Global Partnerships on a Path to Sustainability

Reimagining the future of peer review
Open Science Paradigm
Cover: Long before Laura McConnell realized that global partnerships provide a path to sustainability, she—as a researcher at USDA-ARS—focused on the development of improved agriculture practices to prevent pollutant transport. Aboard a University of Maryland Horn Point Center for Environmental Studies research vessel, she collected oysters for analysis. Read more about Laura’s experience and inspiration page 3.
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Officer’s Column

The Common Language of Chemistry

by Greta Heydenrych

Every two years, IUPAC partners with one of our member associations to host chemists from all over the world and to organise the World Chemistry Congress. In the August 2023, I had the extraordinary privilege to attend IUPAC|CHAINS in The Hague, organized by the Royal Netherlands Chemical Society. The Congress was accompanied by the IUPAC General Assembly and Council Meeting, two key events on the IUPAC biennial calendar, and I was present at both for the very first time.

What became plain in almost every conversation I had, and every meeting or talk that I attended was that the entire field of chemistry is in the midst of an upheaval, spurred on by the digital revolution in all spheres of our lives. Most, if not all, chemists have heard of FAIR data and digital standards, many of us already apply this in their own work, but to many of us this is still a rather intimidating and abstract notion.

And this is exactly where IUPAC can contribute and support your work. IUPAC is the global organisation for standards in chemistry. Traditionally associated with chemistry naming conventions, IUPAC is undergoing a revolution to develop tools, standards and guidelines to enable chemists to not only make their own data FAIR, but to be able to contribute to the digitalisation of chemistry with their own applications. One key endeavour in this area is the WorldFAIR project, initiated by the CODATA Committee of the International Science Council. IUPAC represents the chemical sciences and, with scientists from other scientific fields, such as physics, geology, and biology, is looking to not only develop a sound approach for digital standards within chemistry itself but is also taking care that those standards align and overlap properly with those developed in adjacent subject areas.

IUPAC is also cooperating directly with organisations that are developing standards applications. Most well-known is probably the International Chemical Identifier (InChI), which started off as a IUPAC project. Since launch, InChI has developed a life of its own and is now maintained by the InChI Trust. More recently, IUPAC has also been cooperating closely with NFDI4Chem, which in turn forms part of a Germany-wide network of scientists from all fields of research to develop a coherent digital infrastructure for research data generated by scientists in Germany and beyond. (see CI Jan 2023, p.8, https://doi.org/10.1515/ci-2023-0103)

All of IUPAC’s work on standards, symbols, terminology and, yes, nomenclature is freely available for anyone to apply in their own work. You may consult the online version of the IUPAC Gold Book or read about the latest recommendations in IUPAC’s journal, Pure and Applied Chemistry. At this point, you might ask yourself, “Who is doing all of this work?”. And the simple answer to this is: You! IUPAC is a community-driven organisation. Our work is done by generous volunteers recruited from the chemistry community at large and supported by a small staff of four people comprising IUPAC’s Secretariat. This also means that anyone who is interested can get involved in IUPAC’s activities. You need not be a nomenclature expert or a data scientist. Anyone with a chemistry background can contribute to IUPAC’s work, as we need chemical expertise to underpin any work that we do in the realm of standards. If you enjoy teaching and outreach, IUPAC has many programmes in this area as well, ranging from safety training for industrial chemists to outreach activities for schoolteachers in emerging economies. If you have a social streak, you can organise a GWB event—the 2024 event will be on 27 February and is themed “Catalysing Diversity in Science.” GWB stands for Global Women’s Breakfast, but this is not a women-only event, it is an event for anyone interested in building bridges within the global chemistry community.

So, in a nutshell—the chemistry world is amid a digitalisation upheaval. IUPAC is the global organisation for data standards. IUPAC is embedded in the chemistry community and invites anyone to become involved in our work—whether as a data expert, a standards nerd, an education advocate or a bridge-builder between areas of expertise, regions of our world or subjects within, and adjacent to, our own field of chemistry. To learn more, visit our website, or be in touch with me anytime at gheydenrych@iupac.org. I look forward to hearing from you! 😊

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1 This column was published in Nachrichten, 31.10.2023 https://gdch.app/article/die-gemeinsame-sprache-der-chemie-4139056
Sometimes one idea can change the course of your life. It happened for me in the Fall of my sophomore year at the College of Charleston. A lecture delivered by Dr. Frank Kinard, my professor and mentor at the College of Charleston, inspired me to pursue a career in environmental chemistry. Frank was a beloved professor at College of Charleston for 41 years who also served as secretary of the American Chemical Society Division of Nuclear Chemistry and Technology for 17 years. More importantly, he loved working with and mentoring students [1].

During his lecture that day, Frank described how he used the ocean as his research laboratory. On board the University of Puerto Rico Research Vessel Crawford (Figure 1), Frank measured dissolved oxygen, temperature, and salinity at multiple depths to 2500 meters along a transect from Puerto Rico to Venezuela in the Eastern Caribbean Sea [2]. From this work, he created underwater maps of dissolved oxygen and increased our knowledge of Sargasso Sea water movement into the Caribbean Sea.

Sitting in his classroom, the light bulb went on for me! I realized that chemical measurement tools could be used outside the walls of a laboratory to explore and understand this amazing planet where we all live. In that moment, I became curious to learn more, so I decided on a path towards an Environmental Chemistry career. Since then, I’ve been on a journey of exploration and discovery working to find solutions to address the critical challenges facing our world.

Exploring Large Lakes

I wonder if you can picture yourself on a ship in rough waters inside a tiny laboratory, trying to operate equipment while the floors are constantly moving. I found that conducting research in the real world while fighting seasickness, was really challenging! As a graduate student at University of South Carolina, I was fortunate enough to find just the kind of chemistry research I was interested in and a great mentor, Dr. Terry Bidleman.

During my graduate research, I dragged stainless steel tanks, and pumps and all sorts of gear on to research ships like the United States Environmental Protection Agency Research Vessel Roger R. Simons (Figure 2). I collected and analyzed water and air samples from the Great Lakes [3] and from the world’s deepest, Lake Baikal [4-5] for trace levels of highly persistent pollutants to investigate the processes that controlled the movement of chemicals like polychlorinated biphenyls from the air into large lakes and then into wildlife like fish and seals.
It was exciting and awe-inspiring to see the beauty and power of nature from the deck of the ship and to feel that I was contributing to protecting our environment. It was national and international partnerships established among scientists and science organizations that allowed me the opportunity to conduct this type of exploratory environmental chemistry research. As an early career scientist, I was beginning to grow my scientific network with help from supportive mentors and colleagues.

**Chesapeake Bay Restoration and the Role of Sustainable Agriculture**

After graduate school, I was fortunate to move into a federal government research scientist role at the Beltsville Agricultural Research Center with the United States Department of Agriculture – Agricultural Research Service (USDA-ARS) near Washington DC. It was here that I began to understand the power of partnerships to expand and amplify the impact of scientific research.

An example of building partnerships for sustainability is the decades of research over the last forty years by many hundreds of scientists on restoration of the Chesapeake Bay in the United States, one of the most iconic and majestic estuaries in the world, and home to important species like blue crabs, oysters, and striped bass [6]. The Chesapeake Bay Watershed (land area draining into the Bay and its tributaries) spans six states and the District of Columbia and has a population of 18 million people. Nitrogen and phosphorus from multiple sources are the biggest contributors to degradation in environmental quality [7]. Therefore, partnerships between scientists, resource managers, policymakers, non-governmental organizations, farmers, and citizens groups are vital to implement a science-based approach to restoration.

In agriculture, strategically implementing management practices like cover crops, conservation tillage,
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vegetative buffers and nutrient management on the landscape can contribute to improvements in soil and water quality. The Federal Executive Director of the Chesapeake Bay Foundation recently stated, “Getting more of these practices on the ground—in areas of the watershed where they will have the greatest effect—is key to reaching the Bay states’ pollution reduction requirements by 2025.”

A primary focus of my research at USDA-ARS was the development of improved agriculture practices to prevent pollutant transport into the Chesapeake Bay and other sensitive ecosystems (Figure 3). I was energized by building, participating in, and growing diverse networks of colleagues from different organizations each bringing their own strengths and talents. The kinds of partnerships built in support of the Chesapeake Bay are needed to make progress on planetary-wide goals like the United Nations Sustainable Development Goals.

Industry and Sustainability

After many years at USDA-ARS, I took on a new challenge at Bayer Crop Science. I joined the Environmental Fate team in Research Triangle Park North Carolina. I was recruited by my friend and colleague Dr. Ellen Arthur. I met Ellen through the American Chemical Society, Division of Agrochemicals (AGRO). In AGRO a large group of active volunteers from different sectors work together and support each other. I benefited from the diverse ecosystem of colleagues who are active in AGRO which made me feel more comfortable moving into an industry role.

More recently I moved into a role at Bayer engaging with university and scientific societies on a global scale on regulatory science topics. This new job has allowed me to build even larger networks in support of sustainability. I see now that Industry scientists have an important role to play in achieving a more sustainable chemical enterprise. Industry partners have the capacity to react quickly to changes in the marketplace and to scale up science-based solutions. One of the things that we as industry scientists need to improve on is reaching out and communicating better with the scientific community and making it easier to build partnerships. One of the ways that we can open a door to collaboration is by providing seminars and communicating with science organizations around the world. Our team at Bayer is launching a project called Science CONNECT (https://sway.office.com/neXTdAQaYuB1MFMf). It is designed to be a quick and easy way to request a Bayer speaker for a seminar or other science event.

Another avenue for industry collaboration is public private partnerships. Since 2015 Bayer has been partnering with all these organizations to support the creation and restoration of Monarch Butterfly and Pollinator Habitat. One of the best examples has been partnering with the National Fish and Wildlife Foundation (https://www.nfwf.org/partnerships/corporate-partners/bayer-crop-science). Bayer and other
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organizations provide funding. Scientists apply for funding through the foundation but must also contribute their own matching funds. This approach multiplies the impact of the work that might have been done as separate organizations.

Building Global Networks

One of the most important networks that I have engaged with during my career has been IUPAC. During my time at the USDA-ARS, I was invited to co-organize a symposium as part of the IUPAC International Congress of Crop Protection Chemistry in Washington DC. Four years later, I received a poster award at the same Congress in London. This resulted in an invitation to join the Division VI Advisory Committee on Crop Protection Chemistry. From there, I was elected to Division VI and later to Division President. Up to December 2023, I served as an elected member of the Bureau. I have remained actively involved with IUPAC because of the critical need the collaborative and international nature of projects taken up by the various divisions and committees.

IUPAC, in partnership with other organizations, has been working to tackle one of the most important challenges on our journey towards global sustainability: to close the gender gap in science to ensure that all scientists are able to bring their expertise and talents to the table and can connect with each other. One effort on this front is the IUPAC Global Women’s Breakfast (GWB) (https://iupac.org/gwb/). The goal of the GWB is to create a network of women and men in support of closing the gender gap in science. It is an event that happens on a single day in February each year, around the UN Day of Women and Girls in Science. I’m part of a global leadership team which includes the founder of the GWB, Professor Mary Garson from Queensland University, and 35 team members who help to coordinate events in their regions (Figure 4). The GWB has grown from 100 events in 40 countries/territories in 2011 to nearly 400 events in 77 countries this year. More than 1500 GWB events have been organized in 100 countries/territories over the last five years [10-12].

Sustainability comes in many forms as expressed in the UN Sustainable Development Goals (https://sdgs.un.org/goals). It will require scientists from all sectors working together and building genuine partnerships to overcome the enormous challenges facing our planet. One of the best opportunities to make progress is in partnership with IUPAC.

I have shared a bit about my journey from academia to government and now as an industry scientist. I hope that you can see more clearly the benefits of being curious and partnering with a diverse network of colleagues to enhance the power and impact of your

Figure 4. IUPAC100 celebration in Paris at the IUPAC World Chemistry Congress after the return of the Global Breakfast in 2019. From left: Juris Meija, Christine Dunne, Nnanake Offiong, Javier Garcia Martinez, Supawan Tantayanon, Hooi Ling Lee, Mary Garson, and Laura McConnell
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research. What will your future bring? How will you contribute? Are you open to new adventures in science? Consider how you can build a network of colleagues to help amplify the impact of your work for the long term. As you can see, there are many different paths available. You also know now that none of us can go it alone. We must go full speed ahead together.

References

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Current Hybrid Perspective towards Open Science Paradigm

by Kazuhiro Hayashi

Data, Society, and Open Science

Today, we live in a data-driven society, where data distribution is considered to be the key to future innovation, and various attempts are being made in this pursuit. In science, too, a paradigm shift in data-centered research is underway in the name of Open Science. Open Science creates a new science and research style (Digital Transformation (DX) of science), and does not deny conventional science, but rather improves its efficiency. New scientific research style is added on top of it; new attempts are stacked, and so on, which are complementary to each other. And, as in the past, the progress of science will change society, including industry, and science and society will be transformed eventually. Alternatively, artificial intelligence (AI) research is generating new knowledge from industry and society and advancing science.

This trend of Open Science and the accompanying transformation of science and society has become a global agenda. Specifically, UNESCO’s Open Science Recommendation [1] was adopted in November 2021 with the endorsement of 193 countries. In the process of its adoption, it also gained the support of the International Science Council (ISC), the United Nations, and other organizations, and is recognized as an overarching global agenda that is beyond the scope of any one international organization. The recommendations themselves are not legally binding, but each country is required to report on its progress every four years and to address seven practical items as a country, including infrastructure development, provision of incentives, and human resource development. What is noteworthy here is that none of the countries has a clear picture of how science and society will change through Open Science, and they are trying to promote change by first promoting the sharing of knowledge, mainly through open access to papers, research data, and software. I participated in the advisory committee for the formulation of these recommendations as a member selected from Asia, and while listening to the examples and discussions in each country, I learned that the situation is still one of groping in the dark and trial and error, even in developed countries.

Understanding DX (Digital Transformation) through a review of past scholarly communication

In order to understand this paradigm shift, let’s first take a look back at the transformation of academic information distribution: in the 1990s, when the Internet and the Web were fully utilized, paper journals began to be digitized. This event was a trigger for me to enter this world indeed. In the 2010s, major academic journal articles were given a digital object identifier (DOI) to uniquely indicate their location on the web, or they were linked to Chemical Abstracts or Google search results. In the 2020s, we are interested in the sharing and publication of research data and the measurement of social impact using altmetrics, which looks at responses to social media such as Twitter (now X). As a titular member and a committee member of the IUPAC Committee on Publications and Cheminformatics Data Standards (CPCDS) in the 2010’s, I enjoyed helping IUPAC publications to adopt to this trend.
Needless to say, this paradigm shift is underway based on the characteristics of information technology, especially the internet, which supports the transformation of the past 30 years, and allows us to quickly and interactively share knowledge that has been created explosively in smaller units with the world. In this context, while until the 2010s it was just a gradual evolution of the information distribution infrastructure centered on academic journals and articles, since the late 2010s it has begun to incorporate the world outside the existing structure. This long-term change is an essence of the paradigm shift, and is one of the most important aspects of DX. COVID-19 unexpectedly strengthened promotion of Open Science dramatically, and research results, including preprinted papers and research data, are being shared quickly [2].

Implications for Chemistry: Data-Driven Research, Remote, Preprint

Open Science has been predicted to transform research activities itself beyond the broad and rapid sharing of research results, and it is certainly having an impact on Chemistry. The most familiar example is material informatics in materials science, which is now being strengthened by policy as a concrete example of research DX. In addition, in the life sciences, the use of robots to remotely conduct highly reproducible experiments is gaining momentum. Although we cannot say that this trend is still affecting all areas of Chemistry, relative to five years ago, we can say that we are definitely being affected by this trend, and we expect it to accelerate in the future. For example, scientific journals like JACS and Angew. Chem. had stated that they would not accept preprints, but they changed their policy now. IUPAC is also in the process of adopting this trend, and has published an article advocating Digital IUPAC, or has set up a Blockchain task force, in which the author participates [3]. Here, we examine how blockchain technology is being used throughout the scientific research workflow, from ideas and hypotheses to publication, sharing, and archiving, and explore a new form of chemistry.

