BNASS 2026: The 22nd Biennial National Atomic Spectroscopy Symposium
1st-3rd July 2026
Cutlers' Hall, Sheffield

BNASS is the flagship meeting for the Atomic Spectroscopy Group of the Analytical Community, Royal Society of Chemistry

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Welcome!

On behalf of the Organising Committee for the 22nd Biennial National Atomic Spectroscopy Symposium (BNASS) and the Atomic Spectroscopy Group (ASG), we would like to welcome you all and thank you for your contributions and participation!

The philosophy of BNASS is to encourage the exchange of ideas and knowledge within analytical atomic spectroscopy field with a mix of established and early career speakers. BNASS is celebrating its 22nd event and during its history, there have been some tremendous changes in atomic spectroscopy. These advances have been showcased at BNASS, which has built an international reputation for both the quality of the science presented and the unique style of the symposium, enabling delegates to meet and discuss issues in a social setting.

This year, we find ourselves returning to Sheffield, the city which hosted the first BNASS and several after. The event venue is Cutlers' Hall, in the heart of the city. The Cutlers' Company was established by a Parliamentary Act of Incorporation in 1624 and for four hundred years has sought to maintain the standards and quality of Sheffield manufactured cutlery and steel products. The current Grade II listed Cutlers' Hall, the third on this site, was constructed in 1832 and is renowned as one of the finest livery halls in northern England.

Please enjoy BNASS 2026. We hope that you take full advantage of the networking opportunities with the speakers, attendees and exhibitors. As chair, I would like to thank the organising committee and ASG for their support and dedication.

Organising Committee

ASG Chair: Dr Sarah Hill, National Measurement Laboratory, LGC
Treasurer: Dr Jackie Morton, Biological Monitoring, Health & Safety Executive
Programme Coordinator: Dr Shaun Lancaster, University of Leoben, and Dr Rebekah Moore, Imperial College London
ASG Secretary: Dr Rebekah Moore, Imperial College London
ASG Committee: Dr Adam Laycock (UK Health Security Agency), Prof Steve Hill (University of Plymouth), Alan Cross (Thames Water)

Social events

Wednesday Evening:

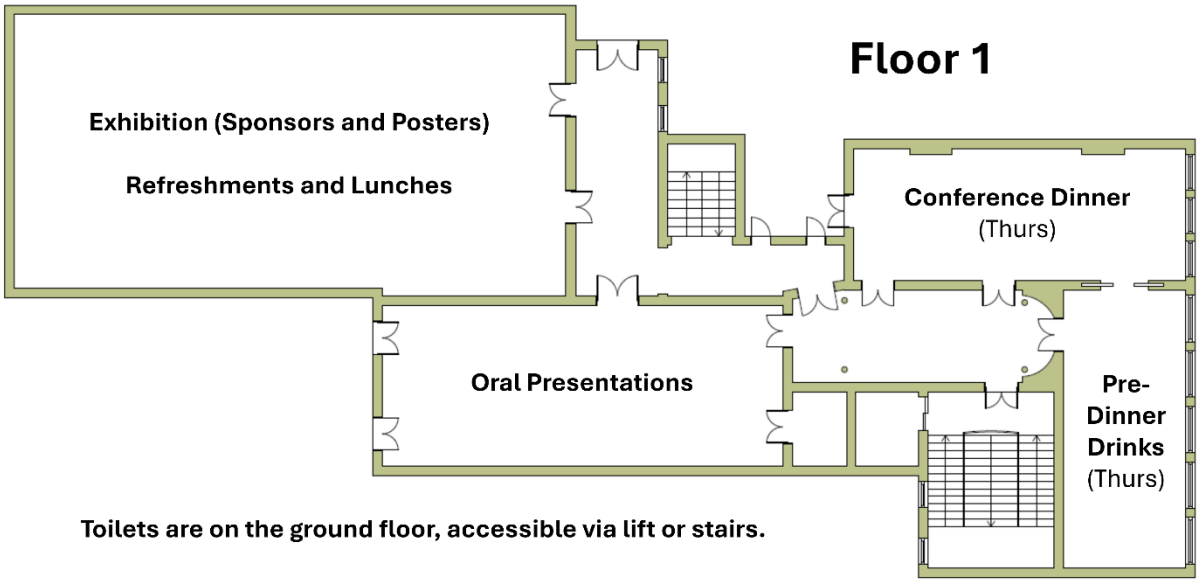
The Riverside Kelham, 1 Mowbray Street, Sheffield, S3 8EN
https://www.riversidesheffield.co.uk/
From 7pm
Join us for BBQ and Quiz!

Thursday Evening:

Conference Dinner at Cutler's Hall with live music from Take the Seven
From 7pm

Link to Google Map Walking Directions for BNASS2026

Conference Floorplan



The Phil Riby Award

Phil was an active member of the Atomic Spectroscopy Group and a big component of BNASS, being the conference chair of the 18th meeting in Liverpool, on the organising committee of 19th in London, and was instrumental in bringing BNASS to Manchester in 2022. His enthusiasm, drive and cheerful nature is still greatly missed. Phil was a people person and a champion for younger scientists, the welfare and success of his students was always his priority. To commemorate Phil's contribution to BNASS, education and the wider atomic spectroscopy community, the Phil Riby prize was announced at BNASS 2022 for the best student presentation at the conference. He was a passionate supporter of early career scientists and the prize provides an opportunity to present a lecture at the next BNASS.

2022 Winner: David King, British Geological Survey

2024 Winner: Bamikole Walter Osungbemiro, University of Strathclyde

Acknowledgements

The Organising Committee wishes to express its grateful thanks to the following organisations for their generous support. BNASS 2026 would not be possible without their involvement and we strongly encourage all attendees to take some time out of the schedule and visit the Vendors Exhibition.

Jump to section…

BNASS 2026 Website → → →

https://www.rsc.org/events/find-an-event/bnass-2026-the-22nd-biennial-national-atomic-spectroscopy-symposium

Atomic Spectroscopy Group website → → →

https://rsc.li/atomicspecgroup

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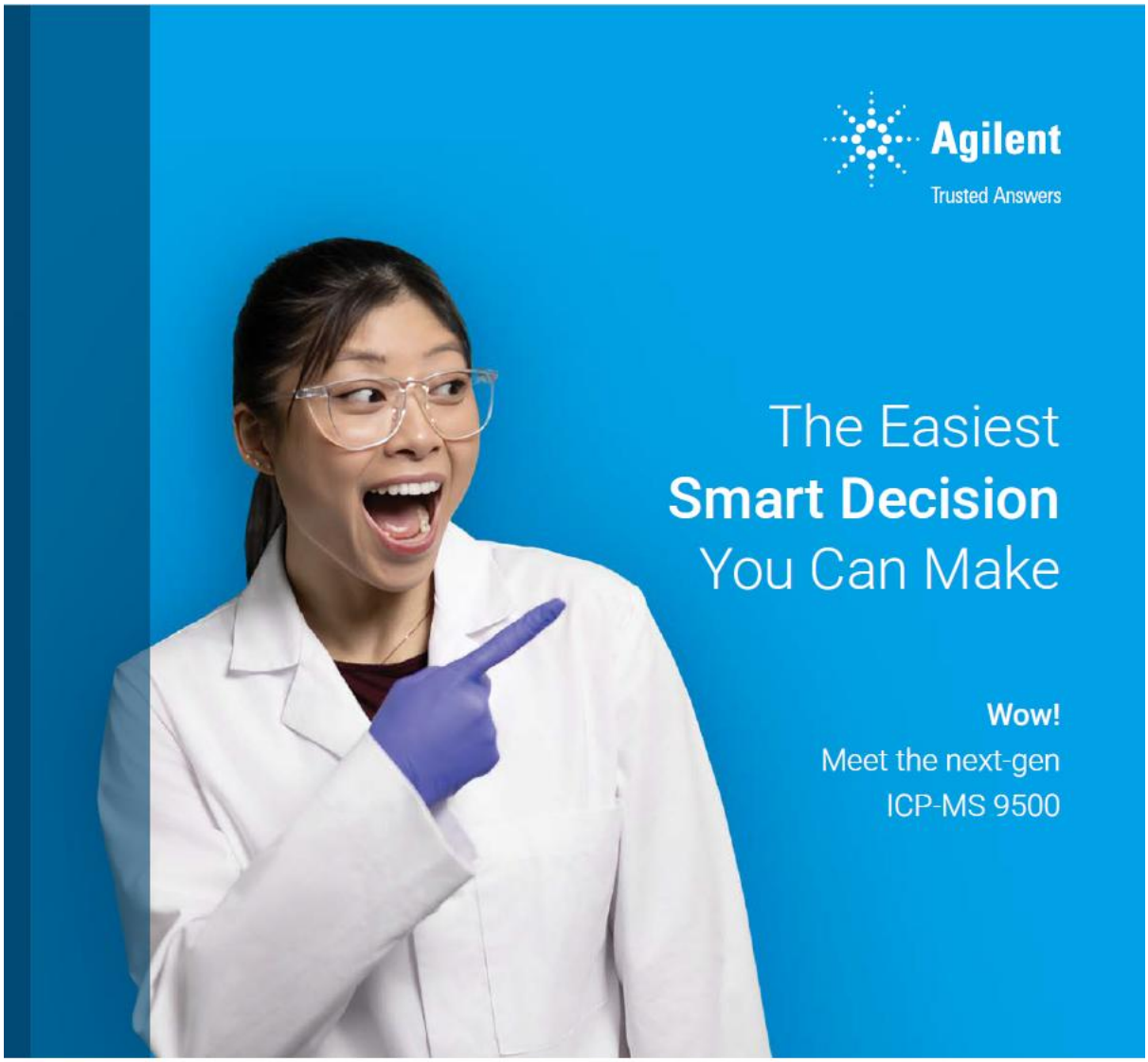

Agilent after-lunch talk

Optimizing ICP-MS analysis: enhancing helium collision and reaction cell modes

Sonia North, Application Engineer Agilent Technologies

July the 2nd – 2PM
within 3rd session "Methodological Developments"

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Programme

Wednesday 1st July	
12:30-13:30	**Registration and Lunch**
13:30-13:45	**Opening Ceremony:** History and significance of Cutlers' Hall
13:45-14:00	**Welcome address:** BNASS 2026 Organising Committee
Session 1: Environmental Applications and Sustainability	
14:00-14:40	**Keynote Speaker: Adrien Mestrot, University of Bern, Switzerland** Arsenic and antimony in soils and beyond. Novel sampling and speciation techniques, fieldwork and laboratory incubations help shed light into less studied parts of their biogeochemical cycle.
14:40-15:00	**Aiman Rizvi, University of Strathclyde, UK** Plant Powered Purification: Sorption of Arsenic and Chromium by using Tannic acid-Sodium Alginate Hydrogel beads
15:00-15:20	**Pierre Couture, University of Surrey, UK** Ion beam analysis of passive bio-indicators for probing traffic-related pollution along an urban-rural gradient from Guildford to Greater London
15:20-15:50	**Refreshment Break**
15:50-16:10	**Platinum Sponsor: Clement Elliott, Shimadzu, UK** Sensitivity vs. Robustness
16:10-16:30	**Christine M Davidson, University of Strathclyde, UK** Improving the Sustainability of Trace Element Analysis through Plastic Sample Vial Re-use
16:30-16:50	**Sarah Hill, National Measurement Laboratory, LGC, UK** Metrological advances to support recycling of technology critical elements from e-waste to support the circular economy
16:50	**Early finish for the World Cup England Game…**
17:15	**Group walk to Riverside, about 15 mins** (evening social event/meal venue)
19:00	**Evening Social Event – BBQ and quiz at the Riverside (and showing the football)**

Thursday 2nd July	
Session 2: Nano- and Microparticles	
09:30-10:10	**Keynote: Katrin Löschner, Technical University of Denmark, Denmark** Nanoparticles in Foodstuffs: What Single Particle ICP MS Can (and Can't) Tell Us
10:10-10:30	**Tatiana Pedrazzi, University of Brecia, Italy** Nanotoxicology of metals: Environmental monitoring and biomonitoring of metal nanoparticles in welders
10:30-10:50	**Phil Shaw, Nu Instruments, UK** Gaining a deeper understanding of multi-dimensional nanoparticle data using Uniform Manifold Approximation and Projection (UMAP) and Hierarchical Density-Based Spatial Clustering of Applications with Noise (HDBSCAN)
10:50-11:20	**Refreshment Break**
11:20-11:40	**Invited Speaker: Bamikole Walter Osungbemiro, University of Strathclyde, UK** Desorption of Cd, Cr and Pb from polyamide-6, poly(ethylene terephthalate) and polypropylene microplastics
11:40-12:00	**Emma Braysher, National Physical Laboratory, UK** Application of element ratio and isotope ratio measurement to ambient particulate matter samples
12:00-12:20	**Shaun Lancaster, University of Leoben, Austria** From lectures to investigations: project-based teaching of spectroscopy concepts to inspire future analytical chemists
12:20-14:00	**Lunch**
13:10-14:00	**Joe Ready & David Price, Elemental Scientific** Solutions for Elemental Analysis: Latest advancements in sample introduction, lab automation and laser ablation

