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EDITORIAL

Elemental mass spectrometry for bioanalysis

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Mass spectrometry (MS) probably represents the most important and versatile analytical tool for the qualitative and quantitative characterisation of matter in living and non-living systems. It is an indispensable tool for identifying unknown and determining known chemical compounds. Its impact is tremendous in both routine analyses like environmental, food, or clinical monitoring and research activities like proteomics and metabolomics, to name just a few examples. For such purposes, the dominating ionisation sources are surely electrospray ionisation (ESI), matrix-assisted laser desorption and ionisation (MALDI), and electron impact (EI) dedicated to the analysis of mostly organic compounds. Complementary to these techniques, elemental mass spectrometry often refers to ionisation sources that degrade any matter to its basic components, to the atoms and their corresponding ions. Although there are various possibilities to produce elemental ions, the primary source is an inductively coupled plasma (ICP). Since its first description in 1980, this technique (ICP-MS) has experienced enormous development in various aspects. Nowadays, extremely low detection limits are achievable for numerous elements of the periodic system of elements (in some cases down to pg L-1 levels). Potential spectral (isobaric and/or molecular) inferences can be controlled in a smart way (mainly by collision/reaction cell technologies) without significant loss of detection sensitivity. Together with its wide applicability in materials science, geochemistry, food control, and environmental science among others, ICP-MS has, therefore, matured into an indispensable analytical tool for trace and ultratrace determinations of multiple elements.

The present topical collection on *Elemental Mass Spectrometry on Bioanalysis* covers in total 24 contributions that reflect actual research and exciting tendencies on this topic. It represents a stimulating mixture of two trend articles, four critical reviews, three short communications, and 15 original articles. Even more exciting is the huge variety of scientific aspects and applications that have been covered. Sample preparation strategies for the determination of total elemental concentration have been highlighted in four articles. In this regard, also quality control aspects have been covered for the determination of rare earth and other less studied elements in reference materials. Total elemental analysis was also combined with biological techniques in order to study in vitro the degeneration in the retinal pigment epithelium. Elemental speciation—referring to the discrimination and determination of different compounds containing the same element—still represents high importance in the field of elemental mass spectrometry. Various contributions cover this topic with a focus on elements like arsenic, selenium, and technetium by the combination of liquid chromatography and ICP-MS. Furthermore, the complementary use of ESI- and ICP-MS gave insights into the metalation of thioredoxin by Au(I) therapeutic compounds. This investigation also links to another important topic that is covered within the collection: determination of biomolecules like proteins by ICP-MS techniques. In total, five research articles and reviews describe the usefulness of different quantitative methodologies to tackle such analytical challenges. Together with solid sampling techniques like laser ablation coupled to ICP-MS (LA-ICP-MS), both trace elements (even with a one-point calibration) and target proteins using labelled antibodies were quantitatively accessible. Imaging LA-ICP-MS was revealed as an important technique to explore detailed

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processes during bacterial infection, although some sample handling techniques—as shown in another study—were found to have a potential influence on the elemental concentrations and distributions in tissue sections.

As an actual field of research activities, the determination and characterisation of small objects (biological cells, nanoparticles, etc.) is also well represented in this collection. Single-cell ICP-MS provided deeper insights into the protective effect of different Se compounds against neurotoxicity induced by methylmercury. A recently introduced configuration of a downward-pointing ICP coupled to a time-of-flight mass spectrometer was studied for the quantitative analysis of single cells and microplastic particles by the detection of various isotopes, including ^{12}C. However, the majority of contributions about the detection of small objects were related to metal-containing nanomaterials. Nanomaterials in food represent an analytical challenge—not only for ICP-MS—that has been highlighted in a trend article. A study on biogenically produced Se nanoparticles in medicinal mushrooms follows that trend. In two critical reviews, the authors discuss the role and potential of ICP-MS in toxicological studies of metallic nanoparticles and investigations related to the potential effects of nanoparticles on the cultivation of edible plants. In terms of a specific toxic impact, Au nanoparticles are highlighted in a study that associated air pollution and kidney diseases.

As guest editors, we greatly acknowledge the effort and great motivation of all colleagues and friends having contributed to this topical collection. Such a project can only be realised with the outstanding support and help of the editorial team of ABC: Thank you very much! Revising the great selection of different topics that have been covered in this topical collection, we strongly believe that the published contributions of general high quality reflect the actual state of the art in research on elemental mass spectrometry in bioanalysis. Finally, we hope that it will serve as a valuable and inspiring source for all readers of *Analytical and Bioanalytical Chemistry*. Enjoy it as much as we do!

Jörg Bettmer is currently Full Professor of Analytical Chemistry at the University of Oviedo, Spain. He defended his doctoral thesis in analytical chemistry (supervisor Professor Karl Cammann) at the University of Münster, Germany, and later his habilitation (mentor Professor Klaus G. Heumann) at the University of Mainz, Germany. During that time and afterwards, he spent several research stays in various research centres like the University of Bordeaux in France; the Complutense University of Madrid in Spain; Humboldt University of Berlin, Germany; and the Bundesanstalt für Materialforschung und -prüfung (BAM), Berlin. Since 2007, he has been working at the University of Oviedo. His main research interests are dedicated to the development of analytical methods based on mass spectrometry, especially ICP-MS. Here, the focus of applications is related to elemental speciation, metallomics, single-cell analysis, and manufactured and biogenically produced nanomaterials. He has published more than 100 research papers, reviews, and book chapters and delivered more than 50 invited lectures and short courses in various national and international conferences.

Mario Corte-Rodríguez is currently Assistant Professor at the University of Oviedo in Spain. He obtained his PhD at this university in 2017 supervised by Professor Elisa Blanco González and María Montes Bayón, and since then, he has had the opportunity to carry out research stays at the BAM in Berlin, Germany, and the University of Vienna, Austria. His current research is focused on the analysis of single particles and single cells by elemental mass spectrometry (ICP-MS). In combination with the use of metal-labelled immunoreagents, he is interested in developing analytical methodologies for the quantification of multiple biomarkers at the single-cell level. He has published more than 20 peer-reviewed articles and several book chapters, with a total of about 500 citations.

Marcia Foster Mesko is Associate Professor at the Federal University of Pelotas (UFPel), in Brazil, since 2009. She has experience in analytical chemistry for the development of methods for sample preparation, ultrasound and microwave technologies, speciation analysis, and quality control of food, pharmaceuticals, and other industrial product analysis using ion chromatography and atomic spectrometry techniques. She has published over 130 peer-reviewed international papers, with over 2534 citations and an H-index of 30. She has a distinguished scholarship from the National Council for Scientific and Technological Development (CNPq), level 1C. She was Director of the Analytical Chemistry Division of the Brazilian Chemical Society. She has received several national and international awards, including the "L'Oréal Brazil – For Woman in Science" from L'Oréal, the Brazilian Academy of Science and UNESCO 2012, JAAS-2018 Emerging Investigator Lectureship from the Royal Society of Chemistry, and the "Periodic Table of Younger Chemists" to represent the element "bromine" for celebrating 100 years of IUPAC and the International Year of Periodic Table, the Young Talent in Analytical Chemistry Award - Brazilian Journal of Analytical Chemistry, and the IUPAC 2023 Distinguished Women in Chemistry or Chemical Engineering. She is an affiliate member of the Brazilian Academy of Science and a titular member of the Pharmaceutical Academy of Science – Chemistry Sciences.