	2.6
Cr	0.13	0.075	3.5
Mn	< DL	0.012	2.7
Fe	0.13	0.074	3.3
Ni	0.16	0.14	3.7
Cu	< DL	0.048	5.0
Zn	0.22	0.14	4.5
As	< DL	0.087	3.5
Cd	< DL	0.020	2.3
Sn	0.088	0.063	2.0
Sb	< DL	0.015	1.6
Ba	0.061	0.033	1.2
Pb	0.081	0.053	1.0

SEMI C30-1110 Grade 5, maximum concentration of listed elements: 10 ppt

¹Analyte elements were spiked at 10 ppt except sulfur, which was spiked at 100 ppt.

References

1. SEMI C30-1110, Specifications for hydrogen peroxide (2010)
2. Determination of trace elements in ultrapure semiconductor grade sulfuric acid using the Agilent 8900 ICP-QQQ in MS/MS mode, 2016, [5991-7008EN](#)
3. Determination of ultra trace elements in high purity hydrogen peroxide with Agilent 8900 ICP-QQQ, 2016, [5991-7701EN](#)

Sulfur Isotope Ratio Analysis in Mineral Waters using ICP-QQQ

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The relative abundance of the two major stable isotopes of sulfur, ^{32}S (94.99% abundance) and ^{34}S (4.25%), varies significantly in nature, so the $^{34}\text{S}/^{32}\text{S}$ ratio can be used to characterize a sample. In sulfur stable isotope analysis, the variation in the $^{34}\text{S}/^{32}\text{S}$ isotope ratio is calculated and reported as a deviation or delta (δ) in ^{34}S abundance relative to a standard material, the troilite (iron sulfide) mineral from the Canyon Diablo meteorite, referred to as δVCDT (Vienna Canyon Diablo Troilite). Natural variations in ^{34}S abundance, expressed in parts per thousand or “per mil” (‰), can be of the order of -50‰ to +40‰ (and occasionally much greater), due to redox reaction.

Sulfur isotope ratio (IR) analysis has been mostly done by gas phase isotope ratio mass spectrometry (IRMS) but the recent development of triple quadrupole ICP-MS (ICP-QQQ) has vastly improved the ability to measure sulfur accurately at low levels using ICP-MS.

Experimental

Instrumentation

An Agilent 8900 ICP-QQQ (#100, Advanced Applications configuration) equipped with the standard Ni cones and x-lens was used. The standard glass concentric nebulizer was replaced with a PFA nebulizer, run using self-aspiration for better signal precision.

Method and cell tuning

All of the isotopes of sulfur are affected by O_2^+ polyatomic interferences, with $^{16}\text{O}_2^+$ on $^{32}\text{S}^+$ being the most intense. The O_2^+ interferences can be resolved by operating the ICP-QQQ in MS/MS mass-shift mode with O_2 cell gas. In this mode, the S^+ ions are converted to SO^+ product ions and shifted +16 amu, avoiding the O_2^+ overlaps, which remain at their original mass. This allows the two sulfur isotopes of interest to be measured accurately at low levels, and potentially offers a faster and simpler S isotope analysis technique.

The same mass-shift mode can be used on a conventional quadrupole ICP-MS (ICP-QMS), but this configuration of instrument does not have a mass filter before the cell, so cannot control inter-isotope product ion overlaps, such as $^{32}\text{S}^{18}\text{O}^+$ on $^{34}\text{S}^{16}\text{O}^+$ at mass 50. This makes accurate S isotope analysis impossible on ICP-QMS.

The acquisition method used a 1 second integration time for ^{32}S and 5 seconds for ^{34}S . Each sample measurement consisted of 10 replicates, each of 1000 sweeps. Tuning conditions are summarized in Table 1.