The shape and nature of open science as it materializes

The following is an example of the embodiment of the essence of Open Science. A Japanese informatics researcher, who was not in the medical field, found the results of a simulation using WHO’s open data on the occasion of COVID-19 interesting, so he published a preprint and shared it on social networking sites (SNS). As a result, international collaborations with researchers in medicine and sociology (cross-cutting scientific impact) were created, and social impact was generated through efforts with the government. The important points of this episode are that neither academic societies nor journals were involved in this process at all, that it took only a little more than half a year from the idea to the social impact, and that the scientific impact and social impact occurred almost simultaneously. In this way, open science provides a way of conducting scientific research and a mechanism for social collaboration that is impossible with conventional systems. In addition, the concrete counterproposals have clearly shown that the academic information distribution systems that have been developed so far are not fundamentally ready to meet the needs of society, although they have become more efficient with some digitization.

Learning from the 17th Century: The Future of Paradigm Shifts

When I give a talk to have the audience understand the potential of Open Science, I always introduce the similarities between the 2020’s and a certain period in the 17th century. Specifically, the Royal Society, one of the roots of academic societies, was born in 1660, and Philosophical Transactions, one of the roots of academic journals, was founded just five years later in 1665. In the 1660s, Newton and Leibniz were active and competitive, and with the invention of calculus, the founders of mathematical physics, a fusion of mathematics and physics, were established. Interestingly, there is a story that Newton, who could not go to university because of the glandular plague that broke out in London in 1665-66, came up with the law of universal gravitation as a result of his contemplation at home.
There are many theories about how the academic societies and journals were born, but it is said that the societies started as salons where people gathered in cafes for free discussions because the universities at that time were too rigid. It can also be said that securing preemptive rights by exchanging letters became popular because researchers were slow to communicate with each other in printed books, and academic journals were born as a way to consolidate this. Looking at the present age from the perspective of such history, the rigidity of academic societies and the need to break free from it have been actively discussed in this paper, and the nature of academic journals and peer review has been questioned again with digitization and COVID-19. On the other hand, academic social networking services are developing, and preprinting is gaining acceptance. In addition, AI (informatics) is merging with existing science, and new research and linked industries are being born as the humanities and sciences converge. In other words, we are about to repeat the history of creating a new science and society by acquiring new means of sharing knowledge among researchers and with society.

**Cutting Edge: The DX of Science and the DX of the Scholarly Community and Publishing in Automated Research Workflow (ARW)**

Open Science is transforming the style of Science itself with a keyword of Digital Transformation (DX). There are many ways to view DX, including the proposition of what DX itself is, and one of the most popular of these is the Automated Research Workflow (ARW) [4], as researchers pursue creative approaches to DX. Researchers are now incorporating AI and scientific instrument automation into their research workflows, not only using AI and machine learning (ML) methods as workflow components, but also using these methods to design experiments and automatically control experiments. In addition, models are tested and trained using experimental and observational data, and designs for the next data collection are generated using AI and ML methods, in an iterative loop that leads to new discoveries. For example, a mobile robotic chemist led to the discovery of compounds with new physical properties through repeated experiments with unprecedented efficiency. In this ARW, robots that can perform highly reproducible experiments are important.

In addition to that, the “code” that commands the robot plays an important role, and the code is seen as a promising shared medium for the future. In other words, science will be “coded” and robots might be able to become members (or partners) of the academic community. In addition, it is increasingly likely that sharing codes that are uniquely interpreted by machines will be more important than sharing papers, a medium that is easily understood by humans but sometimes ambiguous in interpretation. The research data generated by such codes will then become artifacts and a source of new value. We are focusing on the possibility that the platform for accumulating this code and data will play a new role that is different from the commercial publishers that now have many academic journals and papers. Koichi Takahashi of RIKEN calls the integration and automation of these research processes by AI and robots the fifth science: AI-driven science [5]. I myself believe that, as an ex-publisher at the Chemical Society of Japan, the way of sharing knowledge created by this new science, and who and how the platform requiring code and data mentioned above will be taken on by the new science will be the equivalent of DX in academic publishing. So that I am highly interested in how the knowledge created by this new science will be shared, and who will be responsible for the platform that requires code and data, which is equivalent to DX in academic publishing.

**Affinity between Chemistry and DX**

To digress for a moment, it should be obvious that chemistry has always been strong on “data”. This is because it is essential for handling chemical compounds, and Chemical Abstracts has been working on collecting such information since the 1900s. Chemistry has progressed along with the development of databases of compound and physical property data. In recent years, as the data on which papers are based are required from the viewpoint of reproducibility and transparency, NMR (Nuclear Magnetic Resonance) data, etc., have been required to be submitted for peer review from an early stage. If we limit ourselves to crystallography, a culture of sharing CIF (Crystallographic Information File) data of X-ray structural analysis has been fostered since the 1960s, and an information distribution system centered on CIF data has been established. It is very interesting to note that the data that serves as the basis of the paper seems to play a more dominant role, and even seems to anticipate the data-driven science. Thus, although chemists, or some areas of Chemistry, are familiar with research data, on the other hand, Chemistry, as a so-called small and closed science, has aspects that make it difficult to share data. Without intending to deny this in itself, Chemistry has developed to date through scientific knowledge that has been generated through highly reproducible experiments and local information sharing.
and discussion by people in relatively small units, and this style will continue to live on as long as new values continue to be discovered in the future.

**Changing Science, Society and the Role of Academic Societies. What Can the Chemist Community Do for the DX of the Society**

In its most comprehensive expression, Open Science is an activity to re-develop science itself, to re-develop society including industry, and to transform society as a whole, including the relationship between science and society, by opening up knowledge widely in response to innovations in the information infrastructure of society. Locally, the manners of science will change, but more comprehensively, we must factor in the fact that social systems, including laws and intellectual property, will also change. Open innovation, which has often been emphasized in the current industry-base within its current social system, is expected to evolve discontinuously along with the changes in social systems.

I am not arguing that academic societies and journals will disappear with this discussion, but rather that they will play an important role in promoting such a paradigm shift. In addition, I think it is realistic to divide the 21st century into the old and the new, and to regard it as a transitional period until these two paradigms coexist and are optimized.

Open Science has the potential to advance chemistry, first of all, by making the distribution of information among its research units (laboratories and institutes) more efficient, etc., while retaining the essence of its small and closed science, and, secondly, by creating DX of research methods themselves and related academic publishing, such as ARW. And we believe that the role of research data and AI/robot-centered networks and platforms will play an accelerating role in both. And chemists who have become accustomed to data will be able to take drastic advantage of these possibilities with a slight shift in mindset. The research that can be seen beyond these efforts and the new community that coexists with AI and robots and shares information, including data and codes, are worthy of much consideration as one of the possibilities for DX in academia.

(This article is translated, integrated and edited by the Japanese articles of the Chemical Society of Japan [6,7].)

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Reimagining the future of peer review

In the face of mounting challenges, is now the time to envision a new future for peer review?

by Aimee Nixon

The scholarly publishing landscape is in a period of unprecedented transformation. Against the backdrop of international unrest and concerns around sustainability and climate change, publishing is facing its own set of unique challenges. The accelerated transition towards open science, the increasingly interdisciplinary nature of research and the emergence and rapid improvement of new technologies such as Artificial Intelligence (AI) are transforming the way that we discover, consume and perceive research outputs. Peer review remains a critical process at the very heart of the publishing process, and our most powerful tool for evaluating the rigor, credibility, and interest of scholarly research [1]. The first record of an editorial pre-publication peer review dates back to 1665 and to the journal “Philosophical Transactions” [2]. With a history of more than 350 years, the concept of peer review has remained relatively unchanged, but with so many significant changes within the wider publishing industry, visible signs of strain are starting to emerge in the peer review workflow.

The theme of Peer Review Week 2023, voted by the scholarly community through an open survey, was “Peer Review and The Future of Publishing.” Contributors to Peer Review Week were asked to consider not just the challenges that face our peer review processes, but how peer review could evolve to help us to address some of the broader challenges facing the industry. Within the framework of Peer Review Week, in September 2023, De Gruyter launched a campaign to ignite discussion about some of the critical questions surrounding the topic. We asked our book and journal editors to comment on what they see as the key challenges, and how they might envision a new future for peer review. Their responses have been curated into a series of blog posts, (https://blog.degruyter.com/tag/peer-review-week-2023/) and we are pleased to be able to share a summary of the key discussions in this features article for Chemistry International.

Research is changing, and growing!

The practice of doing research is evolving. Researchers are increasingly engaging in interdisciplinary and hyper-specialised projects. Collaboration is becoming more common, both in terms of cross-disciplinarity and increased globalisation. The number of science and engineering articles published with international research collaborations (including authors from at least two countries) increased from 17% to 23% between 2008 and 2018 [1]. Finding a diverse pool of reviewers who can assess these more diverse research outputs is proving to be increasingly difficult. Alongside finding the right reviewers, publishers are also facing the challenge of reviewer fatigue. The volume of scholarly research has increased significantly in recent years. According to data from Dimensions, the number of research articles in the Chemical Sciences field increased by 62%, from nearly 3.3m articles in 2014 to over 5.3m articles in 2022 [3]. As a result, publishers have significantly increased the number of reviewer invitations they send out, which is resulting in increasing pressure amongst the reviewing community. According to a study by the Institute of Physics, this has led to fatigue among experienced reviewers, who are being asked to review more frequently. As many as 40% of German, US and UK reviewers said they receive too many review requests [4].
There is also an increasing call for publishers to ensure that they adopt diversity and equality policies which reflect the community when selecting reviewers and editorial team members. Guy Edwards, Senior Journals Manager at De Gruyter, believes that “Publishers have a key role to play in encouraging greater diversity and inclusivity in academia. Peer Review is an area where we can influence change and we must be mindful of supporting our journal editors to develop a more diverse community of reviewers. Making conscious choices to diversify a journal’s reviewer base can have huge benefits, giving a greater balance of perspectives to improve research outputs and also ensuring better representation of all groups in academia as a whole.” [5]

At De Gruyter, we are currently developing a set of internal guidelines to support best practice on how to consider diversity when establishing editorial teams and in managing the peer review process.

While editors and publishers are placing more focus on diversity and inclusivity in the peer review process, some stress the need to focus on equality in workloads. Professor Andy Gao, Editor-in-Chief of the journal International Review of Applied Linguistics in Language Teaching, urges the community to “look into the data related to the ratio of reviews vs. publications by reviewers.” He adds: “I am concerned that those who review a lot for the community publish disproportionately less than those who do not review. We should aim to achieve equity in both sharing the review load and having opportunities to publish.” [5]

Faced with a world where we need more reviewers, and where there is a need for diversity in both reviewer background and expertise, how can we incentivise reviewers to continue carrying out the vital work they do?

Until recently, peer review has always been regarded as a voluntary task. Dr. Myrto Aspioti, Acquisitions Editor, believes that “Peer review is not a chore, it is an important service to communities of knowledge without which we are vulnerable to bias, disinformation, and ‘alternative facts’ and that the practice can benefit scholars by being added as a research activity to their resumes. [5] However, with increasing pressure on workloads, editors and publishers are finding it increasingly difficult to find reviewers with capacity to take on the task. According to the Managing Editor of a book series, in the last decade the workload in academia has multiplied by 10 and "we must find a way to compensate reviewers for their efforts.” [5] Many publishers have started to introduce incentives such as book discounts, or vouchers for open access publishing. There are also initiatives such as Publons which record reviewing activity and ensure reviewers receive recognition for the work they do.

With the increasing complexity and volume of research, finding reviewers will continue to be a key challenge. The resounding feedback from the community is that publishers should do more to recognise and reward reviewers, and ensure that the burden of reviewing is not disproportionate from the opportunities to publish.

Alternative Peer Review Models

“Open access” (OA) is defined as the broad international movement that seeks to grant free and open online access to academic information, such as publications and data [5]. Although OA has origins in the 1990s, the OA model and broader open research practices have accelerated in recent years. Between 2012 and 2022 the percentage of OA articles made available via gold open access (i.e. whereby access fee is paid by the author or on their behalf) has increased from 9% to 35% [10].

‘Open science’ is not only transforming business models, but also the way in which all stages of the research workflow are shared and consumed. Many journals and research platforms such as F1000 Research have started to explore different, more open peer review models, and where the take up has not been as significant as originally hoped, many communities are keen to see the principles of openness be more broadly adopted in the peer review process. At De Gruyter, we have integrated an open review approach to the open access journal Economics, whereby the reviewer reports are published alongside the final article.

Rabea Rittgerodt, a Senior Acquisitions Editor, believes there are many benefits to an open peer review model. She believes the process is “more transparent, less hierarchical, as well as faster and easier for everyone involved” but she also highlights the need for some moderation. “As is always the case with peer review, criticism must be constructive, and a third party – the publisher for instance – must ensure that is the case for each comment before it becomes public.”[9]

Beyond open peer review models, which other models could support an open and constructive dialogue in the future?

Within the social sciences and humanities there are a number of new initiatives emerging based on the concept of collaborative peer review. Dr Serena Pirotta, Editorial Director for Classical Studies and Philosophy, believes that a compelling alternative to traditional peer review
Reimagining the future of peer review

Perhaps one of the reasons open peer review has not been as widely adopted as originally hoped, is that some still value the benefits of the blind peer review process. As a Managing Editor of a De Gruyter book series commented, “Peer reviewing is absolutely essential for high quality journals and not least for high quality book series. To be effective, reports must be critical, constructive and detailed. And, above all, blind: neither author or editor nor reviewer should be informed of identities, only this way can independent reviewing be promoted.”[9]

In a world where an overwhelming volume of information has led to challenges in trust and integrity, will open review models increase confidence amongst readers? Current opinion remains mixed. What is clear is that publishers, journals and research communities continue to experiment with new models and new collaborative approaches to peer review.

New Technologies

Finally, and perhaps most significantly, one of the biggest challenges to face scholarly publishing in recent years is the emergence of new technologies, namely natural language processing (NLP) and AI, which appear to present the industry with both threat and opportunities in equal measures. Many automated AI driven tools are already being used in the publishing workflow. Tools have emerged that help with the assessment of plagiarism, image manipulation, and fraud. Machine learning algorithms can help to assess patterns and structures in research articles, to highlight potential weaknesses in arguments, methodology, or data analysis [1]. AI tools are also being used to support reviewer selection. These pre-screening tools have helped introduce efficiencies in the review process, freeing up precious time for editors and reviewers. However, despite the obvious benefits afforded by AI, there is a great deal of concern about the negative impact the new technologies could have on research practices and scholarly communication. The concerns have been mainly focussed around how AI might be used, or misused, in the authorship of articles, and how this could have a negative impact on quality and integrity. The Committee on Publication Ethics (COPE) has issued a position statement on the use of AI for authorship and asserts that AI tools cannot be listed as authors of a paper. COPE states that AI tools cannot meet the requirements for authorship because they are not legal entities and therefore cannot take responsibility for the submitted work [8].

But how might the use of AI further extend to the peer review process? Could we envision a future where
Reimagining the future of peer review

it is not a human scholar, but AI tasked with deciding between acceptance, revision and rejection?

Dr. Shahid Hussain turned to AI itself to ask this question “Have you ever encountered AI being used in the peer review process? If so, what role did it play and did it do a good job?” According to ChatGPT, “AI has been used in peer review for tasks like language checking, plagiarism detection, reviewer matching, and content analysis. Its effectiveness varies; it aids language correction and plagiarism detection but struggles with nuanced judgment. Balancing AI’s role with human review is vital to maintain quality and prevent bias.” [10]

It appears that even AI believes that where technology can provide much needed automation and drive efficiency, the value of peer review remains in that nuanced personal judgement and expertise. Although it seems inevitable that AI will play an increasing role in peer review, feedback from the community suggests that it will probably never come to the point of completely replacing traditional review. Professor Paulo de Medeiros echoes this with his comment “Whether we like it or not AI will play a role in peer review, if it does not already. However, it will probably never come to the point of replacing traditional peer review as that depends not only on expertise and recognition of past scholarship (AI with a large database will exceed human capabilities of recall and identification) but also on personal judgement.” [10]

There are also concerns about the limitations AI faces in assessing innovative new ideas. Dr. Alireza Haghighi Hasanaliandeh Editor of the journal Open Agriculture points out that “AI works on the basis of past information” and so it will not prove to be a useful tool for research with an innovation aspect. [10]

The community appears to be approaching AI with both caution and hope. Many believe that AI will play a useful role in peer review, but it will have limitations and should be used responsibly. Excitingly, perhaps there is an opportunity to enhance the current process, to help alleviate some of the pressures highlighted by the community throughout this campaign. It is hoped that these efficiencies will relieve pressure on an overburdened system and leave space and time for the human interaction with science.