Session 3: Methodological Developments	
14:00-14:20	**Platinum Sponsor: Sonia North, Agilent Technologies, UK** Optimising ICP-MS Analysis: Enhancing Helium Collision and Reaction Cell Modes
14:20-14:40	**Julian Tyson, University of Massachusetts, USA** Expressing the agreement between the measured value and the certificate value: A closer look at the t-test
14:40-15:00	**Claire Richards, University of Loughborough, UK** The development of a GC-ICP-MS interface for the analysis of bromine VOCs
15:00-15:20	**Nikolay Solovyev, Atlantic Technological University, Ireland** Iodine in Biological Media using ICP-MS: Challenges and Perspectives
15:20-15:50	**Refreshment Break**
15:50-16:10	**Ayush Agarwal, Paul Scherrer Institute, Switzerland** From Sampling to Analysis: Measuring Trace Contaminants in Biogas
16:10-16:30	**Ben Russell, National Physical Laboratory, UK** Developing mass spectrometry-relevant low level radioactivity standards: Results from a European comparison exercise and future developments
16:30-16:50	**Jenny Laird, National Physical Laboratory, UK** Development of hyphenated techniques with ICP-MS for medical radionuclide separation and detection
16:50-17:20	**Lightning Poster Talks**
17:20-18:00	**Poster Session and Drinks Reception**
	Conference Dinner at Cutlers' Hall (food served from **19:00**).
21:00	**Live music (Take the Seven) and bar at Cutlers' Hall**

Friday 3rd July	
Session 4: Biological Applications	
09:30-10:00	**Invited Speaker: James Coverdale** Boron on the clock: single-cell ICP-MS reveals rapid BNCT kinetics
10:00-10:20	**Philip Holdship, University of Oxford, UK** Quantifying Iron in Immune Cells by sc-ICP-MS
10:20-10:40	**Alice Fearn, University of Hull, UK** Using spatiotemporal metallomics and transcriptomics to identity novel therapeutic targets for diabetic wound repair
10:40-11:10	**Refreshment break**
11:10-11:30	**Rachel Dennis, Loughborough University, UK** LA-ICP-MS Analysis of 'Empty' Fingermarks Developed using Vacuum Metal Deposition: A Preliminary Investigation
11:30-11:50	**Olivia Doolan, Sheffield Hallam University, UK** 3D multi-modal imaging of germinating barley
11:50-12:10	**Rebekah Moore, Imperial College London, UK** The effect of arbuscular mycorrhiza on zinc phytoavailability, uptake and translocation in rice: a pilot natural stable isotope investigation
12:10-12.30	**Prizes and Final Remarks:** BNASS Organising Committee
12:30	**Lunch and depart**

Keynote Speakers

Dr Adrien Mestrot is Associate Professor for Soil Science at the Institute of Geography of the University of Bern. He obtained his Ph.D. from the University of Aberdeen (UK) in 2011. He then worked with the Soil Science Group at the University of Bern where he received a Marie Curie IEF Fellowship in 2013 and an SNSF Professorship in 2016. He obtained the Chair of Soil Science in 2019 and was promoted from Tenure-Track to Associate Professor in 2022.

His research focuses on understanding the biogeochemical cycle of trace elements with a special focus on arsenic, antimony and mercury in soils. Specifically, he investigates how different environmental factors (e.g. land use or climate change) can impact the release of these trace elements from soil to plants, biota, atmosphere and groundwater and their subsequent fate. Leveraging advanced analytical tools such as High Performance Liquid Chromatography (HPLC) coupled to Inductively Coupled Plasma Tandem Mass Spectrometry (ICP-MS/MS) with fieldwork and laboratory incubations, his team investigates how microbial biotransformations (e.g. biomethylation and biovolatilisation) can impact the global biogeochemical cycle of these inorganic pollutants by generating new chemical species of different toxicity and mobility.

Adrien Mestrot (0000-0002-4387-3886) - ORCID

Dr Katrin Loeschner is Associate Professor at the Technical University of Denmark (DTU), National Food Institute. She obtained her Ph.D. in 2008 from the Fraunhofer Institute for Mechanics of Materials in Halle, Germany, and has since worked at DTU in the field of analytical food chemistry.

With a background in materials science and polymer research, her work has evolved towards the study of nanoparticles and trace element species in food systems and packaging. She investigates their occurrence and behaviour in relation to food safety and regulatory questions, using advanced analytical techniques such as single particle ICP-MS and field-flow fractionation coupled to ICP-MS.

She contributes as a member of the European Food Safety Authority Working Group on food additives and is involved in European standardization and Joint Research Centre activities on nanomaterials in food.

Katrin Loeschner (0000-0003-1741-8406) - ORCID

Wednesday 1st July 2026

Session 1 – Environmental Applications and Sustainability

Keynote speaker 1

Arsenic and antimony in soils and beyond. Novel sampling and speciation techniques, fieldwork and laboratory incubations help shed light into less studied parts of their biogeochemical cycle.

Adrien Mestrot[1]

1. University of Bern, Bern, Switzerland.

Abstract

Arsenic and antimony are two toxic trace elements present in soils that are redox sensitive and can thus be remobilized upon flooding. Once released in soil solution, they can be transformed to numerous different chemical species by soil biota and especially by soil microorganisms. Two such bio-transformations, that are very relevant yet still poorly studied, are biomethylation and biovolatilisation. In this talk, I will discuss i. the environmental relevance of antimony and arsenic release from soils upon flooding, ii. mechanisms behind their remobilization using Size-Exclusion Chromatography coupled to ICP-MS/MS and iii. drivers of biomethylation and biovolatilisation. For this last part we will go from the laboratory to two field sites, namely a Swiss rice paddy and the High Altitude Research Station of the Jungfraujoch situated at 3’572 m.a.s.l. in the Bernese Oberland.

Plant Powered Purification: Sorption of Arsenic and Chromium by using Tannic acid-Sodium Alginate Hydrogel beads

Aiman Rizvi[1], King Hang Aaron Lau[1], Christine M. Davidson[1]

1. Department of Pure and Applied Chemistry, University of Strathclyde, Glasgow, G1 1XL, United Kingdom.

Abstract

Arsenic and chromium contamination in water poses a serious threat to public health and the environment, particularly in regions where industrial discharge and geogenic pollution coexist. This work investigates a sustainable, nature-inspired approach for selective removal of arsenic and chromium using tannic acid–alginate (TA–Alg) hydrogel beads synthesized from plant- and seaweed-derived biomolecules. The material contains abundant oxygen-donor functional groups (–OH and $–COO^-$) capable of binding both cationic and oxyanion metal species.

Batch sorption experiments in deionized water evaluated removal of As(III), As(V), Cr(III), and Cr(VI) under varying contact time, pH, and initial concentration conditions. Multi-element concentrations before and after sorption were quantitatively determined using an Agilent 7700x inductively coupled plasma mass spectrometer. Increasing tannic acid content significantly enhanced metal sorption, while Fe-incorporation into the TA–Alg matrix further improved removal efficiency.

To evaluate performance under environmentally relevant conditions, adsorption was examined in simulated freshwater containing common dissolved ions, where removal efficiencies remained largely unchanged, indicating minimal interference from major cations. Competitive sorption was also investigated in a multi-element solution containing As, Cd, Cu, Cr, Mn, Ni, Pb, and Zn, with ICP-MS enabling simultaneous quantification of all analytes. Despite strong competition, preferential removal of arsenic (85.0%) and chromium (98.1%) was observed. Finally, the beads were tested using water collected from Polmadie Burn (Glasgow, UK), a stream impacted by historic chromite ore processing residues. Effective chromium removal (94.6%) was achieved. These results demonstrate the potential of plant-derived hydrogel materials for selective removal of toxic metals in complex environmental waters.

Ion beam analysis of passive bio-indicators for probing traffic-related pollution along an urban-rural gradient from Guildford to Greater London.

Pierre Couture[1], Di Wu[1,2], Roger Webb[1], Vladimir Palitsin[1], Isabella Gray[3], Muskaan Khaidun[3], Harry Roberts[3], Lana Roberts[3], Alan Um[3], George Valatka[3]

1. Ion Beam Centre, Faculty of Engineering and Physical Sciences, University of Surrey, Guildford, UK, GU2 7XH. 2. Nuclear Engineering, Kyoto University, Gokasho, Uji, Kyoto, Japan, 611-0011. 3. Sponsored by Surrey SATRO, Surrey Technology Centre, Surrey Research Park, Guildford, GU2 7YG.

Abstract

Environmental pollution remains a critical concern for human health, with millions of premature deaths worldwide attributed to poor air quality[1]. Green infrastructure interventions, including vegetated barriers, have been investigated to improve air quality [1-4]. In this study, we investigate the use of mosses and trees as passive bio-indicators to assess spatial elemental pollution variations across an urban to rural gradient.

We characterised elemental composition and pollution indicators using Particle-Induced X-ray Emission (PIXE). PIXE enables multi-element, trace level detection (~ppm) with minimal sample preparation. We present results from an expanded sampling campaign, more than 40 collection sites, including residential areas, near major roads, railway infrastructure, and vegetated locations like parks. This analysis focuses on the relation between variations in elemental profiles and traffic intensity. Preliminary findings indicate that local factors, particularly traffic density and proximity to major roads and railway, exert a stronger influence on pollution indicators than the simple urban vs rural classification. Consistently elevated concentrations of elements associated with anthropogenic activity[5], like Al, Cr, Mn, Zn, Br and Pb, were observed in moss samples collected near high traffic locations compared with nominally lower pollution exposure sites. The results demonstrate the value of IBA investigation of bio-indicators for spatial patterns of environmental pollution in urban settings. The developing dataset supports local scale pollution source attribution and assessment of vegetation's influence on the accumulation of key pollutants. It also informs future monitoring strategies integrating atomic analysis with ecological and urban planning considerations.

[1] doi/10.1016/j.ufug.2017.07.005
[2] doi/10.1016/j.scitotenv.2018.04.106
[3] doi/10.1016/j.egypro.2011.05.068
[4] doi/10.1016/j.buildenv.2021.108595
[5] doi/10.1016/j.atmosenv.2019.117061

Sensitivity vs. Robustness

Clement Elliott[1]

1. Shimadzu UK, Limited, Milton Keynes, England.

Abstract

ICP-MS is renowned for its exceptional sensitivity; however, maximising sensitivity alone does not always deliver the most reliable or sustainable analytical method. In real-world laboratory environments, robustness is equally important to ensure consistent performance, reduced maintenance, and dependable data quality over time.

This presentation explores the balance between sensitivity and robustness in ICP-MS method development, using a sliding scale with sensitivity at one end and robustness at the other. It demonstrates how methods can be optimised for sensitivity and then deliberately "backed off" to enhance robustness while still meeting analytical requirements.

A key focus of the talk is recognising when this balance has been achieved. Practical indicators will be discussed, alongside the concept of "fit-for-purpose" performance, helping analysts determine when additional sensitivity no longer justifies reduced method resilience.

The session will also include a selection of practical "tips and tricks" drawn from Shimadzu's global field experience.

Improving the Sustainability of Trace Element Analysis through Plastic Sample Vial Re-use

Christine M. Davidson[1], Bamikole W. Osungbemiro[1], Declan D. Reid[1], Daniel E. Enenche[1]

1. Department of Pure and Applied Chemistry, University of Strathclyde, 295 Cathedral Street, Glasgow G1 1XL, UK.

Abstract

Environmental contamination with plastics is a major concern. Scientific laboratories contribute to plastic waste through reliance on single-use items, including plastic sample vials. The low limits of detection achieved by modern atomic spectrometry techniques mean that these vessels are commonly discarded after a single use for fear of cross-contamination.

This study investigated the re-usability of polypropylene sample vials (50 mL Falcon® tubes). To assess cross-contamination, vials were filled with a 1 mg/L multielement standard solution, emptied, rinsed repeatedly with either distilled water, deionised water, 5% HNO3 or detergent, and then refilled with 2% HNO3. Trace elements in the acid were determined by ICP-MS (Agilent 7700x, Cheshire, UK). To determine the effects of acid exposure on the polypropylene, vials were filled with different concentrations of HNO3 for a six-week period then analysed by ATR-FTIR and SEM.

There were no marked differences between the efficiencies of the four washing reagents, but the residual concentrations of elements varied, reflecting their propensity for carry-over. Even after four consecutive rinses, concentrations of some analytes exceeded typical ICP-MS LODs. Decontamination was, however, sufficient to allow reuse of vials with less sensitive techniques such as FAAS. No changes in the FTIR spectra of the vials were observed over a six-week period although SEM revealed some minor surface damage.

Work is ongoing to determine whether analyte carry-over is enhanced in acid-aged vials and to compare the environmental impact of vial washing and re-use vs. single use.

This study was funded by RSC Sustainable Laboratories Award L23-5123357636

Metrological advances to support recycling of technology critical elements from e-waste to support the circular economy

Sarah Hill[1], Ahmad Abukashabeh[1], John Entwisle[1], Heidi Goenaga Infante[1]

[1]National Measurement Laboratory, LGC, The Priestley Building, Guildford, GU2 7XY, UK.

