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The Future of the Book ▶

DNA: From Structure to Synthesis ▶

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

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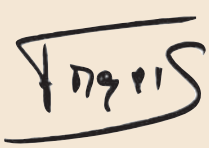
From the Editor

Chemical nomenclature is one of those topics that is, for many, synonymous with IUPAC; and, if there is just one reference that compiles these concepts, it is "the" *Principles of Chemical Nomenclature—A Guide to IUPAC Recommendations*. Following the latest release of this book in December 2011, Jeffery Leigh, editor and contributing author of "the Principles," began writing a regular column for *CI* called "Nomenclature Notes" in which he reviews the book's coverage and content, and illustrates the intricacies of the subject.

The Nomenclature Notes in this issue (p. 26) is about chemical structure representation, a topic newly introduced in the 2011 edition of Principles. Leigh starts by noting that "the drawing of chemical structures is not strictly a nomenclature matter." Yet, similar to "textual" nomenclature, it is a communication tool developed and used by chemists. Oliver Sacks in his recent book *The Mind's Eye* reminds us that Kekule said of himself that he had "an irresistible need for visualization." This is of no surprise to chemists, and it is therefore only fitting that IUPAC set out recommendations on drawing chemical structures.

Drawing chemical structure is an alternative and supplementary tool to traditional nomenclature. Chemists, but also software, can infer chemical nomenclature from structural representations and vise versa. It is an essential communication tool used by instructors and professional chemists. The requirements for standardized drawing are not only aesthetic, but they are driven also by the feasibility (and desirability) of making electronic publications richer by way of embedded information. In chemistry, that includes chemical structure representations. Practically, recommendations for the production of chemical structure diagrams aid in the correct recognition of structural information by computer methodology, such as InChI. Simply put, the idea is to make the structures speak for themselves, not only to human eyes, but more importantly, for the computers that support and drive exchanges of information.

Such standards are a prerequisite for enriching communications about chemistry, especially through new digital media. With that said, I invite you to read Peter Atkins's feature (p. 3) and think about what the advent of e-books will mean for chemistry. With digital devices such as tablet computers providing a plethora of easily accessible and retrievable information, Atkins asks "How can we ensure that text books still foster imagination and creativity?"



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Cover: See feature on page 7. The discoverers of the structure of DNA. James Watson (b.1928) at left and Francis Crick (b.1916), seen with their model of part of a DNA molecule in 1953. *Photo credit: A. Barrington Brown/Science Source. Copyright © 2013 Photo Researchers, Inc.*

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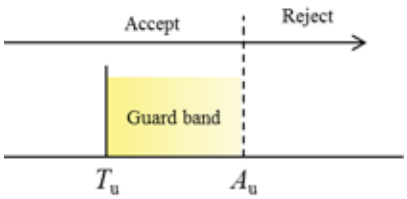
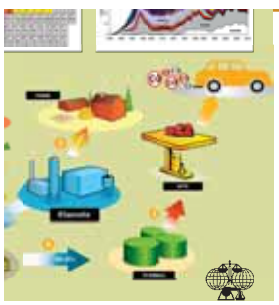




Stamps International, 20

Let's Meet in Istanbul

by Mehmet Mahramanlioglu

On behalf of the Turkish Chemical Society, I would like to invite you to participate in the 44th World Chemistry Congress, which will be held in Istanbul, Turkey, 11–16 August 2013.

When we began planning the congress we had six main objectives:

- recognize and highlight core concepts, and look at chemistry in many different ways
- assess where chemistry is coming from and build a vision for the future
- show that chemistry brings about many benefits to our economic progress and enhances the quality of our lives
- provide a platform for communication among academics and nonacademics
- organize symposia that will attract eminent chemists from all over the world
- have the conference theme be **"Clean Energy through Chemistry"** to highlight the relationship between chemistry and energy and demonstrate how chemistry is used to solve environmental and energy problems

The scientific topics of the congress are as follows:

- Clean Energy Through Chemistry
- Chemical Analysis
- Chemistry for Cultural Heritage
- Chemical Synthesis
- Physical Chemistry
- Macro and Nano Science and Technology
- Environmental Chemistry, Green and Sustainable Chemistry
- Life Chemistry
- Materials Science
- Chemistry Education
- Chemical Industry and Innovation

The scientific program will follow the traditional structure of plenary, keynote, oral, and poster presentations. Three Nobel Laureates in chemistry and other distinguished chemists will be plenary and keynote speakers.

The organizing committee hopes that the congress will be more than just chemists talking to chemists. Therefore, we encourage interactions with other disciplines. Although academic research is always at the heart of all the IUPAC congresses, we have expanded our orientation to also include nonacademics. One of the targets of this congress is a delegates mixture of 80 percent academic and 20 percent nonacademic, a higher ratio than previous congresses.

Istanbul is not only the largest city in Turkey, but also one of the world's most important, economic, financial, and trade centers. It has a worldwide reputation as a result of its long history and rich culture. Istanbul sits astride Europe and Asia: Indeed it is the only city in the world located on two continents. These two parts of Istanbul are divided by a strait of water called the Bosphorous linking the Black Sea to the Sea of Marmara. There are currently two bridges that connect the Asian side to the European side of Istanbul. A new, third bridge will also be built in the near future. You can see many places in the world, but no other place rivals the beauty of Istanbul.

Turkish Airlines is the official Airline of the congress and offers a special discount for international participants. You may find more information about the congress at **www.iupac2013.org.**

We sincerely welcome you to attend the congress and share your experiences and research. We look forward to seeing you in Istanbul!

When/Where/What

Congress Date: 11–16 August 2013

Congress Venue: The Istanbul Lutfi Kırdar Convention and Exhibition Center & the Harbiye Military Museum & Convention Center

Registration: Online registration is available on the web-site. The deadline for early bird registration is 11 April 2013 with discounted rates for IUPAC members and affiliates. Also there are many hotel options for every budget.

Abstracts: The deadline for abstract submission is **31 March 2013.** Details how to submit the abstract are on the web-site with the rules step by step.

Sponsorships: Several sponsorship opportunities are available; please contact us to discuss about your activities at the congress in Istanbul.

www.iupac2013.org

The Future of the Book

In 2009, *CI* asked Peter Atkins to explore questions surrounding the development of e-books (May-June 2009 *CI*, p. 9). Atkins wrote "An e-book is a nimble thing, and, once its current deficiencies have been eliminated, it is inevitable that it will dominate the world." Today, four years later, many of us are daily users of an iPad or similar tablet devices. Thus, *CI* has asked Atkins to revisit the question of "What is the future of the book?"

by Peter Atkins

The book has no future. Most of us who have been brought up surrounded by the tactile pleasure of paper books (p-books) have a sentimental attachment to them, relishing their feel, enjoying being curled up with them in their friendly presence, responding perhaps subconsciously to their smell, enjoying their instant access, finding it easy to browse, serendipitously opening a page and lighting on an enjoyable enlightenment. For those like us in this respect, there will always be paper books, just as there are vintage cars for enthusiasts. The rest of the world, however, will have moved on.