Envisioning a new future

In academic publishing, as in the wider world, we face uncertain times, but with this comes opportunity to evolve and try new ideas. Peer review is and will remain at the heart of the research publishing process. The pressures on the wider industry may necessitate change, and in recent years we have seen innovation in new models and approaches. Looking to the future, feedback from the community suggests that peer review will need to continue to evolve, to ensure it remains relevant to an increasingly complex landscape, and that where the true value of peer review remains in the nuanced personal feedback and expertise, we should embrace new technologies to alleviate pressure on the system, and to focus more on incentivising and rewarding the reviewing community.

References


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Chemistry Digital Standards: Tools for an increasingly digital research culture

by Fatima Mustafa, Leah McEwen, and Ian Bruno

After over 100 years of developing standards for chemistry, IUPAC is moving forward towards the “Digital IUPAC” era which embraces modern practices working with data, a propensity towards Open Science and application of the FAIR Data Principles. In a recent webinar hosted by *Chemvoices platform, Fatima Mustafa, WorldFAIR Chemistry project coordinator, moderated a discussion with Leah McEwen, the chair of the IUPAC Committee on Publications and Chemical Data Standards (CPCDS), and Ian Bruno, CPCDS titular member, to enlighten the chemists community on efforts around digitizing IUPAC.

From archives to digital publishing

“How did chemistry tools such as SciFinder and Reaxys and others evolve from the original print sources? As we move away from print, how can we make sure that chemical information is discoverable and accessible in the more networked environment of the internet and the cloud?”

Those questions led Leah on a sabbatical to study the history of online chemical information and the IUPAC Archives [1] after the Physical Sciences Library at Cornell where she works decided to close their stacks and move online! Moving online created many questions among scientists about how to publish digitally, and how workflows could be improved. To consider these questions, Leah and her colleagues set up a symposium at the ACS in 2012 and invited chemical information specialists to discuss what the future might hold. The outcomes were published in a book [2]. As per now says Leah “Our traditional reporting practice for much of chemistry data looks non-reusable. e.g., spectral data published in your final paper gets embedded in PDF.” So, those static images would not enable users to search the compound or find smaller peaks or search substructure! If those images are not static, and instead measurements and spectral data are represented in digital files then the research published in manuscripts will be more reusable. This is what Leah and colleagues in CPCDS and the chemistry community are tackling.

Very few articles include original downloadable data files [3]—why is this the case given that most data are generated by instruments & software? Data presented in PDF can be searched by text mining technologies but this can be misleading and inefficient as contextual information might get lost. The policies of sharing data in journals are also a topic of interest. For example, in organic chemistry journals, characterization data are often found in the Supplementary Information (SI) section, so there’s some long-standing practice in publishing data with manuscripts, but very few data files are actively put into repositories and linked back to manuscripts [4]. A recent study of author guidelines in chemistry journals took a further look at many different kinds of data [5]. The authors observed that we’ve made some progress at a general level with adoption of ORCID for identifying researchers, and including data availability statements in journal articles for example. Not so much progress has been made publishing structure information or data types such as spectra in a digital form. So, we haven’t really moved the needle much in the last decade.

What is an example of a digital standard file format for chemical data?

Ian has spent several decades at the Cambridge Crystallographic Data Center, where he has been able to see the profound impact that Digital Data Standards have had on data publishing workflows. “When I joined, creating a database of crystal structure data often involved retyping the coordinates that a researcher had typed to get them into a table in their article, but things are very different now,” said Ian. Today they get around 60,000 small molecule crystal structures published each year, the majority of which are associated with one of 16,000 journal articles and these are all made discoverable and accessible through indexed data resources such as the Cambridge Structure Database. Underpinning these workflows is a standard file format known as CIF (Crystallographic Information File). What’s important is not just how the information and data is laid out in the file; it’s the fact that it’s structured in a way that each of the data items in there has a very specific definition associated with it. But having the file formats themselves is not enough. The CIF format was first published in 1992 and it took a period of about 8 years to get to a point where around 80 % of structures were being published in that format. A major factor driving this progress was

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1 This article is based on a ChemVoices webinar held on May 22, 2023. The recording is available at https://youtu.be/_Jd2kGQv_ak. ChemVoices is the result of a partnership between IUPAC and IYCN and was created to showcase the talents and impact of early-career scientists worldwide. It is a platform to discuss issues that are relevant and of immediate concern to early-career scientists. <https://chemvoices.org/>
the adoption of standards by the software and tools that crystallographers use on a routine basis. Not only crystallographers, but also publishers and the data repositories working together to come up with workflows that make it easy for people to deposit their data as part of the manuscript submission process.

**How can IUPAC support data sharing?**

**Leah:** So, when we think about standards, Ian mentioned CIF and how scientific parameters are defined as well as the importance of syntax for machine-readability. This is very similar to areas IUPAC has been working in for a very long time as a standards organization for chemical information. The mission for IUPAC is to be the global organization that provides objective scientific expertise and develops essential tools for the application and communication of chemical knowledge. And by tools here we mean those underlying definitions that describe the parameters for chemical methods and quantities, essential for consistent communication and reporting of quality measurements. So that’s what IUPAC does, engaging experts from all over the world—currently there are 2000 volunteers that work on defining these chemical concepts through a consensus-based process.

Similar to the CIF dictionaries, IUPAC defines units, symbols, uncertainty, nomenclature, graphical representation, etc. These are documented as openly available standards; however, most of them are still in PDF. How to move to machine-readable? Computers are getting quite clever, but they’re not chemists, and they need those same rules that chemists need to use standards consistently. They need to have these articulated in machine logic and language so that they can be directly implemented into code and data systems. This is the task that IUPAC volunteers have taken on—developing digital standards for chemistry. Some standards that have progressed include InChI and the Gold Book, a compendium of terminology from IUPAC recommendations that cover different sub-disciplines in chemistry. The Gold Book was put online about 15 years ago and each term has its own DOI that users can cite just as if they are citing other people’s papers.

**What of existing ways of structure identification and representation?**

**Leah:** People have been, for a long time, representing chemical structures in electronic forms and even if you think you haven’t used these formats you quite possibly have through databases and drawing programs. They are underpinning systems such as SciFinder, Reaxys, and PubChem. Over time people have developed more compact ways of representing structures, for example SMILES, which is a linear notation. These are often used in Cheminformatics to enable manipulation and processing of structures, make inferences about properties and generate depictions and models.

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**Digital Object Identifier (DOI)**

One of the key-enablers is adoption of standard identifiers for the various objects involved in research. Digital Object Identifiers or DOIs are assigned for each article, and similarly we can assign them to any data sets to enable data to be easily linked to associated articles and at the same time encourage citation of the data. We can also assign standard identifiers to researchers, organizations, instruments, samples, specimens and chemical structures.
A weakness of SMILES is that there can be more than one way of representing the same structure and this is where the International Chemical Identifier (InChI) comes in. InChI is the IUPAC International Chemical Identifier. It is a very popular IUPAC standard, and the majority of this webinar audience have either used it or had heard about it. This digital standard encapsulates chemical structure into a canonical string that can be used to match different representations across different datasets. You can generate an InChI for structures associated with a dataset, using ChemDraw for example (although there are some complex structures that InChI does not currently fully handle). InChI is helpful because it’s like nomenclature—you can compare InChIs, and it will help you organize and index, but it’s a little bit more systematic and a little bit easier for computers to handle than nomenclature.

How to describe samples, quantities, conditions—from Electronic Lab Notebooks to manuscripts?

Capturing chemical measurements is dependent on information about samples, but samples introduce complexities when we talk about data. Sample origin can be quite varied (e.g., product mix from a synthesis reaction, or the output of a batch process, or collected from a natural environment soil, water, rocks, etc.). Many pieces of information are attached to each sample, including type, quantity, location, physical state, mixture/solution/pure, time of measurement, further analysis, etc. How do we embed all of this information (metadata) and report it digitally without losing any context?

Leah: It’s a big challenge! If we all use the same software, then it solves everything! But we would not be able to get one software that answers all the questions! Our take on this in the WorldFAIR project is to try to describe what are those core components for the chemistry itself—the chemical system and its components, the parameters and conditions of the measurements, the properties that you’re measuring, and the units necessary for communicating and interpreting your data. In terms of conditions, temperature and pressure are usually the most critical ones to capture, including the estimated error of the measurement. So it’s a lot of moving parts and some of them are entered by the researcher and some of them are captured by the instruments that you’re using—keeping track of all those information threads is a really big challenge.

In publishing spectral data for example, imagine that everything’s being automatically captured into a nice package that has your data, all your structure files, your spectra files, including maybe your raw and processed files, any other data files that you might have generated during that time, all the description about your samples, and it’s all packaged up together. Then imagine it is deposited into a repository, and you can also generate a description of your supplemental information to include with your manuscript for interested readers—that’s our target idealized workflow and what IUPAC digital projects are aiming to support (see below). Again, many pieces to keep track of through many different software programs, to communicate with instruments and with places that files are stored. There are many different tools emerging such as electronic lab notebooks to help with these workflows.

This is the trajectory where we are heading to publish data, similar to the case around Crystallography as Ian was describing earlier. It is important to publish along with that data all the documentation that you need and to utilize tools such as ELNs to capture and to connect information as seamlessly as we can between different software programs and then repositories.

What does it mean to have FAIR Chemical Data? What is the role of IUPAC in implementing FAIR data principles?

The ‘FAIR Guiding Principles for scientific data management and stewardship’ were released in 2016 (Wilkinson, M. D. et al. 2016; https://doi.org/10.1038/sdata.2016.18). The authors wanted to offer recommendations for enhancing the Findability, Accessibility, Interoperability, and Reuse of digital assets. Leah indicated that the driver is interoperability of data and interpretability by machines as more open data becomes available. Everyone was getting excited—we thought we could use this data in data
Tools for an increasingly digital research culture

science and to build models. However, we are discovering that reusing data is a harder job than expected and more information is needed alongside the data. There are specific criteria that define each of the FAIR characteristics, including using standard identifiers, having standard access protocols, using standard vocabulary, using standard vocabulary (such as defined by IUPAC), incorporating these into standard metadata schema, having repositories that index metadata and enable their access.

FAIRSpec is an IUPAC project on the “Development of a Standard for FAIR Data Management of Spectroscopic Data,” to facilitate better workflows for reporting spectral data as described above. The IUPAC WorldFAIR project <https://iupac.org/project/2022-012-1-024/> is also developing further guidelines and tools to support implementation of FAIR data principles.

This is all new to me—where can I get help?

Leah: We are involved in the WorldFAIR project where IUPAC is leading a chemistry effort with a focus on standards that can help facilitate the work of FAIR enablers. We are one of 11 different domains, Nanochemistry and Geochemistry are also among them, coordinated by CODATA and the Research Data Alliance (RDA). The Chemistry project has three target outputs that we’re working on through the project.

• We published in May 2023 the first version of a guidance document which is essentially a landscape view of all the different standards that IUPAC and other groups in the community have been working on over time.

• We have a Cookbook project, the idea of which is to provide open source actionable demonstrations of how you can use data in the cloud, how you can connect, describe them in a machine actionable way, and how you can handle machine readable metadata.

• The third tool is the Structure Validation tool that we talked about earlier.

In the WorldFAIR Chemistry project, we are collaborating with many other initiatives and activities including PubChem; CCDC; NFDI4Chem, a national infrastructure project in Germany to support research chemistry data sharing; and PSDI, a national level Physical Sciences Data Infrastructure project in the UK. These collaborations provide the opportunity to learn how to put FAIR into practice and evolve our workflows around data sharing. Ultimately, we can share resources, apply these in our classes and in our research.

To find out more, check out the resources below:

References

1. The IUPAC print archives are held by the Science History Institution (fka Chemical Heritage Foundation).


Leah McEwen is a Chemistry Librarian at Cornell University, in Ithaca, NY, USA. She is currently chair of the Committee on Publications and Cheminformatics Data Standards (CPCDS) of IUPAC, responsible for the design and implementation of digital standards and lead on the WorldFAIR Chemistry project led by IUPAC and to advance FAIR data practices in Chemistry.

Ian Bruno is a Director of Data Initiatives at the Cambridge Crystallographic Data Centre (CCDC), in Cambridge, IK. He is a member of CPCDS. He is the current lead of the WorldFAIR Chemistry sub-committee developing “Reporting Guidance.”

Fatima Mustafa is a chemistry lecturer at the University of Texas in San Antonio (UTSA), in Texas, USA. She is the coordinator of the WorldFAIR Chemistry project.
Janusz Pawliszyn and Xin Yan were presented with the 2023 Awards in Analytical Chemistry

In 2020, the Analytical Chemistry Division (Division V) established two awards honoring excellence in analytical chemistry. The IUPAC Analytical Chemistry Medal honors significant lifetime contributions to the aims of the Analytical Chemistry Division of IUPAC and the Emerging Innovator Award in Analytical Chemistry recognizes outstanding work undertaken by an emerging analytical scientist that corresponds to the aims of the Analytical Chemistry Division of IUPAC. These awards recognizing outstanding analytical chemists are conferred and award lectures are presented during General Assemblies.

In 2023 Janusz Pawliszyn received the IUPAC Analytical Chemistry Medal recognizing a lifetime of world leading, foundational research in analytical sample preparation and the invention of solid phase microextraction. He is Canada Research Chair Professor, University of Waterloo, Ontario, Canada.

The primary focus of his research program is the design of highly automated and integrated instrumentation for the isolation of analytes from complex matrices and the subsequent separation, identification, and determination of these species using gas chromatography, liquid chromatography, and capillary electrophoresis coupled to a variety of detection systems, including a range of mass spectrometry techniques. Currently his research is working to eliminate organic solvents from sample preparation to enable on-site monitoring and in-vivo analysis. His research also explores the application of the computational and modeling techniques to enhance performance of sample preparation, chromatographic separations, and detection.

Pawliszyn’s award lecture, “Significance of Fundamentals in Development and Optimization of Sustainable Sampling and Sample Preparation Technologies” is available on YOUTUBE.

In 2023 Xin Yan, Assistant Professor, Texas A&M University received the Emerging Innovator Award in Analytical Chemistry recognizing her ground-breaking work in electrochemical reactions in droplets using mass spectrometry.

Her research combines expertise in mass spectrometry, microdroplet chemistry, electrochemistry, and biology to develop novel approaches for disease diagnosis, structural lipidomics, and accelerated electrochemical reactions. In particular, the work is motivated by the possibility of enabling new technology for next-generation approaches to precision medicine, and sustainable synthesis. Her research interests span a range of topics; including structural lipidomics, metabolomics in brain research, interfacial electrochemical reactions, and novel electrogenerated cationic transition-metal electrocatalysis. Her research group is highly interdisciplinary, providing students the opportunity to obtain hands-on experience in analytical, biological and synthetic chemistry.

Yan’s award lecture “Microdroplet Mass Spectrometry for Lipid Isomer Analysis and Accelerated Discovery of Transition Metal Catalysis” is available on YOUTUBE.

https://iupac.org/the-2023-awards-in-analytical-chemistry/

Franzosini Award to Yongheum Jo

The 2022 Franzosini Award was given to Yongheum Jo, in recognition of his contribution to the IUPAC Solubility Data Project, at the 22nd Annual Meeting of the IUPAC Subcommittee on Solubility and Equilibrium Data, held in Bragança, Portugal, on 12 September 2022, during the 20th International Symposium on Solubility Phenomena and Related Equilibrium Processes.