Abstract

Technology Critical Elements (TCEs) are essential for use in smart phones, laptops, energy efficient lighting and new green energy initiatives including electric vehicles (EV) and wind turbines. These 'unusual' elements such as gallium, indium and neodymium, along with precious metals such as gold and platinum, have unique properties, making them difficult to replace with alternatives. In 2022, 5 Mt of e-waste was scrapped in the EU and 62 Mt globally (~50% is estimated to be metals). Whilst elements such as copper are commonly recycled, TCEs are rarely recovered. Therefore, a clear mechanism is required to improve the recycling of TCEs from waste electronic goods, which actively supports the European Circular Economy Agenda[1] and the UN Sustainable Development Goals[2].

The analysis of waste streams is a complicated task due to the huge variety of materials present, e.g. metal, glass, plastics, ceramics, etc., and is highly heterogeneous. The recycling industry needs fast, reliable analytical methods to determine the economic value of the waste and to develop recycling processes. To address some of these gaps, the MetroCycleEU consortium has supported the development and validation of reliable analytical methods as well as producing suitable reference materials for TCEs in e-waste. This metrological framework has been invaluable to ensure SI traceability, standardisation and validation of routine techniques. This presentation will highlight the LGC NML contribution to the project and discuss the analytical challenges with the joint development of real-world matrix certified reference materials produced within the MetroCycleEU project[3].

[1] https://environment.ec.europa.eu/strategy/circular-economy-action-plan_en
[2] https://sdgs.un.org/goals
[3] https://www.metrocycle.eu/

Thursday 2nd July 2026

Session 2 – Nano- and Microparticles

Keynote speaker 2

Nanoparticles in Foodstuffs: What Single Particle ICP MS Can (and Can't) Tell Us

Katrin Loeschner[1]

1. National Food Institute, Technical University of Denmark, Denmark.

Abstract

Food is a major route of human exposure to inorganic nanoparticles (NPs), which may be naturally occurring, intentionally added as food additives, incidentally formed during processing, or introduced from environmental sources. Reliable analytical methods are therefore essential for exposure assessment and food safety evaluation. Single particle inductively coupled plasma-mass spectrometry (spICP-MS) has become a key technique for the detection and characterization of inorganic NPs in complex food matrices, offering element specific detection, particle number concentrations, and size information at environmentally relevant levels.

This presentation will review the application of spICP-MS to the analysis of inorganic NPs in food additives and foods, with a focus on titanium dioxide (E171) and iron oxides and hydroxides (E172), as well as broader screening studies in food and biota. Results from method development, validation, and interlaboratory studies will be discussed to illustrate the strengths of the technique, including sensitivity, throughput, and compatibility with routine food control laboratories.

At the same time, the talk will critically address the limitations of spICP-MS, such as assumptions regarding particle composition, density, and shape, challenges related to agglomeration, and difficulties in source attribution. The need for complementary techniques, particularly electron microscopy, and the role of reference materials and quality controls will be highlighted. Overall, the presentation aims to provide a balanced perspective on what spICP-MS can and cannot tell us about NPs in foodstuffs.

Nanotoxicology of Metals: Environmental Monitoring and Biomonitoring of Metal Nanoparticles in Welders

Tatiana Pedrazzi[1], Lucia Paolini[2], Riccardo Magarini[1], Francesca Orlandi[3], Maria Enrica Gilberti[3], Paolo Bergese[4], Giuseppe De Palma[1]

1. University of Brescia, Brescia, Italy. 2. Center for Colloid and Surface Science (CSGI), Sesto Fiorentino, Italy. 3. ASST Spedali Civili, Brescia, Italy. 4. Institute for Research and Biomedical Innovation (IRIB-CNR), Palermo, Italy.

Abstract

Nanoparticles (NPs) are increasingly recognized as hazardous agents in occupational settings. Welding fumes represent a major source of exposure to metallic NPs, and welders constitute one of the main occupational groups exposed, although accurate exposure characterization remains challenging.

An environmental monitoring and biomonitoring study was conducted among welders. Environmental measurements were performed at 19 welding stations (TIG, MIG, shielded metal arc). Airborne particles were assessed using a Mini-WRAS spectrometer (particle number concentration, size distribution).

Male welders aged 30–40 years were recruited, and biological samples were collected at the beginning (BS) and end (ES) of the work shift. Non-exposed subjects served as controls. Urine, plasma, and exhaled breath condensate (EBC) samples were analyzed using single-particle ICP-MS to determine chromium (Cr) and nickel (Ni) NPs concentration and size. The association between urinary NPs and extracellular vesicles (EVs) was investigated through EV isolation and cryo-electron microscopy; the EV separation protocol also enabled concentration of samples containing low NP levels, improving analytical detectability. Environmental monitoring revealed GM diameters in the nanoscale range (31–62 nm) and higher particle concentrations during MIG welding. Urinary Cr and Ni NP concentrations were higher in ES to BS samples, controls showed lower levels. NPs were also detected in plasma and EBC, suggesting systemic distribution. Cryo-EM identified free nanoparticles, particles enclosed within EVs, and particles associated with EV membranes, indicating a potential role of EVs in NP biokinetics.

This study provides an integrated characterization of occupational exposure to metallic nanoparticles and supports advanced occupational health surveillance strategies.

Gaining a deeper understanding of multi-dimensional nanoparticle data using Uniform Manifold Approximation and Projection (UMAP) and Hierarchical Density-Based Spatial Clustering of Applications with Noise (HDBSCAN)

Phil Shaw[1], Lukas Schlatt[1], David Clases[2], Mickaël Tharaud[3], Pascal Bohleber[4]

1. Nu Instruments, Wrexham, UK. 2. Uni Graz, Graz, Austria. 3. IPGP, Paris, France. 4. AWI, Bremerhaven, Germany.

Abstract

The advent of time-of-flight (TOF) mass spectrometry for inductively coupled mass spectrometers has enabled the elemental and isotopic dimension specifically for fast transient signals. Other commonly used mass selectors such as the quadrupole can only detect isotopes sequentially making it impossible to detect multiple isotopes within a few milliseconds. The advantages that TOF enable are especially important for nanoparticle analysis, where each nanoparticle arrives at random times and the signal durations are in the low millisecond range.

As opposed to the detection of scanning mass spectrometers, TOF allows for the detection of not only single isotopes but the composition of particles. While the advantages gained can be applicable in many areas of current research such as forensic or environmental analysis, the data analysis can be a complicated task due to the multi-dimensional datasets. Many algorithms have been used to tackle similar problems in other areas of computer science, but their applicability to SP-ICP-TOF-MS needs to be examined and understood.

In this talk we will discuss the use of Uniform Manifold Approximation and Projection (UMAP)[a] for data reduction and Hierarchical Density-Based Spatial Clustering of Applications with Noise (HDBSCAN)[b] for unsupervised clustering on nanoparticle samples acquired on a Vitesse TOF-ICP-MS to differentiate and examine various clusters of particles separately. The results give a deep insight into the total population of all particles detected from which interesting insights can be drawn.

References:
a: McInnes, L, Healy, J, UMAP: Uniform Manifold Approximation and Projection for Dimension Reduction, ArXiv e-prints 1802.03426, 2018
b: L. McInnes, J. Healy, S. Astels, hdbscan: Hierarchical density based clustering In: Journal of Open Source Software, The Open Journal, volume 2, number 11. 2017

Winner of the Phil Riby Award 2024
Supporting Early Career Scientists

Desorption of Cd, Cr and Pb from polyamide-6, poly(ethylene terephthalate) and polypropylene microplastics

Bamikole W. Osungbemiro[1], Christine M. Davidson[1], John J. Liggat[1]

1. University of Strathclyde, Glasgow, UK.

Abstract

Recently, studies on the adsorption of potentially toxic elements (PTEs) by microplastics have gained attention, but a significant knowledge gap remains regarding PTE desorption, which is crucial for assessing the potential risks posed by microplastics in the environment.

This study investigated the effects of simulated photo-weathering (PW), thermal weathering (TW), and mechanical weathering (MW) over 18 weeks on the desorption of Cd2+, Cr6+, and Pb2+ from polyamide-6, poly(ethylene terephthalate), and polypropylene microplastics. Virgin and weathered microplastics were loaded with PTE using 500 µg/L analyte solutions at an average freshwater pH of 7.5, agitated for 24 h at 170 rpm, and then air-dried. Desorption experiments were carried out on the metal-laden microplastics using deionised water at pH 4, 6, 8, and 10. The concentrations of Cd2+, Cr6+ and Pb2+ released were measured by inductively coupled plasma mass spectrometry (Agilent 7700X, Cheadle, Cheshire, UK).

The amounts of PTEs absorbed onto MPs varied among analytes, with ranges in the order: PW (1.6-2.5 µg/g) > MW (1.4–2.2 µg/g) > TW (0.7–1.4 µg/g) > virgin (0.7–1.2 µg/g). The percentage desorption of all PTEs was higher in weathered microplastics than in virgin microplastics, suggesting that the amount of PTEs desorbed depends on the treatment applied. The effect of pH on the percentage desorption of all PTEs from MPs followed the order pH 4 > 6 > 8 > 10, except for Cr6+.

The results highlight the influence of different weathering conditions on the interactions between microplastics and PTEs in freshwater systems.

Application of element ratio and isotope ratio measurement to ambient particulate matter samples

Emma Braysher[1], Anu Bhaisare[1], Jody Cheong[1], Jenny Laird[1], Hibaaq Mohamud[1], Ben Russell[1], Annabel Sumeray[1]

1. National Physical Laboratory, Hampton Road, Teddington, TW11 0LW.

Abstract

Accurate element ratio and isotope ratio measurements provide powerful chemical fingerprints for tracing the sources and behaviour of environmental contaminants. In this work, we demonstrate the application of inductively coupled plasma tandem mass spectrometry (ICP MS/MS) for high precision isotope ratio analysis in ambient particulate matter, without any offline separation. A proof of concept evaluation was first carried out using certified reference materials, including uranium isotope ratios (238U/234U) in a uranium standard (CRM U970) and lead isotope ratios (207Pb/206Pb, 208Pb/206Pb) in a high purity lead wire reference material (NIST SRM 981), establishing instrument performance. The method was then applied to uranium and lead isotope ratios measured in ambient particulate matter samples, highlighting the technique's capability to characterise airborne contaminants. Element ratios of platinum group metals were also studied for monitoring of automotive catalyst emissions. Additionally, lead isotope ratios were determined in deposited dust samples from the ambient environment. These results illustrate the suitability of ICP MS/MS for environmental isotope fingerprinting and its value in understanding pollutant provenance across diverse sample types.

From lectures to investigations: project-based teaching of spectroscopy concepts to inspire future analytical chemists

Shaun T. Lancaster[1], Johanna Irrgeher[1], Thomas Prohaska[1]

1. Montanuniversität Leoben, Department General, Analytical and Physical Chemistry, Franz-Josef-Strasse 18, 8700, Leoben, Austria.

Abstract

Analytical chemistry and atomic spectroscopy rely on highly-trained, motivated young scientists. Effective teaching is therefore essential not only for conveying technical knowledge but also for fostering long-term interest in the discipline. Core learning outcomes in analytical chemistry education include appropriate sampling strategies, understanding analytical techniques and their capabilities, selecting fit-for-purpose methods, and critically evaluating and validating measurement results. Traditionally, these topics are taught through lectures complemented by laboratory exercises. While this approach effectively transfers knowledge, student motivation is often predominantly extrinsic, focusing on examination performance rather than sustained engagement with analytical chemistry.

At Montanuniversität Leoben, we have redesigned undergraduate and graduate analytical chemistry courses to strengthen intrinsic motivation and student engagement through student-centered teaching and project-based learning approaches.

In the bachelor curriculum, students participate in short research-oriented laboratory projects embedded within ongoing scientific activities and directly linked to their respective engineering and science disciplines. This allows students to experience the relevance of analytical chemistry in real-world applications from the beginning of their studies.

At the master level, a long-term interdisciplinary project has been developed in which students act as forensic investigators solving a complex murder case using analytical and spectroscopic techniques. The project integrates method selection, sample preparation, instrumental analysis, data interpretation, quality assurance, and scientific communication within an authentic problem-solving environment.

Student feedback and course evaluations indicate substantially increased engagement, higher levels of self-determined learning, and a stronger identification with analytical chemistry compared to traditional teaching formats. Furthermore, a noticeable increase in the number of students choosing analytical chemistry topics for their bachelor's and master's theses has been observed. These results suggest that research-based and project-oriented teaching approaches can play an important role in attracting and retaining the next generation of analytical chemists and spectroscopists.

Session 3 – Methodological Developments

Optimising ICP-MS Analysis: Enhancing Helium Collision and Reaction Cell Modes.

Sonia North[1], Matthew Cassap[1]

1. Agilent Technologies LDA UK Ltd, Cheadle, UK.

Abstract

Inductively Coupled Plasma Mass Spectrometry (ICP-MS) is a key analytical technique for trace elemental analysis. Traditionally, the use of collision/reaction cell (CRC) gases such as helium and oxygen has been somewhat element-specific, requiring detailed method development and frequent gas switching to optimize sensitivity and eliminate interferences.

This study examines the effectiveness of an enhanced single helium mode for analysing all elements, with the aim of simplifying laboratory workflows without compromising analytical performance. Our results show that operating ICP-MS in enhanced collision mode provides reliable interference removal across a broad suite of elements, including those that are traditionally challenging to analyse. The simplicity of this approach significantly reduces method complexity and the wasted instrument time associated with gas switching, thereby improving efficiency and reproducibility in multi-element analysis.

