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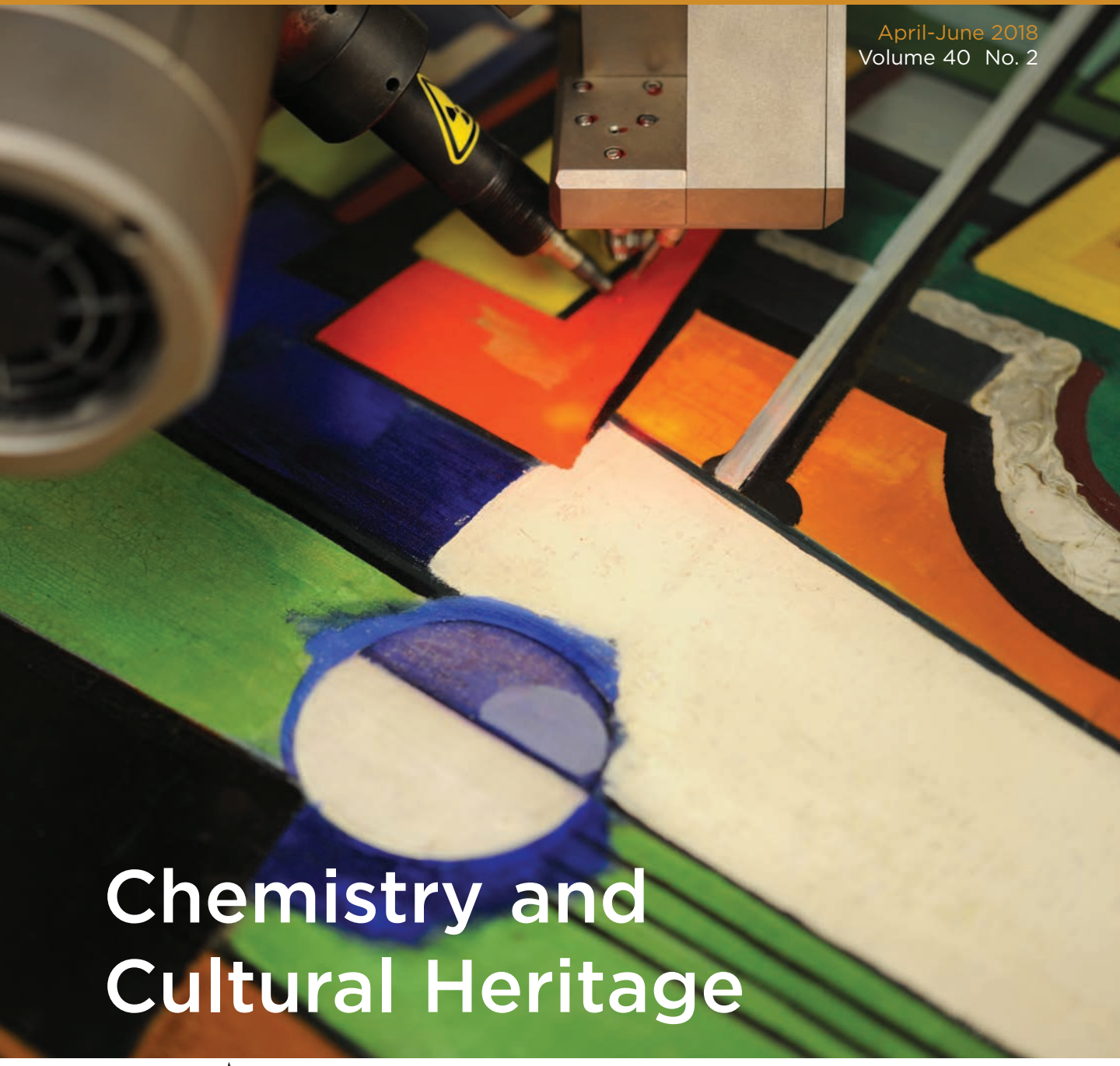

Chemistry and Cultural Heritage

Jamaican Chemists in Early Global Communication ▶

Everything Flows ▶

INTERNATIONAL UNION OF
PURE AND APPLIED CHEMISTRY

CHEMISTRY International

The News Magazine of the
International Union of Pure and
Applied Chemistry (IUPAC)

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Cover: The understanding of the materials which make up works of art is key for conservation. Advanced analytical techniques are applied to characterize the materials aiming to establish whether a work is at risk (detail from a painting of Amadeo de Souza-Cardoso, Fundação Calouste Gulbenkian collection). A special issue of IUPAC scientific journal *Pure and Applied Chemistry* (March 2018) is devoted to Chemistry and Cultural Heritage; read more page 20.

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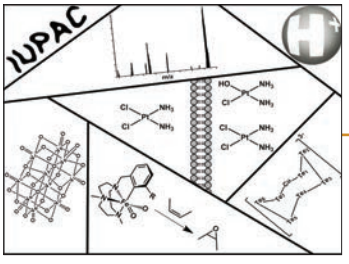


IUPAC CENTENARY CELEBRATION

continued on page 2

A Good Beginning Makes a Good Ending

by Natalia Tarasova

On 28 July 2016, I received the following message from Sir Martyn Poliakoff, Professor at Nottingham University in the UK and a Foreign Member of the Russian Academy of Sciences, who I have known for years. He wrote:

> "Dear Natalia,
> I hope that you are well. I have realized that 2019 will be the 150th anniversary of Mendeleev's publication of the Periodic Table. Therefore, I was wondering whether IUPAC might lead a request to make 2019 the International Year of the Periodic Table. I feel that this proposal might get a lot of support. What do you think?
>
> Best Wishes
> Martyn."

It was the beginning of a story with a happy ending. On 20 December 2017, the United Nations General Assembly proclaimed 2019 the International Year of the Periodic Table of Chemical Elements (IYPT 2019) during its 74th Plenary Meeting, at the 72nd Session. In proclaiming an International Year focusing on the Periodic Table of Chemical Elements and its applications, the United Nations has recognized the importance of raising global awareness of how chemistry promotes sustainable development and provides solutions to global challenges in energy, education, agriculture, and health. Indeed, the resolution was adopted as part of a more general Agenda item on Science and Technology for Development. This International Year will bring together many different stakeholders, including UNESCO, scientific societies and unions, educational and research institutions, technology platforms, non-profit organizations, and private sector partners to promote and celebrate the significance of the Periodic Table and its applications to society in 2019.

As I was involved in the activities of the 2011 International Year of Chemistry Management Committee, the algorithm of the procedure was clear to me. The key element at the initial stage is to identify the country which will be willing, through its National Delegation to UNESCO, to promote the idea of the IYPT. It is UNESCO, as the UN body, that can recommend that the UN General Assembly proclaim the year 2019 as the IYPT. In fact, the time we had to move the idea forward was quite short. According to UN rules, the decision must be taken two years in advance. My colleagues from the IUPAC Executive Committee supported the idea of the IYPT in principle, though with healthy skepticism, based on the memories of the proclamation of the International Year of Chemistry in 2011. Russia, as the motherland of Dmitry Mendeleev, was chosen to lead the initiative through UNESCO.

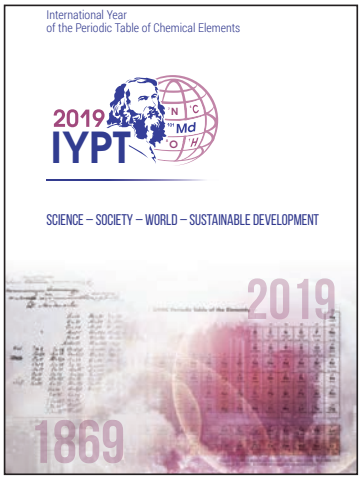
On 30 September 2016, 3000 participants of the 20th Mendeleev Congress, held in Ekaterinburg, Russia, unanimously voted for the proclamation of the IYPT in 2019. The resolution was supported by the Mendeleev Russian Chemical Society and the Russian Academy of Sciences. Based on this resolution, academician

Table of Contents (cont.)

Vladimir Fortov, at that time the President of the Russian Academy of Sciences, sent a letter to the Minister for Foreign Affairs of the Russian Federation, Sergey Lavrov, asking him for the support of the IYPT initiative in UNESCO. Simultaneously, the letter from the Russian Academy of Sciences (the Russian National Adhering Organization (NAO) for IUPAC) was sent to the IUPAC Secretariat. The Russian Academy of Sciences invited IUPAC to be the leading Union for the IYPT, as the identification of a leading international science union is a compulsory part of the UNESCO procedure. Based on this request, on 18 December 2016, I sent a letter to Professor Irina Bokova, at that time the Director General of UNESCO. I wrote:

> "It is with great pleasure that the International Union of Pure and Applied Chemistry (IUPAC) accepts the invitation from the Russian Academy of Sciences to be the main sponsoring organization for the application to UNESCO that 2019 be designated as the International Year of the Periodic Table of Chemical Elements, celebrating the 150th Anniversary of the Mendeleev Periodic Table.... The periodic table is strongly linked to IUPAC's mission. The chemical elements are crucial for humankind and our planet, and for industry. At the same time, it is important that whilst they are used to give added value and products necessary for our civilization, that this is done in a sustainable way. In particular, awareness is needed of the sustainability of the use of scarcer elements, which are often either diluted in the earth's crust or only available in very specific locations. An International Year of the Periodic Table of Chemical Elements would give an opportunity to draw the attention of children through to senior adults to these aspects that are important for the future of our planet, whilst also celebrating the genesis and development of the periodic table over the last 150 years. Other activities will also be organized making full use of the extensive network of IUPAC members. We very much hope that UNESCO will grant the request for the International Year of the Periodic Table of Chemical Elements and IUPAC is very proud and honoured to be the main sponsoring organization for the application."

The end of 2016 was rich in events linked to the Periodic Table of Chemical Elements. On 28 November 2016, IUPAC approved the names and symbols for four new elements: the names nihonium (Nh), moscovium (Mc), tennessine (Ts), and oganesson (Og), were officially applied to element 113, 115, 117, and 118, respectively. This event was widely covered by the mass media. In the beginning of 2017, the inauguration ceremonies took place at the Oak Ridge National Laboratory (ORNL, USA), at the Joint Institute for Nuclear Research, Dubna and in Moscow (Russia), and in Tokyo (Japan). During the inauguration ceremony in Moscow, a letter to UNESCO was signed by the director of the ORNL, Thomas Mason, the director of Lawrence Livermore National Laboratory (LLNL, USA), William Goldstein, and the director of the Joint Institute of Nuclear Research (Dubna, Russia), academician Victor Matveev. In this letter, they supported the IUPAC appeal to UNESCO on the declaration of the year 2019 as the International Year of the Periodic Table of Chemical Elements. They wrote:



The 2019 IYPT Prospectus

> "Dear Prof. Bokova,
>
> One of the greatest scientific achievements of the XIXth century was the discovery made by D.I. Mendeleev. He was the first to notice that the properties of chemical elements are periodic in their nature. In 2019 the world scientific community will celebrate the 150th anniversary of the Periodic Table of Chemical Elements. Today, for the first time in its entire history, the Table looks most complete: all the elements of its 7 periods have been discovered and have acquired their final names.
>
> Over the past 100 years, humankind has made a giant leap in the understanding of how elements found in nature are formed. This has allowed, among other things, conducting laboratory synthesis and studies of the properties of more than 20 transuranic elements. Over the past 16 years, scientists from the Joint Institute for Nuclear Research (JINR, Dubna) in collaboration with their colleagues from the leading US nuclear centres: the Lawrence Livermore and Oak Ridge National Laboratories, as well as Vanderbilt University and the University of Tennessee at Knoxville, have become the first to synthesize five superheavy elements completing the seventh row of the Periodic Table.

In 2012, IUPAC named element 114 as flerovium (Fl) and element 116 as livermorium (Lv). On 28 November 2016, IUPAC made a final decision to assign the following names to elements 113, 115, 117, and 118: nihonium (Nh) for element 113; moscovium (Mc) for element 115; tennessine (Ts) for element 117; and oganesson (Og) for element 118.

The Periodic Table of Elements truly is the province of all humankind. All the leading countries of the world have made their invaluable contribution, completing the Table with new elements, studying and specifying the properties of the discovered ones. The international colloquium dedicated to the naming of the three superheavy elements with numbers 115, 117, and 118 was held in Moscow on 2 March 2016. The participants of the colloquium were over 200 delegates from 112 countries, among them representative delegations of JINR (Dubna, Russia), ORNL (USA), LLNL (USA), Vanderbilt University and University of Tennessee at Knoxville (USA), RIKEN (Japan), GSI (Germany), PSI (Switzerland), GANIL (France), IUPAC and IUPAP, and the Russian Academy of Sciences, as well as the leading scientists who made significant contributions to this field of nuclear physics.

We, the undersigned, on behalf of the participants of the colloquium, taking into account the importance of D.I. Mendeleev's discovery, support the IUPAC appeal to UNESCO on declaration of the year 2019 as the International Year of Periodic Table of Elements."

Over the next few months, the initiative of the IYPT was supported by the International Union of Pure and Applied Physics (IUPAP), the European Association for Chemical and Molecular Sciences (EuCheMS), the International Astronomical Union, The International Union of History and Philosophy of Science and Technology (IUHPS), and by more than 80 IUPAC National Adhering Organizations, Academies of Sciences, chemical societies, and research institutions. Tremendous work to support the initiative was done by the IUPAC Secretariat, led by Dr. Lynn Soby.

On 24 January 2017, I had the pleasure and privilege to present the concept of the IYPT at the 10th meeting of the UNESCO Scientific Board at UNESCO Headquarters in Paris. Following the recommendations of the UNESCO International Basic Science Programme, the International Steering Committee was formed. Thirteen scientists from all over the world, together with the Working Group of the Russian Academy of Sciences (scientific secretary and member of the RAS, professor Julia Gorbunova) produced a 15-page Prospectus on the IYPT. Many volunteers from all over the world helped with pictures, ideas, and comments (and sometimes with criticism). The Prospectus and the concept were presented at the IUPAC 49th General Assembly, 7-13 July 2017, in São Paulo, Brazil. The Russian Permanent Delegation to UNESCO and the Commission of the Russian Federation for UNESCO worked very effectively to get support among the UNESCO member countries, and at its 39th Session on 2 November 2017, the UNESCO General Conference adopted the resolution recommending the U.N. General Assembly declare 2019 as the United Nations International Year of the Periodic Table of Chemical Elements.

United Nations Educational, Scientific and Cultural Organization

2019 IYPT

International Year of the Periodic Table of Chemical Elements

And it happened.

Labor recedet, bene factum non abscedet. A little more than 18 months after Sir Martyn Poliakoff wrote to me, the International Year of the Periodic Table of Chemical Elements became a reality. It was IUPAC's 98th birthday when he first wrote to me on 28 July 2016. At the time, it did not occur to me, or to him, that the IYPT will likely be the most unusual birthday present IUPAC has ever received—in 2019, not only will we celebrate IYPT, we will also celebrate the IUPAC Centenary.

Natalia Tarasova <tarasnp@muctr.edu.ru> is Past President of IUPAC since January 2018. She was President in 2016 and 2017 and has been a member of the IUPAC Bureau since 2008 and of the Executive Committee since 2010. She is a professor at the D. I. Mendeleev University of Chemical Technology of Russia, a Member of the Russian Academy of Sciences, Director of the Institute of Chemistry and Problems of Sustainable Development, and a Chairholder of the UNESCO Chair of Green Chemistry for Sustainable Development.

Jamaican Chemists in Early Global Communication

by Robert Lancashire

Justus von Liebig (1803-1873) has been described as "one of the founding fathers of organic chemistry and a great teacher who transformed scientific education, medical practice, and agriculture in Great Britain" [1]. His research was generally initially published in German, although in some cases an English translation was released at the same time. William Brock identified a number of people associated with providing English translations. Most of these were former students, such as John Buddle Blyth (1814-1871), John Gardner (1804-1880), William Gregory (1803-1858), Samuel William Johnson (1830-1909), Benjamin Horatio Paul (1827-1917), Lyon Playfair (1818-1898), Thomas Richardson (1816-1867), Warren De La Rue (1815-1889), as well as Edward Turner (1796-1837) and his brother Wilton George Turner (1810-1855). In this article, the emphasis is on Edward Turner, Wilton George Turner, and John Buddle Blyth, who were all born on sugar plantations in Jamaica [2].

Edward and John became founding Professors of Chemistry at The University of London, England (University College) and Queen's College, Cork, Ireland, respectively. Wilton returned to the region, where he ran a sugar plantation and zinc refinery in British Guiana.

The Turner Family

Edward Turner (24 June 1796, Jamaica - 12 February 1837, London, England) was the eldest surviving son of Dutton Smith Turner and Mary Gale Redwar (see below). Their next child was William Dutton Turner (1798-1858) who became a Physician in Spanish Town, Jamaica. **Wilton George Turner** was their 9th child (9 December 1810, Jamaica - 23 October 1855, Salt Quay, Turks Islands). They were all considered "creole", that is, born in Jamaica of British descent [3].

Dutton Smith Turner (7 April 1755, Clarendon, Jamaica - 2 Oct 1816, "*Teak Pen*", Clarendon) was the son of Thomas Turner and Syddippe Smith, both born in Jamaica, and his monument in the family vault at *Teak Pen* provides the details that he died leaving a widow and eight children. Dutton married Mary Gale Redwar (3 October 1776, St. Catherine, Jamaica - 16 March 1822, Bath, Somerset, England). She was the eldest daughter of Henry Redwar (1752-1798) and Elizabeth Gibbons Lewis (3 May 1754 - 7 May 1825, Bath England).

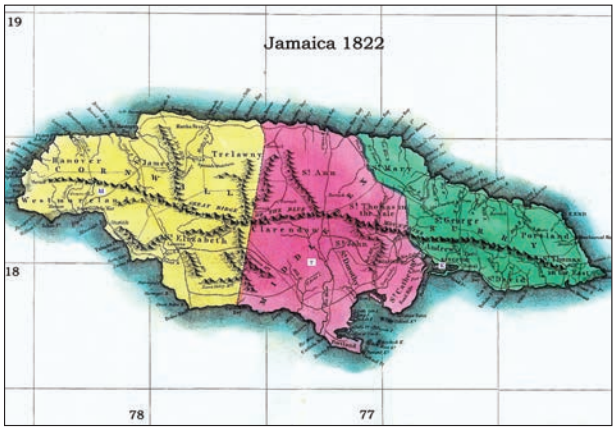


Figure 1. 1822 Map of Jamaica (K=Kingston, east region in green T=Teak Pen, (Central area in pink M=Mesopotamia) K=Kingston (East region in green)

The Blyth Family

John Buddle Blyth, a "free child of colour," was the son of John Blyth, Esq., of Berkeley Square in the parish of Westmoreland and of Mary Buddle, a "free woman of colour" of the same Parish, according to the Baptism Records for Westmoreland, Jamaica of 17 April 1816. His exact date of birth is not recorded but is accepted as July 1814 at the Mesopotamia Estate, Westmoreland, Jamaica [4,5].

Education

Edward and John permanently left Jamaica at an early age to attend school, Edward in Bath, England and John in Dumfries, Scotland. The two of them, as well as Edward's brother William, obtained Medical Degrees from the University of Edinburgh, graduating in 1819, 1839, and 1820, respectively [6]. Wilton is known to have excelled in Mathematics at the Edinburgh Academy, where, since both parents had died by 1822, he and his unmarried sisters lived with Edward [7]. When Edward was appointed to the University of London, Wilton attended lectures in Physics and Chemistry in London as well.

Subsequent to obtaining Medical Degrees, Edward and John spent time studying in Europe, quickly turning away from Medicine to become Chemists. Edward took courses with Stromeyer at Gottingen [8] and John spent about two years at Giessen with Justus von Liebig and a further six months in Berlin with Heinrich Rose and Gustav Magnus [9]. Wilton spent time in Europe, as well (he married a Berliner, Marie Auguste Fricke, in London in 1836) and received a PhD in 1838 from Giessen, working with Justus von Liebig [10,11].

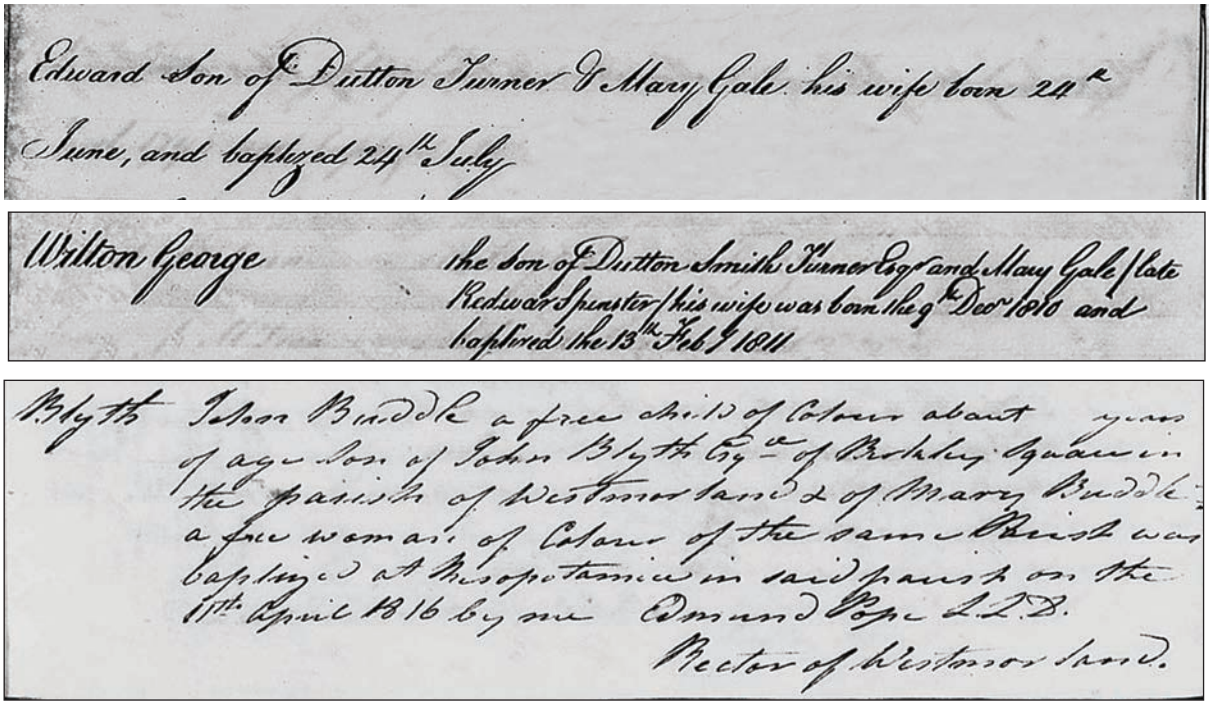
Wilton's wife's sister Friederike Auguste Frick (1805-1847) married Gustav Rose (Heinrich's younger brother) in 1828, creating a link to the Rose family, well known for its distinguished scientists. After graduation, William departed to Spanish Town, Jamaica, gaining respect and recognition for his role there, especially in treating a small-pox epidemic in 1851 with his cousin, Dr. Lewis Quire Bowerbank (1814-1880) who graduated from the University of Edinburgh in 1836) and a cholera epidemic in the 1850's.

Careers

In 1823, Edward returned to Edinburgh from Gottingen and was appointed a Lecturer in Chemistry. From there he was appointed as the first Professor of Chemistry at the University of London [3].

Wilton taught Mathematics at University College School between 1832 and 1839, having only a few years earlier received a certificate for merit in examinations in Physics in a Junior Course run by the Rev. Dr. Dionysius Lardner. He is noted as having acted as Senior assistant to Edward, running Chemistry practical classes as well as having given the chemistry lectures for 1836-37 when Edward died [12]. He wrote to Whewell on 26 April 1837 asking advice about applying as Edward's replacement. The position, however, went instead to Thomas Graham. He had earlier unsuccessfully applied for Chairs in both Mathematics and Mineralogy at the University of London. He applied for several patents between 1840 and 1846 while the partner of Christian Allhusen (1806-1890) at the Allhusen, Turner and Co. soap and alkali works in Newcastle. Finally, he left England for British Guiana, where he has been credited as one of those who put the rum industry on proper scientific grounds [13,14].

John was appointed at the Royal College of Chemistry in 1845 to work with August Wilhelm Hofmann. Hofmann and Blyth were the first to use the term "synthesis", in their paper "On Styrole, and Some of the Products of Its Decomposition" [18]. From there, John went to the Royal Agriculture College in Cirencester in 1847. Like several of his predecessors, it appears he had a falling out with the Administration and left after


Edward Son of Dutton Turner & Mary Gale his wife born 24th June, and baptized 24th July

Wilton George the Son of Dutton Smith Turner Esqr and Mary Gale [late Redwar Spinster] his wife was born the 9th Decr 1810 and baptised the 13th Feb 1811

Blyth John Buddle a free child of Colour about – years of age Son of John Blyth Esq of Berkeley Square in the parish of Westmoreland and of Mary Buddle a free woman of Colour of the same Parish was baptized at Mesopotamia in said parish on the 17th April 1816 by me Edmund Pope LLD Rector of Westmoreland

Figure 2. Register of Baptisms for the Parish of Clarendon 1796 page 223 *"Edward son of Dutton Turner and Mary Gale his wife born 24th June and baptized 24th July"*
"Wilton George the son of Dutton Smith Turner Esq and Mary Gale [late Redwar Spinster] his wife was born the 9th Dec 1810 and baptised the 13th Feb 1811"
"Blyth John Buddle a free child of Colour about – years of age. Son of John Blyth Esq of Berkeley Square in the parish of Westmoreland and of Mary Buddle a free woman of Colour of the same Parish was baptized at Mesopotamia in said parish on the 17th April 1816 by me. Edmund Pope LLD Rector of Westmoreland"

a few years. He was then appointed as the first Professor of Chemistry at Queen's College, Cork, Ireland in 1849 [15,16]. He made several trips to Europe and copies of Belgian and French visa papers from the 1840's are maintained at the archives at what is now the Royal Agricultural University (RAU), Cirencester.