There will be certain losses accompanying the replacement of p-books by e-books, as there are losses whenever progress replaces the comforts of familiarity. Perhaps at the most trivial level, with a big fat p-book, you know how far you have come and how far you have to go: the daunting thickness gives way, millimeter by millimeter, as the course progresses, and you have a real sense of achievement knowing that you have dealt with all the pages on the left with only the remaining pages on the right to go. Any e-book needs to be constructed with signposts so that the reader is aware of how much more is left, and a monitor of achievement so far.

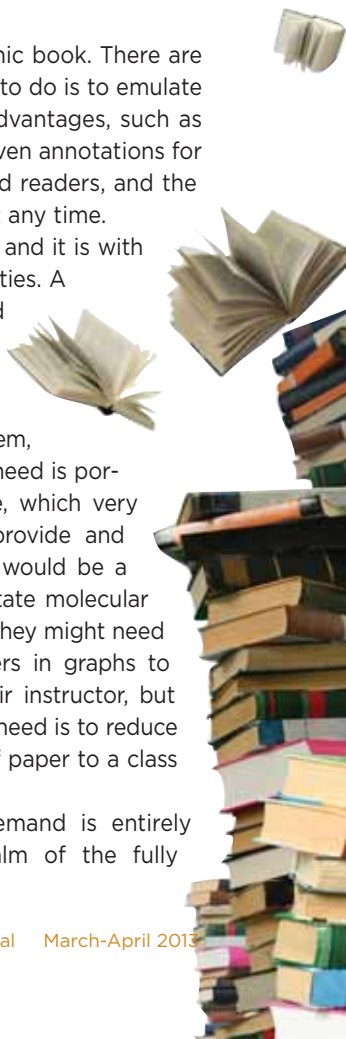
The book has no future.

Moreover, it might be an effective pedagogical procedure to struggle with a structured intellectual pathway provided by the author rather than to be provided in an e-book with too many shortcuts and helpful hints. The blood on the floor after struggling with a p-book might be a sign that you have truly mastered a topic. Learning involves grappling with a subject, ingesting and digesting it, making it a part of you like a medieval king made another country a part of his kingdom by battle.

A further point might be that whereas a p-book encourages you to use your imagination to build up internal mental representations of a subject, an e-book might do the creative work for you and leave your imagination under-developed: that is rather like going to see the movie of a novel rather than reading the novel itself and building your own imaginative world of the scenes and characters. An e-book must aspire to develop the imagination of the reader, for science is imagination in alliance with honesty. A richly resourced, well-constructed and pedagogically superior e-book can encourage great creativity by providing the reader with resources; but if its creation is careless, it could instead encourage laziness.

There are three kinds of electronic book. There are novels, where all the e-book needs to do is to emulate the p-book and scatter in a few advantages, such as dictionaries, bookmarks, perhaps even annotations for over-enthusiastic or under-informed readers, and the ease of purchase from anywhere at any time.

Here, I shall deal with textbooks, and it is with them that there might be two varieties. A student at a lecture does not need the distractions that a fully functional e-book might provide: they might need to refer to a graph, a table of data, or an exercise. For them, in the context of a lecture, all they need is portability and the ability to annotate, which very simple versions of e-books can provide and for which fully functional e-books would be a distraction. They might need to rotate molecular models and crystal structures, and they might need to play around with the parameters in graphs to explore points being made by their instructor, but the needs are basic. Their principal need is to reduce the burden of carrying kilograms of paper to a class and to be able to add notations.

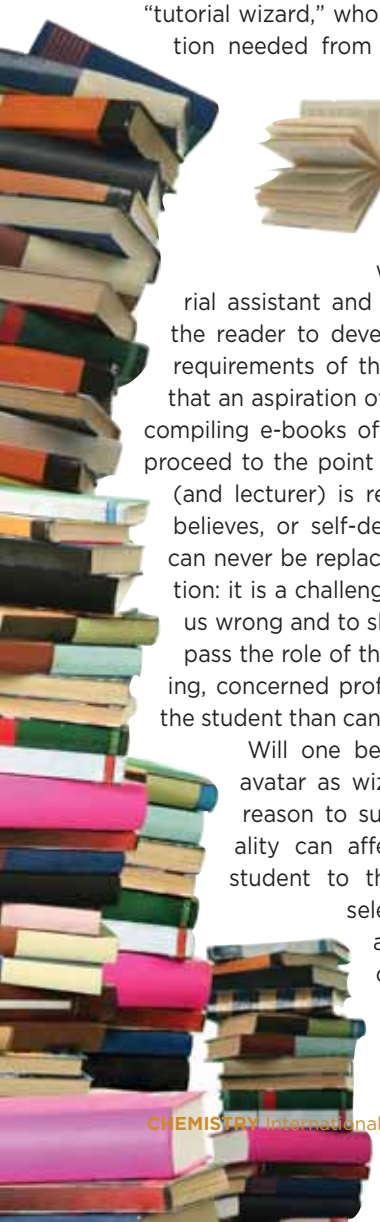


Back at home, though, the demand is entirely different. Now we enter the realm of the fully

functional, multidimensional, richly endowed e-book, designed to provide an elaborate, encouraging, and enlightening educational experience.

Apart from its easy portability, the principal advantage of an e-book is that it is interactive. Once again, it is important to distinguish between two different types of interactivity. There are all the obvious kinds of interactivity for chemists, such as the ability to plot graphs with varying parameters, the ability to build and rotate molecular structures, the ability to pull up videos of experiments and procedures, the ability to carry out mathematical transformations (I have Wolfram's .cdf format in mind), the ability to summon up data from any central resource, and the ability to sail away into the web to gather further information.

Then, there are the less obvious kinds of interactivity, which include the ability to adjust the level at which the reader receives help or is encouraged to go beyond the basic exposition. This is the role of the "tutorial wizard," who can judge the level of explanation needed from its monitoring of the reader's habits or simply open up successive levels of explanation until the reader is satisfied and feels able to move on to other topics. A truly effective tutorial wizard would go beyond being a tutorial assistant and would find ways to encourage the reader to develop interests beyond the basic requirements of the text. Indeed, it seems to me that an aspiration of those who in the future will be compiling e-books of this richly endowed kind is to proceed to the point where the conventional lecture (and lecturer) is redundant. Each of us probably believes, or self-deludes ourselves, that a lecture can never be replaced by wholly electronic instruction: it is a challenge to e-book compilers to prove us wrong and to show that an e-book can encompass the role of the wise, understanding, stimulating, concerned professor, giving more attention to the student than can perhaps be achieved in real life.



Will one be able to choose an agreeable avatar as wizard? Why not? There is every reason to suppose that the wizard-personality can affect the responsiveness of the student to the advice, and if that means selecting a voluptuous blonde or a muscular hunk to play the role of tutor, then so be it. Maybe highly respected scientists, or celebrities of various kinds, will be able to license their images to be used as tutorial avatars.

The extreme kind of interactivity, of course, is the wikitext, where the community of instructors and students build the text themselves. We are already seeing steps in this direction, and conventional publishers are rightly concerned that wikitexts will prove to be the future, as well they might. The challenge is reliability and consistency, and the possible loss of intellectual integrity that (I at least like to think) a single-author or few-author text imposes on the subject. Education is not a democratic marketplace with everyone's stalls of equal value: skill, judgment, authority, and sensitivity must pervade e-books just as these qualities commonly pervade p-books.