Table 1. ICP-QQQ tuning and method conditions

	Tuning parameter	Value
Plasma	RF power (W)	1550
	Sampling depth (mm)	8.0
	Nebulizer gas flow rate (L/min)	0.90
	Make up gas flow rate (L/min)	0.30
Lens	Extract 1 (V)	-80
	Extract 2 (V)	-150
	Omega (V)	10.0
	Omega bias (V)	-120
Cell	Octp Bias (V)	-5
	Axial Acceleration (V)	2.0
	KED (V)	-8.0
	Cell gas	O_2
	Cell gas flow rate (mL/min)	0.45

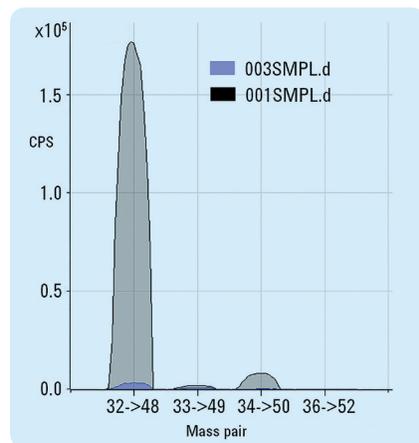


Figure 1. MS/MS spectrum of 10 ppb sulfur solution (grey) and blank (blue)

Reagents and sample preparation

Sulfur isotope certified reference materials IAEA-S1 ($\delta^{34}\text{S}_{\text{VCDT}} = -0.3\text{‰}$) and IAEA-S2 ($\delta^{34}\text{S}_{\text{VCDT}} = +22.7\text{‰}$) were purchased from NIST, Gaithersburg, USA. Each CRM was gently dissolved in dilute nitric acid to give the appropriate concentration. A matrix blank was prepared with

50 ppm Ca (SPEX Certiprep, US) and 100 ppm NaCl (Wako Pure Chemical Industries Ltd, Japan) in 1% nitric acid (Tama Pure 100: Tama Chemicals Co. Ltd, Japan). This solution was also used to dilute the standards and samples, and as a second, re-equilibration rinse.

Mass-bias correction, matrix effects and background control

Instrumental mass-bias was corrected using sample-standard bracketing. A 0.5 mg/L standard solution of known S isotope composition (IAEA-S-1) was measured before and after each sample, and the sample IR was corrected by the average IR of the two standard measurements.

To minimize the effect of the mineral waters' variable sample matrix, the mass bias standard and mineral water samples were diluted using a solution which contained 50 mg/L calcium (Ca) and 100 mg/L sodium chloride (NaCl). Use of this diluent reduced the variation in mass bias that could otherwise have been caused by the wide variation in the matrix level of the samples. The S concentration of the matrix blank was around 0.7 ppb which was below the level that could have affected the accuracy of the IR analysis.

Results and Discussion

Water sample analysis

Three different brands of mineral water were purchased at a local store in Tokyo, Japan. The mineral water samples were prepared for analysis, together with samples of JSAC 0301, a Japanese river water CRM (from the Japan Society for Analytical Chemistry); a spring water collected from the IKAHO hot spring in the north of Japan; NASS 5 seawater CRM (National Research Council, Canada); and Tama Pure-AA 100 high purity sulfuric acid (Tama Chemicals Co., Ltd.). The dilution factors applied to the samples are given in Table 2.

Table 2. Dilution factors

Sample	Dilution factor
Mineral water A	10
Mineral water B	10
Mineral water C	1000
JSAC 0301: Japanese river water CRM	10
IKAHO hot spring water	1000
NASS 5	2000
High purity sulfuric acid	50000

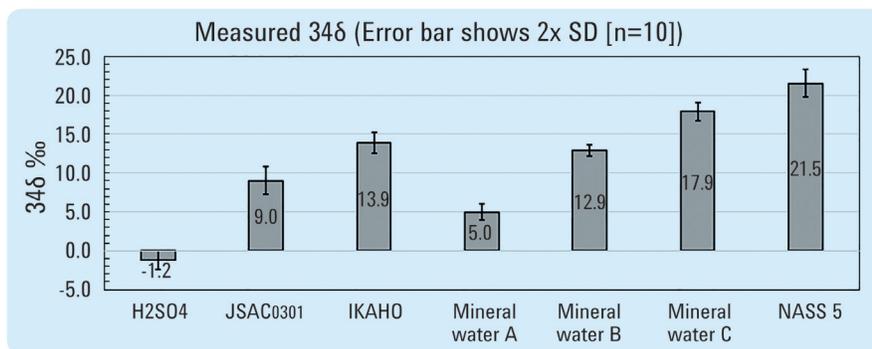


Figure 2. Measured sulfur IR for sulfuric acid, river water CRM, spring water, 3 commercial mineral waters (brands A, B and C) and seawater CRM

Each sample was measured 10 times and the average and the standard deviation were calculated. Figure 2 shows the average IR and the error (as two times standard deviation) of the IR for each sample.