The inauguration of Queen's College, Cork took place on 7 November 1849 and the first President of the College was Sir Robert Kane, a distinguished chemist and Fellow of the Royal Society (another who worked at Giessen with von Liebig). In 1842, Kane had published his textbook called "Elements of Chemistry" in Dublin and in the same year a US edition appeared with John William Draper (a former student of Edward Turner who later became the first President of the American Chemical Society).

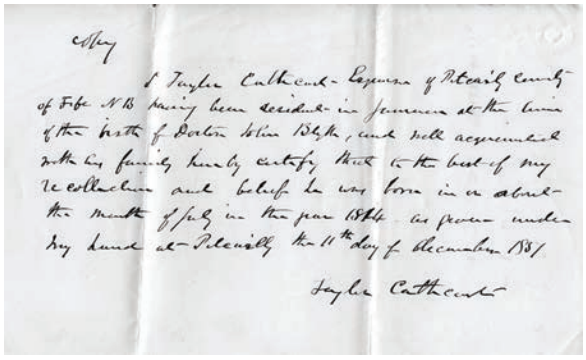
English translations of von Liebig's articles and books

Edward first published his textbook "Elements of Chemistry" in Edinburgh in 1827 and undoubtedly it was because of its popularity that he was appointed at the University of London. It went through numerous editions and for the sixth edition, where he collaborated with Professor Justus von Liebig, a section on Organic Chemistry was enlarged. It was the first English Language textbook covering Organic Chemistry. Edward did not live long enough to see this published and it was completed by his younger brother, Wilton.

The text was published in London by Taylor & Walton. A German translation was produced by Hartmann and there were many American editions, the first supervised by Franklin Bache, later ones by James Blythe Rogers and his brother Robert Empie Rogers, and the last edited in 1856 by John Johnston and published in Philadelphia by Thomas, Cowperthwait & Co. and Charles Desilver; and in Baltimore by Cushings & Bailey [1].

In October 1840, William Gregory, while still at Aberdeen prior to taking up the post of Professor of Chemistry in the University of Edinburgh, wrote to Michael Faraday [17]:

> "I regret that I was not concerned in the translation or editing of the first part, which I think might have been rendered more easily intelligible to the student, as well as more interesting. This part, in which the general principles of organic chemistry are developed, was edited by a gentleman [Wilton George Turner] who had no practical acquaintance with organic chemistry, and who in consequence committed some mistakes, occasionally even reversing the author's meaning. In the part now published, which contains chiefly details of facts, I could not repair the errors of the introductory part, but I have endeavoured as far as possible to render these details clear and consistent....
>
> I have further to mention that the concluding part of the Organic Chemistry, to be published before Christmas, will be, except the first few pages, written by myself; so that I shall consider myself in reality the responsible editor of that part of the work. Imperfect as I fear it will be, still I have some satisfaction in the consideration that the subjects it contains will be for the first time offered to the British public in their actual state of progress. I omit no endeavours to keep myself fully informed of everything that is done on the Continent, where alone, I regret to say, with hardly an exception, organic chemistry is as yet pursued. I fervently trust that the rising British chemists will take their fair share in the future advancement of this department of our science."



"I Taylor Cathcart of Pitcairlie County of Fife NB (Newburgh) having been resident in Jamaica at the time of the birth of Doctor John Blyth and well acquainted with his family, hereby certify that to the best of my recollection and belief he was born in or about the month of July in the year 1814 as proven under my hand at Pitcairlie the 11th day of December 1837. - Taylor Cathcart"

Figure 3. Letter from Taylor Cathcart of Carbiston (1777-1857) giving DOB of JBB as Jul 1814 Courtesy of the Royal Agricultural University, Cirencester archives

Gregory decided to revise the textbook from scratch, and the revision appeared as a 7th edition in December

Figure 4. John Blyth passports a) Belgian 1844 b) French 1839 Courtesy of the Royal Agricultural University, Cirencester archives

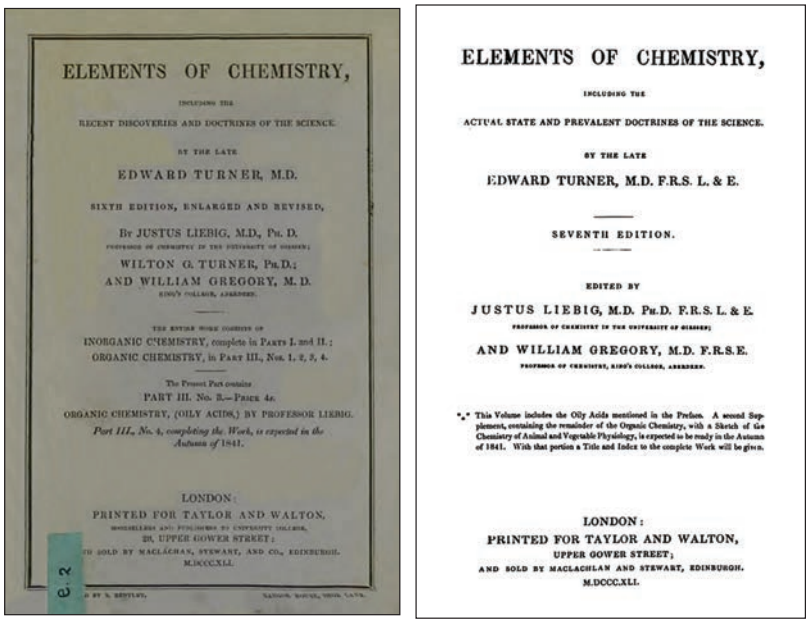
1842. An Advertisement for the 7th edition noted that

> "There is no English work on Chemistry which has been in so many hands, and has met with such universal approbation, as Turner's Elements; and there is scarcely any work which has received so many additions and improvements in passing through its numerous editions. The present one appears to fulfil all that can be desired of a work of this kind. In the former editions, which were conducted by the late lamented Dr. Turner, the inorganic division of the subject was treated with that clearness, perspicuity, and beauty of arrangement, so peculiarly his own; but the organic part of the work, although giving a very good general outline of this part of chemistry, was not so full as could be wished, when the most miraculous advances of this interesting branch of the science were taken into consideration. The edition now before us, by W. Gregory and J. Liebig, leaves nothing to be desired in this respect; they have rendered it exceedingly complete, carrying out at the same time the original idea of Turner. As a compendium of the present state of chemistry, and a text-book for all beginners, we consider it as unequalled by any in the English language, and we even doubt whether there are any of the Foreign manuals, of an equal size, which can venture to compete with it." -*Chemical Gazette,* 1 Dec 1842.

Gregory later informed von Liebig, that "*Turner was too expensive and too advanced for British students*", and in consequence he planned to compile his own simpler textbook. Gregory's highly successful *Outlines of Chemistry* was duly published in 1845 [19].

Wilton Turner and William Gregory seem to have clashed again some years later over a proposal based on a December 1847 patent by John Scoffern to use lead salts to process sugar. In 1849 investigations were instituted in a range of countries including by the Governor of British Guiana, that resulted in

> "reports from Dr Shier, the colonial agricultural chemist; Dr. Blair, the surgeon-general; and Dr. Wilton Turner, a chemist of eminence, employed in investigations on the manufacture of sugar; who concurred in opinion that the complete separation of lead from sugar made by Dr Scoffern's process cannot be ensured, and that specimens made by the agent to the patentee had been found to contain the pernicious ingredient in sufficient quantity to render it injurious to health. Dr Wilton Turner suggested


ELEMENTS OF CHEMISTRY,

INCLUDING THE

RECENT DISCOVERIES AND DOCTRINES OF THE SCIENCE.

BY THE LATE

EDWARD TURNER, M.D.

SIXTH EDITION, ENLARGED AND REVISED,

By JUSTUS LIEBIG, M.D., Pm. D.

WILTON G. TURNER, Pm.D.;

AND WILLIAM GREGORY, M. D.

THE ENTIRE WORK CONSISTS OF

INORGANIC CHEMISTRY, complete in PARTS I. and II.:

ORGANIC CHEMISTRY, in PART III., Nos. 1, 2, 3, 4.

The Present Part contains

PART III. No. 3.—PRICE 4s.

ORGANIC CHEMISTRY, (OILY ACIDS,) BY PROFESSOR LIEBIG.

Part III., No. 4, completing the Work, is expected in the Autumn of 1841.

LONDON:

PRINTED FOR TAYLOR AND WALTON,

28, UPPER GOWER STREET:

TO BE SOLD BY MACLACHLAN, STEWART, AND CO., EDINBURGH.

M.DCCC.XLI.

E. 2

ELEMENTS OF CHEMISTRY,

INCLUDING THE

ACTUAL STATE AND PREVALENT DOCTRINES OF THE SCIENCE.

BY THE LATE

EDWARD TURNER, M.D. F.R.S. L. & E.

SEVENTH EDITION.

EDITED BY

JUSTUS LIEBIG, M.D. Pm.D. F.R.S. L. & E.

AND WILLIAM GREGORY, M.D. F.R.S.E.

*** This Volume includes the Oily Acids mentioned in the Preface. A second Supplement, containing the remainder of the Organic Chemistry, with a Sketch of the Chemistry of Animal and Vegetable Physiology, is expected to be ready in the Autumn of 1841. With that portion a Title and Index to the complete Work will be given.

LONDON:

PRINTED FOR TAYLOR AND WALTON,

UPPER GOWER STREET;

AND SOLD BY MACLACHLAN AND STEWART, EDINBURGH.

M.DCCC.XLI.

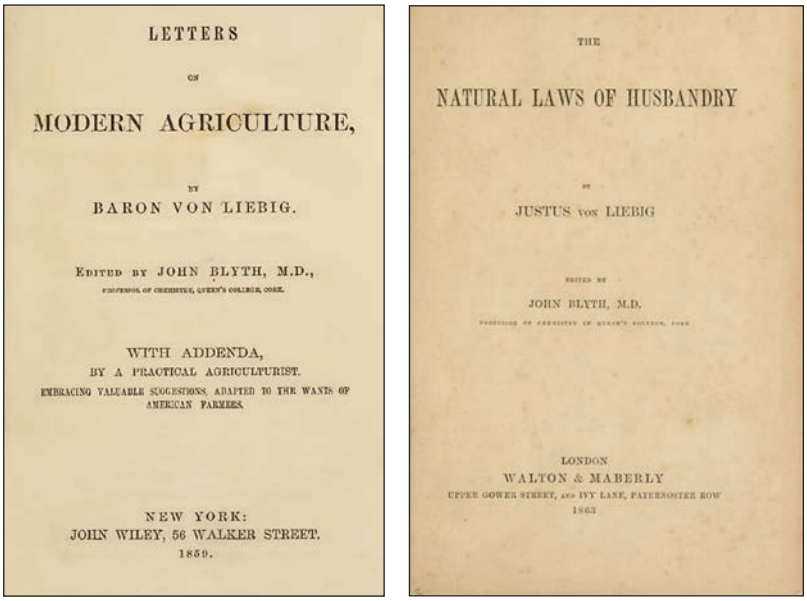
Figure 5. Turner's Element's of Chemistry a) 6th Edition b) 7th Edition Public domain

that the casks containing sugar made by this process should be branded with the word "lead" [20].

William Gregory wrote in 1850 that he had fed lead sulfite to dogs and rabbits over a series of days and weeks and seen no ill-effects. In fact they appeared so well and fat that many were stolen. He concluded that it was perfectly innocuous and "*as harmless as chalk would be*" [20]. The proposal was ultimately rejected.

Following the death of William Gregory in 1858, Justus von Liebig noted in the Preface of the 4th Edition of Familiar Letters on Chemistry that:

> "My friend Dr. Gregory, who assisted me in the former editions, has, meantime, been removed by a Higher Power from his family and from science. United for more than twenty years by the ties of a sincere and intimate friendship, no one feels more keenly than I do, the great loss sustained by his friends in his death. Rare extent of knowledge, combined with admirable powers of mind, enabled him to apprehend exactly the ideas and views of others, and to put them forward in the best form, and with the precision of original composition.
>
> I have requested Dr. Blyth, Professor of Chemistry, Queen's College, Cork, my friend and former pupil, to edit the present edition of my Letters. Dr. Blyth is one of the most distinguished Chemists of Great Britain. From his intimate acquaintance with chemical science, and with the different subjects discussed in these Letters, I esteem myself fortunate, that he has in the kindest manner acceded to my wishes."


LETTERS

ON

MODERN AGRICULTURE,

BY

BARON VON LIEBIG.

EDITED BY JOHN BLYTH, M.D.,

WITH ADDENDA,

BY A PRACTICAL AGRICULTURIST.

EMBRACING VALUABLE SUGGESTIONS ADAPTED TO THE WANTS OF AMERICAN FARMERS.

NEW YORK:

JOHN WILEY, 56 WALKER STREET.

1859.

THE

NATURAL LAWS OF HUSBANDRY

OF

JUSTUS von LIEBIG

JOHN BLYTH, M.D.

LONDON

WALTON & MABERLY

1863

Figure 6. Liebig books a) Letters on Modern Agriculture b) Natural Laws of Husbandry Public domain.
Figure 7. Bust of Edward Turner housed at University College, London (Photo taken June 2012 by the author)

John Blyth was appointed by von Liebig as the editor of a number of his works in Britain and translated "Letters on Modern Agriculture" (1859), the fourth edition of "Chemical Letters—Familiar Letters on Chemistry" (1859) and "Natural Laws of Husbandry" (1863) [21].

Translations of the "Preface" and "Introduction" to the 7th edition of von Liebig's great work on agricultural chemistry of 1863 were not published in English, even though all the rest of the book eventually was, and even though all of von Liebig's previous editions had been issued in English only months after their appearance in German (The first edition had been translated by Lyon Playfair). The reason was that this "Introduction" (or "Einleitung") was seen as too critical

of English high farming and John Blyth decided not to provide a translation. Walton, the publisher, apparently destroyed the whole of the first volume [22].

An unpublished translation of the "Einleitung," was produced by Lady Gilbert [Maria Smith], the [2nd] wife of one of the most distinguished agricultural chemists, Henry Gilbert, in January 1863, and a copy apparently exists in the archives of the Rothamsted Experimental Station (now IACR-Rothamsted) in Hertfordshire [22].

Conclusions

Edward Turner died aged 40. In a memorial to him Robert Christison noted that

> "I have reason to believe he never made an enemy, and never lost a friend" and that "upwards of three hundred of his former students attended the funeral at Kensal Green Cemetery in London on the 18th February, many of whom continued to wear mourning afterwards as if for a relative" [24].

No pictures of Edward seem to have survived and it is noted that Timothy Butler is said to have produced "A remarkably clever work of art. The action of the head is particularly spirited, and characteristic of the subject, of whom it is a striking likeness; a circumstance deserving of the higher commendation, as it is a posthumous production" [25].

Wilton Turner left England for British Guiana and by November 1852 he was obviously in arrears with the Chemical Society, who recommended that his name be removed from the list of Fellows. In Guiana he was reported to run a sugar plantation and zinc refinery and is credited as being one of those who improved the quality of rum there that had previously been described as being of poor quality [14]. In 1853, Wilton is to be found in Barbados, where his daughter Eliza died and was buried at the church of St Matthias in Christ Church. Still in Barbados in 1855, he was acting as a homeopathic doctor treating cholera. He was reported as having excellent results, with less than 10% deaths, compared to others using more conventional treatments. Finally, while travelling to Canada he died in the Turks Islands in 1855 (where large deposits of guano had been found and exported to Europe, perhaps a stop influenced by von Liebig?). His remaining family seems to have finally settled in Guelph.

According to an obituary for John Blyth published in the Journal of the Chemical Society in 1872,

Figure 8. Colourised photo of John Buddle Blyth, 1862, from a B/W image courtesy of the Royal Agricultural University, Cirencester

> "In this new institution he had most arduous duties to perform, not only in connection with the Chair of Chemistry, but also in conducting the course of medical jurisprudence. His success as a teacher here was such as to render it necessary to make large additions to the laboratory for the accommodation of the students".

Blyth died of apoplexy on 24 December 1871, and was buried on the December near his friend and Mathematics colleague, Dr. George Boole, at St Michael Church at Blackrock, Cork. A local obituary noted

> "on Thursday he delivered an able lecture to the Chemistry Class in the College with his accustomed vivacity. On Friday two of his brother College professors dined with him at his residence on Wellington Road, Cork. During dinner he was in his usual spirits—conversational and entertaining. Shortly after the removal of the tablecloth, he leant back in his chair, apparently in a swoon; but one of his guests, a medical gentleman, quickly declared his illness paralysis. Every

aid was sought, and every known remedy applied, but he never rallied, and he breathed his last on Saturday night to the deep regret of all who were favoured with his acquaintance" [26].

Justus von Liebig died in Munich, 18 April 1873, outliving all three.

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Hannah Gay and William P. Griffith, The Chemistry Department at Imperial College London, A History, 1845 –2000. x + 569 pp., illus., tables, bibl., index. London: World Scientific, 2017. Appendix One: Liebig at Giessen; Some early 19th Century Chemistry

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Continuous Micro-Flow for Pharmaceutical Production

by Volker Hessel

The pre-Socratic philosophers made the first honest attempt, at least in the western world, to describe natural phenomena in a rudimentary scientific manner and to exploit those for technological application [1]. Pythagoras of Samos (570–495 BC) was an Ionian Greek philosopher and the first to actually call himself a "philosopher". He was credited with many mathematical and scientific discoveries, including the Pythagorean theorem, Pythagorean tuning, the five regular solids, the theory of proportions, and the sphericity of the Earth. The Pythagorean triple is also well-known. Heraclitus of Ephesus (535–475 BC) was famous for his insistence on ever-present change as the fundamental essence of the universe, as stated in the famous saying *"panta rhei"*—everything flows.

Like the pre-Socratics, continuous micro-flow is the first of its kind, being very different from any other micro-systems technology. It found its way to serious scientific and technological use from a beginning as a spectacular, revolutionary item. A major quality of continuous micro-flow is its 'ever-present change', that is, its ongoing transformation towards new applications and towards a constant re-definition of the whole approach itself. One could say that micro-flow is continuously flowing to new directions.

Microreaction technology—a branch from the micro-systems technology tree

Microstructured fluidic devices were developed in the 1990s and tested for chemical reaction engineering after micromechanical systems were developed in the 1980s for a manifold of applications in the field of actuators, sensing, optics, pumping/fluid transfer, dispensing, and more [2]. With the emergence of the micro total analysis system or, as it was later called, the "lab-on-a-chip", the door was opened to bioanalysis, biochemistry, chemical analysis, and environmental analysis. The next logical step was to extend this approach to chemistry [3].

A founding initiative was needed to provide a platform to embrace the scattered activities in this new field and to unite researchers and institutions in a combined force. This was done by PNNL, AIChE, Dechema, and the Institut für Mikrotechnik Mainz in late 1995, manifested in a discussion paper, "Micro reaction technology", in 1996. This in turn led to the foundation of the International Conference of Microreaction Technology (IMRET) as a platform for the nascent community, as well as a new topic, coined Microreaction Technology.

The first wave: bulk chem—the right solution for industrial problems, but on the wrong scale

Initially, chemical engineers took the lead in the new field, referring to their efforts as microreaction engineering [4]. The first issues they approached were process scenarios that stopped industrial process development, such as those requiring highly exothermic reactions, the handling and generation of toxic or hazardous materials, or operation in formerly explosive regimes. The fluorination of aromatics [5] and phosgene manufacture [6] have all of those characteristics. In these scenarios, the superior heat exchange achieved with microreactors is their winning point. This has been termed transfer intensification [7]. The pull from global chemical players, such as Dow, DuPont, and BASF, directed microreactor applications in the bulk-chemical direction [8]. "Think Big" was the directive, and this culminated in the realization of the *ca.* 6 m long DEMiS 'microreactor' [9]. But the technology was not mature enough to cope with the needs of the first 'industrial wave'. Still, hope came from optimistic market studies, which were seen more frequently at this time then ever again [10].

The second wave: fine-chem—the right scale searching for the right problems

By around 2001, several fine-chemical pilot plants were reported in very short time, giving microreactor development a needed push [11]. Most of these plants were developed in Japan through a public-private partnership. The reactions were fast and, thus, needed even faster operating process equipment. Consequently, almost all of these plants relied on micromixers and, where needed, added micro- and milli-capillaries as residence time loops to complete the reactions. Virtually hundreds of different micromixers were developed [12]. Selectivity control was the main issue. Another chapter of transfer intensification was opened [7].

Yet, this 'second industrial wave' could not provide cost arguments which were game-changing, although

many benefits from an engineering and chemistry point of view were shown. Despite this, the developments achieved during this time made the move to a larger productivity scale and up to production scale not only a possible, but a routine event. This prepared the field for the 'third wave'—the real industrial move towards microreactors.

By that time, the focus of research was much more on liquid organic than on gas phase chemistry. Organic chemists who were open-minded about innovative process chemistry tested the new microreactors and found that they were too expensive, too complicated to operate, and insufficiently flexible for the chemist's needs. To address these shortcomings, they invented "flow chemistry" [13].

Flow chemistry—continuous micro-flow for the chemist

As chemists developed flow chemistry, small-scale continuous equipment available in most labs, such as that used in HPLC, was reused as heating, cooling, and reaction capillaries [14]. Small tee pieces served for mixing, and back-pressure regulators were used to operate under pressure. This allowed solvents to operate above their boiling points in single phase. The equipment developed is interchangeable, may be of one-way use, and in a way modular. These processes allowed for the investigation of ever more complex chemistries—the new tool was now the enabler of new process paths and even of new chemical products.

Novel Process Windows—Research in 2011-2016

New avenues in chemical intensification in continuous micro-flow were explored under the aegis of the ERC Grant "Novel Process Windows—Boosted Micro Process Technology" (project No: 267443).

- **New reaction pathways:** modern activation principles, such as UV-photo-flow and homogeneous catalysis, open doors to new pathways. With the first, the synthesis of Vitamin-D was intensified, both using commercial and laser light sources [16]. With the second, the direct synthesis of adipic acid from cyclohexene was achieved, replacing a two-step synthesis with a direct route [17]. The use of an alternative reactant provides a third option: using gaseous HCl in place of thionyl chloride enabled a green hydro-chlorination [18].
- **High-T processing:** the result is often a 100–1,000 fold speed-up of reaction time—sometimes even more. The Huisgen dipolar cycloaddition of a dienophile and1,3-dfluoro benzylazide to a rufinamide precursor was accelerated in this way [19].
- **High-p processing:** high-pressure flow chemistry studies were very rare in 2011, and remain so today. A high-p study on the above-mentioned Huisgen dipolar cycloaddition gave insight into what pressure can do in combination with continuous micro-flow [20].
- **High-c processing:** flow chemistry typically uses high reactant concentrations. Some continuous-flow reactions were even run solvent-free. For the first time, a complete flow cascade (3-steps) was realized completely solvent-free [21]. This was done for three flow chemistry steps towards the rufinamide precursor, including the mentioned hydrochlorination, an azidation, and the Huisgen cycloaddition reaction. As an alternative to solvent-free processing, organic solvents can be replaced by modern designer solvents. A CO_2 converting methoxylation used a supported liquid phase catalyst (SLPC) in supercritical CO_2 [22].
- **Process simplification:** Flow processing enables the direct synthesis of adipic acid from cyclohexene by omitting one process step, while simplifying the other. The corresponding impact was quantified for the first time by sustainability (LCA) and cost/cash-flow analysis [23]. A cost/cash-flow analysis was performed for micro-flow synthesis in modular container production platforms [24].
- **Process integration:** a 4-step flow cascade to cinnarizine, cyclizine, and buclizine was realized [25]. Synergistic process effects could be shown for a fully-continuous, uninterrupted 3-step flow cascade to rufinamide, resulting in environmental benefits, considering 5 more steps starting from the platform chemical nitrobenzene [26]. Assuming a world-scale (400 kt/a) continuous-flow process for the direct adipic acid synthesis, energy costs can be reduced by classical process optimisation (heat integration, pinch analysis) [27].

Entirely new process regimes, *e.g.* with regard to temperature and pressure, were opened and termed novel process windows (NPW) [15]. This allowed to conduct reactions several orders of magnitude faster, and made the factor-1000-acceleration "normal." NPW achieved the latter through an exploration of unusual and typically harsh process conditions with much enhanced activation. They also provided the chance for different selectivity patterns [15]. Several flow chemistries were developed via high-T, high-p, high-c (solvent-free; alternative solvent) concepts, leading to a boost of reactivity. This is complemented by the implementation of new smart electromagnetic activation modes (photo, ultrasound, plasma, microwave, etc. with their discrete rotational, vibrational, electron levels) as a powerful alternative to temperature activation (Maxwell-Boltzmann theory: collision, momentum, probability). Once the single processing steps are intensified, they can be brought to a higher level of process integration and simplification—process-design intensification [7].

The third wave: flow chemistry and pharmachem—a perfect fit

As the success of medicinal syntheses attracted the pharmaceutical industry, flow chemistry was able to fill the gaps left by industrial process development, *e.g.* as for too large exotherms, for highly hazardous materials, and in cases with the potential danger of explosions. As a consequence, all major pharmaceutical companies engaged in flow chemistry [28] and the first business cases were reported and representatives of the pharmaceutical industry engaged with the ACS Institute Green Chemistry Roundtable [29]. They listed their top 10 priorities for new technologies: (small-scale) continuous processing received the highest score. Just five years later, the FDA declared the batch-to-continuous transition to be the new standard in pharmaceutical manufacturing [30]. This gave Johnson & Johnson's Janssen drug unit the thumbs up for the continuous manufacturing process for the production of HIV drug Prezista on a line at its plant in Gurabo, Puerto Rico [31].