A side issue in the world of wikitexts, which might become serious, is the question of copyright, when students raid extant sources and deliver them unacknowledged into the wikitext arena. It will be a daunting task for the supervisors and editors of entries into a wikitext to maintain a consistency of style, substance, and notation as well as monitoring and eliminating transgressions of copyright. Perhaps the whole concept of copyright will vanish as wikitexts come to dominate the world of education.

Each of us probably believes, or self-deludes ourselves, that a lecture can never be replaced by wholly electronic instruction . . .

The "collectivization" of the creation process that the wikitext model takes to an extreme applies to a lesser extent to more conventional production approaches. Whereas a p-book typically has only one or a tiny band of authors and, for better or worse, their personality can shape the presentation of the material in the book, it is hard to believe that an e-book can be created by anything other than a committee, with all that that implies. It may be the case that in the future a "Hollywood model" emerges, where the project is led by an iron-willed director who gives shape and personality to the production, with a team bending to his direction and doing the fabrication largely anonymously. Thus, great authors will give way to great directors.

A related point is that e-book creators have a serious problem about the appearance of the book, especially in relation to the graphics. The young are currently immersed in computer games with their quite extraor-

dinarily good (and expensive) graphics. The danger is that academic e-books will seem tawdry by comparison and convey to the reader a sense of disappointment. It will be essential for e-book creators to find ways to produce graphics of matching quality, including 3D images and animations. I am not suggesting that an e-book should be modelled on a computer game, and certainly not on the violent paradigms that so many of them represent, although there might be a creative opportunity lurking in that thought. Some attempts have already been made to pursue the game paradigm into educational software. The challenge will be to avoid trivialization of what should be a demanding, enjoyable, and instructive intellectual adventure. One-person shoot-ups of the periodic table are not the way to go.

A pessimistic continuation of the same thought is that an e-book might contribute to the demise of the written word. Although e-book readers are popular, it might be the case that when images are present, they squeeze out the need for words. It is hard to anticipate the ratio of words to images that are appropriate to screen learning, but my suspicion is that that ratio will become smaller as time goes on. The development of e-textbooks might, therefore, contribute to the lowering of literacy.

I have already touched on the impact of e-book creation on the role of authors, in the sense that individuals might give way to multitalented committees. There is another aspect. The current typical cycle for the preparation of printed textbook new editions is three or four years, depending on the level. The typical effort cycle of a p-book author is therefore about one year of writing, one year of seeing the book through the elaborate production process, then one year assisting with marketing and perhaps—towards the end of that year—for thinking about the next edition. If the cycle is four years, then there is at least the possibility of time off and the regirding of loins in preparation for embarking on the next edition. That changes with e-books, which can be continuously updated with no opportunity for respite for the author or the publisher. Indeed, it is probable that the traditional quantization of editions (1, 2,...) will succumb to the software model of versions with fractional updates between major revisions. Writing e-book textbooks will become an exhausting, absorbing process, and will appeal only to those who do nothing else. Publishers already find it difficult to draw authors into their clutches (despite the pleasures of those clutches that some of us have experienced over the years): They will find it increasingly difficult as potential authors assess the commitment required and perhaps the best brains will simply refuse to give up their other interests.

There will be some advantages to publishers in the e-book model, principally that it will be able to control and possibly eliminate the second-hand market. That market is currently the main driver of the high price of p-books, for within a year or so of the appearance of new edition, the second-hand market takes over and publisher and author look on helplessly with no remuneration for their efforts as used copies of texts churn below their gaze. Unlike a p-book, an e-book can be tied to a device, or even be time-limited, and although there might evolve a market in second-hand, loaded devices, that is probably less likely than the easy circulation of p-books.

Does that mean that e-books will become cheaper? Unfortunately, probably not, for if the market demands increased sophistication, so the expense of production increases even though paper, printing, storage, and transport are eliminated. Moreover, currently the content of p-books is generated by authors slaving away hopefully in garrets, whereas, as I have already indicated, the creation of e-books will draw on the talents of a professional, expensive team working in well-equipped, sophisticated offices. Upgrades might become feasible and provide a cheaper experience: instead of buying a whole new book to keep in step with editions (but which student does that anyway?) publishers might entice continued commitment with cheap upgrades. Partial upgrades will be pushed out to users, just as service packs are now.

New pricing models will become available whatever the core price structure of the book. Do you want

the solution of an exercise?: here it is for 10c. Do you want more detail in a derivation?: that will be 25c, please. One year access to data?: $5 please. And so might evolve a whole landscape of micropayments for supplementary items. Your licence is about to expire: continue (with a free forthcoming new edition) for $10. You bought that text?: buy its sister volume with a 50 percent discount.

One consequence of the team taking over from the individual, a consequence of little importance to readers but vital to authors, is the contractual complexity that will emerge, with elaborate terms covering the various responsibilities and rewards of the members of the team and awkward clauses relating to translation and supplementary rights.

I have not touched on the opportunities that e-books provide for collaborative learning. Social networking built into the devices and the e-book itself will certainly emerge as a pedagogical phenomenon. Whether that will be educationally valuable or simply yet another way to fritter away one's time, remains to be seen. However, those who favour collaborative learning rather than old-fashioned quiet, individual reflection might well be able to develop e-books with collaboration in the core of the presentation, which is perhaps an offshoot of the wikitext model I mentioned earlier, but local to the course.

In conclusion, let me say that all these conjectures are likely to be regarded as absurd when the e-book becomes established as the universal face and mode of education: The only prediction about the future that is always true is that it is impossible to predict the future, and that almost all predictions become risible when viewed from some future viewpoint.

Although we sentimentalists will regret the passing of the printed page, and regret the passing of the shelves of old friends that we have accumulated over the years, each with its own personality and each one remembered for the mark it made on our educational progress, we have to welcome the new dynamic e-era. That era brings a multidimensional environment to our teaching, putting information effortlessly at our fingertips, and will use special, unique, and as yet unimagined but extraordinarily imaginative ways of bringing the best out of young developing brains.

Peter Atkins <peter.atkins001@btinternet.com> was an Oxford professor of chemistry and fellow of Lincoln College until his retirement in 2007. He has written more than 70 books, the best-known of which is Physical Chemistry, which will soon be published in its tenth edition. His other major textbooks include 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.

DNA From Structure to Synthesis

April 2013 marks the 60th anniversary of the DNA structure proposed by James Watson and Francis Crick. Together they had penned a 1000-word article in the 25 April 1953 issue of Nature *unravelling the structure of DNA, the key hereditary molecule. This discovery is perhaps one of the greatest milestones in human history; the double helix structure proposed for DNA is not only central to our understanding of the molecular machinery operating in cells, but it also lead to the development of genetic engineering technology.*

by Krishna N. Ganesh

The DNA double helix made up of two antiparallel strands complementary to each other through specific base pairing of A with T and G with C codes the key information necessary for synthesis and regulation of all proteins and enzymes required of functioning of a cell from cell division to cell differentiation and cell development. The discovery also gave birth to the fields of molecular and structural biology, which have been key to the genetic revolution that has resulted in the development of vital products, ranging from hormones and enzymes to therapeutic molecules and vaccines. The penultimate achievement stemming from the discovery of DNA's structure was the unraveling of the entire human genome in 2001 and work continues unabated on the genomes of other organisms. These discoveries have implications for our understanding of diseases at the molecular level and, thereby, the development of cures. Some of the most spectacular applications take advantage of the self-assembling properties of the genetic molecule DNA to make nonbiological novel generic materials.