Yongheum Jo completed his bachelor’s degree in 2014 and master’s degree in 2016, both from the Korea Advanced Institute of Science and Technology (KAIST) in South Korea. He then received a PhD in radiochemistry in the Department of Nuclear Engineering under the academic supervision of Jong-II Yun (KAIST). Following
his PhD studies at KAIST, Jo did a PostDoc at the Institute for Nuclear Waste Disposal (Institut für Nukleare Entsorgung, INE) of the Karlsruhe Institute of Technology (KIT), Germany, from 2020 to 2022. Research at KIT-INE was mainly focusing on a better description of Nb(V) aquatic chemistry in cementitious environments. Niobium-94 is an activation product potentially present as part of nuclear waste, and a better understanding of Nb aqueous speciation and retention processes in cementitious environments are needed to provide a significantly improved description of Nb(V) mobility in an applied repository context.

After his PostDoc at KIT-INE, Jo worked as a senior researcher at Korea Atomic Energy Research Institute (KAERI) from 2022 to 2023. Starting in 2023, Jo assumed the role of an assistant professor in the Department of Nuclear Engineering at Hanyang University in Korea. His current work focuses on Nb solids solubility in alkaline aqueous solution in the presence of organic materials. The objective of this topic is to establish a comprehensive chemical thermodynamic description of Nb solids solubility in the presence of organic compounds and Nb-organic complexation. In addition, he is developing a chemical model that depicts the chemical interaction between organics and cementitious materials, covering dissolution and precipitation phenomena. Building on his previous work, he is expanding his investigation to explore the ternary M-AnO2-CO3 system in the context of neptunium(VI) to derive chemical equilibrium data. His research group will continue to explore the chemical thermodynamics to unravel the chemical processes of radionuclides in various environments.

Yongheum Jo has an impressive set of excellent scientific knowledge and expertise. This is covering a broad field in the context of actinide and radionuclide chemistry relevant in fundamental research and to assess scenarios in nuclear waste disposal and the back-end of nuclear fuel cycle. Studies on solubility phenomena and the related chemical speciation play a key role in his research profile.

More details at https://iupac.org/what-we-do/awards/franzossini-award/

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ISC’s Unlocking Science series wins Digital Communications Award

The multimedia series Unlocking Science, produced in partnership with BBC StoryWorks, the International Science Council (ISC) Members and other partners, is voted the best in the ‘Video Series’ category at the prestigious Digital Communications Awards (DCA).

The Unlocking Science multimedia hub, which uncovers innovative global stories behind the science of sustainability, was lauded by the DCA jury for its compelling and innovative storytelling. These stories feature communities engaging with science and technical innovation to deliver transformation. The series covers researchers out in the world working on practical solutions or shaping our understanding of the problem. One of the most popular films recounts one woman’s quest to save Malawi’s crops and rethink the future of farming. In another film, a team of researchers weed out discrimination for an inclusive AI world. The stories represent a wide array of science disciplines and take audiences from the outback of Australia to the forests of the Amazon.


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Richard Hartshorn elected CODATA Vice President

Held on 27-28 October 2023, in Salzburg and online, the 2023 CODATA General Assembly elected a strong and diverse Executive Committee and approved eight Task Groups and one Working Group. The full summary of the General Assembly, including presentations, results of voting and the recordings can be consulted on codata.org.

For the first time in CODATA’s 57-year history, CODATA has elected a female president, and the overall gender balance is 7-8 (female-male) for the elected members is the best ever. This is also the highest number of Officers/ExComm members nominated by International Scientific Unions in at least the last ten years, which shows a confidence in CODATA mission to engage with data issues from a range of scientific fields. Coming from IUPAC, former Secretary General Richard Hartshorn has been serving as a member of the Executive Committee since 2018 and is now elected...
The following CODATA Task Groups were approved:

- Data Systems and Services for Crisis Situations (DSTS-CS)
- Advancing Data Science for Sustainability
- Geographic Indications and Sustainability (GIES-TG)
- Data Ethics Task Group (DE-TG)
- Data-Driven Social Change Towards Society Promoting Cognitively Healthy Aging
- Citizen Generated Data for the SDGs
- Digital Representation of Units of Measure (DRUM-TG)
- FAIR Data for Disaster Risk Research

The CODATA General Assembly took place during International Data Week (IDW), co-hosted by CODATA and the Research Data Alliance (RDA). IUPAC was an active contributor through the involvement of CPCDSD and community collaborators. Some highlights are noted below; further summaries of these activities will be forthcoming in Chemistry International and other articles.

- IUPAC’s WorldFAIR Chemistry project (IUPAC project 2022-012-1-024) was the hosting organizer of two multi-disciplinary sessions at IDW:
  - Beyond FAIR: Reusing Chemical Data Across-disciplines with CARE, TRUST, and Openness
  - Describing Chemical, Physical and Biological samples digitally: Seeking harmonization

Brief descriptions have been written-up in the recent WorldFAIR newsletter. With thanks to Fatima Mustafa, IUPAC WorldFAIR Chemistry-Project Coordinator, to manage the session organization for these in collaboration with several other WorldFAIR case studies, including Nanomaterials, GeoChemistry and Agricultural Biodiversity, and RDA Interest Groups, including Chemistry Photons & Neutrons and Physical Samples. Other collaborators included PARC (Partnership for the Assessment of Risk of Chemicals), PSDI (Physical Sciences Data Infrastructure) in the UK, and the NFDI4Chem data infrastructure project in Germany. IUPAC colleagues who presented or moderated included Ian Bruno, Stuart Chalk, Jeremy Frey, and Leah McEwen.

The CODATA Task Group on Digital Units of Measure (see also IUPAC project 2022-009-1-100) hosted a session that featured talks from Richard Hartshorn and Stuart Chalk, who are members of the CODATA DRUM group along with Jeremy Frey.

IUPAC is also invited to participate in a new RDA Working Group on “Harmonised terminologies and schemas for FAIR data in materials science and related domains”, described in an IDW poster: “Review and Alignment of Domain-Level Ontologies for Materials Science and Chemistry” that references the IUPAC Gold Book.

https://iupac.org/richard-hartshorn-elected-codata-vice-president/

The IUPAC Periodic Table Challenge Now Available in Nine Languages

On November 1, IUPAC has launched two additional translations of the Periodic Table (PT) Challenge: German and Romanian.

The IUPAC PT Challenge dates back to the International Year of the Periodic Table of Chemical Elements (IYPT2019) and the IUPAC centenary in 2019 when an online activity about the Periodic Table of the Elements was launched to celebrate IUPAC anniversary. The PT challenge is targeted at a global audience of young students, scientists and the general interested public, and has had impressive global reach. Since its launch, the PT Challenge has been played more than 130 000 times by players from over 160 countries, from every continent, including Antarctica.

Over the last four years, the PT Challenge has been expanded to include three difficulty levels (beginner,
intermediate, advanced) and has been translated into Arabic, Chinese, Spanish, Russian, Italian, and French. With each new translation of the PT Challenge saw an increase in participation in the related countries, and this has encouraged additional translations. The German translation has been led by Johanna Irreger (Montanuniversität Leoben, Austria) with support from the Austrian Society of Chemistry GÖCH. Aurelia Vişa (Romanian Academy, “Coriolan Drăgulescu” Institute of Chemistry, Timișoara, Romania) provided the Romanian version of the PT Challenge.

“The Periodic Table Challenge is a wonderful opportunity for students, teachers, and really everyone to learn more about the chemical elements and their key role in our lives and in building a more sustainable future,” says IUPAC president Javier García-Martínez.

Being translated in so many languages, the Periodic Table Challenge provides an opportunity for everyone to learn more curiosities about each chemical element. By doing so, it also provides an example of science as a common language among nations. Earlier this summer, IUPAC PT Challenge was also featured in the International Year of Basic Sciences for Sustainable Development (IYBSSD).

If you have an interest in supporting an effort to have another language version of the IUPAC Periodic Table Challenge made available to the global science and chemistry community, please contact IUPAC Executive Director at executivedirector@iupac.org.

See iupac.org/periodic-table-challenge

Polymer Competition

The IUPAC Polymer Division, Subcommittee on Polymer Education and the Committee on Chemistry Education have launched a Polymer video competition.

The competition is open to all educational levels, individuals or groups.

Various categories allow everyone to take part, from high-school students, to undergraduate and postgrads. The content of the video shall depend on the age/education group and focus on one of the following topics:

- Basic polymer concepts
- Polymer history
- Polymer experiments
- Advanced polymer concepts
- Polymer experiments
- Polymer nomenclature

See examples, detailed guidelines and resources are available online via https://iupac.org/polymer-video-competition/

There will be 9 winning entries in total. The selected videos will be showcased in the IUPAC’s official YouTube channel in the “Polymer Educational series.” We will also be giving out the following:

- Group 1 – Individual certificates and IUPAC chemistry goodies and an invitation for a virtual presentation at an IUPAC Polymer division meeting
- Group 2 – Individual certificates and IUPAC chemistry goodies, an invitation for a virtual presentation at an IUPAC Polymer division meeting, and an invitation as a Young Observer for an IUPAC world congress or MACRO conference and with 1000 USD of travel fund
- Group 3 – Individual certificates and IUPAC chemistry goodies and an invitation as a Young Observer for an IUPAC world congress or MACRO conference and with 1000 USD of travel fund

New, creative, and original content related to polymer topics in video format are encouraged! To submit your video, please complete the submission form: https://bit.ly/polymervids

Submission deadline is 31 March 2024.

For more info go to: https://iupac.org/project/2022-003-2-400/ or https://iupac.org/polymer-video-competition/

The Top Ten Emerging Technologies in Chemistry – Call for Proposals For 2024

IUPAC has released its call for proposals to identify the top ten emerging technologies in chemistry with the results to be announced in 2024.

This initiative began in 2018 in recognition of IUPAC's Centenary in 2019, to showcase the value of Chemistry (and chemists!) and to inform the general public as to how the chemical sciences contribute to the well-being of Society and the sustainability of Planet Earth. The most recent finalists for 2023 were announced in October 2023 and detailed in the Oct 2023 issue of Chemistry International (CI). The finalists for previous years are presented online at <iupac.org/what-we-do/top-ten/>

The call for the 2024 proposals is open and until 31 March 2024 anyone can submit one or more proposals. This call for proposals is open to the global science

The IUPAC Polymer Division, Subcommittee on Polymer Education and the Committee on Chemistry Education have launched a Polymer video competition.

The competition is open to all educational levels, individuals or groups.

Various categories allow everyone to take part, from high-school students, to undergraduate and postgrads. The content of the video shall depend on the age/education group and focus on one of the following topics:

- Basic polymer concepts
- Polymer history
- Polymer experiments
- Advanced polymer concepts
- Polymer experiments
- Polymer nomenclature

See examples, detailed guidelines and resources are available online via https://iupac.org/polymer-video-competition/

There will be 9 winning entries in total. The selected videos will be showcased in the IUPAC’s official YouTube channel in the “Polymer Educational series.” We will also be giving out the following:

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For more info go to: https://iupac.org/project/2022-003-2-400/ or https://iupac.org/polymer-video-competition/
community as well as to the general public.

This initiative is to help to raise chemistry’s profile and reinforce its essential role in the advancement of science and technology.

For more information, see <iupac.org/what-we-do/top-ten/>

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**Solvay International Award for Young Chemists—Call for applicants**

The call for the 2024 IUPAC—Solvay International Award for Young Chemists is open!

The IUPAC-SOLVAY International Award for Young Chemists is intended to encourage outstanding young research scientists at the beginning of their careers. The awards are given for the most outstanding Ph.D. theses in the general area of the chemical sciences, as described in a short essay. The award is generously sponsored by Solvay.

Each year, IUPAC awards up to five prizes. Each prize consists of a USD $1000 cash award and up to USD $1000 towards travel expenses to attend the next IUPAC Congress, where the awards will be presented. In keeping with IUPAC’s status as a global organization, effort is made to ensure fair geographic distribution of prizes.

**Who can enter?**

- You must have completed your PhD in the 2023 calendar year, including your defense.
- Your PhD must be from an institution based in an IUPAC member country/territory.
- Your PhD must be in the field of chemical sciences: “chemistry and those disciplines and technologies that make significant use of chemistry.”

All entries are due before 15 February 2024 and can be submitted online.

**What does the entry include?**

A 6000-character essay describing the thesis work in 6000 characters and placed in the context of the broader research field in the chemical sciences. The essay must be written in English.

The contact details of people who can write a support letter for the application are required.

This next round of awards will be presented at the 2025 IUPAC Congress, to be held in Kuala Lumpur, Malaysia, from 11-18 July 2025. Each awardee will be invited to present a poster on his/her research and to participate in a plenary award session, and is invited to submit a review article for publication in *Pure and Applied Chemistry*.

For any questions, please contact IUPAC by email at executivedirector@iupac.org. • https://iupac.org/2024-iupac-solvay-international-award-for-young-chemists-call-for-applicants/

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**Recognising Excellence in Chemistry Education: CCE 2024 Awards Announcement**

The IUPAC Committee on Chemistry Education (CCE) is soliciting nominations for three types of awards which will be made during the 27th International Conference on Chemistry Education (ICCE2024) in Pattaya, Thailand, on 15-19 July 2024. These prizes recognise outstanding work being done in any part of the world to promote excellence in the teaching and learning of chemistry. The awards are:

- Distinguished Contribution to Chemistry Education (DCCE) Award which recognise outstanding service to chemistry education and practice and/or professional service to chemistry education over a lifetime.
- Outstanding Early Career Researcher in Chemistry Education Award which recognizes early career researchers who are producing high quality and impactful chemical education research as evidenced by their research output.
- Special Recognition Award for Excellent Service to the Committee on Chemistry Education which acknowledges individuals who have given excellent service to the CCE, i.e. to further CCE priorities and IUPAC strategic objectives related to chemistry education.

Detailed description and procedures are available online <https://iupac.org/recognising-excellence-cce-2024-awards-announcement/>

**Your next steps to nomination**

Nominations are open and will close on 28 February 2024. All members of IUPAC-affiliated countries are encouraged to consider nominating candidates for these awards. If there is anyone that you think is making outstanding contributions to chemistry education, don’t hesitate to put them forward. More information about eligibility and selection procedures can be found online.

https://iupac.org/what-we-do/awards/chemistry-education-awards/
The Prize is intended to reward an original work in chemistry, of benefit to mankind, society or nature. The Grand Prix will be awarded for the nineteenth time in 2024 to one or several persons, irrespective of nationality. It carries a monetary award of 35,000 Euros.

Entries must imperatively be presented through a scientists’ society or a national or international scientific organisation without any direct link with the nominee. Entry forms, together with a report detailing the arguments for the nomination, must be received at the Fondation de la Maison de la Chimie no later than 30 April 2024. The nomination documents should be sent by e-mail to presidency@maisondelachimie.com.

The international jury composed of a chairman, nine members recognized for their work in the various fields of chemistry, and the laureates of the two previous Grands Prix. Three members of the jury must be of a nationality other than French. The jury is assisted by a scientific coordinator. The chair of the jury is the incumbent president of the Fondation de la Maison de la Chimie, the other members being appointed by the Board of the Foundation.

The laureate will be invited to deliver a lecture on her/his work at an award ceremony that will take place at the Maison de la Chimie in February 2025.

<https://actions.maisondelachimie.com/les-prix-de-la-fondation/grand-prix-de-la-fondation/>
Greenness of official sample preparation standard methods
by Elefteria Psillakis, Alberto Chisvert, Cecilia Cagliero, Sibel A. Ozkan, Marcela Segundo, Zoltan Mester

1. Introduction

Analytical chemistry plays a crucial role in evaluating the environmental condition of various systems. However, it can also contribute to environmental issues due to the utilization and production of harmful substances throughout the analytical process, as well as indirect effects stemming from high energy consumption. These contradictory aspects were brought to light by Paul Anastas shortly after the introduction of Green Chemistry, and the concept of Green Analytical Chemistry (GAC) emerged as a relevant field in both research and industry. In 2013, the 12 principles of GAC were formulated, emphasizing the significance of safeguarding the environment and human well-being when developing and utilizing analytical methods.