The results show a clear difference in the S IRs for all of the samples, including between the 3 brands of mineral water. The $\delta^{34}\text{S}$ value of +21.5‰ determined in the seawater reference material agrees well with the global average oceanic seawater value of +21‰ for seawater sulfate per Table 3 [1].

Table 3. Sulfur isotope distribution in nature

Source	$\delta^{34}\text{S}$ (‰) relative to VCDT
Igneous rocks	0
Sedimentary rocks	-40 to +40
Seawater SO_4	+21
Atmospheric SO_4	-30 to +30
Surface water/groundwater SO_4	-22 to +135
Soil (organic sulfur)	-30 to +30
Vegetation (organic sulfur)	-34 to +32
Animals (organic sulfur)	-10 to +22
Fossil fuels (organic sulfur)	-11 to +28

Conclusions

The Agilent 8900 Advanced Applications configuration ICP-QQQ is ideally suited to $^{34}\text{S}/^{32}\text{S}$ isotope ratio analysis, which can provide valuable information for sample characterization in natural systems or to monitor anthropogenic impact.

The 8900 ICP-QQQ provides a low background and high sensitivity for sulfur, which enabled us to develop a new method that simply required the sample to be diluted with the matrix blank before analysis. Sample/standard bracketing was used to correct for any instrumental mass-bias or drift.

The new, fast, ICP-QQQ method for sulfur isotope analysis could be useful in identifying the natural characteristics of a water-source, monitoring seasonal and biogeochemical variations, and also for determining the impact of man-made sources of sulfur on the environment.

References

1. R. Tostevin, A. V. Turchyn, J. Farquhar, D. T. Johnston, D. L. Eldridge, J. K. B. Bishop and M. McIlvin, 2014, *Earth and Planetary Science Letters*, 396, 14-21

More Information

Sulfur isotope fractionation analysis in mineral waters using an Agilent 8900 ICP-QQQ, Agilent publication, 2016, [5991-7285EN](https://www.agilent.com/en-us/video/bristol-petrov)

Environmental Inorganic Speciation Analysis Testimonial



Watch Dr. Panayot Petrov, a science leader in inorganic speciation analysis from LGC, Teddington, UK give a testimonial about how Agilent LC, GC, Single Quadrupole and Triple Quadrupole ICP-MS helps his lab with speciation analysis in food and water, as well as nanoparticle characterization.

Learn how the latest techniques available to environmental scientists are used to achieve extremely low limits of quantification for dangerous and toxic elements which would otherwise go undetected by standard analytical techniques.

www.agilent.com/en-us/video/bristol-petrov

Analysis of TiO₂ Nanoparticles using Single Particle-ICP-QQQ

Michiko Yamanaka and Steve Wilbur

Agilent Technologies

Titanium dioxide (TiO₂) particles are widely used in a range of products including paints, colorants for foods, cosmetics, pharmaceuticals, and photocatalysts. In many cases, the desired properties of the TiO₂ product depend on the particles being nanoscale – between 1 and 100 nm. This is a matter of concern since NPs are small enough to be absorbed through membranes, so there may be a risk to organisms and environmental systems. However, at this stage, much remains unknown, and the impact of NPs to the long-term health of mammals and marine life is not well understood. A rapid, accurate, sensitive technique for characterizing and quantifying smaller TiO₂ NPs is necessary to aid research in this area.

Single Particle ICP-MS

Single particle (sp-)ICP-MS uses a standard, liquid sample introduction system and time resolved analysis (TRA) method. If the sample is sufficiently dilute, each nanoparticle passes through the plasma individually, giving a distinct transient signal. Particle concentration, particle size (diameter), size distribution and composition can be obtained.

High sensitivity is critical for the detection of small particles, because the mass of a (spherical) particle is proportional to the diameter cubed. If the diameter of a particle is reduced by half, the mass, and therefore the signal, is reduced by 8x. Low background is also critical because NP detection limits are defined as a multiple of the signal to noise. Small peaks can be lost in the noise.