Such end-to-end processing requires automated operation. Behind superb process control that ensures pharma's process analytical technology (PAT) and process quality standards, the new fully automated flow machines prepare us for another chemical revolution [32]. This so-called 'Chemical Nespresso Machine' can do much more than gather automated synthesis [33]. Flow machines can be controlled and operated at very different and distant sites of the world and even communicate with and learn from each other. This variant of the Chemical Internet of Things is the "All-Around-The-World-Synthesis" or the "March of the Machines" [34]. The potential is even greater—fully automated, self-developing multi-step synthesis by virtue of artificial intelligence and 3D-printed flow reactors [33-35].

The Flow Chemistry Society was founded as a platform for the flow chemists, creating a journal for flow chemistry and organizing many conferences on the topic. As the formation of the IMRET conferences did for microreactors about 15 years prior, this provided a major push for the popularity of the topic.

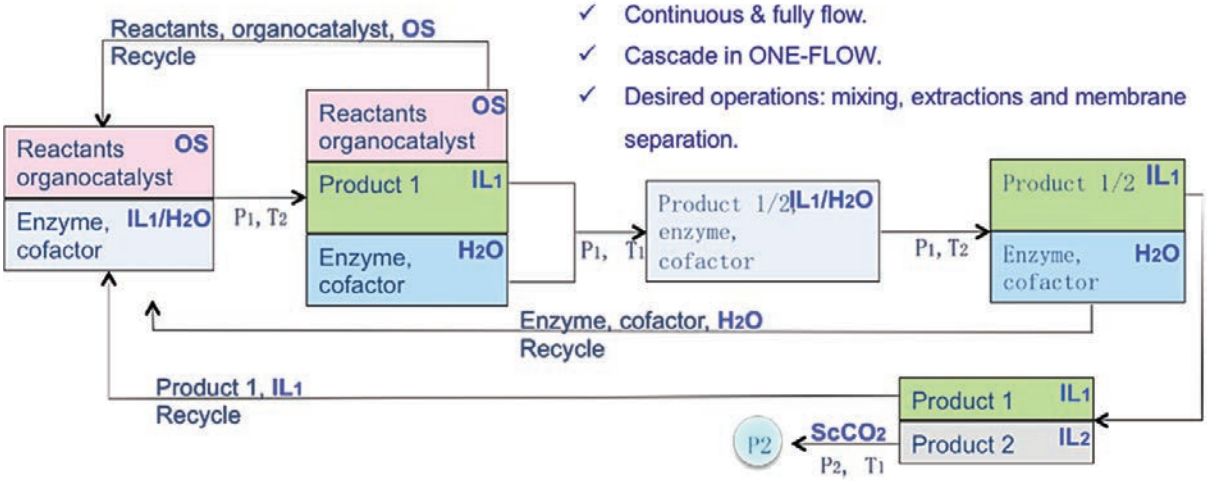

Fig. 1: Proposed designer solvent system which acts as fluidic 'reactor-separator' for the flow cascade to (1R,3S)-1-(3-chlorophenyl)butane-1,3-diol .

Future systemic innovations for continuous pharmaceutical manufacturing

Two current topics on the application of continuous micro-flow for pharmaceutical synthesis are important for future exploration. One is the exploration of new 'factory' concepts to handle the complexity of multi-step synthesis, purification, and formulation (with the pill as the final product). The other topic of relevance is ensuring quality control in a highly legislated production environment.

Two future approaches of the author's research are presented here as an outlook to this feature.

ONE-FLOW

The FET-Open project ONE-FLOW translates the 'vertical hierarchy' of chemical multistep synthesis, with its complex machinery, into the self-organising 'horizontal hierarchy' of a compartmentalized flow reactor system—a biomimetic digital flow cascade machinery with just one reactor passage [36]. To keep horizontal hierarchy manageable, orthogonality needs to be increased among the different consecutive reactions. Luckily, nature has already invented catalytic cascades. ONE-FLOW builds on this by enabling the best bio- and chemocatalysts working door by door: four synthetic flow reaction networks ('metabolic pathways') and one flow cascade driven by automated intelligence ('signaling pathway') will be developed, producing 4 Top-list 2020 drugs.

A functional solvents system serves as an integrated reactor-separator for the 3-step flow cascade to (1R,3S)-1-(3-chlorophenyl)butane-1,3-diol. The ethoxylated ionic liquid Among 110TM acts as a phase separator for the biocatalyst alcohol dehydrogenase while also increasing its activity and stability. The system water/acetophenone/Ammoeng 110TM gives up to 5 metastable phases. The large diversity of ILs (>10 exp 6) and conventional solvents (> 7000) opens up the possibility for solvent modelling via the COSMO-RS method. Cost/LCA assessment and experimental screening will then guide users to the final solvents of the "Multi-Step-Solvent-Factory."

On-line PAT quality control

A very fast flow chemistry reaction—the photo-Claisen rearrangement of allyl phenol—has been combined with a modified ultra-high-performance liquid chromatography (UHPLC) system, allowing for very fast lowest-volume sampling and analysis [37]. With the applied online sampling system, it is possible to perform a full factorial analysis of all relevant reaction conditions (243 experiments) almost unattended, while using 12 times less sampling volume, all in just three days. Assuming a systematic difference compared to manual sampling and dilution of 0.5 % ± 1.4, online sampling avoids random errors due to automation. The reproducibility and robustness of the sampling were tested as well.

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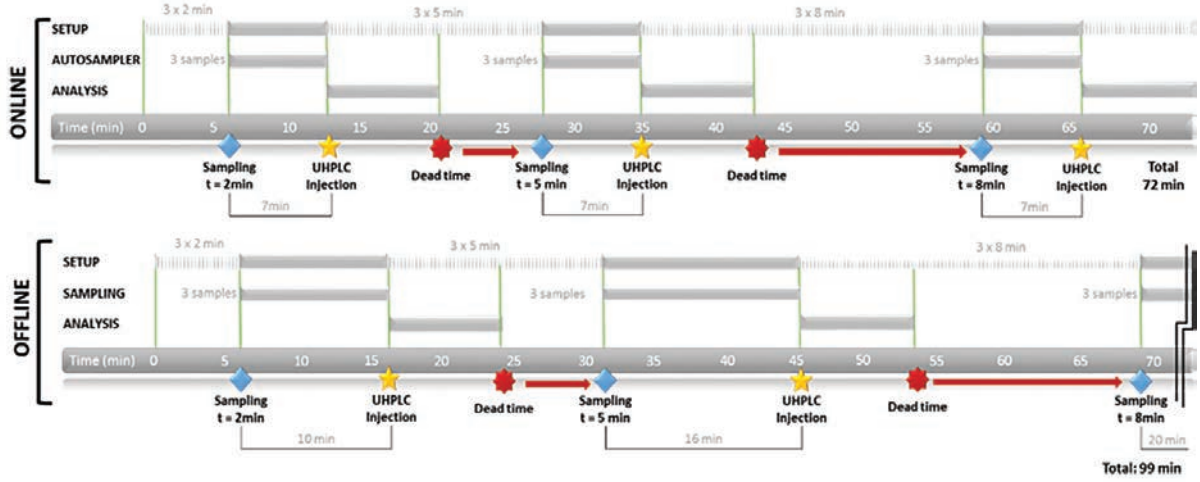

Fig. 2: Process sequence in UHPLC analysis with online and offline sampling for the photo Claisen rearrangement of allyl phenol.

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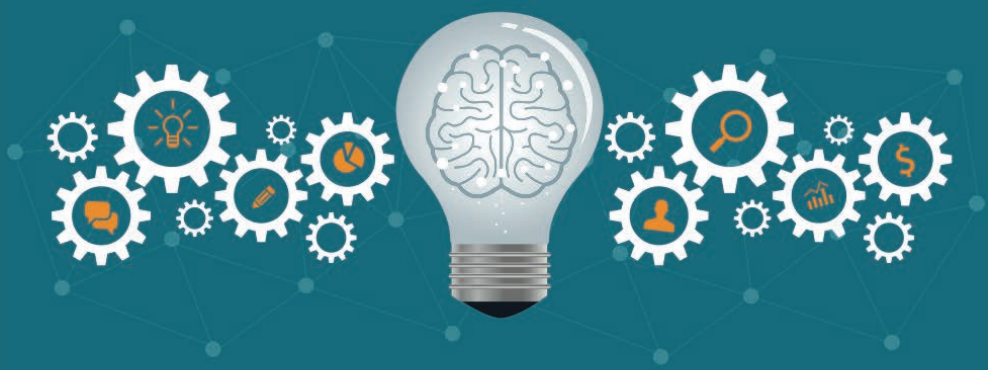
The IUPAC-ThalesNano Prize in Flow Chemistry and Microfluidics will be awarded again in 2018. The award shall be presented at the 15th International Conference on Micro Reaction Technology [IMRET] in Karlsruhe, Germany, 21-24 October 2018.



CHEMRAWN helps establish an International Centre for Natural Product Research

by Leiv K. Sydnes

After a long-lasting and demanding effort, a dream has come true: plans to establish the International Centre for Natural Product Research (ICNPR) in Dhaka, Bangladesh are becoming a reality. At the end of November 2017, the Islamic Development Bank approved a significant loan that made it possible to achieve an ambitious idea. The centre will be built at, and become an integrated part of, Bangladesh University of Health Sciences in Dhaka. This odyssey would never have become a success if it had not been for Professor Mohammad Mosihuzzaman, who worked relentlessly to build international support for the idea through IUPAC projects and CHEMRAWN XX.

Background

The dream was born when Professor Mosihuzzaman realized that, although "Health for all" is a vision which everybody strives for, it will remain inaccessible to a majority of the human population for the foreseeable future. This has generated a need for scientific investigations of other forms of knowledge to develop healthcare products. Traditional medicine practices, largely herbal in nature, are now regarded as important tools against a number of diseases. The World Health Organization (WHO) recognized this fact in the early 1970s and encouraged governments to utilize local knowledge of herbal medicines to prevent diseases and promote healthcare.

However, traditional medicines suffer from a range of shortcomings. These include insufficient evidence regarding safety, efficacy, and standardization; inconsistent production practices; and potential interactions with allopathic medicines. Furthermore, herbal medicinal products are largely unregulated: contamination from heavy metals, pesticides, microbes and insects is a safety issue, and adulteration with synthetic chemicals is an important challenge. Therefore, traditional medicines must be produced in

From the opening of the joint FACS and Eurasia meeting in Hanoi in October 2003. To the far right, Professor Hitoshi Ohtaki, Japan, is recognized; to the left, then-IUPAC President Professor Leiv K. Sydnes, Norway.

From the opening of the IUPAC-sponsored conference on Biodiversity and Natural Products: Chemistry and Medical Applications, held in Delhi, India in January 2004 as a joint ICOB and ISCNP meeting.

accordance with stringent protocols if their use is going to increase.

With this conclusion as a basis, Professor Mosihuzzaman argued relentlessly for a more transparent and far-reaching 'scientification' of traditional medicine. The manufacture of herbal medicines needs to be governed by a similar assessment of safety, quality, and efficacy as those required for pharmaceutical products. A first step in this direction was the inclusion of Traditional Medicine among the scientific topics of the Tenth Asian Symposium on Medicinal Plants, Spices, and Other Natural Products, held in November 2000 in Dhaka, Bangladesh. A good number of traditional medical practitioners participated in the conference, where aspects of the safety, efficacy, and standardization of herbal medicines were thoroughly discussed in an open forum. Gradually, the idea developed to establish a multidisciplinary research centre for natural product chemistry and biology, where these issues could be investigated. This idea was incorporated in the Dhaka Declaration adopted by the Asian Coordinating Group in Chemistry at a meeting shortly after.

The proposal to establish a natural-product research centre was further discussed at the FACS (Federation of Asian Chemical Societies) meeting in Hanoi, Vietnam and in the ASOMPS XI meeting in Kunming, China, in October 2003. A draft proposal presented at these meetings was well received, and the idea gained momentum.

IUPAC projects

At this point in time, IUPAC entered the scene, because Professor Mosihuzzaman felt that the emerging plans needed to be exposed to an even wider international scientific community. The occasion was the IUPAC-sponsored conference on Biodiversity and Natural Products: Chemistry and Medical Application, which was held in Delhi, India in January 2004. During that conference, a more complete draft of the plans was presented at a workshop supported by IUPAC. As IUPAC President at that time, I presided over the workshop proceedings—indeed, this was my first official task as President. Thirty-eight scientists from 18 countries attended the workshop. It was generally agreed that an International Centre for Natural Products Research (ICNPR) should be established, preferably in Bangladesh. A Task Group of scientists from different continents was formed to prepare a proposal to establish the ICNPR, and IUPAC was again involved when the plans were finalized at a meeting in June the same year.

During the next couple of years Professor Mosihuzzaman actively promoted the plans at international conferences. An outcome of this activity was a project proposal entitled, "Development of methodologies and protocols for documentation, evaluation of safety & efficacy and standardization of herbal medicine", which was sent to IUPAC with a funding request. At its meeting during the IUPAC General Assembly in Beijing, China in August 2005, the Organic and Biomolecular Chemistry Division (Division III) funded the project essentially as requested. The work was very competently carried out as proposed by a team of renowned scientists led by Professors M. Mosihuzzaman and M. Iqbal Choudhary (from H. E. J. Research Institute of Chemistry, Karachi, Pakistan). A tangible output was the IUPAC Technical Report, "Protocols on Safety, Efficacy, Documentation and Standardization of Herbal Medicine", published in *Pure and Applied Chemistry* in 2008 (*Pure Appl. Chem.* **80**:2195-2230 (2008)).

CHEMRAWN XX

The publication of this report in *Pure and Applied Chemistry* became, in several ways, a turning point. The report essentially defines a new coordinate system for herbal medicines and calls for a stronger scientific basis for this discipline. This is where IUPAC's interest is the strongest, because chemistry is the fundamental science for assuring reliable clinical outcomes for these plant-based products. This has been recognized by the World Health organization, which in both 2001 and 2011 called for an evidence-based approach to, and a strategic plan for, a comprehensive enhancement of traditional medicine.

Inspired by all this, Professor Mosihuzzaman worked persistently to develop a programme for a CHEMRAWN conference on herbal medicine. He presented his plans for the CHEMRAWN committee at the IUPAC General Assembly in Puerto Rico, July 2011. After a good and fruitful discussion, the drafted plans got the go-ahead and he was picked to chair the international Task Group appointed to plan the conference. At the next IUPAC General Assembly, in Istanbul, Turkey in 2013, the CHEMRAWN Committee approved the concrete proposal for such a conference, adopted, "Herbal Medicine for Health Care in the 21st Century" as its title, gave it the CHEMRAWN number XX, and decided to pick Dhaka, Bangladesh, as the venue.

Professor Mohammad Mosihuzzaman, now Honorary Director of Bangladesh University of Health Sciences (BUHS) in Dhaka, Bangladesh, has been the most instrumental person in the planning of ICNPR for many, many years.

The ICNPR Mission Statement:

The Centre will provide scientific and technical support to the local natural products industry, traditional practitioners and patients by generating scientific data and human resources necessary for development. It will also endeavor to document traditional herbal knowledge, protect intellectual property rights and conserve natural resources in Bangladesh.

The conference was planned to be held in November 2014, but due to difficulties in raising enough support for the conference, always a challenge for CHEMRAWN conferences, the meeting was eventually postponed until 6-9 November 2015. A thorough report of the meeting has appeared in this publication (*Chem. Int.*, 38 (3-4), pp. 41-42 (2016)), where it was mentioned that the conference generated a lot of support for the idea of establishing an *International Centre for Natural Product Research* (ICNPR) in Bangladesh. This solidified the initiative that had been taken with the Bangladesh government in this regard and which brought the Islamic Development Bank in the country onto the stage. It is this bank that decided on 12 November 2017 to approve the loan needed to establish ICNPR (see Mission in the box above) and turn the institute idea into a reality.

Many more than I can name deserve words of thanks on this occasion, but above all is Professor Muhamad Mosihuzzaman. For more than 20 years, he has worked hard to achieve this goal. But then, he has a virtue worth mentioning: he is a living example of how to use IUPAC, and particularly CHEMRAWN, to prove with international authority that plans fulfil scientific requirements and are up to the standards set by the profession. As a past chair of CHEMRAWN, it gives me great satisfaction to see that the CHEMRAWN process has helped improve the quality of these plans and make ICNPR a reality, not only in its own right, but also as a visible testament to the value of CHEMRAWN itself.

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Chemistry and Cultural Heritage*

For long term preservation of cultural heritage, the development of effective and sustainable conservation materials is fundamental. In this issue, innovative methodologies developed for cleaning are discussed (detail from a stained glass, D. Fernando II collection, Parques Sintra – Monte da Lua).

by Maria J. Melo, Austin Nevin and Piero Baglioni

"...il n'est pas possible de bien conserver ce que l'on connait mal" -Louis Pasteur

Made to measure

The conservation of works of art makes them accessible, and will ensure the transfer of cultural heritage to future generations,. For long term preservation, the development of effective and sustainable conservation materials is of fundamental importance. Although in the past traditional approaches in restoration have used highly effective natural materials for cleaning, modern research has focused on the systematic design of materials and methodologies. For instance, during the nineteenth century conservators reported the use of materials such as vinegar, wine, lemon juice, and today saliva is still used in cleaning applications. Although it is now recognized that these materials contain components that are effective cleaning agents, until recently there has been a lack of systematic studies regarding the control of their structure and reactivity.

The last 50 years have witnessed major advancements in conservation science [1, 2]. Many efforts have been dedicated to the development of analytical techniques for the study of artifacts, but significantly less research has focused on the design of innovative materials and methods for the remedial conservation of works of art, which includes cleaning. In this sense, colloids and materials science have provided valuable novel systems for the cleaning, protection and consolidation of cultural heritage objects. The key feature of newly developed materials is that they are designed and engineered to have enhanced effectiveness while showing physical chemical properties similar to the original artifacts. This allows one to minimize drawbacks or negative impacts, in the long-term, following treatment of the works.

Starting from the aftermath of the Florence and Venice floods in the late 1960s, which threatened significant masterpieces, many systems, including nanoparticles, microemulsions and gels, were specifically designed and applied to counteract the degradation processes that affected the artifacts. These new solutions have proved more effective and compatible than synthetic and macromolecular materials (*e.g.* polymeric adhesives and coatings), and guidelines have been described to help conservators in the use of advanced tools. Recently, the palette of conservation materials has expanded significantly as the critical conservation issues of modern and contemporary art become apparent.

A closer look

The field of Chemistry for Conservation is vast and it encompasses analysis, materials characterization, degradation studies, surface science and the development

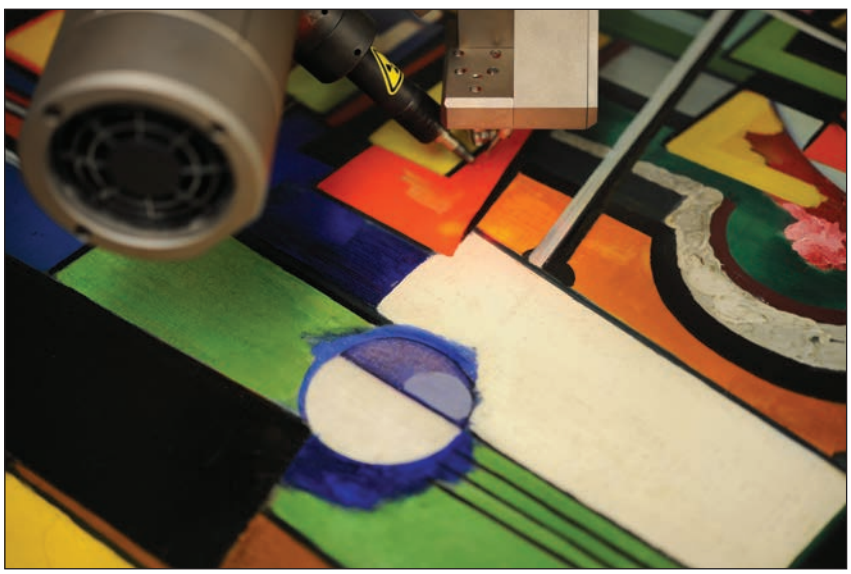
* A special issue of *Pure and Applied Chemistry* published in March 2018; reproduced here are the Preface (https://doi.org/10.1016/j.tet.2018.02.016) and Foreword (*PAC* 90(3), pp. 425-427. https://doi.org/10.1515/pac-2018-0107)

and synthesis of novel materials for conservation. A key part of conservation is the necessary understanding of the materials which make up works of art, very few of which are simple. Indeed it is not uncommon to find a heterogeneous mixture of organic and inorganic materials, whether animal or vegetal binders, pigments, dyes, fibers, macromolecules, polymers, minerals, semiconductors, alloys or metals when examining a work of art. Contemporary art, and the range of plastics and additives which have been used over the last century, poses particularly difficult challenges to conservators and scientists due to the intrinsic susceptibility of materials to degradation, much of which remains poorly understood. Whether ancient of modern, materials, and the ways they have been manipulated, synthesized and employed, all contribute to this unique physical record of our past. Indeed, the complexity of constituent materials makes the study of art a fascinating challenge, and various approaches have been developed for the examination of our cultural heritage.

It is useful here to remind the reader that Conservation generally aims to establish (a) whether or not a work is at risk, (b) if degradation is ongoing, or (c) if degradation has occurred but is no longer progressing. If intervention is necessary, it becomes critical to establish suitable methods for stabilization or consolidation, cleaning, and, often, protection. Chemistry can, therefore, play a key role in providing data to answer these questions, whether through the identification of materials, some of which could degrade, to the detection of oxidation or similar degradation reactions, to the development of new methods and materials.

As detailed in the Glossary provided as Supporting Information to the *PAC* Preface (https://doi.org/10.1515/pac-2018-0106), much of the study of works of art can be achieved without sampling—a particularly relevant issue for the vast majority of heritage which is immovable. Great strides have been made in the development of instrumentation and the application of portable techniques for the study of works of art and their degradation, and methods and tools are becoming increasingly available in major research centers, but may remain inaccessible for many collections and conservators. Current trends in the field include the study of model materials and their degradation with increasingly complex methods for the characterisation of degradation mechanismsˆusing both theory and experimental data. Preventive conservation relies on the elimination of factors which lead to degradation. The integration of data from different, often multiple, analytical techniques on different scales—from microanalysis to the study of large surfaces with imaging techniques—is becoming more common, especially for the analysis of easel paintings.

Even when instrumentation and methods can travel to an object, whether wall paintings in a grotto, religious buildings, monuments, or museums, for example, it is not always possible to answer some of the key questions posed by conservators specifically for conservation without careful sampling and suitable study with reasonable analytical techniques. Internationally, conservation scientists strive to answer conservation-driven questions, where the integrity of an object should be the ultimate aim. When instrumentation cannot travel, or when questions are sufficiently motivated, sampling may be necessary. Micro-sampling techniques thus pose a key advantage and are increasingly used in studies—indeed, invisible detection and



The understanding of the materials which make up works of art is key for conservation. Advanced analytical techniques are applied to characterize the materials aiming to establish whether a work is at risk (detail from a painting of Amadeo de Souza-Cardoso, Fundação Calouste Gulbenkian collection).

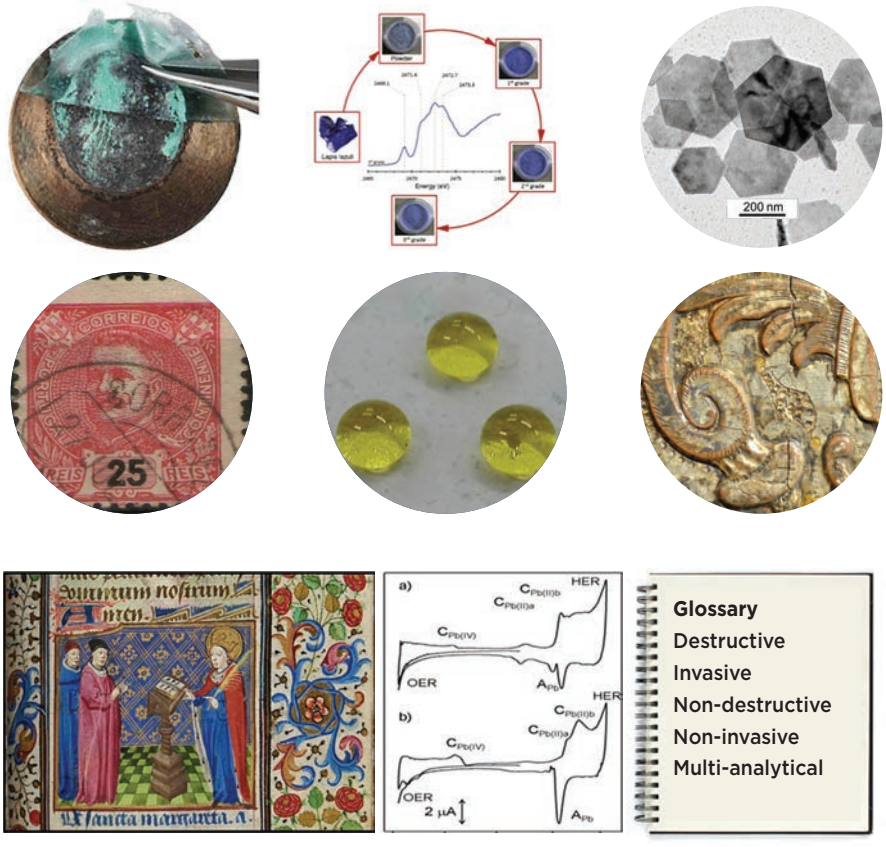
identification of minute samples can yield fundamental knowledge for conservation. Much of the knowledge of the materials of our past has been gained through microscopy and micro-analytical techniques which continue to dominate studies of works of art and cultural heritage. Increasingly sophisticated micro-analysis can be achieved by combining different methods for thorough study of the stratigraphy or samples, the oxidation state of elements, and micro-pore structure, for example.