We also introduce a new reaction mode in the CRC, offering a sustainable, cost-effective, and safer alternative to bottled oxygen. Experimental data indicate that we can achieve similar levels of interference removal and analytical performance for elements such as sulphur, phosphorus, and arsenic, which typically require oxygen for optimal detection. This further streamlines laboratory operations by eliminating the need for a dedicated oxygen-supply infrastructure.

Together, the enhanced He mode and the new reaction mode can transform routine ICP-MS analysis by optimizing simplicity, safety, and cost-effectiveness, thereby making high-quality elemental analysis more accessible across various laboratory settings.

Expressing the agreement between the measured value and the certificate value: A closer look at the t-test

Julian Tyson[1]

1. University of Massachusetts, Amherst, USA.

Abstract

The 2026 JAAS ASU “Advances in the analysis of clinical and biological materials, foods and beverages”, contains a summary table of 57 papers on preconcentration methods. Most of these included discussions of the results of the analyses of CRMs that were not satisfactory. I will summarize these various shortcomings and present an approach based on the version of the t-test that should be used, now that computers and appropriate software (e.g. Microsoft Excel®) are readily available. No t-test is needed if (a) the certificate value falls within the 95% confidence interval (CI) around the measured result, and/or (b) the mean of the experimental result falls within the 95% CI about the certificate value. But what happens when the CI about the experimental mean does not include the certificate value? To explore this case, I will show the effect on the critical difference between the means (beyond which $p < 0.05$) of changing the uncertainty in the “certificate” value. It turns out that this distance (a) depends on the number of degrees of freedom (DF) calculated from the Welch-Satterthwaite equation, and (b) is not a smooth function, as DF is rounded down to the nearest integer. A way of applying Welch’s t-test to real CRMs is proposed in the light of recent additional text to NIST certificates: “To propagate this uncertainty, treat the certified value as a normally distributed random variable with mean x and standard deviation $U_{95\%}(x)/2$.” I will show that the calculations can be readily performed in Excel®, and so researchers are strongly encouraged to adopt this approach, expressing the result as a p value, thereby avoiding the need for any subjective commentary about the extent of agreement between their measured values and the certificate values. Researchers are also strongly encouraged to define all ± terms and give the number of replicate measurements, thereby allowing referees to check the calculations.

The development of a GC-ICP-MS interface for the analysis of bromine VOC's.

Claire Richards[1], Matthew Turner[1], Amy Managh[1]

1. Loughborough University, Loughborough, UK.

Abstract

Gas chromatography (GC) has traditionally been used alongside element-specific detectors, including chemiluminescence detectors for nitrogen (NCD) and sulphur (SCD), atomic emission detectors and electron capture detectors. Whilst these instruments offer valuable selectivity, their applicability is constrained by limited element specificity and insufficient sensitivity, particularly when analysing complex sample matrices.

To address these limitations, the coupling of GC with inductively coupled plasma mass spectrometry (ICP-MS) has emerged as a more powerful analytical approach. GC-ICP-MS provides significantly enhanced sensitivity, a wide linear dynamic range, and the ability to resolve isotopic composition while preserving chromatographic separation. These capabilities make GC-ICP-MS the preferred method when conventional detectors cannot deliver analytical performance. Moreover, GC serves as an alternative sample introduction method pathway for volatile species which aren't suitable for traditional ICP-MS sample preparation and sample introduction.

In this study, a custom-built GC to ICP-MS interface has been developed to allow cross-manufacturer coupling of GC and ICP-MS systems, overcoming the limitation of existing commercial solutions that only support coupling of systems from a single vendor. The design has been evaluated for the separation of bromine VOC's (volatile organic compounds), drawing on concepts from historic designs as well as from a prototype LA (laser ablation)-ICP-MS direct concentric injector system. A clear chromatographic separation of an alkyl bromide series has been successfully achieved, which was further optimised with respect to detection limits and sensitivity, peak profile shape and analytical throughput. This presentation outlines the development and testing of the new interface, highlighting key design considerations and performance characteristics.

Iodine in Biological Media using ICP-MS: Challenges and Perspectives

Nikolay Solovyev[1], Tanya Mehra[1], Aimee Mcloughlin[2], James F. Coverdale[2,3]

1. Department of Life Sciences, ATU Sligo, Atlantic Technological University, Ash Lane, Sligo, Co. Sligo F91 YW50 Ireland. 2. School of Pharmacy, School of Health Sciences, College of Medicine and Health, University of Birmingham, B15 2TT, UK. 3. Department of Chemistry, University of Warwick, Coventry, CV4 7AL, UK.

Abstract

Iodine is a non-metal trace element with unique biochemical properties; for vertebrates, iodine is indispensable for the synthesis of thyroid hormones, regulating growth, development and general metabolism regulation. Worldwide, iodine deficiency remains an important public health problem, due to the severity of the outcomes, including irreversible arrested development of the central nervous system under sever iodine shortage during pregnancy.

Intervention studies, epidemiological research on iodine deficiency and the studies of iodine metabolism, using cell and animal models, require reliable analytical methods of iodine quantification, single cell analysis, and speciation. Inductively coupled plasma mass spectrometry (ICP-MS) provides excellent opportunities for multielement analysis of biological samples; however, iodine can be considered as a relatively challenging element for ICP-MS.

As compared to other non-metal elements, such as selenium and arsenic, iodine, which is naturally monoisotopic with m/z of 127, is relatively spectrally free of interference, so the main analytical challenges for ICP-MS measurements lie in biological material sample preparation and effective ionisation of the analyte. The key issues of ICP-MS analysis for iodine are related to its high volatility at relatively low temperatures, sensitivity to the acidity and oxidative potential of the medium, pronounced memory effects/adsorption on the glassware and tubing of the instrument and high ionisation energy of iodine, reducing the sensitivity. Thus, designing adequate sample preparation protocols for iodine quantification, speciation and single cell analysis becomes a non-trivial task. Using basic digestion/dilution reagents such as ammonia, avoiding high temperatures etc. and using adequate internal standards are vital for adequate iodine quantification in biological media such as saliva and urine as well as biological tissue and cell cultures in model research.

From Sampling to Analysis: Measuring Trace Contaminants in Biogas

Ayush Agarwal[1,2], Laura Torrent[1,3], Julian Indlekofer[1], Sylvain Bouchet[4], Lucy P. Culleton[5], Serge Biollaz[1], and Christian Ludwig[1,2]

1. Paul Scherrer Institute (PSI), Villigen PSI, Switzerland. 2. Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland. 3. University of Girona (UdG), Girona, Spain. 4. Federal Institute of Metrology (METAS), Bern-Wabern, Switzerland. 5. National Physical Laboratory (NPL), Teddington, United Kingdom.

Abstract

Biogas contains trace level contaminants that can strongly affect process reliability, upgrading performance, and end use compatibility. In particular, volatile silicon compounds and sulfur containing species are associated with silica deposition, catalyst poisoning, corrosion, and increased maintenance demands. Their routine determination remains challenging because of low concentrations, matrix complexity, and the lack of robust field compatible workflows. This contribution presents a liquid quench gas chromatography inductively coupled plasma mass spectrometry approach for element selective biogas diagnostics, enabling simultaneous trace level quantification of silicon and sulfur based contaminants in a single analytical run.

Preconcentration factors of up to 1500 were achieved, allowing quantification at concentration levels relevant to EN 16723 requirements. The use of liquid calibration standards avoids important sources of uncertainty associated with gaseous standards and improves analytical robustness. Method performance was evaluated through laboratory validation, field campaigns at commercial Swiss biogas plants, and participation in an international interlaboratory round robin study, where the approach showed excellent reproducibility and accuracy. Sample stability was demonstrated for at least four weeks, supporting decentralized sampling and shipment to centralized laboratories.

The results highlight the value of element selective analysis for improving confidence in biomethane quality assessment and operational decision making.

Developing mass spectrometry-relevant low level radioactivity standards: Results from a European comparison exercise and future developments

Ben Russell[1], Hibaaq Mohamud[1], Niall Falconbridge[1]

1. National Physical Laboratory, Hampton Road, Teddington, TW11 0LW.

Abstract

Mass spectrometric techniques are increasingly being used as a rapid and sensitive alternative to decay counting techniques for low-level radionuclide measurement. This must be supported with standards and reference materials to validate techniques and provide confidence in measurement.

As part of the Euramet project on Metrology for the harmonisation of measurements of environmental pollutants in Europe (MetroPOEM), a range of radionuclide standards were prepared and characterised using mass spectrometric and decay counting techniques for an interlaboratory comparison exercise, focusing on the capabilities of different mass spectrometers for low-level radioactivity measurement. Participating labs around Europe were asked to determine activity levels for a range of actinides (234U, 236U, 237Np, 239Pu, 240Pu, 241Am, NatU and 239Pu/ 240Pu) and 90Sr. Standards were characterised for their activity per unit mass and impurities using a combination of decay counting and mass spectrometric techniques.

The laboratories provided information on the values measured and details of the instruments used. For all radionuclides, results were submitted for a range of different mass spectrometric techniques, including ICP-MS/MS, ICP-SFMS, MC-ICP-MS, ICP-TOF-MS and AMS. Results are presented for each radionuclide standard, covering the technique used, the agreement with the reference value and any feedback from the participating laboratory on the nature of the standards received and the measurements made.

The results provide information on the capabilities of mass spectrometry for low-level radionuclide measurement and has already informed the development of future standards, specifically 135Cs/137Cs and a broader range of 239Pu/240Pu ratios.

Development of hyphenated techniques with ICP-MS for medical radionuclide separation and detection

Jenny Laird[1], Annabel Sumeray[1], Ben Russell[1], Alexandre Tribolet[1]

1. National Physical Laboratory, Teddington, Middlesex, TW11 0LW.

Abstract

There is a current and growing demand to develop the latest generation of medical radionuclides, which offer the potential for more focused cancer treatment. A key stage in the development of these radionuclides is chemical isolation from interferences and effective labelling of peptides to enable their targeting capability. Whilst the high activity levels and short half-lives of medical radionuclides are not suitable for ICP-MS measurement, stable analogues of these radionuclides can be used to develop separation and labelling protocols prior to handling of radioactive material. This work presents the coupling of an automated radiochemical separator and HPLC to ICP-MS for online measurements, enhancing medical radionuclide procedure development.

Automated extraction chromatography separation of lanthanides (specifically Tb as an analogue of Tb-155 from Gd, Ce and Eu) using Triskem International Ln and TK211 resins has been coupled with ICP-MS, using Time Resolved Analysis to measure the elution profile. This is a rapid alternative to manual collection and measurement of each separation fraction and has been used to demonstrate the difference in separation performance for different flow rates and mobile phase acid concentrations, leading to faster determination of separation conditions.

HPLC-ICP-MS enables high-throughput testing of labelling procedures, prior to active method validation. Coupling of HPLC to ICP-MS has enabled the quantification of the labelling efficiency of stable Lu (Lu-177), Eu (Eu-154) and I (At-211) with various labelling agents. Peptide recovery was assessed by UV detection following reverse phase HPLC and the labelling efficiency was determined using ICP-MS.

Friday 3rd July 2026

Session 4 – Biological Applications

Winner of the Thermo Spectroscopy Award

Boron on the clock: single-cell ICP-MS reveals rapid BNCT kinetics

Jack G. Finch[1], Rhiannon J. Pass[1], Maria Rita Fabbrizi[1], Aimee E. P. McLoughlin[1], Stuart Green[2], Jason L. Parsons[1], James P. C. Coverdale[1]

1. University of Birmingham, Edgbaston, United Kingdom. 2. University Hospital Birmingham, Edgbaston, United Kingdom.

Abstract

Accurate quantification of boron at the single-cell level is critical to understanding the pharmacokinetics of therapeutics used in boron neutron capture therapy (BNCT). Conventional bulk measurements often infer intracellular boron from extracellular concentrations and fail to resolve the rapid dynamics of cellular uptake and efflux. We present two complementary ICP-MS-based workflows which are designed to overcome these challenges. A rapid in situ tryptic/acidic digestion method enables quantitation while preventing premature efflux (LOD 10-B = 0.2 µg/L, LOD 11-B = 0.4 µg/L) with recoveries of 102.5 ± 0.5% (pre-digestion spike) and 103 ± 3% (post-digestion spike). In parallel, real-time monitoring of boron efflux from live cells using single-cell ICP-MS (scICP-MS) reveals a biological half-life of 6 minutes. Together, these approaches deliver new analytical capabilities for probing boron transport and retention in individual cells, offering powerful tools for advancing BNCT therapeutic design and expanding the scope of single-cell elemental analysis.

Quantifying Iron in Immune Cells by sc-ICP-MS

Philip Holdship[1], Megan R. Teh[2], Michalina Mazurczyk[2], Dana Costigan[2], Giulia Pironaci[2], Huei-Wen Chuang[2], Michael B. Zimmerman[2], Nicole U. Stoffel[3], Robert G. Hilton[1], David Price[4], Jon Wade[1], Hal Drakesmith[2]

1. Department of Earth Sciences, University of Oxford, UK. 2. MRC Translational Immune Discovery Unit, MRC Weatherall Institute of Molecular Medicine, University of Oxford, UK. 3. Department of Chemistry and Applied Biosciences, ETH Zürich, Switzerland. 4. Elemental Scientific Inc., UK.