Ti is a difficult element to measure at trace levels by conventional quadrupole ICP-MS (ICP-QMS), due to polyatomic overlaps in matrices that contain P, S, Si and C. Also, ⁴⁸Ti (74% abundance) cannot be measured reliably by ICP-QMS, due to an isobaric interference from ⁴⁸Ca, whereas ICP-QQQ with MS/MS can resolve isobaric interferences, as explained in Figure 1.

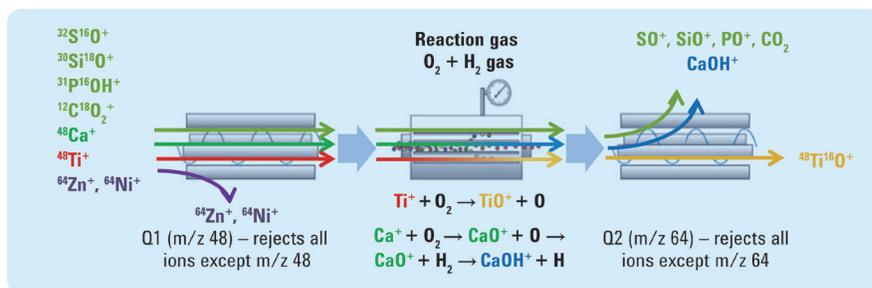


Figure 1. Q1 allows only ions at *m/z* 48 to pass to the cell – all other ions are rejected. ⁴⁸Ti⁺ is converted to ⁴⁸Ti¹⁶O⁺ in the cell with O₂/H₂ reaction gas. Q2 measures TiO⁺ at *m/z* 64. ⁴⁸Ca⁺ reacts to form CaOH⁺ at *m/z* 65, so does not interfere with TiO⁺ at *m/z* 64

Experimental

Reference Materials and Samples

Anatase (one of the common mineral forms of TiO₂) was used as a reference material (US Research Nanomaterials, Inc). Sunscreen was purchased from a local store in Tokyo, Japan.

Sample Preparation

Intermediate TiO₂ standards were diluted with 1% Triton X-100. Working solutions were diluted with DI water, tap water or matrix mixture including 100 ppm P, 100 ppm S, 50 ppm Ca, 50 ppm Si and 0.1% ethanol.

Instrumentation

An Agilent 8900 ICP-QQQ equipped with a standard quartz sample introduction system was used in MS/MS mass-shift mode with O₂ reaction gas.

Table 1. ICP-QQQ operating parameters

Parameter	Setting
RF power	1600 W
Reaction gases and flow rates	O ₂ 0.1 mL/min + H ₂ 5 mL/min
Q1/Q2 mass	48/64
Dwell time	0.1 ms

Results

A size distribution plot for Anatase is shown in Figure 2. The mean size of 36 nm agrees with the nominal reference value of 30-50 nm.

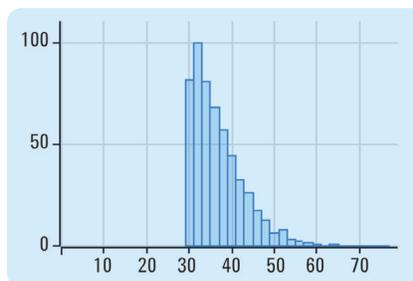


Figure 2. Size distribution plot for Anatase reference material

TiO₂ Matrix Samples

Size distribution plots for samples

containing sunscreen (Figure 3) show consistent particle size distribution, despite the variable matrices.