A chemical measurement procedure consists of multiple stages: sampling, sample preparation, analytical measurement, and data evaluation. During the sample preparation step, samples are frequently modified to ensure compatibility with the analytical instruments used, cleaned up from interfering matrix components, or, in other cases, analytes are enriched to meet the sensitivity needs of the analytical method. Traditional sample preparation methods can be energy-consuming and often require large quantities of toxic solvents and reagents. Consequently, the first principle of Green Analytical Chemistry (GAC) recommends using direct analytical techniques to avoid the sample preparation step. However, direct analysis is not always an option, and not always carry less environmental impact. Sample preparation has been and will be in the foreseeable future a crucial step in analytical process and efforts should be focused on promoting advancements in green technologies within the field. A detailed understanding of the environmental footprint of sample preparation within the chemical measurement continuum will be a major contributor to a sustainable analytical chemistry.

2. The IUPAC Project

There has been unprecedented growth in the sample preparation field. Several contemporary and mature sample preparation technologies fulfill the requirements for greening this critical step in analysis while maintaining (or even improving) the analytical features of the overall method. However, despite these advances, many official analytical methods still rely on traditional sample preparation procedures that use harmful solvents and generate large amounts of toxic laboratory waste, among others. The IUPAC project #2021-015-2-500 aims to evaluate the greenness of official standard methods for sample preparation, such as those provided by ISO, CEN, US EPA, AOAC, IFRA, ASTM, and Pharmacopoeia. The assessment includes methods used for analyzing regulated chemicals in various sectors such as the environment, agriculture, food, and pharmaceuticals. The final goal of the project is to propose greener alternatives that exhibit comparable or even superior overall method performance.

The concept of green sample preparation was initially formulated to evaluate the greenness of official sample preparation standard methods. Subsequently, a new quantitative metric tool was developed, dedicated to the quantification of the environmental impact of sample

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The ten principles of Green Sample Preparation

1. Favor in situ sample preparation
2. Use safer solvents and reagents
3. Target sustainable, reusable, and renewable materials
4. Minimize waste
5. Minimize sample, chemical, and material amounts
6. Maximize sample throughput
7. Integrate steps and promote automation
8. Minimize energy consumption
9. Choose the greenest possible post-sample preparation configuration for analysis
10. Ensure safe procedures for the operator

Fig. 1. The ten principles of GSP and their interconnections. Adapted from 10.1016/j.trac.2022.116530
preparation methods. This green metric is currently used for the evaluation of official standard methods.

The project currently includes members from academia, IUPAC/Analytical Chemistry Division, EuChemS/Division of Analytical Chemistry, private companies, and national standard bodies. To meet the final goal of developing a roadmap for greener alternative analytical methods, the next steps will involve the establishment of a permanent network of experts, instrument manufacturers, consumable suppliers, major routine laboratories, and key standardization bodies, all actively working on this topic. This network will foster a common understanding of the greenness of sample preparation and promote its practice. It will serve as a platform for discussions through events and publications, creating opportunities for in-depth conversations on official standard methods and their level of environmental friendliness. By bringing together stakeholders from various sectors, the network will enable collaborative efforts to drive the implementation of greener practices in the field of analytical chemistry.

3. The principles of Green Sample Preparation

In 2022, members of the IUPAC project #2021-015-2-500 introduced the concept of Green Sample Preparation (GSP) through the formulation of ten principles shown in Fig. 1 (DOI: 10.1016/j.trac.2022.116530). These principles were developed to comprehensively describe the underlying structure, properties, and mechanisms of GSP. The ten principles were not independent but formed an integrated system of design (Fig. 1), where improvements aligned with one principle could synergistically address the deficiencies associated with other interconnected principles. The aspects considered by GSP included the use of safe solvents/reagents, materials being reusable and originated from renewable/recycled sources, minimizing waste generation and energy demand, minimization of samples, chemicals, and materials, procedure simplification and automation,

Fig. 2. Graphical representation of the functions applied for the assessment of the evaluated criteria.
operator’s safety, and maximizing the number of prepared samples per unit time.

The concept of GSP set goals that were common to GAC but also had several distinctive and innovative features. This is because GSP placed sample preparation in a central position and defined greenness based on the specific needs and requirements of the sample preparation step. By doing so, GSP emphasized the critical role of sample preparation in achieving environmentally friendly analytical methods. More than a year after its introduction, GSP has gained acceptance and is being implemented in a wide range of research and practical settings within the field.

4. **AGREEprep the first Analytical Greenness Metric for Sample Preparation**

The first metric tool for evaluating the analytical greenness of sample preparation methods was introduced in 2022 by members of the IUPAC project (DOI: 10.1016/j.trac.2022.116553). The green metric, termed AGREEprep, uses ten assessment steps related to the ten principles of GSP. These ten individual assessment steps take scores ranging from 0 to 1, with the extremes representing the worst and ultimate performance, respectively. These levels were selected by considering the experimental conditions used in a wide range of conventional and state-of-the-art sample preparation approaches previously reported in the literature (Fig. 2). Each criterion has a default weight to the overall score. Assessors may change the default weights and adjust them to their analytical goals, provided they justify these changes. The scores from each criterion are weighted and combined to yield the overall score ranging from 0 to 1, with 1 representing optimum performance or absence of a sample preparation step.

AGREEprep uses open-source software to calculate and display results. The software can be obtained from mostwiedzy.pl/AGREEprep; the code is available at git.pg.edu.pl/p174235/agreeprep. AGREEprep requests input data for each of the ten steps of assessment. After completion of the evaluation, it produces a round pictogram with a circle in the center that shows the overall score, surrounded by ten trapezoid bars corresponding to the ten criteria, each having a length equivalent to the assigned weight. The color of each element changes after evaluation, thus providing an easy way to identify the weak and strong points of the procedure and their contribution to the final score. A detailed tutorial was also published in 2022 that serves as an in-depth yet simple guide for new users that elucidates all aspects of the greenness assessment (DOI: 10.1016/j.sampre.2022.100025).

Compared to other published metrics, AGREEprep provides appropriate levels of accuracy and specificity for assessing the environmental impact of sample preparation methods, mainly because previously published metrics did not give sufficient attention to the sample preparation step. In addition to evaluating greenness, AGREEprep assessment can effectively identify the strong and weak aspects of methods, thereby facilitating the greening of sample preparation procedures.

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**Fig. 3.** AGREEprep scores of the evaluated US EPA methods for the analysis of organic pollutants from solid matrices
5. Initial results on the greenness of official sample preparation standard methods

The members of the IUPAC project are organized into four working groups: environmental/organics, food, inorganic, and biological applications. These groups are responsible for ongoing evaluations of official sample preparation standard methods. Over the past year, a considerable number of official standard methods dealing with environmental analysis of organic and inorganic compounds and food analyses have been evaluated using AGREEprep.

Twenty-five reference methods from the United States Environmental Protection Agency (US EPA), which rely on Soxhlet extraction for the analysis of solid samples like sediments and fish tissues, were initially evaluated. These methods covered a wide range of environmental applications for the determination of different persistent organic pollutants, such as pesticides, halogenated compounds, N-containing compounds, and endocrine disruptors, among others. However, in most cases, Soxhlet extraction was time-consuming and involved the use of significant amounts of solvents and energy for extended periods. Moreover, before and after Soxhlet extraction, samples were submitted to additional treatment processes such as drying, cleanup and evaporation, thus consuming extra amounts of reagents/solvents, energy, and time. As a result, the obtained AGREEprep scores for these selected US EPA methods (Fig. 3) exhibited very low levels of environmental greenness, with the final scores ranging from 0.04 to 0.12.

Furthermore, fifteen official methods from AOAC INTERNATIONAL, which focus on food analysis, have also been evaluated. They covered a wide range of applications, from food safety (such as the determination of target pesticides in pesticide formulations, pesticide residues in foods, and impurities in food additives) to food integrity with the determination of some of their representative active ingredients (e.g., caffeine in roasted coffee). The sample preparation step of the selected AOAC methods consisted of traditional sample preparation methods, i.e., Soxhlet extraction, maceration, or digestion with organic solvents. They revealed a significantly low level of environmental greenness, with final values ranging between 0.05 and 0.22 (Fig. 4). Generally, the methods examined employed relatively simple post-sample preparation measurement techniques, such as gravimetric or spectrophotometric analysis, having a minimal environmental impact. However, the simplicity of the determination step, combined with the complexity of the food matrix, imposed the use of highly selective sample preparation techniques. As a result, all the methods involved a large number of discrete steps and required manual execution with significant operator involvement. This made the sample preparation step extremely time-consuming, negatively impacting the greenness of the method but also the accuracy of the results. Moreover, the methods under evaluation involved multiple and long heating steps that were energy-consuming. Another critical aspect of the evaluated methods was the extensive use of reagents and materials that were highly toxic and posed significant health risks to the operators. Among the particularly hazardous substances used in the methods were asbestos, benzene, and mercury.

![AGREEprep score for AOAC methods](image)
Last, twenty-five USEPA methods dealing with the analysis of trace metals and elements in aqueous and solid samples were evaluated using AGREEprep. The sample preparation methods mainly involved acid digestion, although microwave-assisted extraction and solid-phase extraction were also considered. The assessment of greenness using AGREEprep resulted in scores ranging from 0.01 to 0.36. The most common drawback was the use of large amounts of mineral acids producing a total mass of waste above the critical value of 50 g (or mL) per sample. Additionally, the majority of the evaluated sample preparation methods were also coupled to energy-demanding analytical instrumentation, with only one method receiving a satisfactory score in this regard. Automation and simplicity of methods, as well as operator’s safety were also not genuine features of the methods evaluated. The summary of the evaluation results of selected USEPA methods is reported in Fig. 5.

6. Conclusions
The IUPAC project continues to evaluate the environmental impact of official sample preparation standard methods. It disseminates the need to rethink sample preparation and analysis when developing new official standard methods. The permanent network to be created will promote a common understanding of greenness degrees and collaborate towards greener and safer official sample preparation standard methods. Technical committees and working groups developing standardized analytical methods could use the outcome of this project to evaluate new proposals for methods. Ultimately new methods should obtain a “greenness” label as a metric of the footprint. Moreover, instrument manufacturers and suppliers of consumables can use the information from this project to develop dedicated tools/supplies for new green sample preparation methods, aligning with sustainable development. The current project will spread the practice of green sample preparation in the general analytical community (including research and routine analysts) and act as an important tier in the protection of the environment. Analytical chemists will also benefit from applying safer and less polluting sample preparation procedures. The application of environmentally benign analytical methods contributes to pollution abatement. It is equally important that greening of analytical methods is one of the social responsibilities of analysts that aligns with the Sustainable Development Goals (SDGs) of the United Nations 2030 Agenda.

https://iupac.org/project/2021-015-2-500

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The Gender Gap in Chemistry – Building on the ISC Gender Gap Project

The gender gap in STEM is a persistent problem, with women underrepresented in all fields, including chemistry. Women chemists face a number of challenges, including slower career progression, harassment, and lack of recognition. To address this issue, there have been a number of activities and strategies developed all over the world intended to close the gender gap in science.

Global Gender Equality Initiatives in Chemistry

The IUPAC project, “The Gender Gap in Chemistry – Building on the ISC Gender Gap Project,” (2020-016-3-020) was proposed to cover work specific to the field of chemistry to use the results of the International Science Council (ISC) project (https://gender-gap-in-science.org) to elucidate the situation with respect to gender in chemistry and to identify possible actions to improve the situation. In the IUPAC project, the task group, with members across five countries, conducted searches on existing programs and initiatives globally that advocate and promote gender equity and inclusion in chemistry. From our search, it was found that there are a number of programs and initiatives designed to support women in STEM. Among these programs are professional development workshops, awards, and policies on gender equity.

Readers of Chemistry International will be well aware of The IUPAC Distinguished Women in Chemistry or Chemical Engineering Awards, which recognize and promote the work of women chemists and chemical engineers worldwide. The awardees also serve as role models for young scholars in the field. Additionally, the IUPAP Working Group on Women in Physics has a number of initiatives to promote diversity and inclusion in physics, including a resolution stating that conferences should have a session on diversity and inclusion and a requirement that meetings have at least 10% women speakers and committee members.

Current Findings

The task group has developed indicators to assess the effectiveness and impact of initiatives that support women in chemistry. These indicators include the number of women who participate in the program, the number of women who advance in their careers, and the number of women who are recognized for their achievements, as a result of these initiatives.

By identifying the most effective practices for supporting women scientists in their careers or studies, we can help to close the gender gap in chemistry and create a more inclusive and equitable scientific community.

The most common activities and strategies used were:

- Providing mentorship and sponsorship opportunities
- Organizing networking events
- Offering training and development programs
- Raising awareness of gender equity and inclusion issues

The most common goals of the initiatives were:

- Increasing the number of women in chemistry
- Supporting the advancement of women in

Mei-Hung Chiu presented the research at the 9th Network of Inter-Asian Chemistry Educators (9NICE) Conference 2023 in Kuching, Sarawak, Malaysia held in July 2023.
Promoting gender equity and inclusion in the chemistry community

The task group also found that the initiatives had a range of potential impacts, including:

• Increasing the number of women who pursue careers in chemistry
• Helping women to advance in their careers
• Creating a more inclusive and equitable chemistry community

Challenges and Opportunities
While there are a number of successful programs and initiatives, there are still challenges that need to be addressed. One challenge is the sustainability of initiatives that rely on finite funding. Another challenge is the difficulty in uncovering evidence of the effectiveness and impact of these initiatives.

Implications for the Future
Our current findings suggest that there is a need for sustainable and impactful initiatives to support women in chemistry. The emphasis on the importance of institutional support and policies, as well as the need to challenge gender stereotype threats, cannot be understated.

From our search, it was found that most initiatives are based on the work of university educators and scientists, with little input from industry or from policymakers. We argue that the participation of policymakers is paramount to the long-term sustainability of initiatives. Another important finding is that the initiatives use a variety of strategies, including mentorship, networking, training, and awareness raising. However, we are unsure whether one-day workshops and conferences are sufficient to achieve the desired goals. We suggest that more research is needed to evaluate the effectiveness of different initiatives.

In addition, there is an urgent need to overcome gender stereotypes. We posit that chemical and scientific career orientations are associated with stereotypes on ethnicity and social class. As a result, young women from disadvantaged social backgrounds and from non-dominant ethnicities are less likely to have career aspirations in science.

Finally, an immediate action to start would be to change in the mindset of social and educational expectations on gender. Therefore, it is crucial to have institutional policies that promote gender equity, as well as alterations to existing criteria to reduce unfair biases. Organizations should recognize the importance of identifying role models and representatives for girls or women scientists at various levels of the education systems.

Recommendations
Based on our findings, the team recommends the following:

• Invest in sustainable and impactful initiatives that support women in chemistry.
• Engage policymakers to ensure gender diversity and inclusion.

The project findings were presented at the 9th Network of Inter-Asian Chemistry Educators (9NICE) Conference 2023 in Kuching, Sarawak, Malaysia held in July 2023 and at the American Chemical Society Women Chemists Committee symposium held in August 2023.

This progress report was prepared by Fun Man Fung, Silvija Markic, Rachel Mamlok-Naaman, Mark Cesa, and Mei-Hung Chiu. For more information and comments, contact Task Group Chair Mark Cesa <markcesa@comcast.net> or Mei-Hung Chiu <mhchiu@ntnu.edu.tw>

https://iupac.org/project/2020-016-3-020/

Global Framework on Chemicals

The International Conference on Chemicals Management (ICCM5) was held in Bonn, Germany from 25-29 September, 2023. It was organized by United Nations Environment Program (UNEP) and hosted by the Government of Germany. Mr. Jean Pelin, Titular member on the Committee on Chemistry and Industry (COCI) and Dr. Bipul Saha, COCI and Bureau member, represented IUPAC in the Conference.

Delegates from more than 150 countries, representatives from United Nations, OECD, World Bank, World Economic Forum, WHO, Pure Earth, IUPAC, IPEN (International Pollutants Elimination Network), IOMC (Inter-Organization Programme for the Sound Management of Chemicals), German NGO Forum for Environment and Development, Friends of the Earth, International Labour organization, CEOs of Chemical Companies and many others participated in the discussion.

During the Conference several groups had their internal meetings. This included regional meetings of EU, Africa, GRULAC (Group of Latin America and the Carribean), Asia and the Pacific, and also meetings of
WHO Health Sector, NGOs, labour organizations, private sector and others.


Based around 28 targets, the framework outlines a roadmap for countries and stakeholders to collaboratively address the lifecycle of chemicals, including products and waste.