Abstract

Iron is crucial for cellular metabolism and cell growth [1]. Nevertheless, in humans, both iron deficiency and disorders of iron overload are widespread [2]. How cellular iron content varies depending upon iron availability, and how this influences cell function is poorly characterised. We developed a method to quantify metals in hundreds of cells per minute via single-cell inductively-coupled plasma mass spectrometry (sc-ICP-MS), and used it to explore iron usage in immune cells. By coupling flow cytometry sorting upstream of sc-ICP-MS, we extended this to assess variability of cellular iron contents ex-vivo by cell type within a murine spleen, an organ that is particularly important in iron metabolism. We found that splenic T-cells and B-cells contained similar mean iron levels per cell and were constrained within particularly tight population distributions, whereas macrophages exhibited a much higher degree of heterogeneity and on average contained twice as much iron. Additionally, by loading enriched stable iron isotopes onto transferrin (the main iron transporter protein), and culturing with cells, we also present the ability of sc-ICP-MS to examine iron kinetics at the single cell level by isotopic detection. This includes applying the technique to accurately measure both cellular iron uptake and its inhibition, by either dosing or blocking the cell surface transferrin receptor.

1. M. R. Teh, A. E. Armitage and H. Drakesmith, Trends in Endocrinology & Metabolism, 2024, S1043276024001097.
2. J. N. Frost and H. Drakesmith, Nat Rev Immunol, DOI:10.1038/s41577-025-01193-y.

Using spatiotemporal metallomics and transcriptomics to identity novel therapeutic targets for diabetic wound repair

Alice Fearn[1], David Price[2], Joe Ready[2], Victor Ubels[3], Hilde Cronwright[4], Alexander Johns[1], Nina Rocha[1], Holly N. Wilkinson[1]

1. Wound Innovation Institute, Hull York Medical School, University of Hull, Hull, United Kingdom. 2. Elemental Scientific Inc., Huntingdon, United Kingdom. 3. Bioengineering Department, Imperial College London, London, United Kingdom. 4. Department of Earth Sciences, University of Oxford, Oxford, United Kingdom.

Abstract

Background

Diabetic foot ulcers (DFUs) cost the National Health Service over £1Bn per annum, often leading to life-threatening amputations. Our previous research showed that endogenous iron is dysregulated in diabetic wounds therefore suggesting metal-targeted therapies may be a promising therapeutic strategy for poor healing. Here, we aimed to characterise the spatiotemporal distribution of metals in diabetic wounds and identify novel metal-linked signaling pathways associated with diabetic wound pathology.

Methods

Diabetic (Db/Db) and non-diabetic (Db/J) mice received 2 x 6mm dorsal excisional wounds and were collected at 1, 3, 7 & 14 days post wounding. Unwounded animals were collected for baseline analysis. Inductively coupled plasma mass spectrometry (ICP-MS) and laser-ablation-ICP-MS were used to assess wound metal concentration and distribution. Bulk RNA-sequencing and spatial transcriptomics (Xenium) were conducted to identify metal-associated pathways dysregulated in diabetic mice.

Results

Our novel ICP-MS data showed important temporal changes in metals, such as calcium and iron, across the wound healing continuum, revealing differences between diabetic versus non-diabetic mice. RNA-sequencing analysis revealed dysregulation of metal-associated wound healing pathway genes in diabetic wounds. Finally, we constructed a spatially resolved single-cell wound atlas to demonstrate, for the first time, that diabetic wounds show perturbed metal signatures in unique cell clusters.

Conclusions

Together, these data suggest metal dysregulation could be a causal factor linked to poor diabetic healing. Future work will link our temporospatial and transcriptional data to elucidate novel therapeutic pathways for functional validation.

LA-ICP-MS Analysis of 'Empty' Fingermarks Developed using Vacuum Metal Deposition: A Preliminary Investigation

Rachel Dennis[1], Paul Kelly[1], Amy Managh[1]

1 Loughborough University, Loughborough, UK.

Abstract

Vacuum metal deposition (VMD) is a Home Office-recommended method for enhancing latent fingermarks on various substrates. Au and Zn are evaporated sequentially under vacuum. Zn preferentially binds to Au between the fingermark ridges producing a 'normal' negative development of the fingermark pattern. Although effective, VMD can produce 'empty' prints- a phenomenon which yields only a faint impression of the fingermark pattern, rendering the mark unsuitable for use in forensic investigations. In this study a laser ablation-inductively couple plasma-mass spectrometry (LA-ICP-MS) approach was explored as a means of recovering fingermark ridge patterns from the 'empty' regions of developed prints and to gain insight into the behaviour of Au and Zn depositions in prints exhibiting this phenomenon. This preliminary investigation proved successful for visualising fingermark patterns in 'empty' prints deposited on glass microscope slides when using a 10µm spot size, a 200µm/s scan speed and laser repetition rate of 20Hz to ablate 2mm x 2mm regions of the fingerprint. Evidence of both Au and preferential Zn deposition in 'empty' print developments was observed. However, less definition between the ridges and furrows of the imaged fingermark and slight distortion of ridge shape when detecting Au was noted in comparison to prints exhibiting 'normal' development. These findings suggest that increased lipid content and deposition pressure could be possible influencers contributing to 'empty' print development. These preliminary results suggest that LA-ICP-MS could prove effective for the recovery and visualisation of fingermark ridge patterns and gain further understanding as to the cause of the 'empty' print phenomenon.

3D Multi-Modal Imaging of Germinating Barley

Olivia Doolan[1,2], Mathew G. Lewsey[2], Marta Peirats-Llobet[2], Nicola Aberdein[1] and Neil Bricklebank[1]

1. Biomolecular Sciences Research Centre, Sheffield Hallam University, City Campus, Sheffield, UK S1 1WB. 2. La Trobe Institute for Sustainable Agriculture and Food, Department of Plant, Animal and Soil Sciences, La Trobe University, AgriBio Building, Bundoora, VIC 3086, Australia.

Abstract

Germination is a pivotal stage in the plant lifecycle, and unsuccessful germination directly limits crop productivity. Barley, a globally cultivated and resilient cereal crop, produced over 150 million tonnes in 2025 and serves as a major resource for animal feed, food, and beverage production. However, up to 25% of sown barley fails to germinate under field conditions, a challenge likely to intensify with ongoing climate pressures. Improving our understanding of the biochemical and structural events affecting early germination is, therefore, essential for improving crop resilience and supporting global food security.

This study applies multi-modal imaging to characterise the complex biochemical and morphological changes that occur across five key time points (0, 1, 3, 6, and 24 hours after imbibition) of germination. Laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) serves as a central analytical technique, enabling high-resolution mapping of essential macro- and micronutrient distributions using an Elemental Scientific ImageBio 266 laser coupled to a PerkinElmer NexION 5000 ICP-MS. Complementary micro-computed tomography (µ-CT) imaging with a Bruker SkyScan 1272 quantifies associated morphological changes in two and three dimensions. These datasets are further integrated with cutting-edge spatial transcriptomics generated at La Trobe University to construct the first comprehensive 3D atlas of nutrient mobilisation, structural development, and gene expression during early barley germination. This integrated framework provides new insight into the cellular processes underpinning successful crop establishment.

The effect of arbuscular mycorrhiza on zinc phytoavailability, uptake and translocation in rice: a pilot natural stable isotope investigation

Rebekah E. T. Moore[1], Sophie Perryman[2], Kate Grainger[1], Katharina Kreissig[1], Dani Fuller[3], Alex Griffiths[1], Jeongmin Choi[2]

1. Imperial College London, UK. 2. University of Cambridge, UK. 3. Natural History Museum, London, UK.

Abstract

Zinc deficiency affects ~20-25% of the global human population and remains a major, under-recognised contributor to poor health outcomes. This 'hidden hunger' is often associated with cereal-based diets. To solve this problem, improvements to zinc phytoavailability and bioavailability are necessary. One proposed nature-based solution involves arbuscular mycorrhizal fungi (AMF), which form symbiotic root associations, known as arbuscular mycorrhiza (AM), with about 80% of land plants. The fungi help plants gather otherwise inaccessible nutrients via their hyphae.

Mass dependent isotope compositions are altered by and hence reflect the processes that occur during elemental regulation by plants. As such, they can reveal whether plants use distinct mechanisms for maintaining homeostasis with changing environmental conditions. This is the first investigation to use natural stable isotope analysis to characterise AM.

Control and AMF-inoculated rice plants were grown in autoclaved sand and half-strength Hoagland solution under controlled environmental conditions. After harvesting, the extent of AMF colonisation was quantified. Zinc concentrations and isotope compositions were then analysed via MC-ICP-MS to investigate whether AM improves Zn phytoavailability and/or alters Zn uptake and translocation mechanisms.

Inoculated plants had ~40% more Zn in the shoots, compared to controls. Zinc in all plants was isotopically heavier than that of the nutrient solution. In 7/8 plants, the shoots contained isotopically heavier Zn than the roots, and this difference was slightly more pronounced in the control plants. Isotope mass balance modelling, for determination of isotope fractionation factors, requires well-constrained systems. To this end, extraction experiments were conducted on the substrate to quantify the effect of adsorption. These pilot results set the foundation for extensive future investigation of AM via natural stable isotope analysis.

Poster Abstracts

1. Novel workflows for multi-elemental analysis of micro-samples to support the purity assessment of organic calibration materials: The power of combining micro-digestion with micro-flow analysis by ICP-MS/MS

Ahmad Abukashabeh[1], John Entwisle[1], Nicola Pace[1], Eli Achtar[1], Cailean Clarkson[1], Sarah Hill[1], Heidi Goenaga-Infante[1]

1. National Measurement Laboratory, LGC, 10 Priestley Road, Guildford, GU2 7XY, UK

Abstract

The purity assessment of high-purity organic calibration materials for critical compounds, such as digitoxin (used for the treatment of various heart conditions), is essential to provide SI traceability to clinical measurements. In order to provide multi-elemental data that underpin purity assessment, wide-spectrum screening and accurate quantification across the periodic table are often required. Traditional elemental analysis typically requires over 200 mg for sample digestion and uses introduction systems requiring several milliliters for multi-mode analysis to achieve selectivity and accuracy. However, this can pose challenges when either dealing with high-cost materials or where only limited quantities may be available. Therefore, there is a critical need for analytical strategies to determine elemental impurities using less than 10 mg of material. This work discusses overcoming these challenges by integrating micro-scale microwave digestion using the Anton Paar Multiwave 7501 (<10 mg sample in 100 µL acid) with the ultra-low flow sample introduction system ESI microFAST (100 µL sample loop at 10 µL/min) with the Agilent 8800 ICP-MS/MS. This enabled comprehensive multi-elemental screening analysis and quantification of 14 elements of interest, using multiple gas reaction and collision modes (O_2, H_2, He) to resolve interferences. This was achieved using a total sample weight of 15 mg for two independent replicates, requiring a volume of 200 µL for analysis. The novel workflow described here could also be highly applicable to the quantification of multiple elements in critical biological materials, such as cerebrospinal fluid or clinical trial samples, where very limited quantities are available.

2. Biological speciation and pharmacokinetic analysis of a novel iridium(III) anticancer agent

Ahmed. K. Alghamdi[1], I. Romero-Canelon[1], and James P. C. Coverdale[1]

1. University of Birmingham, Birmingham, United Kingdom.

Abstract

Metal complexes such as Ru, Os, and Ir are currently under investigation for the treatment of cancer, including notable examples that have reached clinical trials. While conventional biological assays can be used to evaluate potency, efficacy and biological mechanism of action, trace elemental techniques can be used to assess extracellular speciation and internalization by cells. Serum speciation was investigated using online LC-ICP-MS anion exchange chromatography and revealed how time-dependent protein speciation correlated with uptake rate, suggesting involvement of protein-mediated uptake and providing new insight into the potential mechanism of action.

3. Development and Validation of an ICP-MS Workflow for Boron Quantification in Three-Dimensional Head and Neck Cancer Spheroids for Boron Neutron Capture Therapy (BNCT)

Aimee E. P. Mcloughlin[1], James Bucag[1], Maria Rita Fabbrizi[2], Leah D. Punshon[2], Jason L. Parsons[2], James P. C. Coverdale[1]

1. Department of Pharmacy, School of Health Sciences, College of Medicine and Health, University of Birmingham, Edgbaston, UK. 2. Department of Cancer and Genomic Sciences, School of Health Sciences, College of Medicine and Health, University of Birmingham, Edgbaston, UK.

