

Meeting the demands of ICP-MS with Type I ultrapure water

Abstract

Inductively coupled plasma mass spectrometry (ICP-MS) is an extremely sensitive technique capable of multi-element analysis at concentrations below one ppt. The highest purity water is an essential requirement for ICP-MS, since the sensitivity of the technique makes it very prone to interference by trace contaminants.

Introduction

ICP-MS combines the high energy of an inductively coupled plasma with mass spectrometry to provide a highly sensitive technique capable of multi-element determination at part per trillion levels. Compared to flame atomic absorption spectroscopy and ICP-OES, ICP-MS offers much higher sensitivity, and can be used for a greater variety of applications, including isotopic speciation. The technique is used increasingly for medical and forensic analysis, in the environmental field¹, and for industrial and biological² monitoring.

To avoid inaccurate results, all reagents and solvents used for ICP-MS must be free of even trace amounts of the element under analysis, as well as any elements or compounds which could potentially interfere with the assay, making the use of the highest purity water^{3,4} essential for the preparation of samples, blanks and standards.

Ions

The key requirement for accurate ICP-MS analysis is ensuring virtually zero levels of the elements of interest. Any impurities can result in artificially high concentrations in samples, blanks and standards, causing increased errors and poor quantification. Higher levels of other ions can cause matrix effects, also affecting accuracy.

Organic compounds

Organic compounds can stick to nebulizer, tubing and spray chamber surfaces, resulting in poor reproducibility and the need for increased frequency of cleaning. Additionally, metals associated with organic moieties can cause elemental contamination.

Bacteria

Bacteria can release ions which may interfere with the analysis, and organic by-products can stick to the nebulizer surface. Bacteria may also behave as particulates, blocking the nebulizer and preventing efficient sample introduction, leading to increased signal noise and reduced sensitivity.

Particulates and colloids

Particulates and colloids may block the nebulizer and tubing, preventing efficient sample introduction into the system.

Purifying water for ICP-MS

ICP-MS analysis requires the use of Type I ultrapure water for the preparation of all reagents, standards, blanks and samples⁵. The exceptional sensitivity (ppt and sub-ppt, Table 1) of ICP-MS demands extremely stringent water purity. ELGA's PURELAB[®] Ultra Analytic or PURELAB flex systems are highly recommended for this application, typically offering Type I ultrapure water with resistivity of 18.2 MΩ.cm, low TOC values – less than 2 ppb and 5 ppb respectively – and bacteria levels below 0.1 CFU/ml (Ultra Analytic) and 1 CFU/ml (flex).

In producing purified water suitable for ICP-MS, the key requirements are passage through a reverse osmosis membrane and the highest purity ion exchange resins. Ultraviolet (UV) radiation will also reduce levels of organic contaminants and bacteria.

Reverse osmosis

The semi-permeable membranes used in reverse osmosis (RO) remove a very wide range of water contaminants. Typically they remove in excess of 95 % of ionic contamination, organic contamination with molecular weight typically over 200 and virtually all particulate contamination, including bacteria and viruses.

Media

The media cartridges in the PURELAB Ultra Analytic and PURELAB flex contain high purity synthetic, activated carbon beads, which adsorb a wide variety of organic compounds, and the highest purity ion exchange resins to minimise the release of impurities.

Filtration

Point-of-use filtration removes any particles, macromolecules and bacteria which may have been introduced during purification. ELGA's PURELAB flex combines high capacity purification cartridges to minimise particle release, with point-of-use filters for effective particle control.

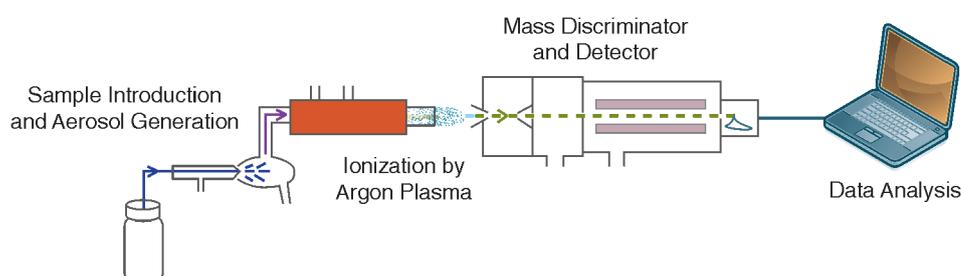


Diagram 1: Analysis of water from the PURELAB Ultra Analytic and PURELAB flex purification systems.

Element	Detection limit (µg/l)		Water from PURELAB Ultra Analytic (µg/l)	Water from PURELAB flex 3 (µg/l)
	ICP-OES	ICP-MS		
Aluminium	1	0.001	<0.001	<0.001
Arsenic	2	0.002	<0.002	<0.002
Boron	1	0.01	<0.01	<0.010
Calcium	0.05	0.002	<0.002	<0.002
Chromium	0.2	0.001	<0.001	<0.001
Iron	0.1	0.002	<0.002	<0.002
Lead	1	0.0002	<0.0002	<0.0002
Lithium	0.3	0.0002	<0.0002	<0.0002
Magnesium	0.04	0.001	<0.001	<0.001
Mercury	1	0.005	<0.005	<0.005
Molybdenum	0.5	0.0005	<0.0005	<0.0005
Nickel	0.5	0.002	<0.002	<0.002
Platinum	1	0.005	<0.005	<0.005
Silver	0.6	0.0005	<0.0005	<0.0005
Sodium	0.5	0.002	<0.002	<0.002
Strontium	0.05	0.0002	<0.0002	<0.0002
Tin	2	0.0005	<0.0005	<0.0005
Uranium	10	0.002	<0.002	<0.002

Table 1: Comparison of the detection limits of ICP-OES and ICP-MS with the levels of elemental impurities detected in water from ELGA's PURELAB Ultra Analytic and PURELAB flex purification systems. Analysis of water from the PURELAB Ultra Analytic and PURELAB flex purification systems demonstrates results meeting the demands of ICP-MS.

Conclusion

Freedom from trace contaminants is the key to accurate and reproducible ICP-MS results. Ultrapure water with high resistivity (18.2 MΩ.cm) and free from particulates, bacteria, organic and ionic compounds, should be used for all ICP-MS applications, to meet the demands of the technique's exceptional sensitivity.

To find out more about ELGA LabWater's water treatment technologies and solutions for analytical applications, visit www.elgalabwater.com

References

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5. ASTM Standard Guide for Bio-applications Grade Water D 5196-06.

About ELGA LabWater

ELGA LabWater manufactures supplies and services laboratory, healthcare and clinical water purification systems. ELGA offices and distributors are located in more than 60 countries worldwide. ELGA is the global laboratory water brand name of Veolia Water Solutions & Technologies.

ELGA is an integral part of Veolia Water Solutions and Technologies. Veolia Water Solutions & Technologies (VWS), subsidiary of Veolia Water, is a leading design & build company and a specialized provider of technological solutions in water treatment. With over 9,500 employees in 57 countries, Veolia Water Solutions & Technologies recorded revenue of €2.15 billion Euros in 2010.

Veolia Water, the water division of Veolia Environment, is the world leader in water and wastewater services. Specialized in outsourcing services for municipal authorities, as well as industrial and service companies, Veolia Water provides water service to 95 million people and wastewater service to 66 million. With 96,260 employees in 66 countries, its 2010 revenue amounted to €12.1 billion.