“Everyone on this planet should be able to live and work without fear of falling sick or dying from chemical exposure. Nature, free from pollution, should be able to thrive and support humanity for millennia to come,” said Inger Andersen, Executive Director of the UN Environment Programme (UNEP). “This is why this framework provides a vision for a planet free of harm from chemicals and waste, for a safe, healthy and sustainable future.”

With the adoption of the Global Framework on Chemicals, “Pollution and Waste”, is recognized at the same level as the crises of climate change and nature and biodiversity loss, which already have frameworks in place.

In addition to the Global Framework on Chemicals, ICCM5 participants adopted the Bonn Declaration, in which they committed to “prevent exposure to harmful chemicals, and phase out the most harmful ones, where appropriate, and enhance the safe management of such chemicals where they are needed.”

They also expressed their will to “actively promote and support transitions to circular economies, including through the development of safe chemical and non-chemical alternatives and substitutes, which protect health and the environment, and lead to reduced waste, recycling free from harmful chemicals, and efficient resource utilization.”

A decision was made to unlock financing for the implementation of the framework from different sources. Germany, the president of ICCM5, pledged EUR 20 million to this fund, which will be administered by UNEP.

During ICCM5, a number of side events were organized during lunch break and after official meeting hours. These included:

- CropLife’s Sustainable Pesticide Management Framework—an integrated approach to Chemicals Management (organized by BASF, Bayer, Corteva, FMS, Sumitomo Chemicals and Syngenta)
- Pathways toward a Sustainable and Climate-friendly Production and Use of Chemicals
- Climate Friendly Fertilizer Production and Application
- Sustainable Management of Fluorinated Gases – Best Practices and Success Stories
- Effective Implementation of the United Nations Globally Harmonized System of Classification and Labelling of Chemicals
- WHO Chemical Road Map – Poison Centres saving lives and health sectors
- Diisocyanate Training for Safe Use and Handling – A unique example of cooperation between authorities, academia and industry
- Advancing chemicals and waste management in economic and industry sectors along value chains: A key dimension of integrated chemicals and waste management under the Beyond 2020 Framework
- A World Free of Lead Poisoning: How do we get there?
- Promoting Sustainable Chemistry: Fostering Non-Toxic Material Cycles and Circular Economy
- Achieving a positive Cost-benefit from green chemistry with effective multi-stakeholder partnership
- Advancing a human rights-based approach to accelerate the sound management of chemicals and waste for people and the planet
- Building capacity for climate action in chemical value chains in developing countries and emerging economies
- Sustainable Chemicals and Materials policy for Protecting the Climate and Biodiversity
- Opportunities for the financial sector to advance a global transition to sustainable chemistry organized by UNITAR
- ISC3 Investor Forum 2023 and Innovation pitches organized by International Sustainable Chemistry Collaborative Centre (ISC3). In this program, winners of the Innovative Ideas from all over the world presented their work to Funding agencies

There were a number of exhibitors who had set up their booth in ICCM5 Conference. This includes:

- IOMC (Inter-Organization Programme for the Sound Management of Chemicals)
ICCM meetings have led to the development and adoption of various important documents and initiatives, such as the Dubai Declaration, the Overarching Policy Strategy, and the Global Chemicals Outlook reports. These outcomes have contributed to advancing chemical safety and management worldwide. ICCM discussions have encompassed a wide range of global challenges, including the management of hazardous chemicals, the reduction of persistent organic pollutants (POPs), the promotion of safer alternatives, and the integration of chemicals management into sustainable development goals.

ICCM is closely associated with the Strategic Approach to International Chemicals Management (SAICM). SAICM is a policy framework developed to promote the sound management of chemicals throughout their life cycle. The ICCM meetings serve as a platform for reviewing progress and setting priorities within the SAICM framework.

The Committee on Chemistry and Industry (COCI) continue to build a strong relationship between SAICM, Global Framework on Chemicals and IUPAC through various projects.

For more information and comments, contact Task Group Chair Bipul Saha <drbsaha@rediffmail.com> https://iupac.org/project/2023-030-1-022/

Personal Protective Equipment Disposal for the Future

The response to the COVID-19 pandemic has generated tens of thousands of tonnes of personal protective equipment (PPE) waste [1]. In 2023, COVID-19 is creeping back into the news cycle as disease rates are increasing in the community in the winter months. Thus, it is likely that PPE will remain part of our daily lives; but the increased use of PPE poses a significant health and environmental challenge for two reasons. First, mask production consumes around 10-30 Wh energy and releases 59 CO$_2$-eq greenhouse gas to the environment [2,3]. Second, the majority of PPE and other infectious waste ends up as waste. Disposable masks are plastic products that are produced on a similar scale as plastic bottles. These masks cannot be readily biodegraded or composted, but fragment into smaller plastics (e.g. microplastics) that remain in the environment for hundreds of years. Directives from the World Health Organization (WHO) mandate incineration of medical PPE, leading to a 600% rise of plastic incineration in cities such as Wuhan in China at the height of the pandemic (up to 240 tonnes/day), exceeding the maximum incineration capacity of the
Project Place

country [4]. The recycling of disposable surgical plastic masks within the community is complicated since there is no official guidance on this topic, making it likely the material is disposed of as solid waste.

Maria Neira, Director of Environment, Climate Change and Health at WHO, said that: “COVID-19 has forced the world to reckon with the gaps and neglected aspects of the waste stream and how we produce, use and discard our health care resources, from cradle to grave.”

Life cycle analysis (LCA) is a valuable tool for assessing the environmental impacts associated with all life cycle stages of face masks. For instance, Allison et al., have shown that choosing to wear a reusable mask generates 85% less waste and has 3.5 lower impact on climate change, which is a significant contribution even if less single-use masks are purchased than assumed [5]. Van Straten et al., have undertaken LCA by evaluating data on ~18,000 high quality medical FFP2 face masks which were recycled through steam sterilization between March and July 2020. It was reported that the carbon footprint appears to be 58% lower for face masks which were reused five times after steam sterilization compared to single use (new) face masks [6]. Such information is vital for both policy makers who need to consider circular economy approaches for use of medical products but also for the general public who want to make informed decisions about use of PPE.

This project, entitled “Personal protective equipment disposal for the future” has brought together members from the IUPAC Polymer, Chemistry and the Environment, and the Chemistry and Human Health Divisions, in addition to the Committee on Chemistry Education and Interdivisional Committee on Green Chemistry for Sustainable Development, to tackle this important societal issue. In this project, three posters to date were developed that described the composition of protective face masks and other PPE (e.g. lab coats, gloves) and what polymers they are made from, how they work, and strategies for reducing, recycling, and reusing of common polymers. These posters have been shown across the world (Cambodia, Egypt, France, United Kingdom, Portugal) and are available in multiple languages including English, Arabic, French, Dutch, and Portuguese.

The posters are freely available at the progress tab of the project page https://iupac.org/project/2021-012-2-400/, or you can enquire with the project team. In addition, a quiz has been developed (https://app.wooclap.com/IUPACPLASTICS/questionnaires/64424ebddd4f0ad876b2b21a) where people can test their knowledge on the topic; feel free to have a go! The project team will use the results of the quiz and activities with the posters to develop educational activities that we hope to publish in an upcoming Chemistry Teacher International publication.

References:
5. Allison et al., The impact and effectiveness of the general public wearing masks to reduce the spread of pandemics in the UK: a multidisciplinary comparison of single-use masks versus reusable face masks, UCL Open Environ. 3, DOI: 10.14324/111.444/uclooe.000022, 2021.

For more information and comments, contact Task Group Chairs Marloes Peeters <marloes.peeters@newcastle.ac.uk> or Michael Walter <Michael.Walter@uncc.edu> https://iupac.org/project/2021-012-2-400/
Chemical data evaluation: general considerations and approaches for IUPAC projects and the chemistry community (IUPAC Technical Report)


Pure and Applied Chemistry, 2023
Vol. 95, no. 10, pp. 1107-1120
https://doi.org/10.1515/pac-2022-0802

At the time of writing, more than 204 million characterized chemical substances have been identified in the CAS Registry, one of the world’s largest substance databases in chemistry. Substances are characterized in a variety of ways by measurements that cover dozens of physical or chemical properties. With repeated measurements of the same property by various techniques over space and time, the number of measured property values in the peer-reviewed literature is vast and growing. Reported measurement results, however, may differ in quality, (defined as the “degree to which a set of inherent characteristics of an object fulfills requirements”) and may not agree with one another. Moreover, the experimental information necessary to assess data quality is incomplete or absent in many measurement reports. With many data for a given property to choose from and multiple sources of error in the underlying measurements, which are commonly difficult to identify for non-experts, chemists and non-chemists alike depend on the critical evaluation of available data by experts for provision of preferred values for practical use.

To give guidance about how to design data evaluation projects, how to evaluate data for quality, and what needs to be considered to make such evaluations reliable and traceable over time, the Interdivisional Subcommittee on Critical Evaluation of Data (ISCED) was instituted in 2018 under the umbrella of IUPAC. This technical report is the first in a projected series providing guidance on the critical evaluation of chemical data for both preparers and users of such data, drawing on decades of experience gained from critical evaluations prepared under IUPAC auspices. In this first report, the general principles of the evaluation of scientific data are defined and best practices and approaches to data evaluation in chemistry are described.


A brief guide to polymer characterization: structure (IUPAC Technical Report)


Pure and Applied Chemistry, 2023
Vol. 95, no. 10, pp. 1121-1126
https://doi.org/10.1515/pac-2022-0602

To bolster the series of Brief Guides released by IUPAC, here we introduce the first Brief Guide to Polymer Characterization. This article provides a concise overview of characterization methods for teachers, students, non-specialists, and newcomers to polymer science as well as being a useful manual for researchers and technicians. Unlike pure low molar mass chemical substances, polymers are not composed of identical molecules. The macromolecules which comprise a single polymer sample vary from one another, primarily in terms of size and shape, but often also in the arrangement or positioning of atoms within macromolecules (e.g., chain branching, isomerism, etc.). Polymer properties are often drastically different from those of other substances and their characterization relies on specialist equipment and/or common equipment used in a specialized way (e.g., particular sample preparation or data analysis). This Brief Guide focuses uniquely on the structural characterization (i.e., analyzing the molecular and multi-molecular aspects) of polymers. The complex nature of the structural variables possible in macromolecular materials often presents a challenge with regard to the detailed structural characterization of polymers. This Brief Guide provides a useful starting point to direct the reader to the most commonly used and useful techniques to characterize these structural variables.

The reader is directed to the online supplementary materials, a formatted two-page version including colored coded links to source documents: gold text to the IUPAC gold book and blue text to PAC source.

https://iupac.org/project/2015-049-1-400/
Analytical chemistry of engineered nanomaterials: Part 2. analysis in complex samples (IUPAC Technical Report)

Ján Labuda, Jiří Barek, Zuzana Gajdosechova, Silvana Jacob, Linda Johnston, Petra Krystek, Zoltan Mester, Josino Moreira, Veronika Svitkova and Kevin J. Wilkinson

Pure and Applied Chemistry, 2023
Vol. 95, no. 11, pp. 1159-1196
https://doi.org/10.1515/pac-2022-0401

Recently, the scope, regulation, legislation, and metrology of the analytical chemistry of engineered nanomaterials (ENMs) have been reviewed in the Part 1 of the IUPAC Technical Report (PAC vol. 95, no. 2, 2023, pp. 133-163). Chemical analysis of nanomaterials in complex sample matrices presents a substantial challenge for analytical science and regulatory agencies. The purpose of the present Part 2 is to discuss the detection, characterization, and quantification of nanomaterials in samples of complex matrices including methods for sample preparation and fitness for purpose. Analytical methods applied to analysis in matrices of environmental samples, food, cosmetics, and biological samples as well as those used to monitor the fate of ENMs in the environment and biological systems are reported. There is a rapid development in the field mostly in the stage of accumulation of factual material. The single-particle inductively coupled plasma mass spectrometry is already widely used at the chemical analysis of metal-containing nanoparticles.

https://iupac.org/project/2017-005-3-500/


Francesca R. Penneccchi, Ilya Kuselman and D. Brynn Hibbert

Pure and Applied Chemistry, 2023
Vol. 95, no. 12, pp. 1217-1254
https://doi.org/10.1515/pac-2022-0801

A Bayesian multivariate approach to the evaluation of risks of false decisions on conformity of chemical composition of a substance or material due to measurement uncertainty is adapted to cases for which the composition is subject to a mass balance constraint. The constraint means that sum of the actual (“true”) values of the composition component contents under conformity assessment is equal to 1 (or 100 %) or another positive value less than 1 (less than 100 %). As a consequence, the actual values of the component contents are intrinsically correlated. Corresponding measured values of the component contents are correlated also. Any correlation can influence evaluation of risks of false decisions in conformity assessment of the substance or material chemical composition. A technique for appropriate evaluation of the relevant risks, including evaluation of the conformance probability of a subject or material composition, is discussed for different scenarios of the data modeling, taking into account all observed correlations. A Monte Carlo method is applied in the R programming language for the necessary calculations. Examples of evaluation of the risks are provided for conformity assessment of chemical composition of a platinum-rhodium alloy, pure potassium trioxidioiodate, a sausage, and synthetic air.

https://iupac.org/project/2019-012-1-500/
Aerogels for Biomedical and Environmental Applications

by Gabrijela Horvat and Zoran Novak

The 3rd International Conference on Aerogels for Biomedical and Environmental Applications was held in Maribor, Slovenia, 5-7 July 2023, and was organized by AERoGELS COST Action and the Faculty of Chemistry and Chemical Engineering, University of Maribor, Slovenia. AERoGELS COST, which features more than 400 participants from 47 countries and more than 200 institutions from academia, industry, and regulatory agencies, focuses primarily on environmental applications such as pollutant treatment and removal, energy management, and life cycle analysis. It also encompasses life sciences, including aerogels’ pharmaceutical, biomedical, and food applications.

The organizing committee was led by Zoran Novak of the University of Maribor, Slovenia. Other organizing committee members were Carlos A. García-Gonzalez from the University of Santiago de Compostela, Spain; Gabrijela Horvat, Amra Perva, and Milica Pantić, all from the University of Maribor, Slovenia.

The Scientific Committee, composed of experts from renowned institutions worldwide, played a crucial role in ensuring the quality and relevance of the conference. Members of the Scientific Committee included Carmen Alvarez-Lorenzo from the University of Santiago de Compostela, Spain; Tatiana Budtova from Mines ParisTech, France; Luisa Durães from the University of Coimbra, Portugal; Can Erkey from Koç University, Turkey; Marta Gallo from Politecnico di Torino, Italy; Jozsef Kalmar from the University of Debrecen, Hungary; Falk Liebner from BOKU University, Austria; Monica Neagu from Victor Babes Institute, Romania; Patrina Paraskevopoulou from National and Kapodistrian University of Athens, Greece; Irina Smirnova from Hamburg University of Technology, Germany; and Željko Tomović from Eindhoven University of Technology, the Netherlands. They all played an important role in evaluating the abstracts and ensuring the high quality of the presentations.

The main objective of the conference was to integrate the latest scientific and technological advances in the field of aerogels. In addition, the event was intended to facilitate networking and strengthen collaboration within the aerogel community through poster sessions, social events, coffee breaks, and meals.

Aerogels are known for their advanced and highly porous nature and have a wide range of applications in biomedical and environmental fields. Aerogels can be used in biomedical applications as drug carriers, bone grafts, and wound dressings. They also serve as insulators, absorbents, sensors, and catalysts in various environmental applications.

The conference program included three Early Career Investigator (ECI) forums, one Short-Term Scientific Mission (STSM) forum, 46 oral presentations, and 16 poster presentations. The ECI and STSM forums were led by young investigators, including graduate students and postdocs. The program provided a platform for young scientists to present their work and foster discussions among participants. The program also included a special session discussing the concept of aerogel. This session took place on the second day of the conference and was chaired by Falk Liebner. The aim of the discussion was to discuss the development of new terminology for aerogels, considering the progress and new trends in the field. This session provided a valuable platform for researchers and experts to exchange ideas and contributed to the ongoing efforts to establish a standardized and accurate terminology in aerogel research.