One of the critical aspects of the study of cultural heritage, whether through analysis of micro-samples, or the use of micro-analytical techniques (either in situ or on the samples) is the relationship between a very small sample and the larger work of art which is intrinsically heterogeneous—and specifically if the sample is representative. To overcome this limitation, current use of in situ imaging techniques which can be low- cost, and in situ examination using suitable microscopy is fundamental prior to any sampling. Samples of works of art are unique—and techniques continue to develop for the study of materials; it is, therefore, likely that with advances in analytical science we will be better equipped to approach questions from conservators.

Pure and Applied Chemistry and Cultural Heritage

In a special issue of *Pure and Applied Chemistry* dedicated to Chemistry and Cultural Heritage, advanced analytical techniques are applied to characterize the materials and techniques used to produce artworks (spanning from ancient times to the twenty-first century), innovative methodologies are developed for cleaning and conservation, and degradation and change of art materials is studied [3].

Seixas de Melo and Pinto discuss the benefits of fluorescence emission in the UV-VIS for characterizing the dyes of the first Portuguese postage stamps. Antonio and Teresa Doménech-Carbó, authors of the book "Electrochemical methods applied to archaeometry, conservation and restoration" (2009), review the various applications of electroanalytical techniques in cultural heritage, covering 17 years of innovative contributions, and discuss exciting future developments in this area. Synchrotron based techniques provide unique insights into the complexity of materials, and by monitoring the sulfur XANES fingerprint, Monica Ganio *et al.* provide new clues for understanding the complex purification



Glossary
Destructive
Invasive
Non-destructive
Non-invasive
Multi-analytical

In the PAC March 2018 special issue advanced analytical techniques are applied to characterize the materials and techniques used to produce artworks (spanning from ancient times to the twenty-first century), innovative methodologies are developed for cleaning and conservation, and degradation and change of art materials is studied. A glossary is provided at https://doi.org/10.1515/pac-2018-0106.

of lapis lazuli reported in many medieval treatises; lapis lazuli blue was an important color in medieval times. Ganio also shows that radiation damage is observed during the first steps of irradiation. Testing the threshold for sample damage caused during analysis using XANES is extremely relevant for the cultural heritage community. Nati Salvadó and her group provide the perfect example of the use of complementary analytical techniques. Colored translucent glazes over gilding in Baroque altarpieces (1671–1775) from the cathedral of Tortosa (Catalonia) were studied with synchrotron based ì-XRD and ì-IR and SEM-EDS, without altering their original layered microstructure. This approach enabled the assessment of the degradation resulting from the interaction among the compounds present in different layers. Hyperspectral imaging is another hot topic covered in this special issue; Marc Walton et al. discuss how to improve the quality of the data handled without being overwhelmed by the enormous datasets acquired.

Cleaning of bronze outdoor sculptures is the challenge addressed by Rodorico Giorgi *et al.*; cleaning is a crucial intervention as it is extremely difficult to accurately assess "what should be removed from an object". Italy is a country well-known for interminable disputes on the effect of cleaning interventions, centered on the question "was the original layer left by the artist removed or not?" One of the most famous disputes was the cleaning of Michelangelo wall paintings in the Sistine Chapel in Rome. Giorgi and his team provide a perfect example on how to address the challenging cleaning of outdoor metal sculptures; first, sound evidence on the molecular degradation mechanism is provided, which enables the characterization of the main degradation products and their multilayer structure. Film forming PVA-based cleaning systems are then used for the removal of corrosion products from historical bronzes; their safeness and efficacy is assessed in artificially aged mock-ups and, finally, applied in the cleaning of "Fontana dei Mostri Marini" by Pietro Tacca in Florence.

Nanomaterials have provided a breakthrough for conservation and restoration practice; examples of their efficiency are astonishing and call for a systematic assessment of their long-term molecular interactions with the original materials. Lime water, a saturated solution of $Ca(OH)_2$, has been used for centuries to consolidate carbonate-based substrates such as limestone or marble. Its importance as a protective and consolidant material for monumental surfaces is revisited by Carlos Rodriguez-Navarro *et al*. Developments of $Ca(OH)_2$ based formulations to overcome the limitations of the lime water treatment are presented and safer greener treatments are anticipated. Other innovative bio-inspired treatments for monumental surfaces are described by Maria J. Mosquera, Luis A.M. Carrascosa and Nabil Badreldin. Superhydrophobic properties as displayed by the lotus leaf combine self-protection and self-cleaning capabilities. The authors show how promising superhydrophobic/oleophobic coatings may be for the preservation of cultural heritage building materials.

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2. P. Baglioni, E. Carretti, D. Chelazzi. *Nat. Nanotechnol.* **10:** 287 (2015).
3. J. Wouters. *Chemistry International* **30**(1), 4-7 (2008); https://doi.org/10.1515/ci.2008.30.1.4

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IUPAC, analytical chemistry and our cultural heritage†

by *D. Brynn Hibbert*

Considering the explanation of "Who we are" on the web site of IUPAC [1] I think the following is relevant to the theme of this special edition. "We are a leader in the provision of objective scientific expertise for the resolution of critical global issues that involve every aspect of chemistry, all of which have societal impact". The cultural heritage of the world belongs to the world, and a world body, such as IUPAC, is needed to provide the intercontinental [2] understanding that allows open science and sharing of approaches to conserving our important artefacts.

Professor Melo and colleagues writing the preface to the papers in this issue quote Louis Pasteur "(...) *il n'est pas possible de bien conserver ce que l'on connait mal*". Not being able to conserve what we do not know echoes the wider motto of many National

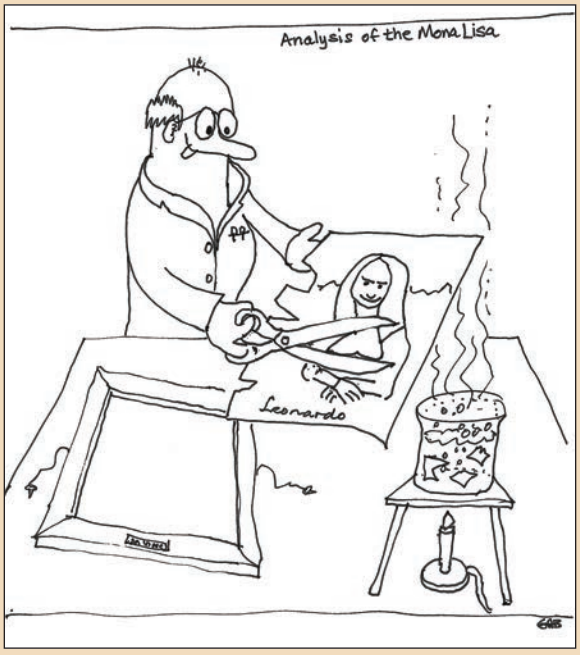
† Reprint from *PAC* March 2018, Foreword; https://doi.org/10.1515/pac-2018-0107

Measurement Institutes "You cannot manage what you cannot measure", and so the thesis of my contribution is that analysis (including analytical chemistry) is the essential platform of our ability to conserve.

Cultural heritage studies require skills from all of chemistry. Analytical chemistry certainly but also a deep knowledge of materials and their properties when part of an object that might be exposed to the environment, or in contact with other strange substances. Perhaps more so in a highly cross-disciplinary field accurate terminology allows scientists, students of the arts and historians to have a discourse that leads to the desired outcomes, namely the conservation of our cultural heritage. To underline this point, we have decided to also publish in this issue a Technical Report in which measurements of mass or volume used in chemistry are described and terms defined [3].

The mass and volume report will become a chapter in the forthcoming, completely new, edition of the IUPAC Orange Book (Compendium of Terminology in Analytical Chemistry) edited by the author [4]. In it we shall see a recrafted terminology of analytical chemistry, which focusses on the methodology of analytical chemistry, rather than the applications. This decision was largely taken because the uses of analytical chemistry are now so many and varied—witness the fascinating papers in this edition of PAC—it would not be possible to give an account of all of analytical chemistry as it is used. However, we have attempted to provide a coherent terminology of modern methodology in analytical chemistry. Adding the names of the many varieties of NMR, or the new techniques of bioanalytical chemistry turned out to be the easy part. What has caused the most discussion is deciding the formal definitions of fundamental concepts of the subject—what is 'analytical chemistry'? [5]

IUPAC has contributed to, and been a major player in, the Joint Committee for Guides in Metrology, the international body that produces the International Vocabulary of Metrology (VIM) [6] and the Guide to the expression of Uncertainty in Measurement (GUM) [7]. Making sense of correct, but occasionally hard to understand, terms and definitions and interpreting them for the chemical community has been a long and interesting activity. The importance of using the correct word to describe accurately the concept that is in our mind cannot be overstated. We have an excellent example in the field of cultural heritage. Professor Melo has drawn our attention to the connotations of the use of the words 'destructive' (Portuguese destructiva; Italian distruttivo) and non-destructive, in relation to sampling for conservation purposes. The image of



Cartoon by Graham Bell, Australia

a rampant analytical chemist chopping up a priceless painting or statue in order to say what it is made of is not a pretty thought. Finding alternative terms (with translations) and then persuading the community to use those terms (and give up deprecated terms) is a task made easier when the terminology comes with the imprimatur of the world body IUPAC, and having been through the scrutiny of the process of publishing IUPAC Recommendations. I therefore invite the community of chemists working in conservation and heritage to work on a project that will give a comprehensive terminology for the field.

I have been interested to read all the articles in this special issue of *PAC*, in particular the work on conserving bronzes. Many years ago, I was asked to analyse the washings of a campaign to clean two bronze equestrian statues [8] outside the Art Gallery of New South Wales in Sydney Australia. Close by Sydney Harbour, the marine atmosphere had created a patina of copper chloride salts which it was deemed had to be removed. Glycine was being used and while the statues were looking cleaner we were monitoring the dissolution of significant amounts of copper. All went well however and happily the statues are still there.

Notes and References

1. IUPAC, https://iupac.org/who-we-are/ (Accessed 18 January 2018).
2. 'Intercontinental' was a much-used adjective by the late

Paul De Bièvre (1933–2016), a long serving member of IUPAC.
3. M. F. Camões, G. D. Christian, D. B. Hibbert. *Pure Appl. Chem.* 90, 563 (2018); or this *CI* page 42.
4. IUPAC project 2012-005-1-500, https://iupac.org/project/2012-005-1-500 (Accessed 18 January 2018).
5. The answer will be found in Chapter 1 of the new edition of the Orange Book and is at present: "Scientific discipline that develops and applies strategies, instruments, and procedures to obtain information on the composition and nature of matter in space and time".
6. Joint Committee for Guides in Metrology. International Vocabulary of Metrology—Basic and General Concepts and Associated terms VIM, JCGM 200:2012 BIPM, Sèvres.
7. Joint Committee for Guides in Metrology. Evaluation of Measurement Data—Guide to the Expression of Uncertainty in Measurement, JCGM 100:2008 BIPM, Sèvres.
8. The Offerings of Peace and The Offerings of War by Gilbert Bayes (1926). Art Gallery of New South Wales, Accession numbers 3254 and 3255.

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Top Ten Emerging Chemistry Technologies—call for input

The Editorial Board of *Chemistry International,* aiming at highlighting exciting new discoveries in chemistry and describing how these are tackling some of our most pressing needs, is proposing to produce an annual review identifying, describing and celebrating the top ten chemistry technologies that are transforming our discipline. Through this effort, IUPAC will recognize some of the most exciting discoveries in chemistry and explaining how these are relevant to tackle some of our most pressing needs and transforming our discipline.

For this effort, we are tapping into the expertise of IUPAC community to identify the most relevant chemistry technologies of the past year. For that, we are asking you to complete a short survey form and share your suggestion, briefly describing a recent emerging chemistry technology.

For questions and inquiries, please email edit.ci@iupac.org

Visit https://iupac.org/what-we-do/journals/chemistry-international/

Photo by Diz Play

IUPAC Offers an Open Door to Chemists of the World*—A Program Revisited

by Colin J. Humphris

At the meeting in São Paulo, Brazil in July 2017, the IUPAC Council approved important recommendations for the revision of the programmes through which individual chemists can be affiliated to IUPAC, either as a paid member (the Affiliate Membership Programme, or AMP) or as a sponsored affiliate (an option for limited numbers of early career chemists from emerging regions).†

These programmes have been in place for over 30 years, supported by the member countries of IUPAC through their respective National Adhering Organisations (NAOs). The objectives of the current changes are to update Affiliate memberships to reflect the realities of IUPAC today and to further broaden and diversify the worldwide membership base by offering chemists in both member and non-member countries the opportunity to engage more effectively in support of IUPAC's international work.

The intention of the revised programme is to build on the original objectives of the AMP:

- To maximize the participation of chemists worldwide in the affairs of IUPAC and to disseminate information about IUPAC, its activities, and its output to a much wider audience globally.
- To provide a broader personal contact base for IUPAC to chemists who are not recorded as active members of IUPAC bodies identified in its Divisions and Committees.
- To promote a wider contact of IUPAC with Chemical Societies and other chemistry organizations by permitting them to operate an Affiliate Program with IUPAC.
- To provide a route for contact with individual chemists in countries not having a Chemical Society (or one with insufficient resources to operate a program) by allowing them to become affiliated directly via the IUPAC Secretariat through an application process.

1980's—The Launch of AMP

The original Affiliate Membership Programme (AMP) was approved at the 32nd General Assembly in 1985

in Lyngby, Denmark by a majority vote of the Council. The first Affiliate members were enrolled at the beginning of 1986 with the recruitment of 5500 members in the first year of operation. This followed a period of extensive discussion that centered on how individual chemists could become associated with IUPAC without interfering with the responsibilities of the NAOs or the way in which Divisions (or then the Commissions) operated. A full review of these discussions is available in previous issues of *Chemistry International* [1,2].

The IUPAC Statutes define the Union as '*a voluntary nongovernmental, nonprofit association of organizations each representing the chemists of a member country, a member country being a country where Adhering Organization has joined the Union.*' Core to the governance structure established for IUPAC was the principle that only the NAOs would be able to communicate with the Union on matters of policy, administration, and other non-scientific matters. This continues today, with the Union governed through the Council of member countries. Individual chemists could only stand for election to Divisions and Committees as Titular Members (financially supported to attend Division or Committee meetings), or as Associate Members or National Representatives (whose attendance is not financially supported). All three categories are contingent on the approval of the members' respective NAOs. Traditionally, therefore, chemists from non-NAO countries have been excluded from the core scientific bodies of the Union.

In 1981, as the original proposals for affiliate membership were under consideration, the International

* The same title was used and published in 1983 when the Affiliate Memebrship Programme was first presented; see ref. 1

† The proposals were developed through a process during 2016 and early 2017 led by the Treasurer and Executive Director, through discussion at the 99th Executive Meeting, Beijing 8-9 November 2016, and the 99th Bureau meeting 8 April 2017, before consideration at Council in July 2017.

Meeting of Chemistry Society Presidents in Belgrade was considering plans for the creation of an International Chemistry Society. These were abandoned, given the initiative under consideration by IUPAC. There was, however, a balance to be struck. The Affiliate programmes were not to interfere with the relationships between chemists and their national chemistry representative bodies. To this end, NAOs or Chemistry Societies were offered the opportunity to coordinate the programme locally, to ensure that chemists only became affiliates through their NAO or their national Chemistry Society. If neither wished to coordinate the programme and had no objections to its chemists becoming Affiliates, chemists could apply to IUPAC directly.

The subscriptions to be paid comprised two components. The first was intended to cover the cost to IUPAC for editing, printing, and distributing *Chemistry International*, to which all affiliate members were entitled. The second component was meant to enable the NAO or Chemistry Society to recover the costs of operating the Affiliate programme. When the programme began, the total proposed annual subscription was to be USD 15. This rose to USD 35 in 2003 and has remained unchanged since.

Where applicable, AMP coordinators from developing and economically-disadvantaged countries were entitled to provide a maximum of 25 complimentary, "Sponsored" Affiliate memberships.

The Changing World of IUPAC

Since the creation of the AMP, IUPAC has changed in a number of important ways. Probably the biggest recent change has been the introduction of a project system for the management of IUPAC work. This not only allowed for better management of activities, but also crucially opened to all chemists, whatever their nationality, the possibility of IUPAC voluntary work. In its report to the Council in 2013, the Evaluation Committee noted that chemists from 77 countries were involved in projects between 1997 and 2012. At the time, IUPAC comprised 61 member countries. Project leaders were drawn from 52 counties, 4 of which were not NAOs. The change was, therefore, having some success in engaging a wider chemistry community. More work remained, however, as most of this early volunteer effort was concentrated in the traditional member countries. Out of the 2966 chemists involved over this period, 1184 were from the USA, UK, or Germany.

Since the turn of the millennium, IUPAC has seen a significant turndown in its publishing income, a fact that lay behind the decision to work with De Gruyter to upgrade publishing activities, especially marketing, a resource IUPAC lacked. The net annual cost to IUPAC for *Chemistry International* had also become very high, at around USD 150,000. Although there were a number of reasons for this, it was clear that a subscription of USD 35.00 would not cover the costs of printing and distribution. The current price of *CI* to third parties subscribing through De Gruyter is USD 74.00 per annum.

A process of reorganization—of the IUPAC Secretariat and its accounting procedures, as well as a fundamental overhaul of the IUPAC website, supporting databases, and IT infrastructure—is coming to fruition at the end of 2017. For 2018, it will be possible to carry out transactions directly with IUPAC electronically, to validate membership online, and to provide member-specific services.

At the same time as publishing income was falling, the 2008 global economic turndown impacted the ability of national members to pay national subscriptions. Many are national science bodies dependent on shrinking government funding. In 2018, approximately USD 900,000 of the total IUPAC income of USD 1,300,000 is provided by national members. There is a need to grow new income sources given ongoing pressure on national budgets.

The Company Associate scheme for corporate members has also been reviewed by the Committee on Chemistry and Industry (COCI). Recommendations were approved by the Council to encourage membership by industrial chemists and the engagement of companies in all aspects of applied chemistry.

AMP Review

In reviewing the AMP scheme, the following core principles were considered:

- To retain and enhance the original objectives of the AMP scheme
- To encourage further engagement and involvement of chemists in all countries, whether in academia, government, or industry, in the work of IUPAC
- To maximize the advantages of working with NAOs or existing Chemistry Societies where possible.
- To make the fullest use of IUPAC's new IT infrastructure and Secretariat capabilities.
- To continue to reduce the net cost of *CI* through digital publishing whilst enabling those who prefer paper copies to receive them.

2018 Affiliate subscriptions (in USD)	Paid subscription	including printed CI
Membership through a Coordinator	**$50.00**	**$75.00**
of which, to Membership Coordinator	$20.00	$20.00
and to IUPAC	$30.00	$55.00
Sponsored Affiliate	**$ 0.00**	**$25.00**
and to IUPAC	$ 0.00	$25.00
Membership direct through IUPAC	**$50.00**	**$75.00**

- To ensure that the subscription fee is commensurate with the benefits package provided.
- To provide practical ways of managing the Sponsored Affiliate scheme to maximize the opportunities for younger chemists to continue to benefit from it.

These led to the key features of the new Affiliate Membership Programme:

1. Affiliate members from both NAO and non-NAO countries are eligible to be nominated as candidates for *Associate Member* positions in Division elections and for election or appointment to Standing Committees. This represents a significant new opportunity for chemists to become further involved with the scientific work of IUPAC.
2. Affiliate members can continue to participate in IUPAC projects, including the development of project proposals, and can serve both as chairs or members of project task groups.
3. Affiliate members continue to receive a 10 % discount on registration fees for IUPAC-endorsed conferences and symposia. Affiliate members will continue to receive a 25 % discount on IUPAC books.
4. Affiliate Members receive complimentary access to the digital version of *Chemistry International* via DeGruyter.com/ci. A print version is available for USD 25.00 annual subscription premium as a contribution to printing and distribution costs for those who would prefer it.
5. The Affiliate programme continues to be administered in many countries through an AMP coordinator. For IUPAC member countries, the coordinator is appointed by the NAO. For non-member countries, the coordinator is appointed by a recognized Chemistry Society, agreed with IUPAC.
6. AMP coordinators in developing and economically-disadvantaged countries also continue to be entitled to provide a maximum of 25 complimentary "sponsored" Affiliate memberships for early-career chemists. Membership as a sponsored affiliate is limited to a total of six years to ensure a suitable turnover of early-career chemists. Sponsored Affiliates have digital access to *Chemistry International*. However, if a sponsored Affiliate would like "printed" copies of *CI,* he/she can acquire such copy at a cost of USD 25.00 per year to contribute to the printing and distribution costs.
7. Affiliate members receive a certificate of membership and an Affiliate membership card. All members will be listed on the IUPAC website, without distinguishing between paid or sponsored affiliates.

To join as an Affiliate, interested chemists can find contact details for their AMP coordinators published at www.iupac.org/home/individual-members/. Alternatively, chemists can apply directly to IUPAC by contacting the IUPAC Secretariat's Affiliate Membership manager, Ms. Linda Tapp, at <LTapp@iupac.org>. IUPAC will keep national coordinators informed of any direct applications in their countries.

References

1. T.S. West. IUPAC offers an open door to chemists of the World. *Chem. Int.,* **5**(1):6-10 (1983).
2. IUPAC Scheme of Affiliate Membership. *Chem. Int.* **5**(4):17-20 (1983).

Colin Humphris <chumphris@iupac.org> has been IUPAC Treasurer since 2016, serving a four-year term. Previously, he was involved in IUPAC's Committee on Chemistry and Industry (COCI), both as a Titular Member (2004-2009) and Secretary (2010-2013). He has also served as IUPAC Secretary General (2014-2015), as well as a Bureau Member since 2010.

Sixth Polymer International–IUPAC Award goes to Cyrille Boyer

The Executive Editorial Board of *Polymer International* (PI) and the IUPAC Polymer Division (Div IV) are pleased to announce Professor Cyrille Andre Boyer as the winner of the Sixth Polymer International–IUPAC award.

Cyrille Boyer

Professor Cyrille Boyer has made sustained, outstanding contributions to the field of polymer science. He has authored 189 refereed review and research articles published in peer-reviewed journals. His work has garnered more than 10,000 citations (with 24 articles having each received over 100 citations and 21 articles ranked as 'Highly Cited' by Web of Science), positioning him as one of the most highly cited polymer scientists of his generation worldwide. Boyer and his group have demonstrated the applicability of their technology to all areas of polymer research, including continuous manufacturing, multifunctional nanoparticles and precision polymer synthesis. Moreover, by utilizing light-mediated polymerization, this new technique offers low energy consumption, high atom efficiency, low waste production, and implements renewable energy resources.

Professor Boyer will receive this award and give a lecture at the World Polymer Congress (www.macro18.org), which will be held in Cairns, Australia from 1st to 5th July 2018. The award includes expenses and travel to the World Polymer Congress (US$ 5000 plus travel and hotel accommodation expenses) and it will be presented in a small ceremony at the conference.

The winner was selected by members of the scientific committee representing PI and the Div IV:

- Kurt Geckeler (Emeritus Editor-in-Chief of PI)
- Greg Russell (President of Div IV, Australasia)
- Jiasong He (PI/IUPAC, Far East)
- Dick Dijkstra (PII/IUPAC, Western Europe)
- Michael Buback (Past President of Div IV, Western Europe)
- Pavel Kratochvil (PII/IUPAC, Eastern Europe)
- Chris Ober (IUPAC, The Americas)

The selection committee, the Editor-in-Chief of *Polymer International* Professor Timothy Long and its Editorial Board extend their congratulations to Professor Boyer.

www.advancedsciencenews.com/sixth-polymer-international-iupac-award-winner

Peter D.J. Grootenhuis is Awarded the 2018 IUPAC-Richter Prize

Peter D.J. Grootenhuis

Peter D.J. Grootenhuis received this award in recognition of his outstanding creative contributions to the invention, discovery and development of ivacaftor (KALYDECO™) which was a transformational event in the treatment of cystic fibrosis (CF). Peter Grootenhuis led the team that not only brought this revolutionary drug to the clinic but also has continued to work in the CF field to extend his work with new drugs to treat CF.

The IUPAC-Richter Prize, comprising a plaque and a check for USD 10,000, will be presented on 1 May 2018 at the 36th National Medicinal Chemistry Symposium in Nashville, TN, USA. The plaque will be signed by Prof. Qi-Feng Zhou, President of IUPAC, Gábor Orbán, Chief Executive Officer of Gedeon Richter Plc (Budapest, Hungary), and Professor János Fischer, Chair of the IUPAC-Richter Prize selection committee. Peter D.J. Grootenhuis will present a lecture at this Symposium and also at the XXV EFMC International Symposium on Medicinal Chemistry in Ljubljana, Slovenia (2-6 September 2018).

Peter D.J. Grootenhuis received MSc and PhD degrees in chemistry at the Universities of Utrecht and Twente in the Netherlands. Subsequently, he performed post-doctoral studies in computational chemistry at UC San Francisco, followed by a short sabbatical at Harvard University. He is Senior Director Chemistry at Vertex Pharmaceuticals Incorporated in San Diego. Prior to joining Vertex™ in 2002, he worked at CombiChem-DuPont and Organon. At Vertex, Grootenhuis has been research project leader in the areas of cystic fibrosis and sodium channel blockers for pain. He is co-inventor of two FDA approved drugs to treat CF (ivacaftor, lumacaftor).

www.iupac.org/peter-d-j-grootenhuis-awarded-2018-iupac-richter-prize

The United Nations Proclaims the International Year of the Periodic Table of Chemical Elements

On 20 December 2017, during its 74th Plenary Meeting, the United Nations (UN) General Assembly 72nd Session has proclaimed 2019 as the International Year of the Periodic Table of Chemical Elements (IYPT 2019). In proclaiming an International Year focusing on the Periodic Table of Chemical Elements and its applications, the United Nations has recognized the importance of raising global awareness of how chemistry promotes sustainable development and provides solutions to global challenges in energy, education, agriculture and health. Indeed, the resolution was adopted as part of a more general Agenda item on Science and technology for development. This International Year will bring together many different stakeholders including UNESCO, scientific societies and unions, educational and research institutions, technology platforms, non-profit organizations and private sector partners to promote and celebrate the significance of the Periodic Table of Elements and its applications to society during 2019.

