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EDITORIAL

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EuChemS
European Chemical Society
Division of Analytical Chemistry

The European Analytical Column is the voice of the Division of Analytical Chemistry (DAC) as a Professional Network of chemical societies and their members working in all fields of analytical sciences within the European Chemical Society (EuChemS). The strategy for 2021–2023 comprehends the promotion of Analytical Chemistry to a wider community, co-operation with other Professional Networks and to support members' activities, particularly through Study Groups and Task Forces. This year we have invited active scientists to share their thoughts about the near future of Analytical Chemistry. Please help us to expand this discussion among the community and feel free to share your opinion and thoughts through our social media and networks!

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DAC-EuChemS activities

One of the main activities of DAC-EuChemS is the promotion of organization of Euroanalysis conference. Every two years, one of the participating scientific chemical societies will host Euroanalysis, with active involvement of local scientists in the organization. Euroanalysis XXI is scheduled for 2023 and it will take place in Geneva, Switzerland, under the auspices of the Swiss Chemical Society (https://www.euroanalysis2023.ch/), organized by Prof. Eric Bakker (University of Geneva), Dr. Marc Suter (EAWAG), Dr. Franka Kalman (HES Sion), and Dr. Bodo Hattendorf (ETH Zurich).

Other ongoing activities of DAC-EuChemS are performed within Study Groups. These include "Bioanalytics", "Chemometrics", "Education", "Electroanalytical Chemistry", "History", "Nanoanalytics", "Quality Assurance", and "Sample Preparation". Please visit the DAC-EuChemS website for updated reports (https://www.euchems.eu/divisions/analytical-chemistry/) and contact the Heads of the Study Groups in order to have more information or to participate in their activities.

Collaboration with other Professional networks within EuChemS is also sought. In particular, exchange of invited lectures and organization of special thematic sessions is planned to take place in the 18th International Conference on Chemistry and the Environment (https://icce2023.com/) and Euro Food Chem XXII conference, organized by the Division of Chemistry and the Environment (DCE-EuChemS) and by the Division of Food Chemistry (DFC-EuChemS), respectively.

Lastly, one of DAC-EuChemS objectives is to support its delegates in the organization of local events open to the international community through dissemination of the event within the Professional Network, including online events. The Steering Committee of DAC-EuChemS will be happy to receive input for additional activities. Feel free to contact one of the following persons: Slavica Ražić, University of Belgrade, Serbia (Chair); Marcela Segundo, University of Porto, Portugal (Secretary); Martin Vogel, University of Münster, Germany (Treasurer); Jiří Barek, Charles University,

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Czech Republic; Charlotta Turner, Lund University, Sweden; Sibel A. Özkan, Ankara University, Turkey; and Franka Kalman, University of Applied Sciences and Arts of Western Switzerland, Switzerland.

Analytical chemistry in 2030: a glimpse of opportunities and challenges

In the second part of this column, we would like to share our thoughts of the present state and future perspectives of Analytical Chemistry, as views of our guest authors, Diane Turner, Manuel Miró, and Antje Baeumner. In that sense and order, and without ambition to cover all fields, let us tackle some of general and particular points and impacts in a few research areas. And, maybe, just maybe, to open the discussion with the next edition of EAC.

Analytical chemistry is used in most industries from petrochemical to clinical and consumer products to food and environment. In academia, not only is it extensively researched and used in chemistry departments, but also in engineering, earth sciences, planetary sciences, archaeology, biology and beyond. The uses of analytical chemistry are many, from quality control to the identification of components in a sample mixture, and the most important questions when thinking and preparing for sample analyses is why you are performing their analysis and what questions you are seeking to answer. The results from sample analysis can be used to determine the next steps in a manufacturing environment, to decide if a product is safe for use or to consume, to present in a PhD thesis or as evidence in a court of law.

There has, for many years, unfortunately been a large gap between using analytical chemistry in an academic setting compared to using it in regulated industry. Even though method validation and quality control are taught at universities, it has been a long-time coming in reaching research projects, with many publications not showing or even mentioning any basic quality control. There are many aspects to consider when developing a method and validating it, from sample collection, storage, and transportation, to sample preparation, sample analysis, data analysis and reporting, the use of blanks, standards, internal standards, the consideration of different sample matrices, and method performance parameters. Then there is on-going quality control and quality assurance (QC/QA) with system suitability checks, analytical quality control (AQC) standards, replicates, checks for carryover and extraction efficiency, and the monitoring of a wide range of other method performance parameters, dependent on the analytical technique employed and the variables that can affect the results of that technique. When performing quantitative sample analysis, there are a lot of standard QC procedures that can be followed, but many of these can be extended into qualitative analysis too. If two samples appear to give different results, are they truly different or is the method not robust and there is poor accuracy and/or precision due to the analytical instrument or any of the steps from sample collection through to reporting? Is a compound genuinely not in a sample or is it below the method detection limit? If so, what is the method detection limit, not just the instrument limit of detection? What is the uncertainty of your result?