Renowned plenary speakers gave insightful presentations on various aspects of aerogels. Ana Aguiar-Ricardo from Nova University of Lisbon Portugal and Igor Lacik from Slovak Academy of Sciences, both IUPAC representatives, gave a tandem plenary talk on “The IUPAC-Aerogels Connection: Aerogels as one of the IUPAC Top Ten Emerging Technologies in Chemistry in 2022.” Ali Ubeytogullari from University of Arkansas, USA, discussed advanced 3D printing technologies related to aerogels for food applications. Matjaž Finšgar from the University of Maribor, Slovenia, gave a presentation on surface analysis of biomaterials.

Award for best oral presentation.
The conference was attended by about 90 people, with an almost equal ratio of women to men. The event was supported by Merel d.o.o., Kemomed d.o.o., Polymers (MDPI), Chemas d.o.o., Micro polo d.o.o., Mettler Toledo d.o.o., Springer, and IUPAC. Three awards for the best oral contributions were awarded to young researchers: Second prize went to Philip Sidney Pein and Sara Valente, who received books from Springer, while Tania Ferreira Goncalves received first prize and a cash prize of €600 from Polymers. Ana Iglesias Mejuto received the prize for the best poster presentation and a cash prize of €400 from Polymers.

The 3rd International Conference on Aerogels for Biomedical and Environmental Applications provided an exceptional platform for experts to share their insights, knowledge, and experiences in the field. The conference provided an excellent opportunity for researchers, engineers, and professionals to learn about the latest aerogel advances and foster collaboration. The conference was a resounding success, and the organizers would like to thank all participants, sponsors, and contributors for their valuable contributions and active involvement. The fruitful outcomes of the conference suggest that advances in the field of aerogels for biomedical and environmental applications will continue, driving innovation and progress in these important research areas.

Over 400 participants from all over the world gathered at the 3rd International Conference on Aerogels for Biomedical and Environmental Applications in Maribor, Slovenia, 5-7 July 2023. The event focuses primarily on environmental applications such as pollutant treatment and removal, energy management, and life cycle analysis.

Solution Chemistry
by Marija Bešter-Rogač and Slobodan Gadžurić

The 38th IUPAC International Conference on Solution Chemistry (38ICSC) was held in Belgrade, Serbia, 9-14 July 2023. The ICSC continued the tradition and fostered interaction among the various research communities worldwide. For the first time, ICSC was organized by two universities from two countries (University of Ljubljana, Slovenia and University of Novi Sad, Serbia). During the event, 130 participants from 32 different countries presented and discussed the new findings on various scientific and technological issues related to solution chemistry. With the advent of new theories, analytical methods, computers and technologies, the research field of solution chemistry has expanded widely and profoundly covering the following topics:

- Ionic liquids
- Solution thermodynamics
- Biochemical effects in solutions
- Solubility phenomena and phase equilibria
- Solution structure and dynamics
- Supercritical fluids and solutions under extreme conditions
- Colloids and interfaces
- Computational solution chemistry
- General solution chemistry
- Industrial applications of solutions.

The scientific program included 6 prominent plenary and 13 invited keynote speakers. The program and the book of abstracts are available online and can
Conference Call

be downloaded from the conference web page https://icsc2023.pmf.uns.ac.rs/.

Five prizes for the best poster presentations were given to young scientists. The awarded students are: Lukas Magenhiam (TU Wien Austria), Andrijana Bilić (University of Novi Sad, Serbia), Aditi Prabhune (Department of Chemistry, Goa, India), Pavlina Matysova (University Usti and Labem, Czech Republic) and Domen Goste (University of Ljubljana, Slovenia).

IUPAC provided financial support that helped six scientists from emerging countries to participate at 38ICSC. Also, the travel expenses for the IUPAC representative were partially covered using the IUPAC support.

During the steering committee meeting it was decided that the 39th ICSC will be held in September 2025 in the town of Monastir in Tunisia.

Marija Bešter-Rogač, University of Ljubljana, Slovenia, and Slobodan Gadžurić, University of Novi Sad, Serbia are co-chairs of 38ICSC.

Connecting Chemical Worlds – IUPAC General Assembly and IUPAC World Chemistry Congress at The Hague

by Bipul Saha

Founded more than one hundred years ago, IUPAC is one of the largest global organizations for chemical professionals. The 52nd IUPAC General Assembly and the 49th IUPAC World Chemistry Congress were held in The Hague (Netherlands) from 18 - 25 August 2023, simultaneously with 11th edition of CHAINS 2023, the largest Chemistry Congress from the Netherlands. More than 2200 delegates from 77 countries attended the program.

Opening Ceremony

The joint opening ceremony was held on 20 August at the “World Forum,” The Hague. IUPAC President Javier Garcia Martinez welcomed the participants and gave an overview of IUPAC. In this inaugural session, the IUPAC-Solvay International Award for Young Chemists was presented. The winners of the 2023 IUPAC-Solvay International Award for Young Chemists, for the best Ph.D. theses in the chemical sciences are:

1. Eduard Bobylev (Ukraine, Netherlands), Ph.D., University of Amsterdam, Netherlands
2. Craig Day (Canada, Spain), Ph.D., Rovira i Virgili University, Spain
3. Nikita Hanikel (Germany, USA), Ph.D., University of California Berkeley, USA
4. Apurva Panjla (India), Ph.D., Indian Institute of Technology, Kanpur, India
5. Yu Zheng (China/Beijing/USA) Ph.D., Stanford University, USA

The IUPAC 2023 Distinguished Women in Chemistry or Chemical Engineering Awards were also presented in this opening session. Through this award, women are recognized for their distinction and excellence in Chemistry or Chemical Engineering, whether in research, teaching, industry, government, academia or whatever work sector in which women are engaged. The awardees of the IUPAC 2023 Distinguished Women in Chemistry or Chemical Engineering are:

1. Lidia Armelao, National Research Council and University of Padova, Italy
2. Annette G. Beck-Sickinger, Leipzig University, Germany
3. Chunying Chen, National Center for Nanoscience and Technology of China, Beijing, China
4. Bin Liu, National University of Singapore, Singapore
5. Laura McConnell, Bayer U.S., Crop Science Division, USA
6. Marcia Foster Mesko, Federal University of Pelotas, Brazil
7. Jyotirmayee Mohanty, Bhabha Atomic Research Centre, Mumbai, India
8. Tatjana Parac-Vogt, Katholieke Universiteit Leuven, Belgium
9. Gill Reid, University of Southampton, UK
10. Mikiko Sodeoka, RIKEN, Japan
11. Nguyễn Thị Kim Thanh, University College London, UK
12. Marinda Wu, Dow (retired), USA

In the inaugural session, a plenary lecture was delivered by Molly Stevens of Imperial College, London on the topic “Healing the Body and Detecting Diseases earlier through New Materials.” She has created a broad portfolio of designer biomaterials for applications in disease diagnostics and regenerative medicine.

IUPAC Committee on Chemistry and Industry led Workshop and Training Program

The IUPAC Committee on Chemistry and Industry conducted (a) “Safety Training Workshop” and (b) “Safety Training Program” for the International Young Chemist Network. IUPAC has been organizing Safety Training Program, both online and off line. Participants from all over the world have undergone
Conference Call

the training program. In this program at the Hague, speakers included Anna Makarova (Russia), Fabian Benzo (Uruguay), Bipul Saha (India), Christine Ashaolu (Nigeria), Gracia Maria Romero (Honduras), Daniela Bruno Welkar (Spain). Daniela Bruno Welkar, Product Stewardship Manager, BASF, Spain discussed the EHS Management process of BASF from corporate governance level to operation level. She also spoke about “Green Deal” of Europe which will transform the EU into a modern, resource-efficient and competitive economy, ensuring no net emissions of greenhouse gases by 2050. Daniela Bruno Welkar mentioned that “Chemical Strategy for Sustainability” has two clear objectives: (a) Improve the protection of human health (b) Drive innovation to enable the transition to safe and sustainable chemicals.

World Chemistry Leadership Meeting on the “Future of Chemistry”

In the last few years, IUPAC has published the “Top Ten Emerging Technologies in Chemistry” based on a Global Survey. This has led to discussion on the future in the fields of Chemistry and Chemical Engineering. Organizers of the Congress arranged a World Chemistry Leadership Meeting on “Future of Chemistry.”

In this session, Nessa Carson of AstraZeneca spoke on a “Digital Transformation of Chemistry.” With the advent of Big Data and Digitalization, modern Chemistry is on the threshold of a transformative change. She said that to realize the full potential of Chemistry research, it is time for digitalization and this will require a global effort.

Laura McConnell, Science Fellow at Bayer Crop Science, spoke about “Feeding the Planet.” With the increase of population and decrease in arable land, the challenge is how to feed the planet. McConnell said that Chemistry is going to be a key driver of increased productivity and sustainability. Digital revolution and tools like A.I., Machine Learning are going to play a key role in future.

Svetlana Tsogoeva delivered speech on “New Methods for Drug Discovery.” She discussed how drug discovery and development processes can be accelerated with cutting edge technologies.

Alejandro Franco of France talked about new fuels. He said that for clean and sustainable energy, batteries are emerging as an important technology for the future. Optimization of the battery production process is complex as there are a large number of factors. Artificial Intelligence and many digital tools can accelerate optimization and improved design by simulating the manufacturing process and predicting performance through multiscale modeling.

Nobel Laureate Ben Feringa, Jacobus H. van’t Hoff Distinguished Professor of Molecular Sciences and Professor of Chemistry at the University of Groningen, The Netherlands and Honorary Chair of IUPAC/CHAINs 2023 World Chemistry Congress, delivered a speech “Reinventing Chemistry.” He said that Chemistry has contributed significantly to shape modern society. However, we now face major challenges like developing sustainable processes and integrating Information Technology with Chemistry. In this context, we now require new approaches to teach Chemistry which includes a “Systems Thinking” approach.

IUPAC Council Meeting and Election

During IUPAC General Assembly, IUPAC Council meeting and elections were held. The IUPAC Council consisting of representatives of 56 Countries discussed various issues and elected Officers and Board members. Mary Garson (Australia) was elected as Vice President and Zoltan Mester (Canada) as Secretary General. The following members were elected as member of IUPAC Executive Board: Bipul Saha (India), Hemda Garelick (UK), Richard Hartshorn (New Zealand), Bonnie Lawlor (USA), Christine Luscombe (Japan), and Zhigang Shuai (China). The following members have been elected to the Science Board: Lidia Armelao (Italy), Derek Craston (UK), Igor Lacik (Slovakia), Michelle Rogers (USA), Frances Separovic (Australia), Eva Åkesson (Sweden), Pierre Braunstein (France), Alejandra Palermo (UK), Peter Schreiner (Germany), Chi-Huey Wong (China/Taipei). Starting in 2024 Ehud Keinan (Israel) will be President for two years and Javier Garcia-Martinez (Spain) will continue as past President, while Wolfram Koch (Germany) will continue as Treasurer.

The Council approved membership of Jordan and Honduras with effect from 1 January 2024. It also approved incorporation of the International Younger Chemists’ Network as an IUPAC Committee. The Czech Republic and Slovakia’s joint bid for Prague as host of the 55th General Assembly and the 52nd World Chemistry Congress from 18-24 August 2029 was also approved.

Plenary Lectures

A number of plenary lectures were organized during the World Chemistry Congress. Marc Koper of Leiden University and President of the International Society of Electrochemistry made a presentation on “How to make
Conference Call

Parallel Sessions and Focus Sessions:
Chemistry and Artificial Intelligence
Chemistry and AI: Reaction Mechanics and Catalysis
Automation and Robotics
Materials for Energy Storage
Materials for Smart Sensing and Actuating
Materials for Photovoltaics and Energy Harvesting
Complex Metal Oxides for Energy Applications
Electrocatalysis and the Synthesis of High Value Chemicals
Materials and Interfaces for Next-Generation Batteries
Energy Storage
Molecular Electronics Metamaterials and Luminescent Molecules
Environmental Science
Carbon Capture and Utilization
Depolymerization and Green Polymers
Biomass Conversion
Biomaterials
Towards Safe and Sustainable by Design
New Plastics Circular by Design
Computational Methods in Drug Discovery
Peptide and Protein Chemistry
Addressing antibiotic resistance
Targeting Toxic Proteins for Detection and Destruction
Novel Imaging Techniques
Towards the Next Generation of Macroyclic-Peptide Therapeutics
Revolutionary Imaging Techniques for Studying Life at the Molecular and Cellular Level
Photo-pharmacology and Photodynamic Therapy
Nanomedicines
Synthetic Methods for Biologically Active Molecules
Life-like materials
Glycochemistry
Colloidal and Supramolecular Materials
Homogeneous and Heterogeneous Catalysis
Electrochemistry
Systems Thinking as a Linchpin in Chemistry Education
Towards Responsible Use of Machine Learning in Chemistry Digital Skills – Data Management in Chemistry Green Chemistry and Sustainability in Education Diversity Equity and Inclusion.

Green Hydrogen.” Jennifer Thomson of the University of Cape Town and President of the Organization for Women in Science in the Developing World spoke on “GM Crops and New Agricultural Improvements.” Charlotte K. Williams of the University of Oxford spoke on her work on “Sustainable Polymer Chemistry using Catalysis to make polymers from renewables and in chemical recycling.” She is particularly focused on carbon dioxide utilization by copolymerization and on the production of bio-derived polyesters, polycarbonates, and block polymers. Bartosz Grzybowski, Distinguished Professor of Chemistry at UNIST and Polish Academy of Sciences spoke on “Synthesis, processes and reaction discovery in the age of computers.” His primary research interest is “Computer-driven Synthesis.” Nicola Spaldin of ETH Zurich made a presentation on “Materials Chemistry and the Future of Human Civilization.” She is best known for her research work on the class of materials known as “Multiferroics,” which are simultaneously Ferromagnetic and Ferroelectric. Timothy Caulfield of University of Alberta delivered a popular lecture on “Science and the Misinformation Crisis.” Hiroaki Suga of the University of Tokyo delivered the van’t Hoff lecture on the topic “De novo discovery of pseudo-natural peptides and products.” Chad Mirkin, Director of the International Institute for Nanotechnology, Northwestern University spoke on “Exploring the Matterverse with Nanomaterial Megalibraries.” He is a world-renowned nanoscience expert with more than 400 approved patents and founded multiple companies.

IUPAC/CHAINS 2023 World Chemistry Congress Themes:
IUPAC/CHAINS 2023 World Chemistry Congress was organized under five themes:
- Chemistry at the Molecular Frontiers
- Chemistry related to Health
- Chemistry related to Sustainability
- Smart and Energy Materials
- Ethics, Education and Society
Different symposiums were organized under each of the above themes. For example:

Chemistry at the Molecular Frontiers
- Quantum Chemical (+ AI) Elucidation of Organic Reactivity
- DNA Nanostructures in Biology
- Mechanochemical applications for sustainable synthesis
Conference Call

Chemistry related to Health
• Addressing antibiotic resistance—the silent pandemic
• Targeting toxic proteins for detection and destruction
• Are we prepared for the next pandemic?
• The role of computational chemistry in the mitigation of infectious diseases from characterization of emerging pathogens to drug development

Chemistry related to Sustainability
• Development of new reaction pathways towards Green Chemistry
• Prospects of CO2 capture & activation for a circular chemical industry
• Electrocatalysis and the synthesis of high-value chemicals
• New plastics circular by design
• A Sustainable Planet and Society
• Chemistry and AI

Smart and Energy Materials
• Complex metal oxides for energy applications
• Materials and interfaces for next-generation batteries
• Dynamical molecular systems for brain-inspired computing
• Ethics, Education and Society
• Crafting an ethical framework for global chemistry
• Make the good choice! Ethics and dual use in chemistry
• Meeting the modern challenges of chemical weapons
• Systems thinking as a linchpin in chemistry education

Apart from oral presentations, there were large number of posters.

The organizers also made other program to make the whole event interesting. It included a quiz, a Chemistry Party, a Meet and Greet with Nobel Laureate Ben Feringa and other eminent scientists, a Tour of the Office of the Organization for Prohibition of Chemical Weapons (OPCW), and a Beer and Cheese Factory tour.

After 7 days of hectic activities, the program came to an end. At the closing ceremony, the baton was passed from The Netherlands to Malaysia. The next Congress will be held in Kuala Lumpur in 2025.