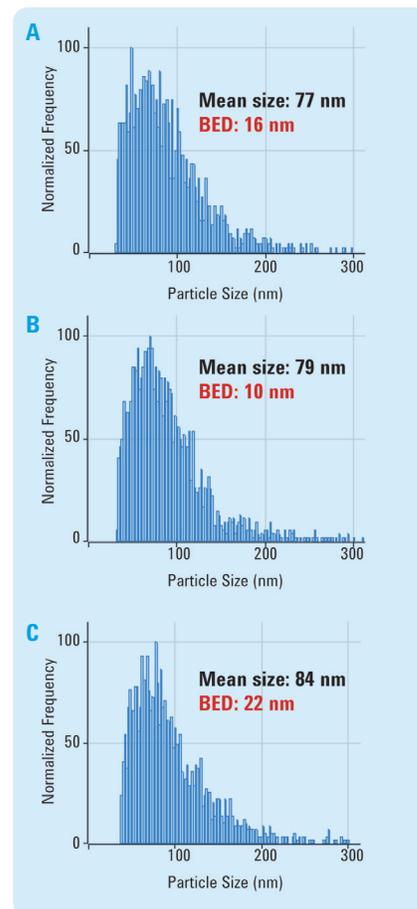


Figure 3. Size distribution plots and background equivalent diameter (BED) for sunscreen in A: DI water; B: Tap water; C: Matrix mixture (100 ppm S & P, 50 ppm Ca & Si, 0.1% ethanol).

Conclusions

The sp-ICP-QQQ method delivers high sensitivity for the determination of Ti and provides quick and accurate results for TiO₂ particles smaller than 100 nm. The MS/MS function effectively eliminates all polyatomic and isobaric interferences on Ti, so the particle size distribution can be measured consistently, even in complex matrices.

Spain Hosts the First European Agilent ICP-QQQ Workshop and Conference

Isabel Cuesta

Agilent Technologies, Spain

Introduction

More than 60 delegates from 13 European countries, plus Australia and South Africa, met in Barcelona in early October to discuss all matters relating to ICP-QQQ.

The meeting started with a Tips and Tricks Workshop where users of Agilent's 8800 and 8900 ICP-QQQ shared their experiences of operating the instruments on a daily basis. The session developed into an interesting and informative discussion of how ICP-QQQ technology was enabling users to surpass the analytical limits of what was possible using ICP-MS prior to ICP-QQQ. This theme was developed in greater detail in the scientific program that followed.

Over the 2-day meeting, 16 topics were presented covering a wide range of applications including foods, semiconductor, nuclear, pharmaceuticals, geochemistry and nanomaterials.

Topics included the detection of emerging contaminants in our rivers and seas; faster and more accurate monitoring of nuclear contaminants; detection of nanoparticles and toxic element species in food; studies of geochronology and low-level volcanogenic sulfur records from ice cores and stalagmites using laser ablation-ICP-QQQ; and investigation into the interaction of nanoparticles with natural environmental and biological systems.

Dr. Philippe De Raeve, Quality Assistance, Belgium, explained how it is now possible to perform absolute quantification of protein concentrations using an ICP-QQQ method and that the method is the subject of on-going discussion with the European Directorate for the Quality of Medicines to add to Chapter 2.5.33 (Total Proteins).



The beginnings of an ICP-QQQ community as attendees meet to share ideas and experiences at Agilent's first European ICP-QQQ User Group Meeting

From Cutting Edge Research to Routine Applications

Some speakers highlighted how ICP-QQQ is supporting the competitiveness of their business as a routine tool. For many contract laboratories, their Agilent ICP-QQQ has become a go-to instrument, as the simple methodology – eliminating the need for sample preparation in many cases – can allow them to reduce the time of analysis from days to minutes, significantly cutting operating costs. A speaker from one commercial lab in Norway reported that their ICP-QQQ is the workhorse for the analysis of geological samples with very complex matrices. Currently they do not use any other atomic spectroscopy instrumentation for the analysis of these samples, as it is no longer needed.

Another attendee from a contract lab in the UK said that they can now do more business with ICP-QQQ, as the whole analysis is so much faster and easier.

Securing Grants

Delegates from many of the universities and academic institutions present at the meeting reported that having an ICP-QQQ in their facility has had a positive impact on their ability to secure funding: "ICP-QQQ allows me to get more revenue as I can do things I couldn't do before. I definitely get more grant funding now".

Future Events

Feedback to the event was overwhelmingly positive, with attendees enjoying the open and supportive atmosphere of the meeting. Dr. Lieve Balcaen, Ghent University, Belgium, summed up the event nicely by saying: "It was an interesting meeting, both from a scientific and social point of view. Nice results were presented, but most importantly, I had the feeling that there was a good atmosphere, allowing for open conversations among users and Agilent representatives. I think all parties benefit from this type of event."