Chemistry has played a central role in the success of these processes, since easy availability of well-defined sequences of DNA in reasonable amounts has been crucial to most of these applications. Har Gobind Khorana's saga of the first of a gene for Phe t-RNA was the first illustration of the power of chemistry in delineating biological processes. Crucial to the success was the development of effective and compatible protecting groups for the exocyclic amino groups of the nucleobases and the hydroxyls of ribose moiety. Since then, it has inspired generations of chemists to improve, optimize, and invent new methods of facile synthesis. The pioneering work of Robert Letsinger and Marvin Caruthers has enabled the synthesis of DNA and RNA even by nonhumans (Automatic synthesis machines). The availability of chemically synthesized, well-defined sequences of oligonucleotides had a major impact on the acquisition of functional information about DNA structure and its interaction with a variety of molecules ranging from metal ions to small molecule drugs and regulatory proteins. Although the structure of DNA was proposed in 1953, it took almost 25 years for the first atomic structure of DNA to be solved, which completely validated the structure proposed by Watson and Crick. Then came the discovery of polymorphism in DNA (A, B, and left-handed Z forms), sequence-specific molecular recognition of DNA by RNA (DNA-RNA hybrids), intercalating and groove-binding molecules, restriction enzymes, repressor proteins, zinc finger proteins, and the structure of DNA triplexes and tetraplexes. Synthetic oligonucleotides as primers were central to Kary Mullis' discovery of polymerase chain reactions and Sanger's DNA sequencing method, which eventually made the human genome sequencing possible. Gene cloning was made possible by the availability of synthetic oligonucleotides as linkers to generate suitable fragments for pasting of DNA fragments in the desired way. The evolution of SELEX as a technique to discover unknown interactions of DNA with proteins and ligands, hinges on the capability of simultaneous synthesis of millions of oligonucleotides in a combinatorial way. This has led to the discovery of aptamers, ribozymes, and DNAzymes, from which a number of practical applications have already emerged.

James Watson (left) and Francis Crick in 1953.

When everyone thought that DNA synthesis has reached saturation in terms of chemistry, came the concept of antisense therapeutics and ribozymes in 1990s, which expanded the synthesis scope to chemically modified nucleic acids. Here, a short stretch of DNA inhibits protein synthesis by complementation-steric blocking of m-RNA reading by ribosomes. Since oligonucleotides reluctantly enter cells due to their anionic character and have short half-lives within the cells (nuclease susceptible), they have to be structurally modified to overcome the above lacunae. This expanded organic synthesis to a wide variety of structural analogues of DNA and RNA. One of the analogues (phosphorothioates) was approved as a drug (Vitravene) for retinosis in 1997 and just recently (29 January 2013) the second drug Mipomersen was approved by the U.S. FDA for a rare cholesterol disorder. The recent discovery of siRNA and miRNA as efficient gene expression probes and, hence, potential therapeutic agents, has pushed the synthetic scope to newer limits. Contrary to initial apprehensions of scaling up synthesis of oligonucleotides, technology has evolved for large-scale production of multikilogram amounts of DNA and its analogues, which has made possible the successful clinical trials. Quite a few more DNA/RNA based drugs are in advanced stages of clinical trials, close to approval for several cancer and viral diseases.

The recent progress in DNA origami pioneered by Ned Seeman and DNA nanotechnology by Chad Mirkhin based on perfect self-assembling properties of complementary DNA strands is bringing a sea revolution to the application of DNA as a generic material. The ability to manipulate and program DNA in engineered cells has given birth to synthetic biology, a logical next step to genetic engineering with potential for artificial synthesis of a functioning cell. The sky seems to be the limit for such unabated progress in the application of chemistry to understand and even direct biology in new directions.

Looking back, the genius of Watson and Crick is still awe-inspiring. The elucidation of DNA's structure followed by the creative contributions of innumerable chemists over the past 60 years has resulted in methods for transforming the genetic material in DNA into the generic "materials and drugs of the future."

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The leap from structure to synthesis took several years and to reflect on how far the scientific community has come since that earlier milestone, CI *asked Marvin Caruthers to discuss the chemistry developed in the late 1970s that remains a standard for oligonucleotide synthesis today.*

Chemical Synthesis of DNA, RNA, and their Analogues

by Marvin Caruthers

When I attended my first Nucleic Acids Gordon Conference in 1975, I was asked to review the state-of-the-art in oligonucleotide synthesis. At that time in my young career at the University of Colorado, we were focused not on DNA chemical synthesis, but on determining how proteins recognize nucleic acids. This was five years before we developed the phosphoramidite chemistry for DNA synthesis. Because I had established a reputation in nucleic acid synthesis through my graduate and postdoctoral research, it was only natural for me to present this lecture. During the evening meal following my review, a molecular biology attendee, who is now a member of the U.S. National Academy of Science, asked me "Marv, why do you want to learn how to chemically synthesize DNA? Certainly Khorana used synthetic DNA to solve the genetic code and now he has synthesized a gene. But what else can you do with it? Surely, you can find something more exciting to do." This lack of interest in DNA synthesis among biologists, biochemists, molecular biologists, and geneticists was very common at that time. They couldn't care less about the field.

There were a few laboratories that understood the power of synthetic DNA and how it could be used in biology. For example, we were chemically synthesizing the *lac*, cI, and cro operators for studies focused on how proteins recognize DNA.[1] Others were synthesizing genes for human growth hormone[2] and insulin[3] which became the first genetically engineered, com-

mercial therapeutic products, and Sanger's laboratory was using synthetic DNA to develop a methodology for sequencing DNA.[4] However, only a very few laboratories were focused on developing new procedures for chemically synthesizing DNA. At this time, only two methods were available—the phosphodiester and phosphotriester approaches. Unfortunately, these synthetic strategies were not accessible to biologists—the scientists who could use DNA in their research. This was because the procedures were complicated, time consuming, and required a trained chemist. Since this brief review cannot be comprehensive, I will only outline the chemistry we developed between 1976–1980 that has become known as the phosphoramidite methodology. Although introduced over 30 years ago, it remains the standard for oligonucleotide synthesis today.

Early observations from Robert Letsinger's laboratory[5] led us to explore using 2'-deoxynucleoside P(III) derivatives for synthesizing 2'-deoxyoligonucleotides on polymeric supports. Our research was predicated on the use of HPLC-grade (high-performance liquid chromatography) silica as a support for several reasons. One was that previous research on organic polymers had failed in part because these materials readily adsorbed the synthons and, thus, their removal after each condensation step was very difficult. This problem, when coupled with the knowledge that HPLC-grade silica had been designed for efficient mass transfer, dictated that it should be explored. Other reasons were that silica would be inert towards reactions with all the reagents we contemplated using and that it was a rigid, non-swelling matrix in common organic solvents. Therefore, HPLC-grade silica could be packed into a column and reactants merely pumped through the column.