See https://iupac2023.org/ for photos albums and aftermovie.

Two IUPAC Poster Prize Certificates awarded at the 75th Annual Congress of the Slovak & Czech Chemical Societies

by Milan Drábik

The 75th Annual Congress of the Slovak & Czech Chemical Societies (held from 4-8 September 2023 in High Tatras, Slovakia) attracted nearly 400 participants who presented and discussed the large scope of topics and achievements of chemists from Slovakia and The Czech Republic. The program comprised an exclusive plenary lecture – Mass photometry: weighing molecules with light, by Prof. Philipp Kukura, Oxford University, U.K., invited lectures, lectures and poster presentations. The organisers had the credit and responsibility to decide on two awardees of IUPAC Poster Prize Certificates. The IUPAC Poster Prize is aimed at PhD students and chemists younger than 40 years, thus poster presentations of nearly 100 young colleagues have been monitored and evaluated with the aim to choose two posters and authors to be awarded. The members of ad-hoc monitoring and evaluating committee, chaired by Milan Drábik, after two evenings of viewing of posters and scientific discussions with authors decided to award and present the certificates to:

Dhiya Krishnan, PhD student at the Institute of Inorganic Chemistry, Slovak Academy of Sciences, Bratislava, Slovakia; for the poster entitled “THE PHASE EQUILIBRIA OF Na₃AlF₆–NdF₃ AND (Na₃AlF₆–NdF₃)EUT–Nd₂O₃ SYSTEM”.

From left to right: Assoc. Prof. Monika Jerigová – chair of the Organizing Committee of the 75th Annual Congress of the Slovak & Czech Chemical Societies, Ms. Dhiya Krishnan – IUPAC Poster Prize awardee, Assoc. Prof. Milan Drábik – Chairman of Slovak National Committee of IUPAC, Prof. Lubomír Švorc – president of Slovak Chemical Society
Martina Machalová, PhD student at the Institute of Chemistry and Technology of Environmental Protection, Faculty of Chemistry, Brno University of Technology, Brno, Czech Republic; for the poster entitled “LA-ICP-MS IN MEDICAL RESEARCH”.

Awardees, when asked to describe in brief their research and results for readers of Chemistry International, answered confidently as follows. Dhiya Krishnan: “I conducted the thermal analysis to investigate the phase equilibria of molten salts to determine the temperatures of primary crystallization and the eutectic temperatures. Notably, the research revealed that the solubility of Nd₂O₃ in the molten eutectic system of Na₃AlF₆-NdF₃ is relatively high compared to the solubility of Nd₂O₃ in the current molten industrial electrolyte (2 wt.%, 0.96 mol.%) for the electrowinning of neodymium (LiF-NdF₃). Results of this investigation hold the potential to provide useful information for electrometallurgical applications, particularly in the electrowinning of Nd and related rare earth elements.”

Martina Machalová: “The presented contribution – LA-ICP-MS in medical research, was focused on the application of laser ablation inductively coupled plasma mass spectrometry in 2D elemental imaging within soft tissue. In this context, a methodology has been developed for the analysis of rat heart sections to study the changes in elemental distribution as a result of myocardial fibrosis. A positive correlation has been found between increased iron distribution and the myocardial fibrosis locations.”

Milan Drábik is the Chair of Slovak National Committee of IUPAC and in IUPAC, he is Titular Member of ICTNS.

Network of Inter-Asian Chemistry Educators – or just NICE

by Soon Ting Kueh, Zuriati Zakaria, and Yvonne Choo Shuen Lann

The 9th Network of Inter-Asian Chemistry Educators (9NICE) Conference 2023 was held in the city of Kuching, Sarawak, Malaysia from 28-30 July 2023. With the theme of “Chemistry for Sustainable Development & Environmental Protection,” the 9NICE Conference 2023 comprised the following:

Lectures: Keynotes, oral & poster presentations
- Cultural & Nature Tours
- Exhibition
- IUPAC Young Ambassadors of Chemistry (YAC) programme

9NICE 2023 was organized by Institut Kimia Malaysia (IKM) in collaboration with IKM Sarawak Branch Committee, Institute of Teacher Education (Batu Lintang Sarawak), Education Department of Sarawak, Universiti Malaysia Sarawak (UNIMAS) and Department of Chemistry, Sarawak. The conference is supported by IUPAC, IKM Law Hieng Ding Foundation and Business Events Sarawak.

NICE is a network of chemistry educators from four Asian countries/regions, namely Japan, Korea, Malaysia, and Taiwan. The main objective of NICE is to promote chemistry education among the younger generation. It also aims to create a network of chemistry educators to share experience and expertise in the teaching and learning of chemistry. NICE organizes a biennial conference and in 2023, the 9NICE Conference was held from 28-30 July 2023 in the nostalgic city of Kuching in Sarawak, Malaysia. The participants of NICE conferences are mainly chemistry educators, teachers and students. This year’s 9NICE Conference attracted 197 participants from 6 countries. The programme included a total of 57 presentations including 4 keynote lectures, 27 oral and 26 poster presentations from 6 countries. The presentations cover many areas in chemistry education,
Keynote papers presented during the 9NICE conference were as follows:

1. Exploring the future of Chemistry Education Centers in Korea, by Jongseok Park, Kyungpook National University, South Korea

2. Raising Awareness: Multiple Uses of Chemicals and Chemical Weapons Convention, by Dato Dr Jamil Maah, Universiti Malaya, Malaysia

3. Analogies in Chemistry Teaching and Learning, by Shingo Uchinukura, Kagoshima University, Japan

4. Equation-free Quantum Chemistry and Molecular Orbital Theory, by Yuan-Chung Cheng, National Taiwan University, Taiwan

9NICE in session

In addition, 9NICE Conference 2023 also included a Young Ambassadors for Chemistry (YAC) 2023 programme especially for students and teachers; see IUPAC project 2023-003-3-050 <https://iupac.org/project/2023-003-3-050/>. This year’s YAC 2023 comprised interactive experiments, demonstrations and workshops held at the Institute of Teacher Education (Batu Lintang Sarawak). The teachers & students enjoyed the interactive experiments and demonstration that aimed to associate chemistry with the UN Sustainable Development Goals (SDG) 2030. About 40 secondary students aged 16-17 with 10 teachers attended the YAC2023 programme. Another 18 students from Taiwan, Japan, and Korea and staff from the Institute of Teacher Education also attended as observers. The participants were divided into 10 groups. Each group consists of four local students, one accompanying teacher and one or more international participants. They were given time to explore the experiments showcased in each of the laboratories before being brought to the next laboratory on a rotational basis.

Details of each laboratory were as follows:

Laboratory 1 – Booth 1 (SDG 6 – CLEAN WATER AND SANITATION)

- Table 1: Learning how to use a dropper
- Table 2: Turbidity Test
- Table 3: pH Test
- Table 4: Identification of Dissolved Ions

Water Analysis Experiment by the Department of Chemistry Sarawak
- Tested water quality (pH, turbidity, dissolved ions, etc.) from local sources
- Showcased the importance of Chemistry in maintaining good water quality via analysis and water purification for better wellbeing.

Laboratory 2 – Booth 2 (SDG 7- AFFORDABLE AND CLEAN ENERGY) and 3 (SDG 9 – INDUSTRY, INNOVATION AND INFRASTRUCTURE)

- Table 1: Veg-based Dye-Sensitized Solar Cells (DSSC)
Conference Call

- Table 2: Water Electrolysis
- Table 3: Tensile Stress of Common Household Materials
- Table 4: Corrosion Protection

The Making of Solar Cell / Water Electrolysis Experiment
- Created simple solar cell (from colored vegetables and artificial dyes)
- Created simple water electrolysis set-up using battery, thumb pins, salt water/bicarbonate soda and transparent cups
- Showcased how the concept works and relate them to existing research on renewable energy (e.g. solar cells, fuel cell/water splitting, etc.)

Experiment Testing Strength of Materials and Corrosion Protection
1. Tested the strength of common materials such as cardboard, rubber glove, plastic bag, etc. using simple set-up (cut materials into strips and exert pulling force using a spring scale between two fixtures resembling tensile test of materials)
2. Tested out methods of preventing corrosion of nails (secondary school experiment)
3. Showcased the need for chemist in the making, testing and protection of existing materials used in industry, innovation, and infrastructure

Laboratory 3 – Booth 4 (SDG 12 – RESPONSIBLE CONSUMPTION AND PRODUCTION) and 5 (SDG 13 – CLIMATE ACTION)
- Table 1-2: The Making of Bioplastic
- Table 3-4: Biodiesel Synthesis

The Making of Bioplastic Experiment
- Made simple bio-plastic with starch (corn starch), vinegar, water and heat source
- Allowed students to bring home the bio-plastic they made to observe the biodegradation part
- Showcased the effort chemists are making in materials development (e.g. biodegradability, toxicity, etc.) and their application in other sectors (e.g. biomedicine, food packaging, etc.)

Waste to Wealth (Biodiesel Synthesis) Experiment
- Conducted waste to wealth experiment: synthesizing biodiesel from used cooking oil
- Showcase the importance of chemistry in climate action initiatives

YAC in session
A welcome reception was held at Roxy Hotel Kuching on the night before the conference started. Participants enjoy a leisurely evening to gather, mingle, and get to know each other as well as socialising and networking.
Welcome Reception at Roxy Hotel Kuching

The second day of the conference was about relaxing. The participants enjoyed a trip to the Semenggoh Wildlife Centre to encounter one of Borneo’s endangered species, Orangutans. Participants got to observe the forest reserve’s caretakers during their feeding time.

Participants also visited the Borneo Cultures Museum, which is the second largest museum in Southeast Asia. The state-of-the-art complex is home to over 1,000 artifacts that boast the rich culture and heritage of the indigenous peoples of Borneo and Sarawak.

Tours to Semenggoh Orang Utan Santuary & Borneo Cultures Museum

On the last day, Uday Maitra from India started the “Chemistry is Fun” session with a series of lectures and demonstrations. He presented interesting lectures on historical chemistry and chemistry in space. The second demonstration was from a school teacher, Liao Hsu-Mao from Taiwan. He discussed the design and application of the Mini Stirrer Modules. The demonstrations were catered for teachers so that they could each bring home a unit to be distributed and demonstrate to their students in their respective institutions. Mr Liao explained the steps involved to assemble each mini stirrer units and showcased the use of such units in teaching.

YAC Workshop Demonstration

During the conference dinner, all the participants from each country showcased their singing talents on stage making the dinner full of entertainment and fun.

Conference Dinner

During the closing ceremony, Datuk ChM Dr Soon Ting Kueh passed the baton to the next NICE conference organizing Chairman, Prof. Dr Kuriyama from Yamagata University, Japan. The next NICE conference will be held in Japan in the year 2025.

https://www.9nice2023.org/
Mark Your Calendar

Upcoming IUPAC-endorsed events
See also www.iupac.org/events

2024

27 Feb 2024 – Catalyzing Diversity in Science – Virtual
IUPAC Global Women Breakfast
https://iupac.org/gwb/

27-31 May 2024 - Polymers for our future - Madrid, Spain
POLY-CHAR 2024, Co-chairs: Araceli Flores and Peter Shuttleworth, poly-char2024@fgua.es
https://www.poly-char2024.org/ Co-chair: Aldrik Velders, Wageningen University; ecb@tfigroup.com
https://www.ecb2024.com/

23-28 Jun 2024 – Nano-Applications - Manchester, NH, USA
Impactful Nano-Applications for Sustainable Food Production
Melanie Kah, co-chair, University of Auckland, New Zealand, melanie.kah@auckland.ac.nz

24-28 Jun 2024 - Polymers for Sustainable Future – Prague, Czech Republic
85th Prague Meeting on Macromolecules – Polymers for Sustainable Future
Program co-chairs: Hynek Beneš, and Zdeněk Starý, Institute of Macromolecular Chemistry, Czech Academy of Sciences; pmm85 @imc.cas.cz • https://www.imc.cas.cz/sympo/85pmm

30 Jun - 3 Jul 2024 - Biotechnology - Maastricht, The Netherlands
19th International Biotechnology Symposium - “Biotechnology for the Grand Challenges of our Society”,
joint with the 19th European Congress on Biotechnology (ECB2024) and the Annual Dutch Biotechnology Meeting (NBC-24)
Co-chair: Aldrik Velders, Wageningen University; contact: ecb@tfigroup.com • https://www.ecb2024.com/

1-4 Jul 2024 - MACRO2024 - Coventry, UK
50th World Polymer Congress—Sustainability: improving lives whilst preserving our planet
Chair: Dave Haddleton, University of Warwick, Coventry, UK, d.m.haddleton@warwick.ac.uk
https://www.macro2024.org/

14-19 Jul 2024 - Photochemistry – Valencia, Spain
29th IUPAC Symposium on Photochemistry
Symposium co-chairs: Gonzalo Cosa <gonzalo.cosa@mcgill.ca> and Maria Luisa Marín <marmarin@qim.upv.es> • https://www.photouiap2024.com/

15-19 Jul 2024 - Chemistry Education - Pattaya, Thailand
27th IUPAC International Conference of Chemistry Education (ICCE2024) - The Power of Chemistry Education for Advancing SDGs
Chair: Supawan Tantayanon, Faculty of Science, Chulalongkorn University, Supawan.T@chula.ac.th; Contact: icce2024@gmail.com • https://www.icce2024thailand.com

23-26 Jul 2024 - Congreso de Química Costa Rica - Heredia, Costa Rica
Chemistry: a solution for global changes
Chair of the IAB and of the Local Organizing Committee: Carlos Vega Aguilar, Carlos.vegaaguilar@ucr.ac.cr
https://eventoscqcr.com/congreso/

11-16 Aug 2024 – Novel Aromatic Compounds - Toronto, Canada
20th International Symposium on Novel Aromatic Compounds
Chair: Dr. Thomas Baumgartner (he/him) York University, Toronto, ON, Canada; isna2024@outlook.com
https://www.isna2024.com/

18-22 Aug 2024 - Physical Organic Chemistry - Beijing, China
26th IUPAC International Conference on Physical Organic Chemistry
Chair: Jin-Pei Cheng, Centre of Basic Molecular Science (CBMS), Tsinghua University, Beijing, China;
icpoc26@mail.tsinghua.edu.cn • https://www.icpoc26.tsinghua.edu.cn/
7-12 Oct 2024 - General and Applied Chemistry – Sochi, Russian Federation

**XXII Mendeleev Congress on General and Applied Chemistry**
Contact: Yulia Gorbunova, Professor A.N. Frumkin Institute of Physical Chemistry and Electrochemistry of RAS; yulia@igic.ras.ru or MendeleevCongress@mesol.ru • http://mendeleevcongress.ru/

24-29 Oct 2024 - Green Chemistry Towards Carbon Neutrality - Beijing, China

**10th IUPAC International Conference on Green Chemistry**
Zhimin Liu, Program committee chair, liuzm@iccas.ac.cn • https://greeniupac2024.org

19-21 Nov 2024 - Chemistry, a lever for sustainable development of African countries - Dakar, Senegal

**Annual Days of Chemistry of Senegal & 9th FASC Congress (FASC|JACS 2024)**
General contact: Modou Fall; modou.fall@ucad.edu.sn, PO Box 15756, Dakar-Fann, Senegal, Tel: +221775557200 • https://csc.ucad.sn (under Congrès and FASC|JACS 2024)

Save the dates!

13-18 Jul 2025 - IUPAC World Chemistry Congress 2025 - Kuala Lumpur, Malaysia
https://iupac2025.org/

**Visas**

It is a condition of endorsements that organizers of meetings under the auspices of IUPAC, in considering the locations of such meetings, should take all possible steps to ensure the freedom of all bona fide chemists from throughout the world to attend irrespective of race, religion, or political philosophy. IUPAC endorsement implies that entry visas will be granted to all bona fide chemists provided application is made not less than three months in advance. If a visa is not granted one month before the meeting, the IUPAC Secretariat should be notified without delay by the applicant.

**How to Apply for IUPAC Endorsement**

Conference organizers are invited to complete an Application for IUPAC Endorsement (AIE) preferably 2 years and at least 12 months before the conference. Further information on granting endorsement is included in the AIE and is available upon request from the IUPAC Secretariat or online.

www.iupac.org
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