The development of the Periodic Table of the Elements is one of the most significant achievements in science and a uniting scientific concept, with broad implications in Astronomy, Chemistry, Physics, Biology and other natural sciences. The International Year of the Periodic Table of Chemical Elements in 2019 will coincide with the 150th anniversary of the discovery of the Periodic System by Dmitry Mendeleev in 1869. It is a unique tool enabling scientists to predict the appearance and properties of matter on Earth and in the Universe. Many chemical elements are crucial to enhance the value and performance of products necessary for humankind, our planet, and industrial endeavors. The four most recent elements (115-118) were fully added into the Periodic Table, with the approval of their names and symbols, on 28 November 2016.

The International Year of the Periodic Table of the Chemical Elements will coincide with the Centenary of IUPAC (IUPAC100). The events of IUPAC100 and of IYPT will enhance the understanding and appreciation of the Periodic Table and chemistry in general among the public. The 100th Anniversary of IUPAC will be on the UNESCO Calendar of Anniversaries on 28th July 2019.

United Nations
ucational, Scientific and
Cultural Organization

International Year
of the Periodic Table
of Chemical Elements

See IYPT story page 2

"As the global organization that provides objective scientific expertise and develops the essential tools for the application and communication of chemical knowledge for the benefit of humankind, the International Union of Pure and Applied Chemistry is pleased and honored to make this announcement concerning the International Year of the Periodic Table of Chemical Elements" said IUPAC President, Professor Natalia Tarasova.

Chemical Elements play a vital role in our daily lives and are crucial for humankind and our planet, and for industry. The International Year of the Periodic Table of Chemical Elements will give an opportunity to show how they are central to linking cultural, economic and political aspects of the global society through a common language, whilst also celebrating the genesis and development of the periodic table over the last 150 years. It is critical that the brightest young minds continue to be attracted to chemistry and physics in order to ensure the next generation of scientists, engineers, and innovators in this field. Particular areas where the Periodic Table and its understanding have had a revolutionary impact are in nuclear medicine, the study of chemical elements and compounds in space and the prediction of novel materials.

The IYPT is endorsed by a number of international Scientific Unions and the International Council for Science (ICSU). The IYPT will be administered by an International Steering Committee in collaboration with the UNESCO International Basic Sciences Programme and an International Secretariat, to start operating in early 2018. In addition to IUPAC, IYPT is supported by the International Union of Pure and Applied Physics (IUPAP), the European Chemical Sciences (EuCheMS), the International Astronomical Union (IAU) and the International Union of History and Philosophy of Science and Technology (IUHPST).

www.iupac.org/united-nations-proclaims-international-year-periodic-table-chemical-elements www.iypt2019.org

World Metrology Day, 20 May 2018

The theme for World Metrology Day 2018 is Constant evolution of the International System of Units. This theme was chosen because in November 2018, the General Conference on Weights and Measures is expected to agree one of the largest changes to the International System of Units (the SI) since its inception. The proposed changes are based on the results of research into new measurement methods that have used quantum phenomena as the basis for standards that are fundamental. The SI will be based on a set of definitions each linked to the laws of physics and have the advantage of being able to embrace further improvements in measurement science and technology to meet the needs of future users for many years to come.

Indeed more widely metrology, the science of measurement, plays a central role in scientific discovery and innovation, industrial manufacturing and international trade, in improving the quality of life and in protecting the global environment.

World Metrology Day is an annual celebration of the signature of the Metre Convention on 20 May 1875 by representatives of seventeen nations. The Convention set the framework for global collaboration in the science of measurement and in its industrial, commercial and societal applications. The original aim of the Metre Convention—the world-wide uniformity of measurement—remains as important today as it was in 1875.

The World Metrology Day project is realized jointly by the International Bureau of Weights and Measures (BIPM) and the International Organization of Legal Metrology (OIML).

World Metrology Day recognizes and celebrates the contribution of all the people that work in intergovernmental and national organizations throughout the year on behalf of all.

www.worldmetrologyday.org

Science for Peace

ICSU's Committee on Freedom and Responsibility in Science issued a statement from the World Science Forum, where it held its 23rd meeting 6-8 November 2017, highlighting the role of science as the bedrock of a peaceful and equitable world. The statement fed into the closing declaration of the World Science Forum 2017.

"On the occasion of the World Science Forum, the Committee on Freedom and Responsibility in Science of the International Council for Science salutes the theme of **Science for Peace**. There is a greater opportunity than ever before to harness the insights, knowledge and technical progress fuelled by advances in science and technology to promote an equitable world, anchored in peaceful relations among nations and citizens. The conduct of science flourishes in times of peace. The free circulation of ideas and people is central to supporting a peaceful world. For the sciences and scientists, free interchange of ideas, and freedom to pursue questions of scientific merit, support their responsibilities to apply the best scientific methods, models and research to improve the lives and wellbeing of the world's peoples. Scientists and science organisations serve as ambassadors for peace and as conduits across nations and national interests, in their focus on global wellbeing."

www.icsu.org/current/news/icsu-committee-issues-statement-on-the-importance-of-science-for-peace

Resolution on the Water Crisis in Gaza

The Malta VIII Conference titled "Frontiers of Science: Research and Education in the Middle East—A Bridge to Peace" took place in the Republic of Malta. From the 10-15 December 2017, one hundred scientists, from 14 Middle East countries, who are committed to using science diplomacy for peace, spent five days collaborating with each other in order to solve regional problems of environmental degradation, water scarcity, chemical and nuclear security, and science and technology education.

This year, the scientists came from Bahrain, Egypt, Iraq, Iran, Israel, Jordan, Lebanon, Morocco, Oman, the Palestinian Authority, Saudi Arabia, Syria, Turkey, and the United Arab Emirates. The conference has been held every two years since 2003. It has become increasingly difficult to obtain visas for everybody. But once there, the scientists engage with each other and create an atmosphere like a family reunion.

One of the outcomes of the Conference was a resolution written by Israeli and Gazan scientists, calling on the international community to leave politics aside and help solve the humanitarian crisis which stems in large part from the existence of widespread water pollution in Gaza. The resolution reads:

"We are scientists from all over the Middle East that met under the "umbrella" of the "Malta Conferences Foundation -Frontiers of Science Research and Education in the Middle East". During our meeting, it became apparent that because of lack of suitable drinking water and energy, the humanitarian situation in Gaza is on the edge of becoming a catastrophe. The problem in Gaza is not confined and the bad environmental issue that may arise will affect neighboring countries like Israel and Egypt. For example, the lack of treatment to sewage causes its deposition in the sea and the pollution affects not only Gaza but also people living at the shore in other countries.

We call the international community to establish a task force that will be able to overcome the political difficulties and will enable professional treatment of the water and environment."

Every Middle East participant voted in favor of the adoption of this resolution.

The Malta Conferences is the only platform where scientists from all over the Middle East can spend five days together, develop collaborations and friendships, which overcome the chasms of distrust and intolerance.

Zafra M. Lerman, Ph.D., FRSC President, Malta Conferences Foundation <zafra@zafralerman.com >

MaltaConferencesFoundation.org

The Chemical Weapons Convention: From Disarmament to Sustainable Development

Peace and security through the destruction of chemical weapons

2017 marked the twentieth anniversary of the entry into force of the Chemical Weapons Convention (CWC). The Convention is a unique and powerful disarmament treaty with the aim of completely eliminating chemical weapons from the world. It is comprehensive, prohibiting not only the use of chemical weapons, but also their development, production, stockpiling, transfer and retention. Currently 192 States have committed to eradicating chemical weapons by becoming signatories to the Convention.

The Organisation for the Prohibition of Chemical Weapons (OPCW) was founded in 1997 as the international organisation responsible for overseeing the

implementation of the Convention. Since its entry into force, the OPCW has verified the destruction of more than 95% of the world's declared chemical weapons stockpiles. This contribution to global peace and security was recognized by the Nobel Peace Prize Committee, which awarded the prize to the OPCW in 2013.

To reach its ultimate objective of "working together for a world free of chemical weapons", the OPCW and its Member States continue to eliminate declared stockpiles of chemical weapons while preventing the re-emergence of these inhuman weapons. This is achieved through a rigorous industry verification regime that ensures chemical production is exclusively for peaceful purposes, and through an international cooperation programme that promotes the peaceful applications of chemistry.

Promoting chemistry for peace and development

Under Article XI, the Convention provides a solid foundation to foster technological and economic development through promotion of the peaceful applications of chemistry in various areas, including research and exchange of scientific information, technology development, and trade and transfer of chemicals.

The OPCW implements a series of capacity building and support programmes for various stakeholders, including chemical industry, academia and research institutions as well as National Authorities. These programmes, which focus on Member States with developing and transiting economies, are broadly divided into three thematic focus areas: i) Integrated Chemicals Management; ii) Enhancing Laboratory Capabilities; and iii) Promoting Chemical Knowledge.

Programmes in *Integrated Chemicals Management* take a multi-stakeholder approach, involving chemical industry, governmental agencies, academia and other entities. The goal of this work is to promote adoption of sustainable approaches in chemical safety and security, as well as to disseminate best practices of sustainable chemicals management throughout their lifecycle, such as the Responsible Care® programme. Activities in this area include training opportunities, and provide fora for information sharing and discussion among stakeholders.

The main focus of *Enhancing Laboratory Capabilities* programmes is to improve the capacities of Member States in the analysis of chemicals subject to the CWC through training activities oriented towards different proficiency levels and instrumental techniques. This includes providing support to institutes aspiring to become an OPCW Designated Laboratory, a certification which enables a laboratory to perform sample analyses on behalf of the OPCW. The OPCW Laboratory Twinning initiative provides an opportunity for institutes to partner with more experienced laboratories as they work towards designation status. Laboratory capacities are also enhanced through the Equipment Exchange Programme which facilitates the transfer of equipment between Member States.

Programmes in the area of *Promotion of Chemical Knowledge,* aim to support research and exchange of scientific information. This includes supporting small scale research projects in a wide range of thematic topics such as the destruction and analysis of toxic chemicals, the development of safer chemical processes and products, treatments for victims of chemical exposure, and environmental protection. Dedicated support is also provided for scientists and technical personnel of beneficiary Member States to attend scientific conferences and undertake on-the-job training in laboratories of other Member States.

Science in context: working with key sectors and stakeholders

In addition to fostering core scientific knowledge, under Article XI of the Convention the OPCW raises awareness on critical issues of responsibility and ethics, education, gender, and safety and security in chemistry. It also encourages scientists to better understand the interconnections between science and other key sectors, and stimulates their active engagement with other stakeholders, including industry and policy makers. To this end, OPCW hosts a yearly workshop on policy and diplomacy for scientists, which provides a platform for young scientists to learn about science-related policies and the work of the international community in the fields of disarmament and chemical safety and security.

Participation in OPCW programmes and activities

The above-mentioned programmes and activities are open to participation of scientists and institutions from all eligible OPCW Member States. As a normal practice, applications need to be endorsed by the respective National Authority for the CWC.

Detailed information can be obtained from the OPCW website: www.opcw.org/our-work/international-cooperation/capacity-building-programmes/

Interdivisional Discussion of Critical Evaluation of Chemistry Data

The exhaustive compilation of the primary chemical literature of property data for systems and the critical evaluation of the resulting data sets by international teams of experts has long been a IUPAC activity. Thus, the current 'Guidelines for IUPAC Projects' states, "The core activity of IUPAC is to provide *critical evaluations of* methods and *data* and to make recommendations for nomenclature, terminology, metrology, and measurement standards" (italics added).

Prior to 2001, when IUPAC activities were organized around Commissions within the Divisions, a number of Commissions and of Subcommittees within Commissions focused on critical evaluation and constituted an ongoing pool of expertise in the critical evaluation of chemical data. According to the IUPAC Handbook 2000-2001, groups with ongoing interests in critical evaluation included the Subcommittee on Thermodynamic Data (within the Commission on Thermodynamics, I.2), the Subcommittee on Gas Kinetic Data Evaluation for Atmospheric Chemistry (within the Commission on Chemical Kinetics, I.4), the Commission on Atomic Weights and Isotopic abundances (II.1), the Commission on Equilibrium Data (V.6), and the Commission on Solubility Data (V.8). Since the reorganization of IUPAC to a project-driven structure, three bodies have existed with a continuing focus on the compilation and critical evaluation of data–the Commission on Isotopic Abundances and Atomic Weights (II.1), the Subcommittee on Modeling of Polymerization Kinetics and Processes within the Polymer Division, and the Subcommittee on Solubility and Equilibrium Data (SSED) within the Analytical Chemistry Division. Additional critical evaluation of data is continuing in the Physical and Biophysical Chemistry Division without formal commission or subcommittee structure as a series of projects creating an evaluated database of kinetic data for atmospheric chemistry. Based on a review of the titles of active projects listed on the IUPAC web site in November 2016, it appears that one project involving critical evaluation of data is underway in the Physical and Biophysical Chemistry Division (Division I), three in the Inorganic Chemistry Division (Division II), five in the Polymer Division (Division IV), and 16 in the Analytical Chemistry Division (Division V).

Although data compilation and evaluation has continued in IUPAC to the present day, the breadth of such work has diminished. The reason seems clear. In parts of IUPAC lacking individuals with experience and interest in data compilation and evaluation, the need for such projects may not be perceived or, when perceived, may be deemed too difficult to address. However, the full dimensions of this situation are unknown. Therefore, it seemed appropriate to bring together interested bodies and individuals to share information about plans and activities and to consider whether it would be useful to hold further meetings, possibly leading to a permanent structure that would share information and help focus attention.

The critical evaluation of data and the dissemination of data products to communicate evaluations to users is a complex undertaking. To better understand IUPAC's current activities and future opportunities in critical evaluation, the SSED organized an interdivisional discussion of the critical evaluation of chemical data as part of the General Assembly held in São Paulo, Brazil in July 2017. This open meeting attracted 14 participants from six Divisions and Committees to discuss ongoing activities and future needs in the area of critical evaluation. See IUPAC project 2016-043-1-500 for more details and for a meeting report.

The São Paulo meeting first heard descriptions of three current activities in critical evaluation. Robin Hutchinson spoke about the critical evaluation of polymerization kinetics data by the Subcommittee on Modeling of Polymerization Kinetics and Processes, Division IV. Thomas Walczyk discussed the critical evaluation of isotopic abundances and atomic weights by the Commission on Isotopic Abundance Measurements and Atomic Weights, Division II. David Shaw described critical evaluations prepared by the Solubility Data Project under the Subcommittee on Solubility and Equilibrium Data, Division V. Further information about these activities can be found in the meeting report.

Ian Bruno, Stuart Chalk, Tony Davies, and David Martinsen provided comments about the work of the Subcommittee on Cheminformatics Data Standards (SCDS) of the Committee on Publications and Cheminformatics Data Standards. For critically evaluated data to be incorporated more broadly into systems used by practicing chemists, they need to be digitally accessible, convenient for chemists, and processable by computer algorithms. SCDS is addressing organizational and technical infrastructure to support digital forms of IUPAC assets for improved access and use in the chemistry community, and is interested to collaborate with these division

projects on electronic delivery of critically evaluated data.

The bulk of the meeting was a wide-ranging discussion of participants' experiences, perspectives, and challenges in critical evaluation. In this context, several themes emerged. The goal of the meeting was to exchange ideas and perspectives; no attempt was made to reach consensus during the discussion. Consequently, not all participants may agree with all thoughts expressed here.

- An essential goal of critical evaluation is to convey to data users, whatever their level of chemical sophistication, a well-supported estimate of the consensus value based on experimental results for the quantity under consideration and of the uncertainty associated with that value. The metrological approach to the expression of uncertainty is an important tool in this context.
- Advances in computer-based handling of scientific data are leading to new possibilities for data manipulation and interpretation. These advances enable more efficient handling and presentation of data and present new challenges in providing information about the data (meta-data) in formats that are assessable to both humans and computers.
- The delivery of data to users is presently in flux because of continuing rapid changes in electronic methods of data aggregation, analysis, and presentation. It is essential to make evaluated data available through channels that potential users prefer, or at least will actually use, as well as accessible for automated functions and collation.

Communication among meeting participants is continuing and interest is coalescing around two interdivisional activities. The first of these is assembling an interdivisional Task Group to prepare a Technical Report describing best practices for the critical evaluation of data. And the second is the establishment of an Interdivisional Subcommittee on Critical Evaluation of Data to continue the discussion of topics of mutual interest and to develop additional projects as the need arises. Wider participation in this interdivisional activity is welcome.

For further information, contact David Shaw <shaw02110@gmail.com>

www.iupac.org/project/2016-043-1-500

Middle east regional cooperation and sustainable water management of transboundary water

The Middle East is in turmoil in various ways, especially through the long-standing political crisis and conflicts affecting the people of the region. Widespread conflict and human rights violations, spurred by unsustainable water and energy supplies, coupled with climate change, are causing the displacement of the population, as well as environmental migration. Poor conservation of the environment and inadequate treatment of pollutants led to the degradation of chronically depleted water resources and the trans-boundary movement of pollutants from one political entity to another, endangering the drinking water quality and contributing to the ongoing conflicts in the region. Thus, the role of water in improving human lives has never been more important, as stated by the UN Sustainable Development Goals (SDGs) [1]. The sustainable management of water resources and the quality of water in rivers, lakes, and aquifers plays a key role in meeting the challenge of climate change and in achieving a secure food supply and improved public health.

The continuous and severe drought over the past few years has raised water scarcity issues and water quality degradation in the region is worsening. As noted by Tal and Abed (2010) and by Schoenfeld (2011), the possibility of dealing with these issues requires experts detached from the political conflict and able to work across geopolitical borders. The involvement of scientists from neighboring nations and the international community is considered the right avenue to address regional issues [2,3].

To review these issues, a workshop titled, "Regional Cooperation and Sustainable Water Management of Transboundary Water", was organized with the support of IUPAC's Chemistry and the Environment Division. It took place in Malta, 10-15 December 2017, as part of the biennial Malta Conferences Foundation (MCF), MALTA VIII, "Frontiers of Science: Research and Education in the Middle East—a Bridge to Peace". This continues previous initiatives, including a prior program of workshops in collaboration with the MCF on regional water chemistry which yielded positive results and several publications and

presentations through IUPAC and at other international conferences.

The workshop was set against this background with the aim to use science to help build bridges across borders and cultures where other mechanisms are less effective. The participants included chemistry and environment researchers and scientists, government regulatory agencies, as well as non-governmental advisory bodies and advocacy organizations concerned with climate change, transboundary water resources management, and regional conflicts.

The workshop was planned to bridge the gap between the science and practice of water management in order to discuss and crystallize practical solutions that would help to achieve the UN 2030 Sustainable Development Goals for water and the following objectives:

Objectives

- To establish a regional alliance of chemists and water engineers to interact and discuss the different aspects of hydrology and transboundary water quality.
- To encourage the multinational activities required to address regional challenges, facilitating the exchange of information and ideas on water chemistry, and harmonizing the approaches available for the scientific community to evaluate water suitability for human consumption and to handle multiple uses of water, while avoiding potential conflicts between the riparian countries.
- To highlight sustainable management strategies for resources that prevent the depletion of the transboundary surface- and groundwater aquifers and the deterioration of water quality, developing closer relations between neighbors and strengthening water security for all.
- To discuss selected case studies and potential mitigation strategies to motivate appropriate multinational actions against transboundary anthropogenic and emerging pollutants.
- To suggest supplementary research to confront issues of food and energy security, the environment, and climate change, as required.
- To recommend applicable standards, enabling valid water monitoring across the region.

Workshop Sessions

During the workshop, over 50 professionals from the regional water community, including students and early-career scientists (supported by IUPAC) from universities and national institutes in 15 Middle East and North Africa (MENA) countries met for 4 days to turn water challenges and risks into an opportunity that delivers benefits well beyond the water sector and the region. In three different sessions, the speakers presented the issues of climate change and the consequence of water scarcity on water availability and water quality including:

- Water insecurity and prospects in the Middle East
- Water quality of critical transboundary water resources
- Going beyond aid for the development of sustainable wastewater treatment and water quality crisis in Gaza Strip (Case studies)
- Stock-taking and critical review of on-going research, evaluating water chemistry issues of relevance to the whole region
- Nano-filtration, bioremediation, and bio-sorption processes for the removal of chemicals and micro-pollutants from the soil and from aqueous solutions.
- Conservation of water resources and ecosystems, as well as reuse of wastewater and desalination technologies.

Mitigation measures and water treatment systems were presented, as well as soil and water pollution prevention systems, highlighting the use of nano-filtration membranes and bio-remediation for the removal of persistent pollutants. Posters displayed throughout the entire meeting included presentations on the impact of climate change, water and wastewater treatment systems, the removal of specific pollutants, and electro-chemical and electro-catalytic oxidation processes.

Round table discussions were organized to discuss and share new ideas and feasible innovative projects on some of the major water, wastewater, and environment challenges, as well as to foster new collaborations. The workshop addressed the challenges and risks and identified the opportunities to drive the regional agenda to meet the needs and expectations of the millions of Middle East citizens by improving water availability, quality, safety, and security.

The water professionals were briefed on the transformation of water in the Middle East, as outlined by presentations focusing on the delivery of water infrastructure solutions to fill the massive gaps in the provision of clean water around the region. This was followed by a discussion on how management programs

can lead water utilities in emerging economies to deliver vastly improved services, even to the poorest in society.

Participants argued that business as usual is not an option if we are to achieve universal access to water and sanitation at the scale that lies ahead. Therefore, it is critical to explore innovative chemical and engineering sciences to help us reach the SDGs, and to seek out non-traditional ways of providing and funding water and sanitation for all. New policies, technology, and management systems are required to improve the regional ecology, as well as social equity, and to empower water professionals to find solutions to:

- climate change
- urbanization and demand for food and energy
- release and dumping of hazardous chemicals
- disposal of untreated waste from industrial, urban and agriculture
- devastation of terrestrial and aquatic ecosystems

Good governance, involving the public, the private sector, local communities, and transboundary cooperation are fundamental elements to achieve sensible water withdrawals, water conservation, and rational use, including:

- Applied advanced irrigation and agricultural production systems
- Advanced treatment of wastewater, allowing complete reuse
- Extending waste to energy and resources recovery
- Accelerating brackish groundwater and sea water desalination

In the Middle East, poor governance, population growth, global warming, and the denial of water and food supplies fuel conflicts, making population displacement and environmental migration prevalent. Signs of climate change are everywhere: long droughts, rising seas, violent storms, melting ice, and the flooding of coastal zones are apparent. These events affect high- and low-income countries across the world. All face water catastrophes, as recognized by the Paris Agenda and the UN SDGs in 2015, and the World Economic Forum in 2016. All see water management as a key to meeting the world food and public health safety, placing water at the top of global risks.

To Conclude:

- Today, more than ever, water scarcity and global warming are at the top of the global agenda. The world is confronted with security and strategic issues: water scarcity is a factor of tension and conflict.
- In the Middle East, environmental degradation, high population growth, fast urbanization, and the displacement of refugees are all causing economic, political, and environmental distress in the region and beyond.
- Adopting active regional hydro-science diplomacy would lead to a fruitful collaboration among the riparian countries, securing water for current and future generations.

As further dissemination of this workshop, a chapter titled, “Impact of Persistent Droughts on the Quality of the Middle East Water Resources”, will be published in an upcoming book edited by Satinder Ahuja [4].

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For further information, contact Task Group Chair Yehuda Shevah <ysheva@gmail.com> https://iupac.org/project/2017-018-3-600

Chemical and Biochemical Thermodynamics Reunification

According to the IUBMB-IUPAC joint commission on biochemical nomenclature (JCBN), two categories of thermodynamics based on different concepts and different formalisms have been established: i) chemical thermodynamics that employs conventional thermodynamic potentials to deal with chemical reactions; ii) biochemical thermodynamics that employs Legendre-transformed thermodynamic potentials to deal with biochemical reactions based on the formalism proposed by Alberty [1].

With this recently approved project, a task group lead by Stefano Iotti will attempt to show that the two worlds of chemical and biochemical thermodynamics, which so far have been treated separately, can be re-unified within the same thermodynamic framework.

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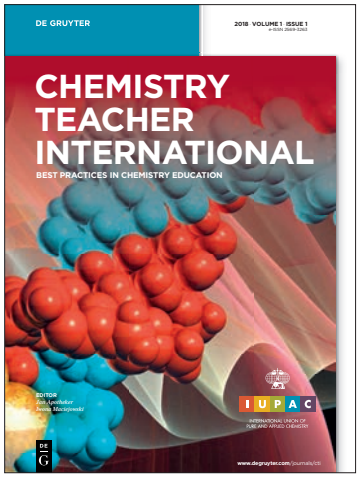
For further information, contact the Task Group Chair Stefano Iotti <stefano.iotti@unibo.it> www.iupac.org/project/2017-021-2-100

Chemistry Teacher International

As part of IUPAC's publishing partnership with De Gruyter, the Committee on Chemistry Education (CCE) will launch a new open access journal, *Chemistry Teacher International* (*CTI*), in summer 2018.

This open access journal will be published biannually, with the inaugural issue released in June 2018 and the second issue in December. The online journal will be peer reviewed and focused on good practices. The target groups are teachers in secondary education, as well educational researchers. CCE expects about 24 articles per year from different sources, in part from selected proceedings of the International Conference on Chemical Education, which the Committee organizes every two years.

Jan Apotheker will function as the executive editor, together with Iwona Maciejowska of the Division of Chemical Education of EuCheMS.