Building on this success, Agilent's European team is planning to hold an ICP-QQQ User Group Meeting and Conference once every two years.

More Information

If you would like more details on the range of topics discussed at the ICP-QQQ Conference, as well as information on future User Meetings, please contact your local Agilent ICP-MS Product Specialist or visit www.agilent.com/chem/icpms

Recorded webcast: ICP-MS/MS: Much More Than A High Performance Quadrupole ICP-MS

Since the commercial introduction of ICP-MS instruments in the 1980s, the occurrence of spectral interferences has been one of the major limitations of the technique. However, over the years, increasingly powerful and versatile means to overcome spectral overlaps have been developed.

In 2012, the first commercially available triple quadrupole ICP-MS (ICP-QQQ) was introduced. The tandem mass spectrometer configuration provides much better control over the ion-molecule reactions taking place in the collision/reaction cell, and opens a new way of dealing with interferences in ICP-MS by monitoring higher-mass reaction product ions that would be subject to overlap in quadrupole ICP-MS. In general, ICP-MS/MS offers improved possibilities for method development, enhanced detection limits and more accurate results for complex samples.

Did you miss the web seminar, first broadcast on November 29?

You can watch it now and hear from Frank Vanhaecke, PhD, Senior Full Professor in Analytical Chemistry at Ghent University (Belgium) who discusses the benefits of ICP-QQQ for a variety of applications:

- Determination of S in organic matrices
- Determination of Ti in body fluids
- Multi-element ultra-trace metal determination in biofluids
- Determination of As and Se in diverse matrices
- Sr isotope ratio determination without prior Sr/Rb separation – with pneumatic nebulization and laser ablation as a means of sample introduction

Click on the “Webcasts” tab at www.spectroscopyonline.com and look for archived webcast: “ICP-MS/MS: Much More Than Just a High Performance Quadrupole ICP-MS”.

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You Are Invited to Celebrate 30 Years of Agilent ICP-MS at EWCPs 2017



Join Agilent – your trusted partner in Atomic Spectroscopy – at the European Winter Conference on Plasma Spectrochemistry (EWCPs) in Sankt Anton, Austria, February 19-24, 2017.

The 17th EWCPs marks a special anniversary for Agilent’s role in ICP-MS. Join us to celebrate 30 years of technological innovation and development in the field of ICP-MS, with scientific seminars, social events and other surprises!

Visit the Agilent booth to meet our team of atomic spectroscopy experts and complete your Agilent Tour. Other events include:

- Sunday Feb 19: Agilent Short Course
- Tuesday Feb 21: Agilent Workshop
- Thursday Feb 23: Agilent Social Event

Coming soon – stay tuned for more information on these activities. In the meantime, find out more about the conference and venue at:

<http://www.ewcps2017.at/>

Conferences. Meetings. Seminars.

The 6th Asia-Pacific Workshop on Laser-Ablation and Micro-analyses, Nov 29 to Dec 1, 2016, Wuhan, China, Email: cuglab@sina.cn

Agilent ICP-MS Publications

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

List of 8900 ICP-QQQ application notes:

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- Determination of trace elements in ultrapure semiconductor grade sulfuric acid using the Agilent 8900 ICP-QQQ in MS/MS mode, [5991-7008EN](#)
- Ultra-low level determination of phosphorus, sulfur, silicon and chlorine using the Agilent 8900 ICP-QQQ, [5991-6852EN](#)
- Sulfur isotope fractionation analysis in mineral waters using an Agilent 8900 ICP-QQQ, [5991-7285EN](#)
- Using ICP-QQQ for UO_2^+ product ion measurement to reduce uranium hydride ion interference and enable trace ^{236}U isotopic analysis, [5991-6553EN](#)
- High sensitivity analysis of SiO_2 nanoparticles using the Agilent 8900 ICP-QQQ in MS/MS mode, [5991-6596EN](#)
- Analysis of 10 nm gold nanoparticles using the high sensitivity of the Agilent 8900 ICP-QQQ, [5991-6944EN](#)
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- Updated: Simultaneous quantitation of peptides and phosphopeptides by capLC-ICP-MS using the Agilent 8800/8900 ICP-QQQ, [5991-1461EN](#)

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