The initial approach we developed[6] is outlined in figure 1. The first step was activating the silica matrix by attaching (3-aminopropyl)triethoxy silane to silica and then treating the product of this reaction with succinic anhydride to generate **1**. The next step (i) was attaching 5'-dimethoxytrityl 2'-deoxythymidine to the support using dicyclohexylcarbodiimide to activate the carboxylic acid for condensation with the 2'-deoxynucleoside. After removal of the 5'-dimethoxytrityl group with acid (ii) to yield **3**, synthesis with an activated 2'-deoxynucleoside 3'-phosphite was then carried out (iii). Of those we examined, the most reactive, while generating the fewest side-products, were the 5'-dimethoxytrityl 3'-methyltetrazoyl phosphites, **4**. Using these synthons, 95 percent yields per condensation were observed during synthesis of the phosphite triesters **5**. After oxidation of the phosphite to phosphate with aqueous iodine (iv) followed by removal of the dimethoxytrityl group with acid (v) to yield **6**, the cycle could be repeated numerous times to generate a deoxyoligonucleotide. Finally, after completion of the deoxyoligonucleotide synthesis, the methyl group was removed from phosphate using a thiol. The oligomer was then cleaved from the support and base protecting groups (N-isobutyroylguanine, N-benzoylcytosine, and N-benzoyladenine) removed with ammonium hydroxide. Based upon the amount of dimethoxytrityl cation released following synthesis of a 12mer having all four bases, the overall yield was 55 percent, which at that time was unprecedented in the nucleic acid field. During the course of this work, we also developed a semiautomatic machine where one cycle of synthesis on a silica column, including all reagents and solvents, could be programmed and completed automatically. The operator added the next appropriately protected 2'-deoxynucleoside 3'-phosphite to the column and initiated another synthesis cycle. Although more successful than any previous method, it was far from acceptable. The main problem was that the 2'-deoxynucleoside 3'-tetrazoylphosphites had to be prepared at -78° C and preferably used the same day. These are procedures that are not appropriate for biologists and biochemists. Moreover, a phosphite adduct on the N-isobutyroylguanine base was very stable and could be removed only by several treatments with anhydrous

Figure 1. Synthesis of DNA on Silica Supports Using 2'-Deoxynucleoside Phosphites.

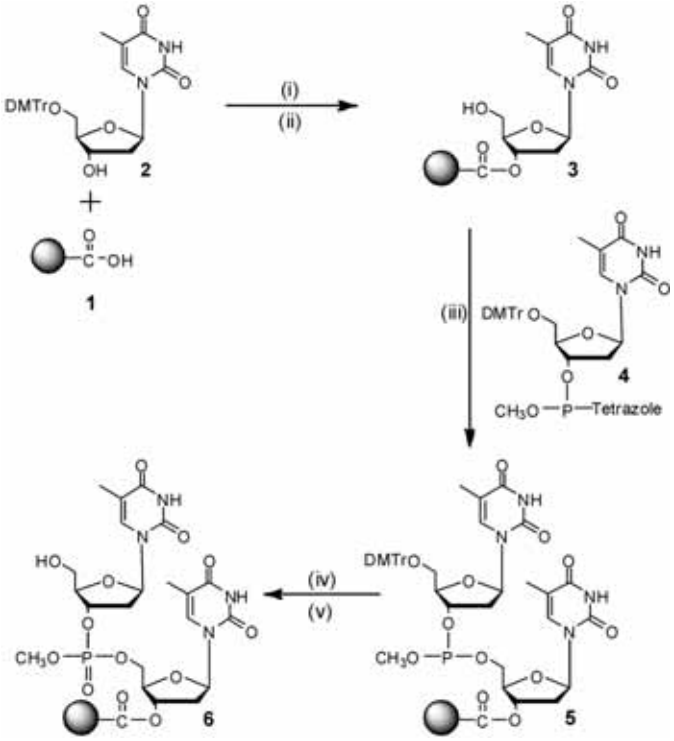
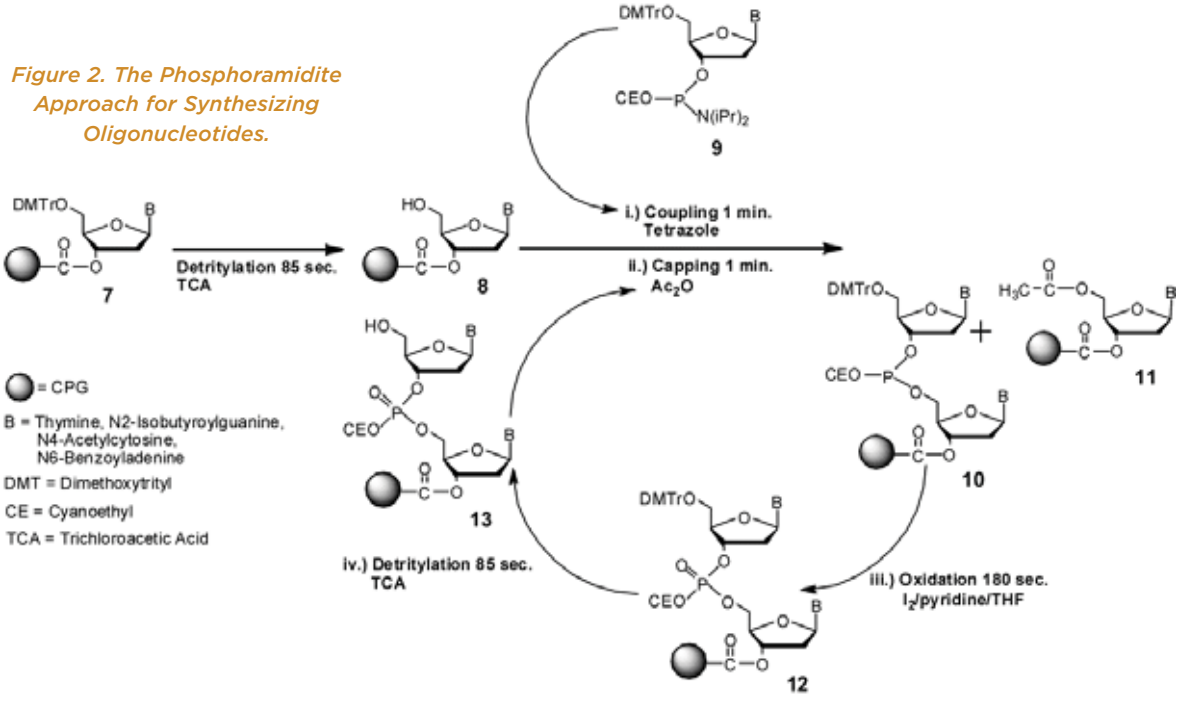


Figure 2. The Phosphoramidite Approach for Synthesizing Oligonucleotides.



pyridine—again a procedure unacceptable for routine synthesis. If these adducts were not removed, yields of deoxyoligonucleotides containing 2'-deoxyguanosine were very low. The major advantage of this approach, even to the present, was the successful development of silica as a matrix for DNA synthesis.