Abstract

Current therapeutic approaches for head and neck squamous cell carcinoma (HNSCC) remain suboptimal, motivating interest in tumour-selective alternatives such as boron neutron capture therapy (BNCT). Quantitative assessment of boron delivery is typically inferred from circulatory measurements, which fails to capture rapid boron pharmacokinetics and tumour-specific intracellular accumulation. While ICP-MS approaches have been applied to two-dimensional models, analytically validated methods for reproducible intraspheroidal boron quantification in three-dimensional tumour systems are lacking. Here, we report a robust ICP-MS workflow for direct quantification and normalisation of intraspheroidal boron in three-dimensional HNSCC FaDu spheroids. Optimised spheroid preparation, washing, and analytical protocols enabled reproducible intraspheroidal boron measurements above detection limits (~ 0.5 ng $^{10}B^{+}$ spheroid^{-1}, while minimising extracellular and matrix-associated interference. Method reproducibility and elemental normalisation were confirmed, supporting reliable inter-sample comparisons. To our knowledge, this represents the first analytically validated approach for direct intraspheroidal boron quantification in 3D spheroids. This workflow establishes 3D spheroids as biologically relevant and analytically tractable preclinical platforms, addressing a critical methodological gap, and supporting optimisation of boron delivery strategies for BNCT development for HNSCC.

4. Temporal Trends in Atmospheric Heavy Metal Deposition across the UK Heavy Metals Network

Alex Adams[1], Emma Braysher[1], Katie Williams[1], David Butterfield[1], Richard Brown[1]

1. National Physical Laboratory, Teddington, London.

Abstract

Atmospheric deposition of heavy metals from anthropogenic sources, such as energy production and mining, represents a critical pathway by which airborne metals are transferred to terrestrial and aquatic environments. These present downstream consequences for soil chemistry, water quality, and biological processes. In the UK, successive policy interventions have driven marked improvements in air quality since the 1950s; however, the continued mortality attributable to ambient air pollution underscores the need for improved monitoring and analysis. To continually assess the efficacy of these interventions on ecological and environmental sustainability, the UK Heavy Metals Network, provides long-term bulk deposition data.

This study draws on publicly available UK-AIR data from five active monitoring sites spanning a range of environments across the UK. Samples were analysed by inductively coupled plasma mass spectrometry (ICP-MS) and atomic fluorescence spectrometry (AFS). Deposition fluxes were converted to μg/m²/day in accordance with standard deposition collection protocols, and Theil-Sen regression was applied to annual site and element averages to characterise the direction and magnitude of long-term trends.

Preliminary findings reveal divergent trends against emissions inventories for some elements. Notably, manganese emissions show an upward trend in emissions inventories, likely reflecting increased biomass burning and domestic wood combustion. However, this is not reflected in the network data; current network coverage may underrepresent these signals, as no monitoring sites are located in proximity to areas with elevated residential burning activity, representing a spatial gap with implications for both network design and emissions policy. Understanding trends in health related impacts of atmospheric deposition is paramount to developing a sustainable energy infrastructure in the UK.

5. Multi Elemental Analysis of Lithium Aluminium Titanium Phosphate by Automated ICP OES

Andrew Brotherhood[1], Matthew Cassap[1], Zhang Ping[1]

1. Agilent Technologies LDA UK Ltd, Cheadle, UK.

Abstract

Lithium aluminium titanium phosphate (LATP) is a promising solid electrolyte for all solid state batteries (ASSBs) due to its high ionic conductivity, chemical stability, and compatibility with high voltage cathodes. Accurate control of major components and trace impurities in LATP is essential to ensure electrolyte performance, safety, and durability.

6. Single-Quadrupole ICP-MS for Size-Resolved Characterization of Multimetallic Nanoparticles

Ayush Agarwal[1,2], Laura Torrent[1,3], Cedric Koolen[2,4], Kenneth Crossley[1], Samuel Gatti[1], Ekta Verma[5], Sara Skrabalak[5], Andreas Züttel[2,3], Christian Ludwig[1,2]

1. Paul Scherrer Institute (PSI), Villigen PSI, Switzerland. 2. École Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland. 3. University of Girona (UdG), Girona, Spain. 4. Empa Materials Science and Technology, Dübendorf, Switzerland. 5. Indiana University, Bloomington, United States of America.

Abstract

The rapid growth of artificial intelligence and computation in nanomaterials discovery is increasingly shifting the bottleneck from synthesis and prediction to characterization. For multimetallic nanoparticles, transmission electron microscopy remains a benchmark technique, but its low throughput, preparation bias, and limited statistical representativeness make it poorly suited for large-scale screening. To address this gap, we advanced a high-throughput hyphenated platform based on a scanning mobility particle sizer coupled to a single-quadrupole inductively coupled plasma mass spectrometer (SMPS-ICP-MS) for simultaneous size-resolved elemental analysis of aerosolized nanoparticles.

In this approach, particles are classified by electrical mobility prior to element-selective detection by ICP-MS, enabling direct correlation of size distributions and composition in a single measurement. Dynamic shape factor and multiple charge corrections were implemented to improve sizing accuracy for anisotropic particles and broaden applicability across complex morphologies. In its current form, the platform characterizes particles from approximately 10 to 350 nm and provides ensemble-representative data for billions of particles within minutes.

The method was demonstrated using Au nanoparticles as a control, Cu-Ag nanocatalysts for electrochemical CO2 reduction, and CoNiSn(OH)6 particles relevant to the oxygen evolution reaction. Results were in good agreement with electron microscopy and bulk elemental analyses, while offering substantially higher throughput. This platform provides an accessible route to reduce characterization bottlenecks in catalyst discovery and supports faster predict-synthesize-test cycles in energy materials research.

7. Evaluating analysis of lithium borate glasses by LA-ICP-MS for the determination of bulk trace element concentrations in geological samples

Danielle Fuller[1], Yannick Buret[1], Ethan Tonks[1]

1. Natural History Museum, London, UK.

Abstract

Trace element compositions of rock samples can reveal a wide range of geological processes, however, their quantification can prove challenging. Currently, trace element analysis for bulk rock data at the Natural History Museum, London are obtained by multi-acid digestion followed by inductively coupled plasma mass spectrometry (ICP-MS) of the solutions. However, this digestion protocol is a multi-day procedure, requires the use of hazardous reagents, and is not always successful, especially if the sample contains refractory minerals.

An alternative approach is to use laser ablation ICP-MS (LA-ICP-MS) on a homogenised solid sample. We present our findings gathered while developing a method for LA-ICP-MS of glass beads formed via lithium borate fusion. We mapped a full suite of elements using LA-ICP-MS to evaluate the effects of volatile migration during the solidification of the bead, and identify any heterogeneities within the sample. We show the effect of changing the laser spot size and fluence on the accuracy of the trace element data. Finally, we evaluate the effect of matrix matched primary standard reference materials (SRMs) by comparing the analysed concentrations of geological reference materials when using either standard NIST SRM glasses or fused NIST SRM glasses as the primary SRM. Our results demonstrate the reliability and considerations that are required when analysing bulk rock samples for trace elements by LA-ICP-MS.

Obtaining the trace element composition of rock samples by LA-ICP-MS of glass beads has the advantage of being fast and reliably yields complete digestion of rock samples compared with multi-acid digestion.

8. Titanium dioxide powder handling simulations – Analytical method development for the quantification of titanium on different collection media

Darren Musgrove[1], Delphine Bard[1]

1. HSE Science and Research Centre, Buxton, UK.

Abstract

Workers can potentially be exposed to airborne particles including nanoparticles in workplaces when handling powders. During these processes, airborne particles can form agglomerates and aggregates which can change the exposure risk and subsequent measurements.

The International Agency for Research in Cancer (IARC) has classified titanium dioxide as being suspected of causing cancer (Group 2B). In an occupational setting, workers can be exposed to airborne titanium dioxide particles during the production of paint, plastics, skincare products and paper.

The aim of this project is to gain a better understanding of the agglomeration state of the released particles when handling nano / pigmentary powders and what should be measured in the workplace. Simulated experiments were undertaken using a calm air chamber whereby five titanium dioxide (TiO_2) powders containing nanoparticles were 'dropped' from height. The airborne TiO_2 particles were measured using a range of real-time devices (e.g. GRIMM Aerosol Technik Mini Wide-Range Aerosol Spectrometer (Model 1371) and Thermo Fisher Scientific DataRAM™ pDR-1500 Aerosol photometer). Additionally, inhalable and respirable sized fractions were collected on filters using 5 different air samplers and analysed using Inductively Coupled Plasma Optical Emission Spectrometry (ICPOES).

Initial findings indicate that some air samplers out-perform others, exhibiting a greater recovery of material.

9. Differentiation between exposure levels in silica based workplaces

Elizabeth Leese[1], Jackie Morton[1]

1. Health & Safety Executive, Harpur Hill, Buxton, UK.

Abstract

Exposure to crystalline silica in the workplace is hazardous to health. Recently we have reported that exhaled breath condensate (EBC) shows potential as a biomonitoring technique to better assess exposure and protect workers. In the work described here we focus on comparing the silicon containing particles measured in both EBC samples and static air filters collected from workers sampled at two different sites (a brick manufacturer & a stone masons.

Using single particle ICPMSMS (spICPMSMS) silicon containing particles were measured using a Agilent 8900 ICPMSMS in hydrogen gas mode using a Single Cell High Efficiency spray chamber and nebuliser from Glass Expansion. All data was exported and analysed using SPCal.

The results showed that one work site had higher levels of Si-containing particles. The spICPMSMS results showed a positive correlation between the number of particles observed in a post shift EBC sample and those on an air filter. There were differences in the size of particles detected; smaller particles were observed in the EBC samples compared with those in the air filters. This work shows the potential of spICPMSMS to measure exposure to crystalline silica in the workplace.

10. Development of a combination ICP-MS and MR-ToF for improved radionuclide detection

Emily Agg[1,2], Kieran Flanagan[1], Giuseppe Lorusso[2], Ben Russell[2]

1. University of Manchester. 2. National Physical Laboratory.

Abstract

Mass spectrometric techniques are increasingly being applied to low-level measurement of radionuclides for applications including nuclear decommissioning, environmental monitoring, and nuclear forensics. Despite the significant advances in sensitivity and online interference removal (such as through variable resolution or collision/reaction cell capabilities), isobaric interferences remain a considerable interference for most radionuclides. Without complete separation using offline chemical and/or online instrument techniques, there is significant impact on the accuracy of the final measurement.

An inductively coupled plasma multi-reflection time of flight mass spectrometer (ICP-MR-TOF-MS) is under development. The Multi-Reflection Time-of-Flight Mass Spectrometer comprises of two electrostatic mirrors and a field-free drift region. Mirrors are separated by a drift tube, which is pulsed to enable ion ejection / extraction. A single ion cluster is reflected multiple times over the drift region, folding trajectory into one-dimensional space. Significant mass resolutions up to 2 x 108 reported, which is sufficient for separation of all isobaric interferences that can impact radionuclides measurable by mass spectrometry, suggesting that MR-TOF-MS can be applied to samples with high levels of contamination. The MR-TOF-MS has been combined with the robust and ell established ICP source, which has been taken from a commercial ICP-MS and modified for extraction, before passing to the MR-TOF via ion optics and beam cooling.

This work will present the progress on the development of the instrument, as well as simulations of the resolving power and sensitivities achievable, focusing on separation of 90Sr from isobaric 90Zr.

11. Development of the LA-ICP-MS method for fast measurement of element distribution in biological tissues

Hana Kučerová[1], Antonín Kaňa[1]

1. University of Chemistry and Technology, Prague, Czech Republic.

Abstract

LA-ICP-MS is a powerful analytical technique that enables spatially resolved determination of elements in solid samples at the microscopic level. Its high sensitivity and minimal sample preparation make this method ideal for applications in the imaging or mapping of biological tissues. However, its wider use is hindered by the time-consuming nature of the process, which also leads to high financial costs. In this study, a novel approach based on pseudorandom sampling grids (e.g., Sobol sequences) combined with Bayesian reconstruction is proposed as an alternative to conventional orthogonal scanning. For a sample area of 1 cm^2 at a spatial resolution corresponding to a 100 µm spot size, the number of ablation points was reduced from 40,000 (conventional grid) to approx. 7,000. The procedure reduces analysis time of up to 80 % while also enabling uncertainty quantification of the reconstructed images, which allows identification of poorly reconstructed regions and supports targeted re-sampling. The quality of the reconstruction was evaluated using the Structural Similarity Index Measure (SSIM). In this case, it had a value of 0.67, that mean the images were similar, with all relevant structures in the sample captured. This new approach enables rapid LA-ICP-MS mapping and significantly increases sample throughput.

This work was supported from the grant of Specific university research – grant No A2FCHI2026008.

12. Breath Research Improving respirable Crystalline Silica exposure assessment (BRICS)

Jack Smith[1,2], Elizabeth Leese[1], Jackie Morton[1], David Polya[2]

1. Health and Safety Executive Science and Research Centre, Harpur Hill, Buxton, United Kingdom. 2. University of Manchester, Manchester, United Kingdom.

Abstract

Respirable crystalline silica (RCS) inhalation is known to cause silicosis, the most prevalent occupational lung disease globally. Although there is currently a focus on occupations involving artificial stone due to rising cases, RCS exposure is a risk in many industries, including sandblasting, mining, quarrying, bricklaying, construction, foundries and ceramics. Air monitoring is the conventional method used to assess exposure to RCS; there is currently no available biological monitoring method. However, work done by Leese et al. (2017) evidenced that exhaled breath condensate (EBC) could be a viable medium in which to assess RCS exposure. In the first phase of the BRICS project, we will compare EBC collection methods and protocols with the aim of standardising a collection procedure. We also aim to streamline the processing of sample data generated from EBC sample analysis. An analytical technique called single particle inductively coupled plasma tandem mass spectrometry can measure silicon containing particles in the EBC sample. Currently a one-minute data acquisition collects 600,000 data points per sample which are transformed to give particle concentration, number and size. These methods will be used to assess exposures of relevant workers, by collecting samples via site visits to be undertaken in 2026/27.