For further information, contact the Task Group Chair Jan Apotheker <j.h.apotheker@rug.nl> www.iupac.org/project/2016-002-4-050

https://www.degruyter.com/view/j/cti

Human Health Risk Consideration of Nano-Enabled Pesticides for Industry and Regulators

Previous IUPAC Nanopesticides projects (*e.g.,* projects 2012-020-3-600 and 2016-016-2-600) have developed risk assessment frameworks and key criteria that could help risk assessment processes for nano-enabled pesticides (especially for ecological risk assessments) [1,2].

While the approach elucidated in the above IUPAC projects is now being considered by regulatory agencies internationally (*e.g.*, US EPA, Environment Canada, APVMA Australia, EFSA Europe), there is a need to expand our thinking and provide more practical information to answer some key questions, such as those listed below:

1. When a new product is presented to regulators, what are the key questions that they would like to ask? This essentially defines the problem formulation step in the health risk assessment framework.
2. What are the key characterization and analytical requirements for the specific product that may be necessary to answer the questions posed as part of Question 1 for a specific product type?
3. What are the specific methods or approaches for human health effects that are readily available and appropriate to answer the questions for the specific product under consideration?

4. What are the current knowledge gaps and uncertainties that the regulators and industry need to consider for a pragmatic approach to decision making?

This project would consist of three phases.

Phase I – Bring together a core group of task members to define the scope of the project, identify specific active ingredients and product types, and undertake problem formulation from the risk assessment perspective.

Phase II – Organize a workshop bringing together expertise from industry, regulatory bodies, and researchers on human health effects and the risk assessment of nano-enabled pesticides, as well as the characterization of nanomaterials that have been identified in phase I.

Phase III – Recommend a sound methodological approach for generating data that is likely to be needed by the regulators. Identify research priorities where current knowledge or methodology are found to be inadequate.

The overall objective is to assist industry, contract research organizations (CROs), and regulators in determining an acceptable and practicable approach for generating the data relevant to human health risk assessment required for the registration of nano-enabled pesticide formulations. Broadly speaking, a nano-enabled pesticide represents a product where nanotechnology is employed (*e.g.* delivery via a nano-carrier) to enhance efficacy, reduce the environmental footprint, or the enhance usability of a pesticide active ingredient.

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For further information, contact the Task Group Chair Linda Johnston <linda.johnston@nrc-cnrc.gc.ca> or Rai Kookana <rai.kookana@csiro.au>

www.iupac.org/project/2017-035-2-600

IUPAC100 Periodic Table Challenge

The year 2019 marks the 100th anniversary of IUPAC and the 150th anniversary of the Periodic Table. The IUPAC Centenary is an opportunity to reflect on the value and work that is carried out by the IUPAC. While doing so, we can inform audiences worldwide of the variety of IUPAC activities—and do so in a manner that covers each and every decade, not just recent years.

IUPAC CENTENARY CELEBRATION

Given the anniversary of the Periodic Table and its central role in chemistry, this project seeks to create an online global competition centered on the Periodic Table and IUPAC. The objective of the project is to promote IUPAC's role in shaping the global affairs of chemistry through a competitive online quiz. With this global activity, we aim to reach a global audience of young students in a way that will be attractive, cost-effective, and that will give visibility to the work that IUPAC has been doing over the last 100 years.

This is your chance to contribute

While some questions have already been prepared, the Task Group needs your input to reach its goal: a question linked to each and every one of the 118 elements, with a full diversity of topics covered. We are looking for creative multiple-choice questions: the focus of the question is free for you to choose. Some obvious choices are questions regarding the name, the chemical or physical properties of the elements, or aspects surrounding the element's discovery.

For examples of questions and to submit your own now, please visit the project page.

For further information, contact the Task Group Chair Jan Apotheker <j.h.apotheker@rug.nl> or Juris Meija <juris.meija@nrc.ca>

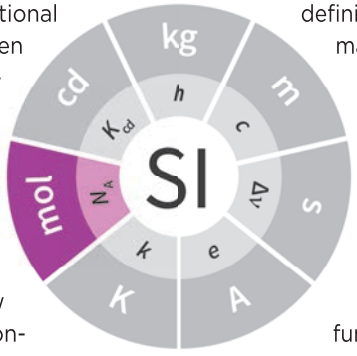
www.iupac.org/project/2017-031-1-050

Definition of the mole (IUPAC Recommendation 2017)

Roberto Marquardt, Juris Meija, Zoltán Mester, Marcy Towns, Ron Weir, Richard Davis and Jürgen Stohner

Pure and Applied Chemistry, 2018
Volume 90, Issue 1, pp. 175–180

In 2011, the General Conference on Weights and Measures (CGPM) noted the intention of the International Committee for Weights and Measures (CIPM) to revise the entire International System of Units (SI) by linking all seven base units to seven fundamental physical constants. Of particular interest to chemists, new definitions for the kilogram and the mole have been proposed. A recent IUPAC Technical Report (*Pure Appl. Chem.* **89**, 951 (2017); https://doi.org/10.1515/pac-2016-0808) discussed these new definitions in relation to immediate consequences for the chemical community. This IUPAC Recommendation on the preferred definition of the mole follows from that Technical Report. It supports a definition of the mole based on a specified number of elementary entities, in contrast to the present 1971 definition.



The new definition is:

The mole, symbol mol, is the SI unit of amount of substance. One mole contains exactly 6.022 140 76 × 10^{23} elementary entities. This number is the fixed numerical value of the Avogadro constant, N_A, when expressed in mol^{-1}, and is called the Avogadro number. The amount of substance, symbol *n*, of a system is a measure of the number of specified elementary entities. An elementary entity may be an atom, a molecule, an ion, an electron, or any other particle or specified group of particles.

This new definition is in contrast to the current definition, adopted in 1971, which relies on the mass of the kilogram. The new definition comes in advance of the anticipated revision of SI, announced in 2011 by the General Conference on Weights and Measures of the Bureau International des Poids et Mesures (BIPM), the international body responsible for the global comparability of measurements. The new SI will link all seven base units to fundamental physical constants. In November 2018, revised definitions of the kilogram, ampere, kelvin, and mole are expected to be approved by the CGPM. The revised definitions are expected to come into force on World Metrology Day, 20 May 2019.

https://doi.org/10.1515/pac-2017-0106

On the future revision of the SI

At its 25th meeting (November 2014) the CGPM adopted a Resolution on the future revision of the International System of Units. This Resolution built on the CGPM's previous Resolution (2011), which took note of the CIPM's intention to propose a revision of the SI and set out a detailed roadmap towards the future changes.

In the revised SI four of the SI base units—namely the kilogram, the ampere, the kelvin and the mole—will be redefined in terms of constants; the new definitions will be based on fixed numerical values of the Planck constant (*h*), the elementary charge (*e*), the Boltzmann constant (k_B), and the Avogadro constant (N_A), respectively. Further, the definitions of all seven base units of the SI will also be uniformly expressed using the explicit-constant formulation, and specific mises en pratique will be drawn up to explain the realization of the definitions of each of the base units in a practical way.

https://www.bipm.org/en/measurement-units/rev-si/

Reactions/comments to the new definition of the mole

Peter W. Atkins—I have always been puzzled by the widespread view that the mole is a difficult subject. It has always seemed to me that many instructors tell their students that it is a sophisticated concept, and the students then wonder what all the fuss is about, suspecting that they have misunderstood it or have not appreciated its subtlety. The new definition cuts to the core of the meaning of 1 mole, and is therefore to be welcomed. Although there are subtleties in its determination, there can no longer be any excuse for misunderstanding its definition. How important it is, too, to distinguish the Avogadro number from the Avogadro constant.

The other aspect to be welcomed is the comment on the name 'amount of substance' with its emphasis on the word 'substance' as merely a place-holder for the entities under discussion. 'Amount of substance', it is widely accepted, is too much of a mouthful for daily use, and although they do not mention it, IUPAC is happy with the synonym 'chemical amount'. Even that, I think, is too long, and not a happy companion when the entities are photons or electrons. Happily, the authors are reluctant to proliferate new names, and I would like to think that one day the single word 'amount' will be the short, uncluttered name of what we measure in moles. We are moving towards that usage.

I suspect that the ungainly name 'amount of substance' and the widely used but regrettable colloquial expression 'number of moles' stem from the historical facts that the physical quantity is a late entry into our vocabulary (compared with mass, length, and time) and that only one unit (the mole) has ever been used to report its value. Thus, chemists have seen 'amount' and 'mole' as unambiguous synonyms and have not acquired the habit of distinguishing the fundamentally unit-free physical quantity from a specific choice of unit.

I do worry, though, about how we shall introduce the definition of the kilogram, as it changes from pointing to a lump of metal to a sophisticated definition that involves Planck's constant. I suspect that in introductory contexts we shall simply admit defeat and put in an appropriate footnote.

Peter Atkins was an Oxford professor of chemistry and fellow of Lincoln College until his retirement in 2007. He has written numerous major textbooks, including *Physical Chemistry, Inorganic Chemistry, Molecular Quantum Mechanics, Physical Chemistry for the Life Sciences,* and *Elements of Physical Chemistry.* Until 2005, he chaired the IUPAC Committee on Chemistry Education.

Bob Bucat—In terms of the basic practice of chemistry, the proposed philosophical re-definition would change nothing. Pedagogically, I believe that the teaching and learning of the concept of chemical amount, and its unit (mole), will be considerably simplified.

What a simple definition for the mole, with the number of entities specified directly: One mole contains exactly $6.022\ 140\ 76 \times 10^{23}$ elementary entities.

Conceptually, this is so much more easily understood than the previous mind-screwing definition, with its indirect specification of the number of entities in 1 mole: The mole is the amount of substance of a system which contains as many elementary entities as there are atoms in 0.012 kilogram of carbon-12.

Of course, students will rightly ask, "Why this strange number?" It seems not too difficult to accept the explanation that this number is chosen for convenience: it happens to be our best estimate of the number of carbon atoms in 0.012 kilogram of carbon-12. This provides us with a standard for measuring numbers of atoms/molecules/ions by measuring mass. [Please don't let me hear a professional chemist say "But it is essentially the same thing!". Indeed, it is but I am considering this, not from the point of view of a practising chemist, so much as from the novice school students struggling to come to grips with its meaning.]

How are we supposed to remember this number? Of course, we don't need to. For example, in considering the reaction between sodium and chlorine, the important concept is that one mole of solid sodium contains the same number of atoms as the number of molecules in one mole of chlorine gas (whatever that number is). Then we can let logic take over to do stoichiometric calculations, as is the case now.

In summary, I believe that the newly proposed definition will facilitate the pedagogy relevant to these concepts.

What is a little worrisome is the proposed definition (or explanation?) of chemical amount: The chemical amount, *n*, is a measure of the number of specified elementary entities. That sounds very much like it is a number: how else does one measure, but with a number? But it is not a number! I understand the complexity of wording the definition of this concept, but this proposed one will perhaps (or surely, in my view) create the conception of a chemical amount as a number—a conception that will be difficult to amend.

Bob Bucat <bob.bucat@uwa.edu.au> is an Honorary Research Fellow at the University of Western Australia. His contributions to textbook co-authorship are based on the findings of chemistry education research.

Terminology of separation methods (IUPAC Recommendations 2017)

Tatiana A. Maryutina, Elena Yu. Savonina, Petr S. Fedotov, Roger M. Smith, Heli Siren and D. Brynn Hibbert

Pure and Applied Chemistry, 2018
Volume 90, Issue 1, pp. 181–231

This chapter contains terms and definitions of concepts relating to analytical aspects of separation. Most of the terms have been drawn from papers published in *Pure and Applied Chemistry.* A number of new sections and terms have been included, using terms proposed as definitions in the literature. To complete these areas, a number of new terms have been proposed for acceptance.

The capitalization of previously accepted terms has been corrected to bring them up to date with current practice. Terms have also been amended, in certain cases, to link the definitions specifically to chromatography "(in chromatography)". In a few cases, minor changes have been made to include both LC and GC in a term, or to reflect significant changes in practice, such as the universal change from chart recorders to electronic integration.

This Recommendation is part of the update of the Orange Book [IUPAC project 2012-005-1-500] and will be the basis for a chapter in the forthcoming fourth edition.

https://doi.org/10.1515/pac-2017-0111

Interpreting and propagating the uncertainty of the standard atomic weights (IUPAC Technical Report)

Antonio Possolo, Adriaan M. H. van der Veen, Juris Meija and D. Brynn Hibbert

Pure and Applied Chemistry, 2018
Volume 90, Issue 2, pp. 395-424

In 2009, the IUPAC Commission on Isotopic Abundances and Atomic Weights (CIAAW) introduced the interval notation to express the standard atomic weights of elements whose isotopic composition varies significantly in nature. However, it has become apparent that additional guidance on how representative values should be derived from these intervals would be helpful, as well as on how the associated uncertainty should be characterized and propagated to cognate quantities, such as relative molecular masses. The assignment of suitable probability distributions to the atomic weight intervals is consistent with the CIAAW's goal of emphasizing the variability of the atomic weight values in nature. These distributions, however, are not intended to reflect the natural variability of the abundances of the different isotopes in the earth's crust or in any other environment. Rather, they convey states of knowledge about the elemental composition of "normal" materials generally, or about specific classes of such materials. In the absence of detailed knowledge about the isotopic composition of a material, or when such details may safely be ignored, the probability distribution assigned to the standard atomic weight intervals may be taken as rectangular (or, uniform). This modeling choice is a reasonable and convenient default choice when a representative value of the atomic weight and associated uncertainty are needed in calculations involving atomic and relative molecular masses. When information about the provenance of the material or other information about the isotopic composition needs to be taken into account, then this distribution may be non-uniform. In this report, several examples are presented of how the probability distribution of an atomic weight or relative molecular mass may be characterized, and also how it may be used to evaluate the associated uncertainty.

https://doi.org/10.1515/pac-2016-0402

Mass and volume in analytical chemistry (IUPAC Technical Report)

Maria F. Camões, Gary D. Christian and D. Brynn Hibbert

Pure and Applied Chemistry, 2018
Volume 90, Issue 3, pp. 563-603

This technical report reviews measurements of mass and volume, including a review of the SI for mass, length, and amount of substance; principles of mass measurement; the calibration of masses and glassware; gravimetry; volumetry; and titrimetry. Measurement uncertainty, metrological traceability, and aspects of quality assurance are also treated.

The text will become the basis for a chapter in the fourth edition of the IUPAC Orange Book [IUPAC project 2012-005-1-500].

https://doi.org/10.1515/pac-2017-0410

Risk assessment of effects of cadmium on human health (IUPAC Technical Report)

Gunnar F. Nordberg, Alfred Bernard, Gary L. Diamond, John H. Duffus, Paul Illing, Monica Nordberg, Ingvar A. Bergdahl, Taiyi Jin and Staffan Skerfving

Pure and Applied Chemistry, 2018
Published online 10 January 2018

IUPAC Division VII, Chemistry and Human Health, provides guidance on risk assessment methodology and, as appropriate, assessments of risks to human health from chemicals of exceptional toxicity. The aim of this document is to describe dose-response relationships for the health effects of low-level exposure to cadmium, in particular, with an emphasis on causation. The term "cadmium" in this document includes all chemical species of cadmium, as well as those in cadmium compounds. Diet is the main source of cadmium exposure in the general population. Smokers and workers in cadmium industries have additional exposure. Adverse effects have been shown in populations with high industrial or environmental exposures. Epidemiological studies in general populations have also reported statistically significant associations with a number of adverse health effects at low exposures. Cadmium is recognized as a human carcinogen, a classification mainly based on occupational studies of lung cancer. Other cancers have been reported, but dose-response relationships cannot be defined. Cardiovascular disease has been associated with cadmium exposure in recent epidemiological studies, but more evidence is needed in order to establish causality. Adequate evidence of dose-response relationships is available for kidney effects. There is a relationship between cadmium exposure and kidney effects in terms of low molecular mass (LMM) proteinuria. Long-term cadmium exposures with urine cadmium of 2 nmol $mmol^{-1}$ creatinine cause such effects in a susceptible part of the population. Higher exposures result in increases in the size of these effects. This assessment is supported by toxicokinetic and toxicodynamic (TKTD) modelling. Associations between urine cadmium lower than 2 nmol $mmol^{-1}$ creatinine and LMM proteinuria are influenced by confounding by co-excretion of cadmium with protein. A number of epidemiological studies, including some on low exposures, have reported statistically significant associations between cadmium exposure and bone demineralization and fracture risk. Exposures leading to urine cadmium of 5 nmol $mmol^{-1}$ creatinine and more increase the risk of bone effects. Similar associations at much lower urine cadmium levels have been reported. However, complexities in the cause and effect relationship mean that a no-effect level cannot be defined. LMM proteinuria was selected as the critical effect for cadmium, thus identifying the kidney cortex as the critical organ, although bone effects may occur at exposure levels similar to those giving rise to kidney effects. To avoid these effects, population exposures should not exceed that resulting in cadmium values in urine of more than 2 nmol $mmol^{-1}$ creatinine. As cadmium is carcinogenic, a 'safe' exposure level cannot be defined. We therefore recommend that cadmium exposures be kept as low as possible. Because the safety margin for toxic effects in kidney and bone is small, or non-existent, in many populations around the world, there is a need to reduce cadmium pollution globally.

https://doi.org/10.1515/pac-2016-0910

Vocabulary on nominal property, examination, and related concepts for clinical laboratory sciences (IFCC-IUPAC Recommendations 2017)

Gunnar Nordin, René Dybkaer, Urban Forsum, Xavier Fuentes-Arderiu and Françoise Pontet

Pure and Applied Chemistry, 2018
Volume 90, Issue 4, pp. 755-808

Scientists of disciplines in clinical laboratory sciences have long worked on a common language for the efficient and safe request of investigations, reports of results, and communications of experience and scientific achievements. Widening the scope, most scientific disciplines, not only clinical laboratory sciences, rely to some extent on various examinations in addition to measurements. The 'International vocabulary of metrology—Basic and general concepts and associated terms' (VIM) is designed for metrology, the science of measurement. The aim of this vocabulary is to suggest definitions and explanations of concepts and a selection of terms related to nominal properties, *i.e.* properties that have no size.

https://doi.org/10.1515/pac-2011-0613

"Speciation" Chemistry: Overdue for a Resurgence

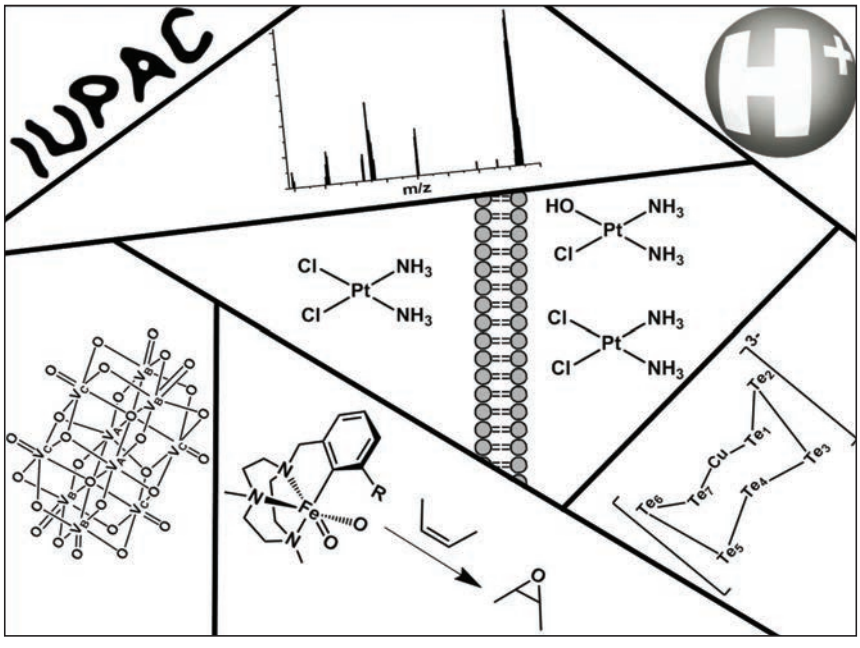
Debbe C. Crans, Department of Chemistry, Colorado State University, Fort Collins, Colorado

The idiom, "the devil is in the details" refers to situations in which some easily-overlooked detail is critical to success. This idiom in a sense embraces some concepts of certain areas of speciation chemistry in which details are so critical for the proper description of a system and depend on a complex interplay of the composition and state of the system. Undoubtedly, specific conditions, such as pH, temperature, and system components, are instrumental to describing so many areas of speciation in chemistry. Unfortunately, in the past traditional research in the speciation field has not received the same limelight that other aspects of chemistry do, despite its importance to our fundamental understanding of chemistry as a whole. Regardless, an increasing number of contributions in speciation chemistry have emerged, although these may not include speciation chemistry as it was originally defined. One recent highlight is the special issue on speciation chemistry just published as a volume of *Coordination Chemistry Reviews* [1,2]. This issue compiles papers that illustrate some of the areas in speciation chemistry and document how the field has evolved [2,3], its interplay with IUPAC [4], and specific examples of how traditional speciation chemistry has changed [5-10].

Speciation chemistry, as originally defined by classical solution chemists [11], has been significantly expanded. Although the terms "chemical species" (the specific form of chemical elements or an element defined by its isotopic composition, electronic or oxidation state, and/or complex or molecular structure) and "speciation analysis" (analytically identifying and/or measuring the quantities of one or more individual chemical species in a sample) are readily used [11] by chemists. This definition, when expanded, encompasses much more that is particularly relevant for modern society and chemists. Several examples of modern approaches to speciation chemistry exist and are actively in use. For example, a speciation chemist with an analytical focus may be more concerned with methods and characterization that may involve the isolation or simply the identification of different forms [12,13]. Other advances in areas of speciation chemistry have led to the development of new methods. For example, the availability of various types of mass spectroscopy allows for the characterization of many new systems, as well as other advances in areas of analytical chemistry.

Inorganic and organic chemists would include structure as an essential component to speciation. In organic chemistry, chirality and conformations resulting in shapes are often critical definitions that reach into all the biological areas of sciences. Similarly, in inorganic chemistry, particularly in coordination chemistry, the formation of complexes is so intrinsically linked to structure and shape that the composition of a system only defines part of the system [3-10].

Given the changing times and the importance of the "devil in the details", many more chemists find themselves involved in work that, in a broad sense, can be characterized as speciation chemistry. After all, providing the specific conditions that make the



Images representing contributions to the volume on Speciation Chemistry reported by Coord. Chem. Rev. *2017, volume 352, The "Pourbaix diagram representing speciation chemistry 2017" was created by Cameron Van Cleave for the volume cover.*

chemistry 'work' requires attention to detail. It is perhaps no surprise, then, that speciation is finally getting some long overdue credit and attention. Speciation chemistry is, and remains, a pillar of solution chemistry, but it is only slowly being recognized that nanochemistry and solid state chemistries are also intrinsically dependent on the detailed chemistries—that is, the nature of the species that exist, the conditions in which they exist, and their reactivity. These are exciting times, and the applications of speciation chemistry seem endless. It is hoped that this recognition will bring to the table a newfound approach that will assist modern practitioners of speciation chemistry in demystifying their chemistry and providing a platform for progress and discovery. Presentations on the topic of speciation in the modern sense are sought for the International Coordination Chemistry Conference in Sendai, Japan [13].

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IUPAC Silver book—corrigendum

In April 2017, *Chemistry International* announced the release of the second edition of the so-called IUPAC Silver book, *i.e.* the "Compendium of Terminology and Nomenclature of Properties in Clinical Laboratory Sciences" [1]. The authors of the Silver Book have since shared a change to Section 6.10.5. The description of how the combined standard measurement uncertainty is obtained has been rephrased in order to conform with the International vocabulary of metrology (JCGM 200:2012 International vocabulary of metrology—basic and general concepts and associated terms (VIM), BIPM, Sèvres. www.bipm.org/vim).

Section 6.10.5 now reads:

> Each component of measurement uncertainty estimated by Type A or B evaluation can be characterized by a variance, u^2, that may be calculated from the distribution of values with repeated measurements (Type A) or assessed by using available knowledge (Type B). The positive square root of such a variance is called **standard measurement uncertainty,** u. Standard measurement uncertainty values may be combined by the law of propagation of uncertainty [JCGM 100: 2008, section 5]: the result is called the **combined standard measurement uncertainty**, u_c [ref. 20, concept 2.31]. Such a quantity has the same dimension as the quantity being measured and is expressed in the same unit.

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Chemistry and the Environment

by Diane Purchase, Sherine Obare, John Unsworth and Hemda Garelick

The IUPAC 46th World Chemistry Congress (in Sao Paulo, Brazil, 9-14 July, 2017) emphasized the importance of the link between chemistry and the environment in their 'Energy, Water and Environmental Science' programme. The Chemistry and the Environment Division of IUPAC (Division VI) has sponsored and organized three symposia to present the latest advances concerning the environmental impact of emerging technologies and the fate of pollutants in the environment. Additional financial support was provided by the IUPAC Project Committee under the 'New Directions in Chemistry' initiative.

The symposia took place over two days (11-12 July 2017), a number of high-profile international speakers presented on:

- E-waste—an emerging global environmental challenge
- Global Environmental Challenges of Nanomaterials
- Fate of Pesticides in Latin American Environments

All three symposia were well-attended and well-received, raising awareness of the three important topics associated with the work and expertise of Division VI membership. They also provided the opportunity to address specific regional problems and expand current, mainly EU and US based networks.

E-waste—an Emerging Global Environmental Challenge (coordinated by Diane Purchase)

The waste stream of obsolete electronic equipment grows exponentially, creating a worldwide pollution problem. E-waste contains potential contaminants that are distinct from other types of waste. The e-waste stream comprises a mixture of different metals, metalloids, glass, plastics, flame retardants and valuable materials such as gold, silver, copper and aluminium. They cause considerable environmental and health impacts and pose substantial challenges in waste management. This symposium highlighted the challenges and opportunities in tackling this emerging, global, environmental concern.