The final, major step in the development of the phosphoramidite methodology was discovering the 2'-deoxynucleoside 3'-phosphoramidites as synthons.[7] This study was initiated with aminophosphines. The strategy was to synthesize 5'-dimethoxytrityl 2'-deoxynucleoside 3'-aminophosphines and then activate these synthons via insertion of CO_2, CS_2, or COS[8,9] to form a mixed anhydride. These synthons would then be condensed with a 2'-deoxynucleoside. In our hands, this strategy was not successful. However during the attempted synthesis of these aminophosphines by reacting 5'-dimethoxytritylthymidine with N,N-dime thylaminomethoxychlorophosphine in pyridine, we observed on thin-layer chromatography the conversion of the 2'-deoxynucleoside to a dimethoxytrityl positive spot that moved similar to a dinucleotide. Based upon the literature, where there is good evidence for acid activation of aminophosphines,[10] we reasoned that the initial product, 5'-dimethoxytrityl 2'-deoxythymidine 3'-N,N-dimethylaminomethoxyphosphine (a phosphoramidite), was further activated by pyridine hydrochloride, which was present in the reaction mixture due to the condensation of the chlorophosphine with the 2'-deoxynucleoside. This protonated 5'-dimethoxytrityl 2'-deoxythymidine 3'-O-methoxy-N,N-dimethylammonium phosphine would then react with excess 5'-dimethoxytrityl 2'-deoxythymidine present in the reaction mixture to form *bis*(5'-dimethoxytrityl 2'-deoxythymidine) 3'-O-methylphosphite.

The next challenge was to learn how to stabilize the 5'-dimethoxytrityl 2'-deoxythymidine 3'-phosphoramidite intermediates so they could be isolated, stored, and then activated during a controlled DNA synthesis. This was accomplished with the aid of phosphorus NMR and by using Hunig's base to remove acid during aqueous work-up of reaction mixtures. Following isolation of these appropriately protected synthons, we immediately discovered that they were easily activated for DNA synthesis with anhydrous pyridine hydrochloride, other amine hydrochlorides, sulfonic acids, halogenated acetic acids, and even 2-nitropropane. However, for routine use by nonchemists, none of these acids was acceptable as they were hygroscopic or mutagenic. We therefore chose to recommend tetrazole as an acid activator because it could be readily purified by sublimation, stored as an anhydrous solid, maintained for days in anhydrous acetonitrile, and then used to synthesize DNA.

These key developments led to the synthetic strategy as outlined in figure 2.[11] The first step is conversion of the 5'-dimethoxytrityl 2'-deoxynucleoside linked to a silica support through a succinate ester to the corresponding 2'-deoxynuceloside by treatment with 2 percent trichloroacetic acid in dichloromethane to yield **8**. The product of this detritylation is reacted (i) with tetrazole and **9**, an appropriately protected 5'-dimethoxytrityl 2'-deoxynucleoside 3'-phosphoramidite to form **10**, a phosphite triester. The next step is acylation with acetic anhydride in pyridine (ii) to generate **11**. This step blocks any unreacted 2'-deoxynucleoside from further reaction and also removes phosphite adducts from the bases. The final steps in the cycle are oxidation of the phosphite triester to phosphate (iii) to yield compound **12** followed by

detritylation with trichloroacetic acid (iv) to yield **13**. Oxidation to phosphate is important as phosphite triesters are unstable to the trichloroacetic acid used in the detritylation step. The cycle is completed in approximately 5–7 minutes and can be used to easily prepare deoxyoligonucleotides 20–60 in length using both manual procedures and instruments.

For many years, the synthesis approach as outlined in figure 2 proved to be satisfactory for biological research where segments 20 or so oligomers in length were adequate. However, over the past 10 years, many new applications required DNA up to 300 oligomers in length. This development led me to collaborate with Emily LeProust and others at Agilent in order to design a synthesis protocol that could lead to DNA of this size.[12] We now have a protocol where 250 000 unique DNA segments are prepared on a glass chip using a modified ink jet printer to deposit the activated 2'-deoxynucleoside phosphoramidites on the surface of this chip. Agilent currently has several DNA synthesizers operating 24/7 producing oligomers 250–300 in length. These machines each day produce the equivalent of the human genome (3 billion base pairs or 6 billion chemical couplings).

The phosphoramidite methodology has also been used to generate large numbers of DNA and RNA analogs with many finding applications in biology, therapeutics, and diagnostics. All were prepared in the Arbusov tradition using P(III) phosphorus derivatives of oligonucleotides to deliver P(V) analogs. For example, the sulfur containing DNA analogs, thiophosphate[13] and dithiophosphate[14] were prepared by sulfur oxidation of phosphites and thiophosphites respectively. By oxidation of phosphites with borane, borane phosphonate DNA has been recently synthesized[15] and shown to be biologically active[16] and to reduce metals.[17] Using classical Arbusov-type chemistry, certain intermediate P(III) DNA derivatives can be converted to phosphate, phosphate triesters, phosphoramidates, and phosphorimidamidates.[18] Moreover, other analogs derived from alkylaminophosphines can be converted to DNA having methylphosphonate,[19] phosphonoacetate,[20] phosphonoformate,[21] and methylboranephosphine[22] internucleotide linkages. This brief discussion on analogs derived from P(III) intermediates is far from complete, even for DNA, and only serves to introduce the possibility for applications in many other areas such as RNA, peptides, and oligosacharides.

The phosphoramidite approach has also been used extensively for the synthesis of RNA. However, the challenge in this field is identifying a series of orthogonal protecting groups for the 2'- and 5'- hydroxyls, phosphorus, and nucleoside bases. Although a large number of strategies have been tested, a recent approach utilizing 2'-thionocarbamates appears to be superior to others as higher cyclic yields and fewer side-products are observed while maintaining a rapid synthesis cycle and a high-yielding methodology for preparing the RNA synthons.[23]

The discovery of the phosphoramidite approach for DNA synthesis has been key to the development of several extremely important procedures commonly used in biology, biochemistry, and molecular biology. These include the use of polymerase chain reaction, DNA sequencing, and site-specific mutagenesis. When this DNA synthesis strategy was combined with other core procedures developed in the late 1970s to early 1980s (restriction modification of DNA; cloning of heterologous DNA elements into plasmids, phages, and chromosomes; and rapid protein sequencing), these new, very powerful technologies reinvigorated biological research and gave birth to the biotechnology industry.

Marvin H. Caruthers is a distinguished professor at the University of Colorado at Boulder. He has been a member of the National Academy of Sciences since 1994 and is a member of the American Academy of Arts & Sciences. He is the recipient of numerous awards, including the U.S. National Medal of Science in 2006, the Imbach-Townsend Award from the International Society of Nucleic Acid Research in 2006, the Promega Biotechnology Research Award in 2006, the National Academy of Sciences Award for Chemistry in Service to Society in 2005, and the Prelog Medal in Recognition of Pioneering Work on the Chemical Synthesis of DNA (ETH, Zurich, Switzerland) in 2004.