13. Alternative matrices for determining blood lead exposures

Jackie Morton[1]

1. HSE Science and Research Centre.

Abstract

Workplace exposure to lead requires the collection of blood samples. The work described here investigates the use of quantitative dried blood spots (qDBS) to help simplify blood sample collection, making it more accessible and less of a burden for workers and companies. The usefulness of urine measurements for assessing exposure to lead in the workplace was also investigated.

To evaluate the utility of qDBS and urine as matrices to assess lead exposure, workplaces were asked to send paired whole venous blood, two blood spots sampled from a finger and a urine sample, when workers were undergoing their planned workplace biological monitoring. Five UK workplaces participated in the study and 103 lead workers provided the conventional venous blood sample with a mix of urine samples (n=99) and a dried blood spot samples (n=81).

Workers who provided the samples exhibited a range of lead exposure with venous blood lead results ranging between 0.3-42.6 µg/dL. The results obtained from the qDBS samples were variable both in terms of successful blood collection and the lead concentrations determined. There was a 22% failure to spot from fingers onto the devices. Overall, there was a correlation of r=0.4 between the blood lead concentrations in the venous sample and those obtained from the dried blood spots. This did vary between workplaces and types of lead exposure, for instance one workplace showed a strong correlation of r=0.98 (n=10).

The correlations seen between venous blood and urine were better than expected. The overall correlation was r=0.72. Only one workplace did not show any correlation. Another workplace showed an improved correlation when only non-smokers were compared.

These results suggest that both urine and qDBA may not be suitable for assessing exposure to lead in all cases but that for some workplaces exposure they implemented as a useful screening test.

14. Urinary Metals as Biomarkers of Occupational Exposure in Welders

Jasmine Hall[1,2], Adam Laycock[1], Jack Smith[2], Jackie Morton[2], Kate Jones[2]

1. UK Health Security Agency, UK. 2. Health and Safety Executive, UK.

Abstract

Welding is an important and widely used technique for metal joining with a broad range of applications in manufacturing, construction, and transportation industries. Welding results in the production of fumes containing ultrafine metal-particles. The composition of these fumes is determined by the type of welding process and materials involved. It is well-documented that inhalation exposure to welding fumes can lead to serious health conditions, including lung cancer, chronic obstructive pulmonary disease, occupational asthma and neurotoxicity.

To assess welder's metal exposure biomonitoring is employed, typically in the form of urine sampling. Here we assess urinary Al, Co, Cr, Cu, Fe, Mn, Ni, Pb, Sn, Ti, V, W and Zn concentrations in welders and a control group and found significant increases ($P < 0.05$) in Cr, Fe, Mn, Ni, Ti and V levels in welders. However, the concentrations were either below or just above the reference value for non-occupationally exposed individuals. This indicates that welders have an elevated, but not excessive, occupational exposure to these metals. Urine has been used for biomonitoring purposes largely due to the ease of sampling/collection. However, this may not be the most relevant medium to best determine lung exposure through inhalation. Future work is planned to compare total metal and metal-particle characterisation in urine, blood and exhaled breath condensate samples collected from welders to assess the appropriateness of these different sampling techniques for occupational biomonitoring applications.

15. Identification of a potential quality control material for Chromium species at a concentration relevant to the consumer product testing

John Entwisle[1], Serhat Doker[1], Sarah Hill[1], Heidi Goenaga-Infante[1].

1. LGC Ltd, The Priestley Building, 10 Priestley Road, Guildford, Surrey, GU2 7XY, UK.

Abstract

Cr (VI) is a toxic carcinogen and, there are numerous consumer protection regulations in place including the following:

- Packaging- EC 2015 (SI 2015/1640).
- Cosmetics-EC No 1223/2009.
- Toys-EN 71-3:2019. Safety of Toys – Part 3: Migration of certain element.
- Cement-Directive 2003/53/EC.
- Electronics-Restriction Hazardous Substances (RoHS) Directive, 2002/96/EC.
- Leather- European REACH Regulation (EC) No 1907/2006 Annex XVII entry number 47.
- Workplace- Directive 2004/37/EC - carcinogens, mutagens or reprotoxic substances at work.

Maintaining species integrity of low levels of Cr (VI) in the presence of significant amounts of Cr (III) is crucial for demonstrating due diligence by manufacturers.

Currently there is a lack of suitable quality control materials for low level CrVI (10-100 ug/kg) that can be used for method validation and proficiency testing schemes. This work will discuss the identification and preliminary characterisation of a potential candidate material to help bridge this gap. The material proved to be suitably homogeneous by external calibration analysis at the 0.1g sample size with CrVI at 35.6 ± 3.7 ug/kg and CrIII at 351 ± 2.7 ug/kg (n=10). The use of species-specific double isotope dilution (spiking with 53Cr (VI) and 50Cr (III)), will be invaluable to demonstrate species integrity during the analytical process and to establish a full uncertainty budget according to GUM principles.

16. Data processing for trace element concentrations determined by solution ICP-MS using a Python based application

Laura Crick[1], Yannick Buret[1], Ethan Tonks[1]

1. Science Innovation Platforms, Natural History Museum, London, UK.

Abstract

The trace element concentrations of a variety of samples provide vital insights to a range of applications across the physical sciences. Following dissolution or digestion of a sample into solution, inductively coupled plasma mass spectrometry (ICP-MS) is used for analysing its trace element composition. However, obtaining accurate datasets comes with significant challenges, such as differing chemical compositions resulting in matrix effects in the ICP-MS. While the quantification of ICP-MS data is relatively routine, some data processing must take place following ICP-MS analysis including calibration calculations, instrumental drift and interference corrections. While processing can be carried out using instrument software, it is helpful to perform further validation offline, often manually using Excel spreadsheets. This process is often time consuming and error prone.

We have developed a Python based application to process ICP-MS data from the raw data and produce a dataset reporting sample concentrations. The application performs blank, drift, and interference corrections while isolating reference material data and propagating uncertainty. The application includes user configurable parameters to automate much of the data processing procedure, including outlier rejection of replicates and calibration points. All steps of processing are visualised with an interactive graphical user interface (GUI). The application is versatile, handling a variety of sample types and sample run complexity. Quality control (QC) checks using known concentration solutions can be visualised throughout the processing alongside a database of certified reference material (CRM) values. All data is exported in formatted tables and includes blank, limit-of-detection, QC, and CRM information.

17. Adsorption of ionic silver and silver nanoparticles onto pristine and aged true-to-life microplastics

Laura Torrent[1], Mary Isabel Villacis[1], Manuela Hidalgo[1], Mònica Iglesias[1], Eva Marguí[1]

1. Department of Chemistry, Faculty of Sciences, University of Girona, 17003 Girona, Spain.

Abstract

Microplastic (MP) pollution is a growing environmental concern due to the ability of these plastic particles to adsorb and accumulate chemical contaminants in aquatic environment. Among the contaminants present in water, metals and metal nanoparticles have garnered particular attention due to their persistence in the environment, posing a potential risk to ecosystems and human health.

In this contribution, the adsorption behavior of ionic silver (Ag(I)) and silver nanoparticles (AgNPs) onto MPs (63-80 µm) of various materials (e.g., polystyrene (PS), polylactic acid (PLA)) was evaluated. In addition, aged true-to-life MPs with analogous properties were tested to determine whether environmental degradation alters their adsorption capacity. True-to-life MPs were obtained by micronizing commercially available plastic items. Moreover, a subset of these MPs was aged for eight weeks under UV radiation at 42°C to simulate environmental degradation. Then, batch adsorption studies were performed over a period of 7 days at room temperature. Afterwards, the aqueous solutions were filtered through a glass wool column and the supernatants were analyzed employing inductively coupled plasma optical emission spectroscopy (ICP-OES).

Results showed two critical factors governing the adsorption of Ag(I) and AgNPs onto MPs. First, the physicochemical properties of the MPs, such as aging, significantly influence the process. Second, the chemical speciation of the metal plays a decisive role, with the ionic form exhibiting a higher adsorption affinity compared to the nanoparticulate form.

Overall, these findings provide valuable insights into how environmental aging and metal speciation influence the role of MPs as vectors of contamination in aquatic systems.

18. High sensitivity speciation of vitamin B12 Forms in Food Supplements Using HPLC-ICP-MS

Marine Nicolas[1], Delphine Morin-Rivron[1], Laure Poquet[1], Philippe Eugster[1], Stéphane Dubascoux[1]

1. Nestlé Research, Lausanne, Switzerland.

Abstract

Vitamin B12 is one of the most studied vitamins, due to essential implication in neurological and hematopoietic functions. Its different forms, cyanocobalamin, hydroxocobalamin, methylcobalamin, and 5'-deoxyadenosylcobalamin, have different levels of bioavailability and stability, which affects their efficacy as nutritional supplements. Deficiencies can lead to serious health issues such as anaemia and cognitive decline, hence the common use of food fortification and supplementation.

While cyanocobalamin is the most commonly used form due to its stability, it must be converted into the active forms, methylcobalamin and 5-deoxyadenosylcobalamin in the body. This has contributed to the increasing availability of supplements containing these active forms.

The stability of these forms can be influenced by environmental factors such as temperature, pH, and light, as well as interactions with other food components. Therefore, analysing the various forms of vitamin B12 in foods and supplements is necessary to ensure product quality, verify labelling accuracy, and support adequate intake.

An HPLC-ICP-MS method has been developed and applied to the analysis of food supplement, both liquid and pill form, and containing different forms of vitamin B12 to study their stability and confirm accurate labelling.

19. Investigation of Zinc Accumulation in Cacao (Theobroma cacao) Trees via Natural Stable Isotope Analysis

Meherun Nesha[1], Rebekah E. T. Moore[1], Katharina Kreissig[1], Alexander Griffiths[1], Mark Rehkämper[1]

1. Department of Earth Science and Engineering, Imperial College London, UK.

Abstract

The introduction of strict upper limits for Cd in cocoa-based food products imposed by the European Union has made compliance challenging for cocoa producers in many countries. A previous study suggested that Zn can mitigate Cd toxicity in juvenile cacao; however, Zn dynamics in cacao have not been systematically investigated in mature trees grown under field conditions.

In this study, we analysed the Zn concentrations and stable isotope compositions of topsoils (0-20 cm) and different organs of mature cacao trees collected from four Ecuadorian cacao farms. The Zn concentrations varied widely among different tree compartments (3.4-130 µg g^{-1}), with the greatest variability observed in leaves, followed by bark, roots, then fruits. The mean annual Zn mass fluxes to tree organs followed the pattern leaves > wood > fruits > roots, with one exception where the fruits acquired a larger Zn mass than wood. Total Zn concentrations in topsoils ranged from 105 to 149 µg g^{-1}, though only 0.3-1.3% of this was extractable by Mehlich 3, which was used to estimate phytoavailable Zn. Zinc isotope compositions of the topsoils across the study sites were similar, at $\delta^{66}Zn$=0.32±0.06‰ (1SD). All studied trees were enriched in heavy Zn isotopes relative to the bulk soils, but substantial variability was observed, with $\Delta^{66}Zn_{\text{total tree-soil}}$ ranging from 0.15‰ to 0.79‰. Future work will investigate the influence of key soil properties on tree Zn isotope compositions and compare Zn and Cd isotope fractionations in mature cacao trees to better understand how these elements are processed in soil-cacao systems.

20. Using Time of Flight ICP-MS to revisit some of the original benefits of ICP-MS and improve measurement confidence in more complex analyses

Phil Shaw[1], Lukas Schlatt[1]

1. Nu Instruments, Wrexham, UK.

Abstract

The ICP-MS ability to collect the full mass spectrum of a sample has been qualitatively useful during method development to look for interferences on the different isotopes of an element in different matrices. The speed of analysis is improved with sequential quadrupole ICP-MS by just measuring one isotope and for most analytical work, the use of quality control standards has offset the reduction in multi-isotope information available from the sample to confirm the presence of an element. With the wider use of ICP-MS for more complex matrices and the use of reaction cell chemistry to eliminate common interferences with the risk that additional new interferences may arise, the ability to confirm the presence of an element by ratio of it's isotopes is becoming more valuable.

This presentation will discuss the advantages of Time of Flight ICP-MS (ICP-TOF-MS) for more reliable quantitative analysis where the measurement of multiple isotopes of an element without compromising speed of analysis can be used to provide a confidence value for the accuracy of the concentration measured. It has already been established that ICP-TOF-MS can be used to improve detection limits by summing isotopes (1). Also, the speed of measurement has established the ICP-TOF-MS technique as the only viable option for multi-elemental analysis of individual nanoparticles (2) and the highest productivity method for trace level elemental mapping (3). The further benefits of confirmation of presence will be discussed for both nanoparticle and elemental mapping when using ICP-TOF-MS compared to quadrupole ICP-MS.