Our keynote speaker, Professor Christer Forsgren, is the Technical and Environmental Director of Stena Recycling International as well as the Adjunct Professor in Chalmers Technical University Gothenburg, Sweden. Stena Recycling International (SRI) is a part of the Stena Metall Group, a family owned company active mainly in the northern part of Europe on about 200 sites. Annual turnover is about 2 billion US$. Professor Forsgren provided a valuable industrial perspective of the formal treatment of electronic waste. His presentation outlined the different, state-of-the-art technologies for the recovery of precious metals, separation of brominated and non-brominated plastics and the recycling of Li-ion batteries. He also explored the concept 'Design for Complete Lifecycle' that can help to reduce the in-use energy consumption of devices, improve the efficient use of resources

Top: Dr Oluseun Popoola, Above: Professor Christer Forsgren, Left: Professor Ming Hung Wong

in their manufacture and increase the possibility of product/component reuse and repair.

A keenly contrasting e-waste experience was provided by Dr Oluseun Popoola from Yaba College of Technology, Nigeria. Dr Popoola has for a number of years, carried out research on the health of the workers in an informal recycling site in Nigeria. She catalogued the challenges facing developing countries: illegal shipment, weak environmental regulations, paucity of technology and inadequate waste treatment stucture. Her research showed that biological samples from the workers contained high levels of toxic metals resulting from the crude recycling process—often involving direct burning of the waste. Even though the subjects are aware of the health impacts, they continue to be involved in the informal recycling of e-waste due to intense social and economic deprivation.

On the other side of the globe, China has one of the world's mega sites for uncontrolled recycling of e-waste, with end-of-life electronic and electrical products shipped from the more affluent countries. Professor Ming Hung Wong from the Education University in Hong Kong is the Regional Coordinator of Central and North-East Asia of the project "Regionally Based Assessment of Persistent Toxic Substances" sponsored by United Nations Environment Program (UNEP) and Global Environment Facility (GEF). Professor Wong is also a panel member to review a UNEP/GEF initiative "Emerging Chemicals Management Issues in Developing Countries and Countries with Economies in Transition" with the aim of understanding the sources and preventing adverse impacts of chemicals on human health and the environment in rapidly developing countries. In his presentation, Professor Wong reviewed the sources, fates and environmental effects of toxic chemicals due to e-waste processing in Guiyu, Taizhou and Hong Kong. He presented a critical evaluation of the e-waste management systems in China in the past decade and the lessons learnt. He also charted some of the progress made by the Chinese government to tackle the e-waste problem as well as offered additional recommendations for further improvement.

Top: Dr Bradley Miller, Above: Dr Kirankumar Surati—Biodegradable materials for semiconductors

Clearly, such a global challenge can only be managed via interdisciplinary collaborative efforts. Dr Bradley Miller from the US EPA elaborated upon the management of e-waste in the US and to identify opportunities for improvement, good practices to be shared and also pitfalls to be avoided. He provided information on the National Strategy for Electronics Stewardship which details the federal government's plan try and reduce e-waste by incentivizing the production of "green" electronics; mandates that the federal government purchases "green" products, increasing domestic recycling, and reducing exports of e-waste. At the national level, some e-waste is regulated under the Resource Conservation and Recovery Act (RCRA), which identifies and regulates hazardous waste in the US. Individual states take the lead in management of non-hazardous waste, which includes household waste, where most e-waste is regulated.

Dr Kirankumar Surati of Sardar Patel University, India, presented his research on organic, bio-degradable semiconductors that could open new avenue in addressing the challenge at the point of manufacturing by using sustainable alternative materials. He presented a number of organic biodegradable compounds that can easily degrade and are useful for fabricate advance organic semiconductor devices. He suggested that such device and materials were one of the best ways to minimize the e-waste. He argued that the organic biodegradable molecules were superior in terms of cost, environmental friendly and easy processability with respect to presently use materials (such as cobalt, gallium, germanium, indium, platinum group metals,

rare earths. He also indicated that these energy efficiencies of bio degradable organic semiconductor is higher with respect to conventional semiconductor materials.

Last, but not least, Professor Rafael Luque of Universidad de Cordoba, Spain, discussed a couple of newly-patented technologies for e-waste valorization to obtain valuable products (materials, chemicals, etc.) that can also facilitate future recycling and/or management of e-waste and provide alternatives towards a more sustainable valorisation and subsequent management.

Global Environmental Challenges of Nanomaterials (coordinated by Sherine Obare)

The overall objective of the symposium was to assess the current framework for understanding the environmental health and safety of nanoparticles (NPs). With an increase in the manufacture and use of NPs in consumer products, there continues to be a needed international consensus on their design, analysis, and determination of their environmental and health impact. The growth in manufacturing and use of anthropogenic NPs will lead to their presence in the environment. The interactions of the NPs with the environment will depend highly on their chemical composition, size, shape, morphology, surface coatings, environmental pH, and ionic strength. All these parameters play an important role on the chemical speciation of the NPs and consequently their toxicology and ecological risk assessment. In order to obtain a molecular level understanding of the materials speciation and consequently transformation, a group of experts consisting of chemists and environmental scientists came together for a symposium held at the 2017 IUPAC Congress in Sao Paulo, Brazil, to discuss critical issues in the chemistry of NPs.

Professor Sherine O. Obare from Western Michigan University gave a talk titled *"Assessing the environmental impact of anthropogenic nanoparticles,"* focused on anthropogenic NPs that have gained increased usage in industrial processes as well as in commercial products. The presentation discussed some of the critical issues that arise in understanding the environmental health and safety concerns of nanoparticles, including the method of preparation, and the resulting properties. In order to obtain a molecular level understanding of the materials speciation and consequently transformation, it is necessary to develop well-defined and well-characterized nanoparticles. Several synthetic protocols were discussed that showed the difference in results obtained when using well-defined materials versus when using commercial materials that lacked uniformity. Consequently, well-defined nanoparticles were used to conduct studies to assess the toxicity of the nanoparticles and correlate the results specifically to the particle size, shape and composition. The results showed that relationship between nanoparticle morphology, their transformation in the environment and their impact on biological species. The interaction of nanoparticles with various environmental components and the analytical methods required for their assessment were also described and showed a systematic method that leads to a critical understanding of the toxicity, bioavailability, and environmental fate and transport of nanoparticles.

Professor Rafael Luque from Departamento de química Organica, Universidad de Cordoba, gave a talk titled *"Addressing nanomaterials toxicity: benign-by-design protocols towards biocompatible nanomaterials."* The presentation focused on the increasing appreciation of the functionality and complexity of such systems that has prompted researchers to consider a number of fundamental properties (*e.g.* mechanical and biological compatibility, corrosion resistance in biological environments, *etc.*) and to address important issues such as their speciation and potential environmental impacts. The talk provided case studies of benign-by-design nanomaterials that have been characterized and addressed in terms of cytotoxicity and environmental impacts, exhibiting improved properties as compared to commercial analogous nanomaterials.

Professor Anna Cristina S. Samia from the Department of Chemistry at Case Western Reserve University, gave a keynote address titled *"Effects of metal oxide nanoparticle exposure on plant growth and on the*

Left: Professor Rafael Luque, Right: Professor Anna Cristina S. Samia

local soil microbe population," that focused on metal oxide NPs, a class of materials with increased use in commercial applications. Despite their growing applications, little is known about their long-term effects on plants and their fate in the environment. Recent reports have indicated both negative and positive effects of different types of nanoparticles on plants in terms of their growth and seed germination. Several factors have been shown to influence the plant-nanoparticle interactions, including plant type, growth media, as well as the nanoparticle concentration, size, composition, and surface chemistry. To date, there is still no conclusive explanation and definite mechanism on the toxicity of nanoparticles in plants, particularly in the soil environment, and further studies are needed to explore their effects in relation to plant growth. The presentation showed results in which the group evaluated the effects of metal oxide NPs exposure on the growth of plants and their nutrient content. In addition, results showed the effects of metal oxide NPs exposure on the local soil microbial groups in the plant rhizosphere, which are important for maintaining soil fertility. The studies showed systematic investigation of how the nanoparticle composition, size, and surface chemistry affect their incorporation and toxicity in model crop plant systems. Given their current usage, and the expectation of greater nanoparticle environmental exposure, additional studies that explore the effects of these materials on plant-soil systems in agriculture are needed to evaluate its impact on plant growth, soil fertility, and the sustainability of nanoparticle applications.

Professor Clemens Burda from the Department of Chemistry at Case Western Reserve University gave a talk titled "*How safe are nanoparticles as drug delivery agents? Insights from in-vivo biodistribution and biotoxicity studies,*" that focused on the medical applications of NPs. Inefficient delivery and poor uptake of therapeutic drugs to tumors hamper the efficacy of cancer treatments. Therefore, the "enhanced permeability and retention" (EPR) effect of solid tumors has been explored extensively as a target in the design of drug delivery systems. Cancerous tumors behave differently from normal tissues, having several abnormalities, such as leaky blood vessels and a poor lymph system. It is an important feature that nanosized particles can extravasate from the vasculature and passively accumulate in tumors. Inorganic nanoparticles, especially gold nanoparticles (Au NPs) with tunable sizes and versatile surfaces have received significant attention as drug delivery systems to improve targeting effect and

Professor Clemens Burda

efficacy for cancer treatments. Covalent and noncovalent attachment to the nanoparticle delivery agent are the two major approaches to deliver therapeutic drugs via Au NPs. A covalent attachment approach requires not only structural modification of the therapeutic drugs, but also requires additional trigger signals to control the drug release, such as enzymes, change in pH, or light. Although a significant number of available effective drugs have been modified to covalently bind to Au NPs, the noncovalent attachment maintaining the active drug structure without modification provides an attractive way to bind, deliver, and release the actual drug without needing such triggers. It allows the drug-loaded NPs to passively accumulate in the tumor and the noncovalently attached drug payload to be concentrated in the tumor mass. However, question arise if the nanoparticle itself could cause complications. Where do the nanoparticles get deposited and how are they affecting the tissue functionality? Can solid, inorganic nanoparticles be excreted? Depending on the respective therapeutics and targets, the drug delivery approach must be chosen carefully.

Finally, a talk given by Professor Petr Fedotov titled "*Nanoparticles of volcanic ash as a carrier for toxic and nutrient elements on global scale*," focused on the increasing release of nanoparticles (NPs) into the environment. It turns out that about 90 % of atmospheric aerosol NPs are considered to arise from natural sources. In fact, studies have shown that a single volcanic eruption can eject up to 30 million tons of ash. NPs of volcanic ash reach the upper troposphere and the stratosphere and as a result, impact human health, and the environment, including climate. A major area where knowledge is lacking is about the source, behavior, mobility, fate, and toxicity of NPs in the environment. The

main reason is the difficulty to recover NPs from environmental samples for further characterization and quantitative analysis. Actually, the problem of characterization of environmental nano- and submicron particles is directly related to the problem of their separation. In fact, nanoparticles in complex polydisperse environmental samples such as dust, volcanic ash, or soil may represent only about thousandths or less of bulk sample. Therefore, their recovery followed by a quantitative determination of analytes is a complex task. For the first time, a methodology for the separation, investigation, and quantitative elemental analysis of volcanic ash NPs has been proposed. For the separation and recovery of NPs, a combination of the sedimentation field-flow fractionation in a rotating coiled column and membrane filtration was used. The size and morphology of the nanoparticles was characterized using static light scattering and scanning electron microscopy. Contents of macro- and microelements in the initial sample and the obtained fractions were determined by atomic emission and mass spectrometry with inductively coupled plasma. The data showed that the total contents of most elements in the ash sample are comparable to their average content in the Earth's crust. However, in the fraction of NPs (50-100 nm) concentrations of Ni, Zn, Ag, Sn, Sb, Pt, Tl, Pb, Bi are one to two orders of magnitude higher than total contents of these elements in bulk samples. This apparently indicates the pre-concentration of the corresponding elements from the volcanic gases by NPs. In the fraction containing soluble forms of the elements as well as NPs smaller than 50 nm, Cu, Zn, Pb, and several other elements were found; the distribution of elements between the solution and solid phase (NPs) was assessed. The proposed methodology has no analogues and is promising for use in the analysis of volcanic ash and other particulate environmental samples from the various regions of the Globe. It can be also extended to study on engineered NPs in the environment.

Professor Petr Fedotov

The interaction of nanoparticles with various environmental components must be assessed and systematic analytical methods for doing so, is required. Through this IUPAC symposium the speakers focused on the broad needs for the critical understanding of the toxicity, bioavailability, and environmental fate and transport of nanoparticles. The symposium speakers will continue this work to provide IUPAC guidelines to support a number of agencies including:

1. Regulatory agencies that are concerned with the risks of nanoparticle disposal and exposure.
2. Chemical industries that use and/or manufacture nanoparticles.
3. Research and government laboratories that are involved in nanoparticle handling and disposal.
4. Toxicology and health groups that aim to understand the transformation of nanoparticles in the environment and the potential risks.
5. Ecological risk assessment groups that need to understand the effects of nanoparticles on the environment.
6. Non-government agencies that are impacted by the growing use and exposure of nanoparticles and the potential risks.

Fate of Pesticides in Latin American Environments (coordinated by John Unsworth)

Agriculture plays a significant role in the economies of Latin American countries, overall Latin American and Caribbean countries account for 24 % of arable land and contribute 11 % of global food production. This region has a diverse and complex range of farming systems due to the wide latitudinal range, varied climatic conditions and different soil types. In general; however, agriculture is characterized by two distinct ways of farming, firstly; commercial farming on large areas of land with the wide scale production of crops such as soybeans, sugarcane, corn, coffee, etc., often as a monoculture and; secondly, smallholding farming, often on family run farms, producing a variety of crops. Pests and diseases pose a significant problem, particularly in the more tropical areas and it has been estimated that farmers lose up to 40 % of their crops because of weeds, insects and fungal diseases. The use of pesticides in this region is, therefore, a necessary tool in reducing crop losses and increasing food production to feed the growing population. However, with the use of pesticides comes the need to ensure that the ecological impact is kept to a minimum. One of the key elements in the safe and sustainable use of a pesticide is to evaluate how likely it is that the environment might be impacted as a result of exposure to the pesticide. It is important, therefore, to understand the growing and climatic conditions, as well as

the agricultural practices. Thus, for example, it can be expected that if the degradation of a pesticide is temperature dependent, then it will degrade faster under tropical conditions compared to temperate conditions. Similarly, leaching may be more important in areas of high rainfall compared to the drier areas of the region. Properties of the soil (pH, CEC, content of organic matter, etc.) might also differ and affect movement and degradation of pesticides.

Before a pesticide is used, it is important to carry out an environmental risk assessment taking account of local conditions. In Latin America discussions on risk assessment first took place in the 1990s and in 2002 the Andean community published the regulation for registration of pesticides and provided a framework for performing environmental risk assessments. For a risk assessment to be useful it is essential that the data used are relevant and of appropriate quality. These data can come from the registrants of pesticides and from open scientific literature, in this latter case the data may not have undergone quality control or quality assurance and their reliability needs to be assessed before they are incorporated in the risk assessment. The term "risk", when used in the process of risk assessment, has a specific definition *i.e.* "the combination of the probability, or frequency of occurrence, of a defined hazard and the magnitude of the consequences of the occurrence". The assessment is carried out to enable risk management decisions to be made *e.g.*, restricting certain uses of a pesticide. Environmental exposure assessments are carried out using established computer models which determine the likely concentration of a pesticide in the various environmental compartment, soil, water, sediment, etc. Thus, in Brazil, models developed by the United States Environmental Protection Agency have proven to be useful for determining likely environmental concentrations and comparing these to ecotoxicity values to determine the risk to flora and fauna. Validation of models for local conditions is an ongoing process and clearly, as well as good data, a good understanding of their relevance to local conditions is required to give results which equate to pesticide levels to be expected under actual use conditions.

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Speakers at the "Fate of Pesticides in Latin America" Symposium (From left to right: Dr. John B. Unsworth, Dr. Ana Cione, Professor Jussara B. Regitano, Dr, Ximena Patino, Dr. Rafaela M. Rebelo, Professor Keith R. Solomon)

Advanced Materials (POLYCHAR2017)

by Chris Fellows and Melissa Chan Chin Han

Organized by

Under the Auspices of

In conjunction with

The 25th **World Forum on Advanced Materials** (POLYCHAR2017) (derived from **POLY**mer **CHAR**acterization), under the auspices of the Scientific Committee of World Forum on Advance Materials and International Union of Pure and Applied Chemistry (IUPAC), was hosted by the Institut Kimia Malaysia at the Putra World Trade Centre, Kuala Lumpur, Malaysia on 9-13 October 2017. A total of 2 plenary, 99 invited, 55 oral, 48 posters and 21 participants from 31 countries were recorded. With the significance of the 25th anniversary of the series, it was an occasion for more than usual

celebration, coinciding also with the 50th anniversary of both the Institute Kimia Malaysia and the IUPAC Polymer Division. The conference dinner was attended by the Malaysian Minister of Science, Technology and Innovation, Datuk Wilfred Madius Tangau. At the closing ceremony Dr. Kevin Menard (Veritas Testing and Consulting), one of the founders of POLYCHAR, talked about how far the series has come from its beginning as an opportunity for graduate students at the University of North Texas to practice giving presentations about their projects.

The philosophy of POLYCHAR is to visit a different part of the world each year to give students and young scientists an opportunity to present their scientific work to a larger international audience, to meet prominent scientists, and to attend tutorials held by international well-known scientists. Previous POLYCHAR meetings had been held in Denton, Texas, (where POLYCHAR had been founded in the year 1992), Guimaraes, Portugal (2004), Singapore (2005), Nara, Japan (2006), Buzios, Brazil (2007), Lucknow, India (2008), Rouen, France (2009), Siegen, Germany (2010), Kathmandu, Nepal (2011), Dubrovnik, Croatia (2012), Gwangju, South Korea (2013), Stellenbosch, South Africa (2014), Lincoln, Nebraska, USA (2015) and Poznan, Poland (2016).

Conference presentations ranged broadly over topics in polymer and composite chemistry, physics, and engineering. They were organised under the themes of:

- Advanced biological, biomedical and environment-friendly polymers
- Electroactive polymers
- Latex chemistry and technology
- Materials for clean and sustainable energy
- Multi-techniques of materials characterization
- Nanomaterials and smart materials
- Natural and synthetic elastomers
- Polymers and nutrition
- Polymeric gels and soft matter
- Processing, rheology and mechanical properties

Two plenary lectures were presented by Zairossani Mohd Nor [Deputy Director General, (Research and Innovation) of the Malaysian Rubber Board, Malaysia] on Positioning R&D towards innovative and sustainable rubber industry and Volker Abetz (University of Hamburg, Germany) on POLYmer Membrane CHARacterisation by scattering, microscopy, and thermal methods.

The Short Course, a POLYCHAR tradition, was supported by IUPAC and held on the first day of the meeting. Seven renowned researchers delivered graduate-level tutorial presentations on the following topics:

- Characterization of polymer electrolytes by dielectric response using Electrochemical Impedance Spectroscopy (**Chan Chin Han**, University Technology MARA, Malaysia)
- Thermal analysis used to analyze the glass transition phenomenon (**Jean-Marc Saiter**, University of Rouen, France)
- Viscoelastic properties of polymers (**Michael Hess**, University of North Texas, USA)
- A simple approach to the mathematical treatment of diffraction and scattering of X-ray and visible light (**Masura Matsuo**, Nara Women's University, Japan)
- Determination of thermodynamic properties by scattering techniques (**Volker Abetz**, University of Hamburg, Germany)

Joint opening ceremony of 25th World Forum on Advanced Materials (POLYCHAR2017); the 8th Biennial Regional Symposium on Total Laboratory Management—Quality, Safety, Environment and Laboratory Informatics (QSEL2017); and the LabAsia 2017 *From left: Dato' Dr. Ong Eng Long (President, IKM and the Organizing Chairman of POLYCHAR2017), Datuk Seri Panglima Wilfred Madius Tangau (Minister Of Science, Technology and Innovation Malaysia), Prof. Dr. Greg Russell (President of IUPAC Polymer Division), Prof. Dr. Jean-Marc Saiter (Vice President of POLYCHAR Scientific Committee), Mr. C P Saw (Managing Director of ECMI ITE),), Assoc. Prof. Dr. Ramzah Dambal (Deputy Secretary-General of Ministry of Science, Technology and Innovation Malaysia) and Datuk Haji Ismail Bin Talib (Director General, Department of Chemistry Malaysia)*

Short Course participants and speakers

- Micromechanics of polymers by electron microscopy (**Sven Henning**, Fraunhofer Institute for Microstructure of Materials and Systems, Germany)
- Characterisation of crosslinks in vulcanised rubbers: From simple to advanced techniques (presented by Kok Lang Mok of the Malaysian Rubber Board for **Aik Hwee Eng** of the Institute Kimia Malaysia).

The Short Course speakers were available for all participants for further discussions throughout the Forum and the short course notes can be accessed on IUPAC website (https://iupac.org/project/2016-033-1-400).

In the POLYCHAR tradition, a number of prizes were awarded at the conclusion of the event. The prestigious **Paul J. Flory Research Prize 2017** went to **Volker Abetz** of Institute of Polymer Research of the Helmholtz-Zentrum Geesthacht and University of Hamburg, Germany, for his exemplary research into block copolymer behaviour.

The **International POLYCHAR Materials Research Prize 2017** was awarded to **Kevin Menard,** one of the founders of the POLYCHAR series for his life's work in the science of polymer materials.

The **Bruce Hartmann Prize for Young Scientists** was awarded to **Valentina Marturano** of the University of Naples, Italy, for her presentation entitled *Visible light responsive polymer nanocapsules.*

The **Jürgen Springer Prize for Young Scientists** was awarded to **Dou Xiaoqiu** of the University of Siegen, Germany, for her presentation entitled *Novel 3D micropatterned poly(vinyl alcohol) hydrogel platform for the controlled formation of cell spheroids.*

Three **Carl Klason Student Awards** were awarded to:

Florian Kung, Friedrich-Alexander-University Erlangen-Nuremberg, Germany, for his work on the *suture-ability of grafts for ocular surface reconstruction;*

Jian Liu, University of Science and Technology of China, for her presentation on *Trifunctional CdSe Quantum Dots-Polymer Composite Film with Electrochromic, Electrofluorescent and Light-Induced Coloration Effects;*

Jyoti Giri, Tribhuvan University, Nepal, for her presentation entitled *Poly(butylene adipate-co-terephthalate) composites with wheat stalk microcellulose: morphological, mechanical, thermal and biodegradation behavior.*

Three **IUPAC Poster Prizes** were awarded to:

Benoit Basse, Onyx Développement, for his poster on *Peanut suspensions crosslinked by means of microbial transglutaminase;*

Top: Paul J. Flory Research Prize 2017: Volker Abetz (left) and Sven Henning (right—Chairman of POLYCHAR Prize Committee)
Above: Paul J. Flory Research Prize 2017: Kevin Menard (left) and Sven Henning (right)

Khong Choy Hung, Tunku Abdul Rahman University, Malaysia, for her poster on *Effect of carbon nanotubes in polyaniline nanocomposites on heavy metal removal*;

Muchao Qu, Friedrich-Alexander-University Erlangen-Nuremberg, Germany, for her poster on *Conductivity of melt spun poly(methyl methacrylate) composites with aligned carbon fibers.*

Recipients of POLYCHAR Prizes, IUPAC Fellowship, members of POLYCHAR Scientific Committee, IUPAC Polymer Division and POLYCHAR2017 organizing committee

Four IUPAC Fellowships were offered by IUPAC for the support of graduate students and young scientists from developing countries, which were awarded to Chayaporn Pareseecharoen (Thailand), Jyoti Giri (Nepal), Lau Kam Sheng (Malaysia) and Manus Sriring (Thailand).

POLYCHAR 26 will return to Kathmandu, Nepal—the site of the very successful POLYCHAR 19—in March 2019. A POLYCHAR satellite meeting, TISAT 2018, is planned for Tbilisi, Georgia, in 2018.

Finally, the 6th Malaysia Scientific and Laboratory Equipment Exhibition and conference (LabAsia 2017) was held in conjunction with POLYCHAR2017 and QSEL 2017. This biennial international trade exhibition for laboratory equipment and services serving the ASEAN scientific community was jointly organised by IKM and ECMI ITE Asia Sdn Bhd. More than 6,000 visitors attended the three-day exhibition. LabAsia 2017 featured 154 exhibitors and principals from ten countries, including China, Germany, France, Britain and the United States, showcasing new products and services.

Assoc. Prof. Dr. Chris Fellows was IUPAC Representative and Assoc. Prof. Dr. Melissa Chan Chin Han was Secretary of Organizing Committee of POLYCHAR2017

Bioorganic Chemistry in an Interdisciplinary Context

by Andreas Marx Chair of the Local Organizing Committee of ISBOC-11

One of the great challenges of the future is to explain the process of life in chemical terms. This ambitious task requires a strong interdisciplinary cooperation and mutual understanding of scientists from both Chemistry and Biology. The **11th International Symposium on Bioorganic Chemistry (ISBOC-11)** focused on this interdisciplinary task by exposing Chemical Biology as important research field. The conference was held from 27 to 29 September 2017 at the University of Konstanz and, thus, for the first time in Germany. It was jointly conducted with the **Konstanz Symposium Chemical Biology**, which is hosted bi-annually by the Konstanz Research School Chemical Biology (KoRS-CB), a top-level graduate school funded within the framework of the German Excellence Initiative.

"We have merged the two conferences although both have their own tradition", emphasized Andreas Marx, head of the local organizing team. In his welcome speech he pointed out the history of and the link between the two conferences: The ISBOC series of meetings was inaugurated in 1986 in New York and has moved around the world at three year intervals. Ten symposia have been held till now in places like Biarritz (France), Pune (India), Sheffield (England), Toronto (Canada), Beijing (China) and Torino (Italy). The Konstanz Symposium Chemical Biology, however, is quite younger. It started in 2010 with the aim to bring early stage researchers in contact with experts in the research fields of Chemical Biology: Synthetic Chemistry, Cellular Biochemistry, Biophysics, Biomedicine, and Computational Life Science. Since its inauguration, the symposium has become a biannual event which has been held four times till date.