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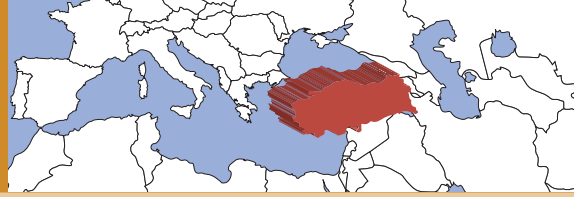
Chemistry Education Research in Turkey



by Mustafa Sozbilir

Chemistry is a central part of science taught at schools around the world. Although the content and subject sequences are more or less similar, each country has developed along different paths due to unique cultural and political influences. When researching chemistry education, it is important to study not only the content of chemistry taught, but to understand the developmental path that has led each country to its individual curricula.

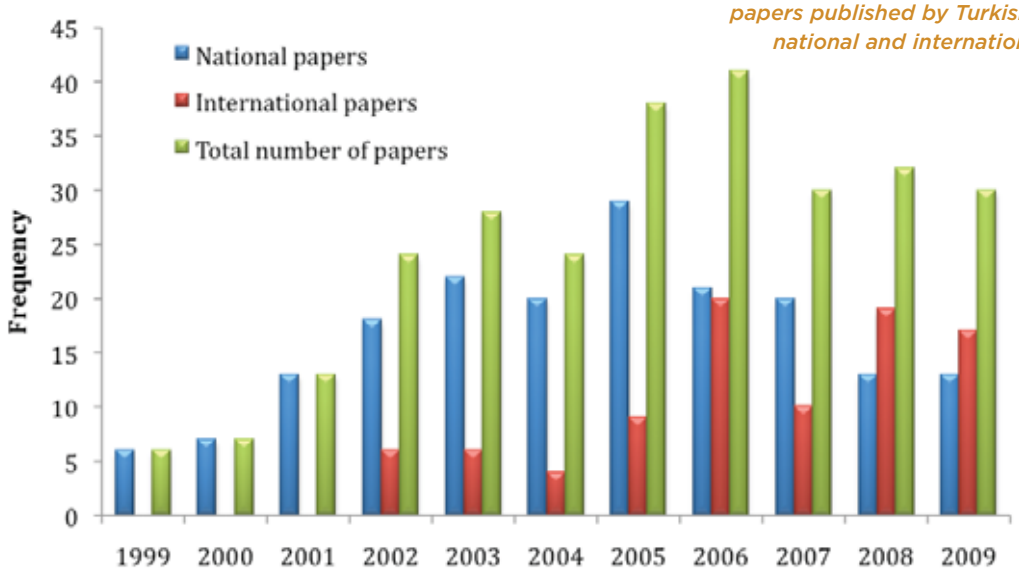
This feature focuses on the development of research in chemistry education in Turkey. Like many countries, Turkey has, over the last century, given special attention and importance to the teaching of chemistry. Starting with a brief introduction to the Turkish education system, the article discusses the history of chemistry education research in Turkey, including a content analysis of chemistry education research papers published at national and international levels by Turkish chemistry educators.

Turkey, with a population about 75 million (Turkish Statistical Institute, 2011) is a bridge between Europe and Asia. Following the collapse of the Ottoman Empire after World War I, the Republic of Turkey was established in 1923 under the leadership of Ataturk. Reforms were undertaken in almost every area of the state, especially in education. The Turkish education system is regarded as the most successful of the Ataturk Reforms instituted following the founding of the new state (Grossman, Onkol, & Sands, 2007). The education system was centralized by the Law of Unification of Instruction in 1924. The *madrasas* (formal education schools) were abolished and governance of all schools, except military schools, was transferred to the Ministry of National Education, while military schools were presided over by the Ministry of Defense. This state-supervised system is largely responsible for producing a skilled professional class, which has benefitted the social and economic welfare of the nation (Özelli, 1974).

Since its inception, the Turkish educational system has undergone further reform, including the acceptance of Latin characters as the official script in 1928 instead of Arabic characters; expansion of secularism in the social, educational, and legal aspects of education (Turkmen & Bonnstetter, 2007); implementation of new curricula (Ayas, Çepni, & Akdeniz, 1993; Turkmen & Bonnstetter, 2007); and reforms in teacher training (Turkmen, 2007). The results of these reforms have been impressive (Grossman et al., 2007).

Today, education consists of four main components: primary (ages 5–10; 5 years including one year optional pre-school education), middle school (ages 11–14; 4 years), high school (lycees or senior high schools including vocational and technical schools, ages 14–18, 4 years); and higher education (universities). Since 2011, the compulsory number of years of education is 12.

Figure 1. The number of chemistry education papers published by Turkish researchers in national and international journals.



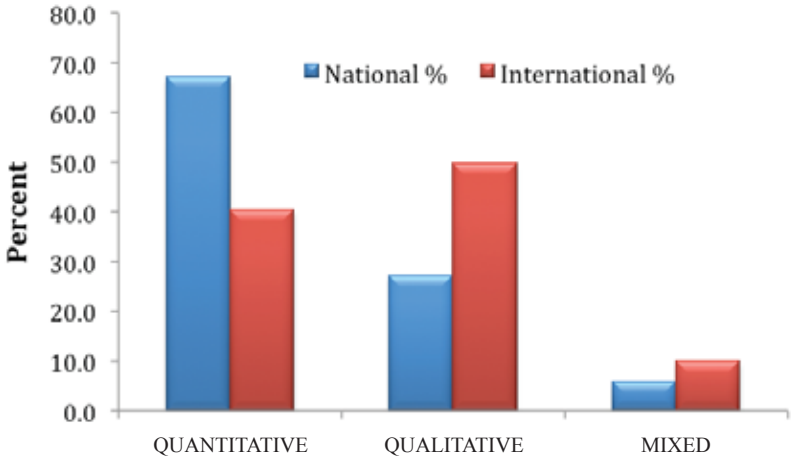


Figure 2. Comparison of the research method used in chemistry education research papers in Turkish and international publications.

Development of Chemistry Education as a Research Area

The roots of chemistry education as a discipline can be traced to several large-scale curriculum development projects in the 1960s, such as Chem Study and Chem Bond in the USA and Nuffield Chemistry in the UK. Following the disappointing results of these efforts, a hybrid discipline (Kempa, 1992; 2002) was born as chemists and educators began trying to understand how students learn chemistry so they could design its teaching in a way that improved learning outcomes. Today, chemistry education is a well-developed and accepted research discipline in developed countries, but has yet to spread throughout the world.