(1) Lockwood et.al. J. Anal. At. Spectrom. 2024, 39, 22
(2) Azimzada et. Al. Front. Environ. Sci. June 2020 8:9
(3) Greenhalgh et. al. J. Anal. At. Spectrom., 2020, 35, 2231

21. Re establishing Multi Isotope Advantages in LA ICP TOF MS Imaging to Enhance Confidence in Quantitative Elemental Mapping

Phil Shaw[1], Lukas Schlatt[1]

1. Nu Instruments, Wrexham, UK.

Abstract

Laser ablation ICP MS imaging increasingly requires robust, interference resistant quantification as sample matrices become more heterogeneous and multi elemental. Quadrupole based LA ICP MS systems typically measure only one “safe” isotope per element to maintain speed, sacrificing both sensitivity and the ability to validate analyte identity through natural isotopic patterns. This limitation becomes more pronounced when reaction/collision gases are used, as additional, unexpected interferences can arise.

Time of Flight ICP MS (ICP TOF MS) restores one of the original strengths of ICP MS—simultaneous, full spectrum detection—but now at acquisition rates compatible with high resolution LA imaging. Full isotopic capture per pixel enables isotope ratio based confirmation, multi isotope summation for improved S/N, and pixel wise deconvolution of overlapping species, all without compromising spatial resolution or mapping speed. Recent studies have demonstrated substantial gains in detection power and confidence when summing isotopes during LA imaging with improvements in S/N of up to an order of magnitude. [1]

In LA ICP TOF MS imaging, these advantages translate directly into more reliable quantification across complex or unknown matrices, improved discrimination of true analyte signals from matrix specific interferences, and enhanced interpretability of high dimensional imaging datasets. Recently this information has been used in machine learning approaches to gain a deeper insights into the acquired data, but a deconvolution of TOF data has yet to be examined in detail. [2]

This contribution will illustrate how multi isotope information improves analytical confidence, quantification robustness, and interpretability in LA imaging workflows. Case examples will highlight gains in isotopic confirmation and data reliability.

[1] Lockwood et al. J. Anal. At. Spectrom., 2024, 39, 227
[2] Kronenberg et al. J. Anal. At. Spectrom., 2025, 40, 3473-3484

22. Understanding the role of zinc in breast cancer through integration of LA-ICP-MS, clinicopathological features and immunohistochemistry

Amy V. Lovejoy[1,2], Alexander P. Morrell[3], Arshiya Banu[4], Naomi Guppy[5], Jamila Din[5], Ioannis Roxanis[5], J. Louise Jones[6], Suchana Mukhopadhyay[7], Piotr R. Golda[3], Tom Lund[8], R. Charles Coombes[9], Mark Rehkämper[1], Rebekah E. T. Moore[1]

1. Department of Earth Science and Engineering, Imperial College London, UK. 2. Clinical Trials and Statistics Unit, The Institute of Cancer Research, UK. 3. London Metallomics Facility, King's College London, UK. 4. School of Biomedical Engineering and Imaging Sciences, King's College London, UK. 5. Histopathology Core Facility, The Breast Cancer Now Toby Robins Research Centre, The Institute of Cancer Research, UK. 6. Centre for Tumour Biology, Barts Cancer Institute, Queen Mary University of London, UK. 7. Imperial College Healthcare NHS Trust, Charing Cross Hospital, UK. 8. Integrated Pathology Unit, Royal Marsden NHS Foundation Trust and The Institute of Cancer Research, UK. 9. Department of Surgery and Cancer, Hammersmith Hospital, Imperial College London, UK.

Abstract

Trace metal dyshomeostasis has been implicated in the pathophysiology of breast cancer (BC). Bulk elemental and isotopic studies have previously suggested altered Zn handling in the tumour microenvironment. Advances in laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) now enable quantitative elemental imaging of tissue sections at high resolution. However, such studies are infrequent due to the highly technical and resource intensive nature of the technology, and have limited throughput due to sampling chamber size.

Here, we present the first application of LA-ICP-MS to a BC tissue microarray (TMA), enabling spatial elemental analysis across ninety-seven 1 mm diameter cores from twenty-eight patients. Distributions of 56Fe and 66Zn were acquired across all cores in a single ~10 h run (4–6 min per core) using a 193 nm, 1 kHz laser system (10 µm spot size) coupled to a triple quadrupole ICP-MS. Our bespoke TMA was designed to capture diverse BC tumour microenvironments, including invasive tumour foci, invasive margins, immune-infiltrated and necrotic regions.

Serial TMA sections underwent LA-ICP-MS, histopathological staining, and immunohistochemical analysis for classical BC subtype markers (ER, PgR and HER2), as well as a proliferation marker (Ki67). Additional serial sections were used to assess Zn-related protein expression of Zn transporter ZIP6 and storage protein MT2A. By integrating this wealth of elemental, clinicopathological and immunohistochemical data, we explore spatial patterns of Zn accumulation and depletion within and between tumours to elucidate its functional significance in BC biology. We also assess correlations with clinically relevant features including tumour grade, stage and subtype. This workflow establishes a scalable approach for high-throughput elemental bioimaging, and provides a foundation for future studies investigating the prognostic and therapeutic relevance of Zn dyshomeostasis.

23. Determination of Phosphorus Purity from the Thermochemical Treatment of Sewage Sludge Ash: The Challenges of Scaling Up

Sydney Simbürger[1], Sara Widhalm[1], Johanna Irrgeher[1], Thomas Prohaska[1], Christoph Gatschlhofer[2], Zlatko Raonic[2], Shaun T. Lancaster[1]

1. Montanuniversität Leoben, Department General, Analytical and Physical Chemistry, Franz-Josef-Strasse 18, 8700, Leoben, Austria. 2. Montanuniversität Leoben, Department of Thermal Processing Technology, Franz-Josef-Strasse 18, 8700, Leoben, Austria.

Abstract

Phosphorus is a critical raw material used as a precursor to produce products that play a fundamental role in our society, especially as fertilizers. Secure and reliable supply chains are crucial for Europe and the circular economy is becoming more essential to address global stability issues. Within the PHOBOS project, a pyrometallurgical process is being developed to enable industrial-scale recovery of white phosphorus (P_4) from sewage sludge ash and sewage sludge charcoal as input materials. Impurities in such production of P_4 arise due to possible formation of red phosphorus during the process, as well as carry-over of other elements from the input material composition. This poster focuses on designing and testing an analytical concept safely capable of assessing the purity of P_4 of sample sizes up to 1 kg. While methods exist for P_4 analysis, the community lacks methods that can be scaled up to industry-level process requirements while ensuring safe handling.

In the analytical approach, an organic extraction approach using carbon disulphide is proposed to separate P_4 from the potential impurities. X-ray fluorescence analysis of a sewage sludge ash input material identified Al, Ca, Fe, and S as potential metal impurities. The quantity of P_4 can then be determined gravimetrically following distillation, and the other impurities can be determined by inductively coupled plasma mass spectrometry (ICP-MS). Experiments using red phosphorus spiked with these target metals during the organic extraction procedure, followed by ICP-MS analysis, obtain a mass balance of each target impurity to understand transport pathways during the P_4 extraction procedure. The first stages of the project involve designing the analytical approach in the absence of P_4 to assess the recovery of the impurities and to ensure safe handling under an oxygen-free environment.

24. High Throughput Analysis of Soils and Sediments by QQQ ICP-MS Using a Combined Helium and Reaction Cell Strategy

Matthew Cassap[1], Sonia North[1], Tetsuo Kubota[1]

1. Agilent Technologies LDA UK Ltd, Cheadle, UK.

Abstract

Accurate measurement of trace and major elements in soils and sediments is crucial for environmental monitoring and regulatory compliance. These matrices pose significant analytical challenges due to high dissolved solids, complex compositions, and interference from polyatomic and doubly charged ions, which can affect data quality and throughput in routine labs.

This work presents a high-throughput ICP-MS/MS method for multi-element analysis of soils and sediments by using an innovative collision/reaction cell strategy combined with discrete sampling. Helium mode was used as the main operating condition for most analytes, offering effective suppression of polyatomic interferences across a broad mass range while maintaining high sensitivity. Reaction mode was selectively used for severe spectral overlaps, including potassium, calcium, arsenic, and selenium, allowing efficient removal of doubly charged and reactive interferences through mass-shift chemistry.

Method performance was assessed using certified reference materials for water, soil, and sediment, prepared and analyzed following a regulatory-compliant workflow. Detection limits for most elements were in the low ng/L range after sample dilution. Quantitative results agreed with certified values, with recoveries generally within ±10%. Matrix spike and duplicate analyses further verified method accuracy and precision. High-matrix samples were analyzed continuously over extended periods, demonstrating stable internal standard responses and consistent performance.

The combined use of helium mode and reaction mode simplifies interference management, decreases the need for multiple acquisition conditions, and supports quick analysis of complex environmental samples. This method allows for fast, reliable, and repeatable analysis, making it ideal for labs aiming to increase productivity without sacrificing analytical quality.

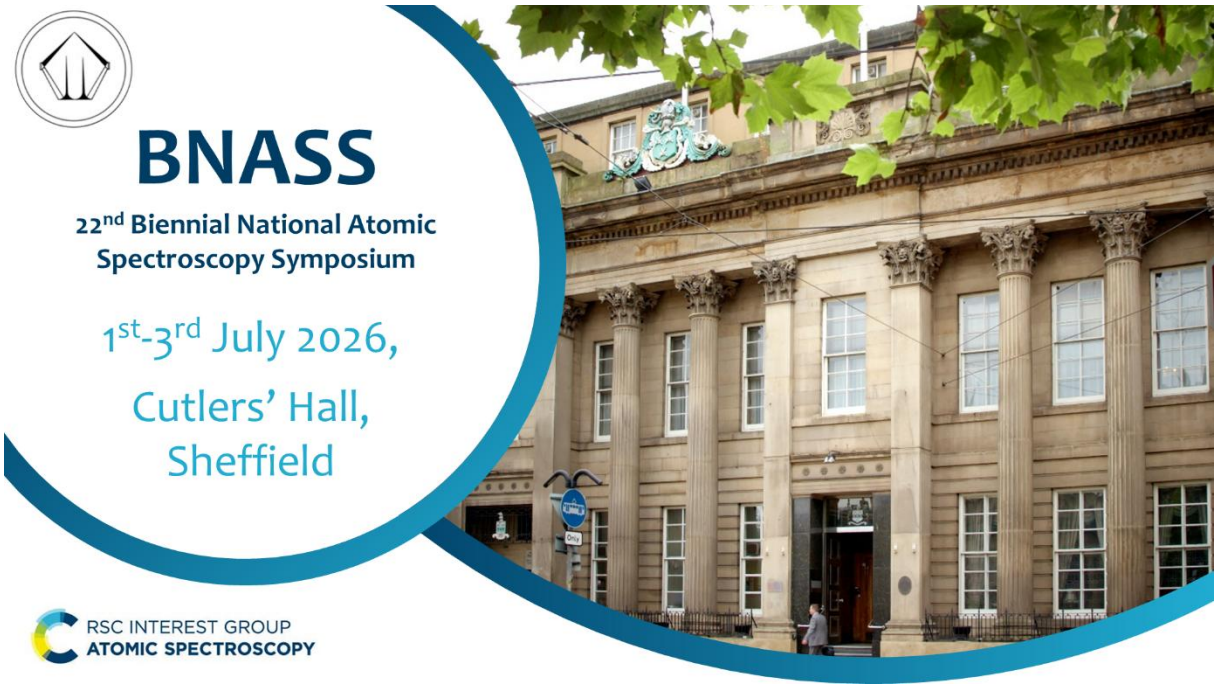
25. Nanoceria–Carbon Nanotube Cryogels as a Preconcentration Platform for Multi-Element ICP-MS: Analytical Performance, Matrix Effects, and Regeneration

Sunaina Mudigonda[1], Yeou-Lih Huang[1]

1. Department of Medical Laboratory Science and Biotechnology, Kaohsiung Medical University, Kaohsiung, Taiwan.

Abstract

Accurate quantification of trace-level toxic elements in complex aqueous matrices remains challenging due to matrix effects, low analyte concentrations, and spectral interferences. In this study, a nanostructured cryogel composed of polyvinyl alcohol (PVA), hyaluronic acid methacrylate (HAMA), functionalized multiwalled carbon nanotubes (f-MWCNTs), and nanoceria ($nCeO_2$) was developed as an integrated preconcentration platform for inductively coupled plasma mass spectrometry (ICP-MS). Three cryogel variants (PH, PHF, and PHFC) were synthesized via a freeze–thaw approach and evaluated for simultaneous enrichment of As(V), Cd(II), Pb(II), and Zn(II). The PHFC cryogel exhibited enhanced adsorption capacity and rapid mass transfer, enabling efficient analyte preconcentration prior to ICP-MS analysis. Analytical performance demonstrated significant signal enhancement, low limits of detection, and high recoveries across all target elements. External calibration with internal standard correction provided excellent linearity and reproducibility, while minimal signal suppression was observed under varying ionic strength and competing ion conditions. Interference studies confirmed effective mitigation of matrix-induced signal distortion. The system retained >80% recovery after six regeneration cycles and delivered reliable results in river water with satisfactory spike recoveries. These findings demonstrate the potential of nanoceria–carbon nanotube cryogels as reusable preconcentration platforms to enhance ICP-MS performance for trace multi-element analysis in complex environmental matrices.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