For many projects, a full method validation to ISO 17025 standards is not required; however, a method should always be checked that it is suitable for the sample(s) and compound(s) to be analysed. Generally, the more samples to be analysed, especially if the matrix varies, the more validation and on-going quality control is needed to ensure that not only is the method suitable but remains suitable and gives the correct results for all samples. At the start, a well-thought-out plan for method development, validation, and quality control is needed and that needs to be referred to and evidenced in any reporting, whether that is a publication, poster, or a document for court. The current drive toward proof of the quality of results is welcomed and in the not-too-far distant future could be mandatory for all analytical methods in research as well as industry, especially if presenting into the public domain.

Considering another perspective and its multidisciplinary nature, analytical chemistry is proven superb to tackle the current societal challenges as recently demonstrated by the fast development of sensing platforms in response to the demands occasioned by the SARS-CoV-2 pandemic. The intimate relationship between analytical chemistry and material science ranging from paper-based (fluidic) systems to nanotechnology including silica, polymeric, and metal nanoparticles triggers the development of simple point-of-need/care sensing devices for customized screening applications. Nanotechnology actually is acting as a bridge to expand analytical chemistry to a plethora of companion disciplines to help answering scientific challenges. Theranostic applications are clear examples on how the interplay between analytical chemistry, nanoscience, and biosciences offer unrivalled opportunities against relevant biomarker identification. Inspired by the industry 4.0 technological pillars (e.g., internet of things), wearable sensors and remote sensing approaches enable real-time identification of changing physiological/environmental conditions, yet further developments are still called for to improve detectability and selectivity issues. Instrumental developments for confirmatory results are linked to efforts toward designing advanced mass spectrometry analysers to leverage imaging, ambient detection, and collision cross-sections for reliable high-throughput analysis.

Material science has impacted the entire analytical process right from the first step of sampling to offer new devices for in situ sample preparation and microextraction for targeted or suspect analysis to the detection step by exploiting the unique plasmonic and electrochemical features of nanoparticles and nanoclusters. A technological breakthrough in this field, mostly linked to polymers but also to noble metal chemistry, which nurtured analytical chemistry is the so-called Additive Manufacturing (i.e., 3D-printing). Advanced technologies such as laser sintering, photopolymer inkjet, low-force stereolithography, and fused deposition modelling are revolutionizing several subdisciplines, such as microfluidics, electrochemical and optical sensing, and sample preparation in terms of fast prototyping of devices and straightforward printing of electrodes and optical detection components, aided by the plethora of functional materials available with distinct optical, conducting, and thermal properties and chemical resistance that can be simultaneously processed. We foresee that higher resolution printers at affordable prices with improved minimum printing size features in X, Y, and Z axes will be available in most of the analytical chemistry labs and also technological companies in the near future, because mass production and commercialization of 3D-printed analytical devices are becoming a reality.

Going via next road of highly potential science, the field of biosensors is currently seeing a dramatic increase in societal interest and demands for improvement much beyond the current state of the art. Wearables and point-of-care tests (POCT) receive the greatest public attention due to the increasingly ubiquitous availability of simple, portable, read-out devices (cell phones, watches) and the critical need for POCT during the recent pandemic. In the future, such sensors must achieve lower limits of detection than they provide today; they must allow for multiplexing and especially enable quantitative detection with high reliability and not only provide qualitative or semi-quantitative results. Since the absolute requirement for simplicity of use puts strict limits on technologies used within such sensors, one can predict innovation and advancements to not be derived necessarily from new detection principles, but rather from improved signaling agents, advanced (nano)materials, and artificial-intelligence-assisted readout apps.

Furthermore, the improvement of sample preparation strategies for bio- and chemosensors in general will be of great demand. It is obvious that good results cannot be obtained from a badly acquired sample, and some sample clean-up through centrifugation, multiple pipetting steps, and the like is difficult to implement in most applications and cannot be employed at all in wearable sensors. Thus, in the next 2–5 years, analytical and engineering research should focus on overcoming these ubiquitous challenges that are limiting most of the current bio- and chemosensors targeting on-site applications.

As mentioned earlier, another area of great development in the coming years will be the move toward digitalization, particularly as far as bio- and chemosensors are concerned regarding their integration into the internet of things, digital diagnostics, telemedicine, and remote environmental and food monitoring. As much as physical sensors are seamlessly integrated into large systems, also bio- and chemosensors will continue moving in this direction. Alongside this will come a need to develop sensor technologies that allow for easy mass production, use of sustainable materials and production technologies, and result in products that do not increase the environmental burden caused by their waste. Considering that a dramatic increase in the use of bio- and chemosensors is predictable, these last points need to become design criteria in the development of innovative new bio- and chemosensors in the coming decade.

We can continue our walk from one to another area of Analytical Chemistry and ask ourselves is the sky the limit? It's allowed in our minds but advancements in other scientific fields, such as material science, physics, and biology, will certainly have their impacts and pave the road in advancements of analytical chemistry in close future. Far future? We do not dare to think about it yet. We can follow the best science, that is sure…