By linkage of the two conferences, the organizers were able to line up an excellent list of speakers comprising two keynote lectures by Nobel Laureates, 16 plenary lectures by invited speakers from across the globe as well as short talks by postdoctoral and doctoral researchers, and poster presentations. The plenary lecturers were as follows: Jürgen Bajorath (Germany), Matthew Bogyo (USA), Aaron Ciechanover (Israel, 2004 Nobel Laureate), Ulrike Eggert (UK), Michael Famulok (Germany), Dorothea Fiedler (Germany), Philipp Holliger (UK), Claudia Höbartner (Germany),

Linda Hsieh-Wilson (USA), Shang-Chen Hung (Taiwan), Yamuna Krishnan (USA), Richard Payne (Australia), Floyd E. Romesberg (USA), Thomas Steitz (USA, 2009 Nobel Laureate), Hiroaki Suga (Japan), Helma Wennemers (Switzerland), and Wei Yang (USA). Keywords of the talks were: Chemical Biology of aptamers and DNA nanostructures, Synthetic genetics, Specific interactions of cell surface carbohydrates with proteins, Controlling supramolecular assemblies with proline-rich scaffolds, as well as Learning from Big Data at the interface of Chemistry and Biology.

Margaret Brimble (New Zealand), who served as IUPAC representative, gave a talk on "Synthesis of cysteine-rich antimicrobialpeptidesandproteins". As highlights, the Nobel Laureates summarized their broad experiences on "The ubiquitin proteolytic system" (Aaron Ciechanover) and "The structure and function of the ribosome complexes with various protein factors and antibiotics" (Thomas Steitz).

ISBOC-11 attracted about 250 participants from 22 countries. It could not have been realized without considerate support by both industrial and academic partners. IUPAC itself endorsed the conference and, moreover, financially supported it within the funding line "New Directions in Chemistry". By this support, travel grants could be offered to early stage researchers and, thus, PhD students from across the globe could be attracted. The organizing team is also grateful for the support from industrial sponsors like BD Biosciences, Böhringer Ingelheim, Bruker, myPOLS, Thermo Fisher and Zeiss, whereof some also acts as exhibitors during the conference. Crucial support was also given by the Deutsche Forschungsgemeinschaft (DFG), the German Chemical Society (GDCh) and the Collaborative Research Centre (CRC 969): "Chemical and biological principles of cellular proteostasis". Furthermore, BioLAGO as a regional but transnational network supported the communication and marketing of the conference.

Along with the symposium, an Autumn School for graduate students took place over a time period of five days. The first days were dedicated to courses where experts from Konstanz introduced in fundamental methods, techniques, and concepts. Topics like bioconjugation chemistry, combinatorial and high throughput technologies, optical spectroscopy, and computational life science exposed the PhD students to state-of-the-art research. Subsequently, the participants joined the ISBOC-11, where most of them presented posters or gave short talks. Finally, poster prizes donated by Dynamic Biosensors, Roche, and Wiley contributed to award nine

Top: Keynote-lecture by Nobel Laureate Aaron Ciechanover Above: Poster Award Winners with Chair of Programme Committee Andreas Marx. From L to R: Andreas Marx, Joachim Lutz, Susanne Ermert, Heike Kropp, Lena Amelie Wurmthaler, Regina Wirth, Elias Arturo Halabi Rosillo, Madeline Kavanagh, and Frank Eggert (picture credits: University of Konstanz / Inka Reiter)

out of 90 posters presented by early stage researchers. Last but not least, social events like a welcome reception, a joint dinner, and a guided city tour in Konstanz enhanced the scientific communication and networking.

ISBOC-11 was a highly successful scientific event that treated advanced research topics, gave insights in future research fields and contributed to build up a network especially between senior and early stage researchers. Photos albums have been added to the conference website at: https://www.uni-konstanz.de/isboc-11/impressions/.

The next ISBOC is expected to be held in 2020 in China.

The heritage of chemistry—A cultural heritage to be revealed

19 June 2018, Paris, France

How is chemistry's past inscribed in the cultural landscape? How can field experiences inspire and equip us for the challenges to come? How to raise awareness among the producers of this heritage and the practitioners?

On the occasion of the European Year of the Cultural Heritage (EYCH), this workshop will be an opportunity to reflect on a patrimony which remains rather little known, that of the chemistry. Many initiatives exist, however, which aim at its development, whether it is university or industrial heritage, private collections, companies or even public organizations.

The different contributions will address a variety of case-studies, and the final roundtable will put into perspective the ways in which this cultural heritage can be identified, preserved and revealed to the widest public.

Organization: Groupe d'histoire de la chimie (SCF Société Chimique de France) (Danielle Fauque danielle.fauque@u-psud.fr), and GHDSO-Université Paris Sud/Paris Saclay https://www.societechimiquedefrance.fr/groupe-histoire-de-la-chimie (See Actualités)

Mémosciences (Brigitte Van Tiggelen, Belgique) www.memosciences.be

CILAC (Florence Hachez-Leroy, France) www.cilac.com

Summer school on analytical sciences, metrology and accreditation

8-21 July 2018, Tallinn, Estonia

This unique **International Summer School** on Analytical Science, Metrology and Accreditation is organised by the Measurement Science in Chemistry consortium, which is a cooperation of universities. The school has shown to attract a variety of people, ranging from master to doctoral students, but also people who already are employed in a laboratory. It has a long tradition. It was initiated in 2008 by the European Commission Joint Research Centre, in view of the importance of quality assured analytical measurement data for many European policies.

Participants are taught core analytical knowledge and skills directly related to quality of analytical data as addressed in the ISO/IEC 17025 standard (*e.g.* traceability, validation, uncertainty, decision rules and compliance testing, use of Proficiency Tests, Reference Materials and Internal Quality Control). Participants are also intensively trained in transferable as well as entrepreneurial skills, such as those needed for planning, time management, (intercultural) communication, team play and leadership.

In 2018 it will be the 11th year that this summer school takes place. Typically some 40 people come together for a two week intensive school to learn about how to obtain quality in chemical or bio-analytical measurements by understanding and practicing how to apply the international standard (ISO/IEC 17025) and of the role of metrology and accreditation.

Send motivation letter and CV to <mscsummerschool@gmail.com>

http://www.msc-euromaster.eu

Organometallic Chemistry

15-20 July 2018, Florence, Italy

The **28th International Conference on Organometallic Chemistry** (ICOMC-2018) will be held from 15-20 July 2018 at the Congress and Exhibition Centre in the heart of the City of Florence, Italy. It will be organised by the Institute of Chemistry of Organometallic Compounds of the Italian National Research Council, in association with the official PCO of the event, Adria Congrex Srl. Maurizio Peruzzini and Alessandro Mordini are co-Chair and Luca Gonsalvi is Scientific Secretary.

The Conference comes back to Italy after 30 years (Turin 1988) as a part of a series of biannual events with a long tradition. ICOMC 2018 will provide a unique opportunity to present and disseminate all the main aspects of modern organometallic chemistry in a lively, multidisciplinary and modern environment.

The scientific program will be organised in parallel Lecture Sessions, focused on different aspects of traditional and emerging areas of organometallic chemistry and related applications. Student attendance will be encouraged by reduced fees and giving the possibility to showcase their results during two Poster Sessions and Flash Presentation Sessions. Top contributions will be shortlisted for Poster Prizes.

www.icomc2018.com

Supporting FAIR Exchange of Chemical Data through Standards Development—a Joint IUPAC and CODATA workshop

16-17 July 2018, Amsterdam, Netherlands

The GO FAIR initiative is intended to encourage and enable accurate data exchange among and across disciplines. FAIR encapsulates the concepts that data should be Findable, Accessible, Interoperable and Reusable. This workshop will explore how these goals can be accomplished in the context of chemical data, addressing some of the issues present within chemistry, but also in the context of broader interaction with other disciplines. The topics have been chosen to begin a process of standards development and maintenance, tool development and maintenance, and addressing use cases from other domains. Key opportunities include interoperability criteria for spectra using IUPAC standards, prioritizing activities within the GO FAIR ecosystem, creating draft roadmaps with key milestones, and recruiting key leaders for ongoing activity.

There is no charge to attend the workshop, but registration is required. The workshop is cosponsored by:

- IUPAC, Committee on Publications and Cheminformatics Data Standards (CPCDS)
- CPCDS Subcommittee on Cheminformatics Data Standards (SCDS)
- CODATA, the Committee on Data of the International Council for Science

https://iupac.org/event/supporting-fair-exchange-chemical-data-standards-development/

Chemistry Education (ICCE2018)

10-14 July 2018, Sydney, Australia

The **25th IUPAC International Conference on Chemistry Education** is being jointly organised by the Chemistry Education Group at the University of Sydney, the Royal Australian Chemical Institute and is supported by the wider Australian chemistry education community.

ICCE 2018 will be a forum where Australian and international chemistry educators can build connections between research and practice to provide richer student learning experiences.

To provide the most fertile ground for these exchanges, the conference aims to:

- React to the changing landscape of a learning environment by providing exemplars of diverse teaching and learning spaces and the role of the instructor
- Synthesise new ideas, pedagogies and practices from seeds that can grow into international networks and collaboration
- Create bonds between our Australian chemistry education community and the global chemistry education community strengthening our shared vision for student learning in chemistry.

The overarching theme of the conference, inspired by one of Sydney's most famous icons, is "**Bridging the Gap**". The session themes are:

- Systems thinking in chemistry education
- Translating assessment into the next dimension
- Enhancing the transition to tertiary chemistry
- Reimagining the chemistry classroom paradigm
- Creating the nexus between research and practice
- Joining the dots in laboratory learning
- Building connections with the wider community

Plenary Speakers

Alison Flynn (University of Ottawa), Ilka Parchmann (Kiel University), Marietjie Potgieter (University of Pretoria), Peter Mahaffy (King's University Edmonton Canada) Steven Matlin (International Organization for Chemical Sciences in Development) Vincente Talanquer (University of Arizona)

The conference aims to give delegates a voice in efforts to improve chemistry education, an essential building block for the future in which both progress and sustainability are fuelled by a deep understanding and appreciation of the role of chemistry in our world.

For more information contact ICCE2018@RACI.org.au www.ICCE2018.org

See also www.iupac.org/publications/ci/indexes/stamps.html

Cultural Heritage Chemistry

The tools of analytical chemistry, and the expertise and enthusiasm of many of its practitioners, have had a profound influence in the field of cultural heritage [1,2]. Analytical techniques, especially those involving non-destructive methods of examination, have played a key role in the characterization, restoration, and preservation of an incredible range of works of art and cultural heritage, including ceramics, textiles, paintings, books, drawings, sculptures, jewelry, and a myriad of artifacts made of glass, wood, or metal. In addition, modern analytical instrumentation has been successfully applied to study the techniques used to produce heritage materials, to verify the authorship or estimate the date of pieces of art, and to detect reproductions and forgeries.

In 2010, a group of French scientists reported the use of X-ray fluorescence (XRF) spectroscopy to determine the composition and thickness of the paint layers in seven Leonardo da Vinci portraits in the collection of the Louvre Museum in Paris, including the famous *Mona Lisa* [3]. Significantly, new light was shed into the painting technique used by Leonardo to attain subtle optical effects that blur outlines and blend shadows like smoke, which is particularly evident in the facial flesh tones of the subjects he depicted.

Historical musical instruments, such as the violins and cellos made by the Stradivari family in Italy during the 17th and 18th centuries, have also been probed by a variety of analytical methods, including X-ray microtomography and reflection FT-IR spectroscopy [4,5]. Many scientists and musical instrument historians have attempted to elucidate the nature of the wood treatment, varnish, binder, glue, and decoration materials used in the manufacture of the most valuable string instruments, and whether there is a reliable correlation between the composition of the materials used to make them and the remarkable quality of their sound.

And a joint team of chemists in Argentina and Brazil recently reported the use of XRF spectroscopy to establish that lapis lazuli was the pigment used for the blue color in the oldest surviving Argentinean flag, dating back to 1814 [6].

In a similar vein, the March issue of *Pure and Applied Chemistry, Chemistry International*'s IUPAC big sister publication, is dedicated to chemistry and cultural heritage. The array of topics in the special issue is as diverse as the definition of cultural heritage itself, with articles ranging from an analysis of the color pigments used to print Portuguese stamps in the second half of the 19th century to the application of X-ray Absorption Near-Edge Structure (XANES) spectroscopy to study the pigment formulations of Cennino Cennini (1360-1427?), an Italian artist who wrote a seminal technical manual on late Medieval and early Renaissance art.

The stakes are high today for museums, auction houses, and private collectors vying for the world's art and cultural heritage treasures, which now fetch outrageous amounts of money when they go on sale. A few weeks ago, on 15 November 2017, Leonardo's "Saviour of the World" was sold at auction for a whopping $450.3 million, the highest price ever paid for a work of art. Analytical chemists used XRF spectroscopy and infrared reflectography to assess the authenticity of the painting, and a majority of art historians, critics, and dealers agreed with

their findings. These days, anyone with a few million dollars (or pounds, euros, riyals, yuan…) to spare, and the blessing of a couple of knowledgeable analytical chemists, could be the proud owner of the next bona fide masterpiece showing up in the open market!

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Written by Daniel Rabinovich <drabinov@uncc.edu>.

Mark Your Calendar

Upcoming IUPAC-endorsed events
See also www.iupac.org/events for links to specific event websites

2018 after July 1

1-5 July 2018 • MACRO2018 • Cairns, Australia
World Polymer Congress
Prof. Sébastien Perrier and Prof. Martina Stenzel (conference co-chairs); Conference Coordinator: Taylor Mills, Leishman Associates; E-mail: taylor@leishman-associates.com.au, www.macro18.org

1-6 July 2018 • Physical Organic Chemistry • Faro, Portugal
24th International Conference on Physical Organic Chemistry, ICPOC 24
Maria de Lurdes Cristiano, Department of Chemistry and Pharmacy, University of Algarve, 8005-199 Faro, Portugal, E-mail: mcristi@ualg.pt or icpoc24@ualg.pt, http://icpoc24.ualg.pt

2-6 July 2018 • High Temperature Materials • Ekaterinburg, Russian Federation
XVI International IUPAC Conference on High Temperature Materials Chemistry (HTMC-XVI)
Dr. Andrey S. Bykov, Institute of. Metallurgy, UB Rus. Acad. Sci, 101 Amundsena Str., Ekaterinburg 620016, Russia; E-mail: a.s.bykov54@mail.ru, http://htmc16.ru

7-14 July 2018 • Postgraduate Summer School on Green Chemistry • Venice, Italy
http://www.unive.it/greenss2018

8-13 July 2018 • Photochemistry • Dublin, Ireland
27th IUPAC International Symposium on Photochemistry
Dr. Miguel A. Garcia-Garibay (Conference co-chair), Los Angeles, E-mail: mgg@chem.ucla.edu, and Dr. Susan Quinn, University College Dublin, Ireland, E-mail: susan.quinn@ucd.ie, http://photoiupac2018.com

8–13 July 2018 • Phosphorus Chemistry • Budapest, Hungary
22nd International Conference on Phosphorus Chemistry (ICPC)
Prof. György Keglevich, Chair, Budapest University of Technology and Economics, E-mail: icpc22chairman@mail.bme.hu, www.icpc22.mke.org.hu

8-21 July 2018 • Summer School on Analytical Science, Metrology and Accreditation • Tallinn, Estonia
http://www.msc-euromaster.eu/

10-14 July 2018 • Chemistry Education • Sydney, Australia
International Conference on Chemistry Education (ICCE) 2018
Chair of the Program Committee: Prof Siegbert Schmid, University of Sydney, School of Chemistry, Siegbert. schmid@sydney.edu.au, www.icce2018.org

14-19 July 2018 • Carbohydrate • Lisboa, Portugal
29th International Carbohydrate Symposium
Amelia Pilar Rauter, DQB-FCUL, Campo Grande, 1749-016 Lisboa, Portugal, E-mail: aprauter@fc.ul.pt or ics2018@chemistry.pt, http://ics2018.eventos.chemistry.pt0

Mark Your Calendar (cont.)

2018 continued

15-20 July 2018 • Organometallic Chemistry • Florence, Italy
XXVIII International Conference on Organometallic Chemistry (ICOMC 2018)
Maurizio Peruzzini, Program Chair, Department of Chemical Sciences and Materials Technologies, Rome, Italy
E-mail: maurizio.peruzzini@cnr.it, www.icomc2018.com

15-20 July 2018 • Solubility Phenomena • Tours, France
The 18th International Symposium on Solubility Phenomena and Related Equilibrium Processes (ISSP)
Chair of Local Organizing Committee: Dr. J. Jacquemin, Université F. Rabelais, Tours, France;
E-mail: jj@univ-tours.fr SECRETARY ISSP18, E-mail: secretary@issp18.org, http://issp18.org

16-17 July 2018 • FAIR Exchange of Chemical Data • Amsterdam, Netherlands
IUPAC and CODATA workshop, Leah R. McEwen, co-chair, E-mail: lrm1@cornell.edu
www.iupac.org/event/supporting-fair-exchange-chemical-data-standards-development

30 July-4 August 2018 • Coordination Chemistry • Sendai, Miyagi, Japan
The 43rd International Conference on Coordination Chemistry (ICCC 2018)
Prof. Ken Sakai, Chair of the Program Committee, E-mail: ksakai@chem.kyushu-univ.jp
Yoshiko Ishibashi, Conference Manager, Department of Chemistry, Kyushu University, Motooka 744, Nishi-ku, Fukuoka 819-0395, Japan; Email : secretariat@iccc2018.jp, www.iccc2018.jp

12-17 August 2018 • Biotechnology • Montréal, Canada
18th International Biotechnology Symposium
Murray Moo-Young (University of Waterloo) and Nicolas Moitessier (McGill University), Scientific Program Committee Co-chairs. Vincent Dodelet, Local Organizing Committee Chair, National Research Council of Canada, Montreal, QC Canada; E-mail: Vincent.dodelet@nrc.ca, http://ibs2018montreal.org/

26-30 August 2018 • Solution Chemistry • Szeged, Hungary
35th International Conference on Solution Chemistry (ICSC)
Pal Sipos, Chair of the local organizing committee, Department of Inorganic and Analytical Chemistry, University of Szeged, Hungary; E-mail: sipos@chem.u-szeged.hu, www.mke.org.hu/ICSC2018

3-7 September 2018 • High Resolution Molecular Spectroscopy • Bilbao, Spain
25th International Conference on High Resolution Molecular Spectroscopy
Prof. Dr. Alberto Lesarri, co-chair (Executive Committee), Universidad de Valladolid
E-mail: lesarri@qf.uva.es, www.chem.uni-wuppertal.de/conference

4-7 September 2018 • Polymer-Solvent Complexes • Grenoble, France
12th Conference on Polymer-Solvent Complexes and Intercalates (POLYSOLVAT-12)
Dr. Jean-Luc Putaux (co-chair), CERMAV-CNRS, Grenoble, France, E-mail: jean-luc.putaux@cermav.cnrs.fr and Prof. Trevor Forsyth (co-chair), Institut Laue-Langevin, Grenoble
E-mail: tforsyth@ill.eu, https://workshops.ill.fr/e/polysolvat12

5-8 September 2018 • Eurasia • Rome, Italy
15th Eurasia Conference on Chemical Sciences
Prof. Luciana Dini, Chair, c/o Cristina Gippa, EuAsC2S-15 staff, Associazione NanoItaly, Roma, Italy
E-mail: cristina.gippa@eurasia2018.org, www.eurasia2018.org

9-14 September 2018 • Green Chemistry • Bangkok, Thailand
8th IUPAC International Conference on Green Chemistry
Supawan Tantayanon, Chair of the organizing committee, Warayuth Sajomsang, Conference Secretary, National Nanotechnology Center (NANOTEC), National Science and Technology Development Agency (NSTDA)
E-mail: warayuth@nanotec.or.th, www.greeniupac2018.com

16-21 September 2018 • Organic Synthesis • Florence, Italy
22nd International Conference on Organic Synthesis (22-ICOS)
Professor Alberto Brandi (Conference Chair) and Professor Maurizio Taddei (Vice-Chair),
E-mail: secretariat@22-icos-florence.it, www.22-icos-florence.it

Mark Your Calender (cont.)

2018 continued

16-21 September 2018 • Solid State Chemistry • Pardubice, Czech Republic

13th International Conference on Solid State Chemistry

Prof. Tomáš Wágner, SSC2018 Chair, Department of General and Inorganic Chemistry and Center of Materials and Nanotechnologies, University of Pardubice, Czech Republic, E-mail: chair@ssc-conference.com
www.ssc-conference.com/2018/

14- 17 October 2018 • Nature Inspires, Chemistry Engineers • Nice, France

4th International Conference on Bioinspired and Biobased Chemistry & Materials

Frédéric Guittard, Chair of Program Committee, E-mail: guittard@unice.fr, University Nice Sophia Antipolis, Institut Méditerranéen du Risque, de l'Environnement et du Développement Durable (IMREDD) E-mail: contact@nice-conference.com, www.unice.fr/nice-conference/

18-19 October 2018 • Energetic Materials • Istanbul, Turkey

International Workshop on Energetic Materials

Prof. Dr. Reşat APAK, E-mail: rapak@istanbul.edu.tr and Ass. Prof. Dr. Ayşem Arda, (co-chairs) Istanbul University
www.iupac.org/project/2015-008-2-500

4-8 November 2018 • Emerging Polymer/Materials Technologies Summit • Hanoi, Vietnam

Dr. Tu Le, School of Engineering, RMIT University, GPO Box 2476, Melbourne, Victoria, 3001, Australia, E-mail: Tu.Le@rmit.edu.au or Tu.Le@iirnet.org http://emts18.org

25-29 November 2018 • Natural Products and Biodiversity • Athens, Greece

30th International Symposium on the Chemistry of Natural Products and the 10th International Congress on Biodiversity

Prof. Leandros A. Skaltsounis, E-mail: info@iscnp30-icob10.org
www.iscnp30-icob10.org

2019

21 January 2019 • Quality of Test Results • Tel Aviv, Israel

International workshop on Quality of Test Results for Conformity Assessment of a Chemical Composition—What is Good and What is Bad? in conjunction with the Isranalytica conference and exhibition (22-23 Jan 2019, http://www.isranalytica.org.il) Dr. Ilya Kuselman, E-mail: ilya.kuselman@gmail.com
www.iupac.org/event/quality-test-results

19-24 May 2019 • Crop Protection • Ghent, Belgium

14th IUPAC International Congress of Crop Protection Chemistry

Prof. ir. Pieter Spanoghe; E-mail: Pieter.Spanoghe@UGent.be, Onderzoeksgroep Fytofarmacie/Crop Protection Chemistry, Campus Coupure, 9000 Ghent, Belgium, www.iupac2019.be

2-6 June 2019 • Supramolecular Chemistry • Lecce, Italy

14th International Symposium on Macrocyclic and Supramolecular Chemistry (ISMSC2019)
Pierangelo Metrangolo, Chair of Program Committee, Laboratory of Supramolecular and BioNano Materials (SupraBioNanoLab), Department of Chemistry, Materials, and Chemical Engineering "Giulio Natta," Politecnico di Milano, Italy, E-mail: pierangelo.metrangolo@polimi.it, https://ismsc2019.eu/

5-12 July 2019 • IUPAC Congress/General Assembly • Paris, France

contact@iupac2019.org, www.iupac2019.org

21-26 July 2019 • Novel Aromatic Compounds • Sapporo, Japan

The 18th international Symposium on Novel Aromatic Compounds (ISNA-18)

Prof. Dr. Shigehiro Yamaguchi, Chair of Program Committee,
E-mail: yamaguchi.shigehiro@b.mbox.nagoya-u.ac.jp, www.isna18.org

2ND INTERNATIONAL CONFERENCE ON GLOBAL CHALLENGES IN NEGLECTED TROPICAL DISEASES

June 25-27, 2018
The Condado Plaza Hilton
San Juan, Puerto Rico
www.cafec.org.pr/ntd2018

United to eradicate the global threat of Neglected Tropical Diseases

The venue, located in the turistic Condado area, is 5-minutes from Old San Juan and 15-minutes from the Luis Muñoz Marín International Airport. A forty five (45) minute drive brings you to El Yunque Tropical Rain Forest.

Confirmed Plenary Speakers

Dr. Marc Ouellete
Professor, Université Laval, Québec, Canada

Dr. Rick Tarleton
University of Georgia

Dr. Mariano Garcia Blanco
UT Medical Branch/Duke

Dr. Dale Kempf
Distinguished Research Fellow, Abbvie Pharmaceuticals

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Conference areas

- Biology and pathogenesis of the pathogens, diseases and hosts.
- Molecular targets-based and structure-based medicinal chemistry approach to maintain healthy drug-discovery pipelines.
- Monitoring, containment and treatment of drug resistant cases.
- Bench to bedside translational research to evaluate new drugs and drug combinations.
- Socioeconomic and public awareness programs in neglected tropical parasitic diseases.
- Opportunities to develop multidisciplinary programs and sponsorship funding.
- IUPAC's ChemRAWN session on low cost diagnostics
- Others (i.e. contributions & innovations from industry)
- Potential workshops(s) before/after congress

The aim of this knowledge convergence forum is to bring researchers and other participants from different world regions, where these diseases are prevalent, to interact with colleagues from North, South, Central America and the Caribbean Basin. The objective is to encourage discussion and knowledge exchange about new approaches for combating these diseases through treatment and prevention. In addition, the conference seeks elevating the awareness of neglected tropical diseases, particularly in Latin America and the Caribbean. Also, this gathering will help stimulate the medicinal chemists from these countries to conduct research in the field by allowing them to have a platform for contacts between laboratories in academia, industry, health agencies and foundations in the Americas and other parts of the world. With the latter in mind, spaces for one to one meetings between participants will be made available throughout the three days of the event.

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