In Turkey, there was very little research in chemistry education before 1990. The bibliography compiled by Bağ, Kara, and Uşak (2002) and other content analysis studies (Sozbilir and Canpolat, 2006; Sozbilir and Kutu, 2008; Sozbilir, Kutu and Yasar, 2012) suggest that before then, only a few publications focused on chemistry education research had been published. Although during the Republican Era numerous education reforms were implemented and applied with great excitement, chemistry education did not improve (Özden, 2007). The most recent comprehensive reform effort was the multi-phased National Education Development Project (NEDP) of 1990, intended to improve the quality of teacher education in Turkey (Sozbilir, Kutu and Yasar, 2012). As a result of NEDP, programs of schools of teacher education (the name of courses and academic structures of teacher training colleges) and curricula (the content of courses) have become unique in the nationwide in 1998 (Türkmen, 2007). This reform increased interest in chemistry education research in Turkey. As figure 1 shows, research papers on chemistry education started to appear in national journals in 1999 and then, in the following years, increased dramatically at the national (Sozbilir, Kutu and Yasar, 2011; in press) and international levels (Chang, Chang, & Tseng, 2010; Lee, Wu, & Tsai, 2009). The total number of papers are still quite low compared to the number of people who are employed in chemistry education.[1]

Following the increasing interest in chemistry education research, the Higher Education Council of

	f	%
Teaching	82	30.0
Learning	82	30.0
Attitude/perception studies	29	10.6
Concept analysis	13	4.8
Studies on teaching materials	21	7.7
Nature of science/chemistry	6	2.2
Computer-aided Instruction	13	4.8
General educational problems	4	1.5
Curriculum studies	5	1.8
Tests/Scales development or translation	8	2.9
Teacher training	4	1.5
Other subjects	6	2.2
Total	273	100

Table 1. Frequently studied subject areas in chemistry education research papers by Turkish chemistry educators.

Chemistry Education Research in Turkey

Turkey provided international postgraduate education fellowships to a handful of students, most of whom studied in the USA and UK, with a few in France and Germany. Since 2000, those Ph.D. candidates have completed their studies and returned to Turkey. Figure 1 clearly shows their impact, with the number of papers published in international journals increasing steadily since 2002, while most of the papers before 2006 were published in national journals. In recent years, more papers have been published in international than national journals. The reason for this is a state policy that makes academic advancement contingent on international publication.

As seen from the table 1, most of the research focused on teaching, learning, and attitude and perception issues in chemistry education, which is similar to international trends. However, overall a broader range of issues were covered compared to international studies.

There are also differences in the research methods used by Turkish chemistry education researchers compared to their international counterparts, as reported by Sozbilir, Kutu, and Yasar (2011). Turkish researchers mostly relied on quantitative research methods, while international researchers tended to use qualitative methods. This may be because qualitative research methods are newer than quantitative methods. In addition, most of the quantitative research is descriptive, such as survey studies that are relatively easy to conduct, analyze, and report compared to qualitative papers that demand strong research and English skills.

The number of journals publishing science/chemistry education research in Turkey has also increased. New national and international journals inclue *EURASIA Journal of Mathematics, Science and Technology Education, Eurasian Journal of Physics and Chemistry Education, Journal of Turkish Science Education,* and *The International Journal of Environmental and Science Education.*

Although there have been significant improvements in the quality of chemistry education research taking place in Turkey, the field has yet to become robust. In particular, it would be helpful if more of the research could focus on how to improve chemistry education within Turkey.

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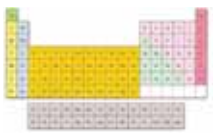
Detailed references are available online:
www.iupac.org/publications/ci/2013/3502/4_sozbilir.html

The Quest for the Periodic Table

Scientific American Classics, December 2012 online special edition

Scientific American recently produced an online resource about the periodic table and the elements. Part of the Scientific American Classics series, it contains original articles that appeared in Scientific American, dating back to the earliest days of the development of the periodic table starting in the 1860s. More than 50 articles are cataloged in this online issue, with the oldest article dating from 1861. Authors include Mendeleev, Le Coq Deboisbaudran, Winkler, Crookes, Ramsey, Soddy, Richards, and more.

Eric Scerri offers a contemporary preface in which he writes: "These days the periodic table has become something of a cultural icon—a meme, if you will. Web sites have spawned "periodic tables" of anything and everything that can be classified, from fruits and vegetables to famous guitar players. YouTube videos alone featuring the periodic table number about 14,000, according to the quick search I made this past October. A Google search for the words _periodic table_ results in almost 23 million hits, which incidentally is more hits than for "relativity theory" or "quantum mechanics." He continues by asking "But how did the periodic table spread? How did it evolve? How was it announced to scientists and the general public?" Read more of his preface at <www.scientificamerican.com/article.cfm?id=the-quest-to-put-elements-their-place>.



www.scientificamerican.com/classics/

Election of IUPAC Officers and Bureau Members—Call for Nominations

At its assembly in Istanbul, Turkey, on Wednesday 14 and Thursday 15 August 2013, the IUPAC Council will be asked to elect a vice president and members of the Bureau to fulfill the vacancies created by retiring members. IUPAC National Adhering Organizations are invited to submit nominations no later than 13 June 2013.

On 1 January 2014 Mark Cesa (USA), vice president and president-elect of IUPAC, will become president. Kazuyuki Tatsumi (Japan), current president, will become past president and remain an officer and a member of the Bureau for a period of two years, while Nicole Moreau (France), current past president, will retire. Secretary General René Deplanque (Germany) was elected to a four-year term 2012-2015 and continues his service for two more years. Treasurer John Corish (Ireland) who was re-elected for a four-year term 2012–2015, continues his service for two more years.

In addition, there are this year six vacancies for Elected members of the Bureau. Elected members are elected to a four-year term, and are eligible for re-election to a second four-year term. No National Adhering Organization shall have more than one Elected member on the Bureau, and the principle of fair geographical representation of members shall be taken into account, as stipulated in IUPAC Statutes.

Elected members whose terms expire at the end of 2013:

- Colin Humphris (UK) (2010-2013), eligible for nomination
- Stanislaw Penczek (Poland) (2006–2009, 2010–2013)
- Elsa Reichmanis (USA) (2006–2009, 2010–2013)
- Maria Van Dam-Mieras (Netherlands) (2006–2009, 2010-2013)
- Itamar Willner (Israel) (2010–2013), eligible for nomination
- Qi-Feng Zhou (China) (2010–2013), eligible for nomination

The following are members whose terms continue to the end of 2015:

- Christopher M.A. Brett (Portugal) (2012–2015)
- Javier García-Martínez (Spain) (2012–2015)
- Ram Lamba (Puerto Rico) (2008–2011, 2012–2015)
- Natalia Tarasova (Russia) (2008–2011, 2012–2015)

In addition to the five officers and the ten Elected Members, the Bureau also includes the eight Division Presidents (each elected by each individual Division), and three ex officio members representing the Operational Standing Committee, i.e. the Committee and Chemistry Education (CCE), the Committee on Chemistry and Industry (COCI) and CHEMRAWN, the CHEMical Research Applied to World Needs Committee.

IUPAC National Adhering Organizations are invited to submit nominations to the Secretary General at <secretariat@iupac.org> no later than 13 June 2013.

It is important for a vibrant organization that all vacant positions are filled after a fair and vigorous election process, so all nominations are encouraged. So, to make your voice heard, contact your National Adhering Organization and get involved.

What Does the Bureau Do?

The Bureau is established by the Council to act for the Union during intervals between meetings of the Council; it therefore fulfills important functions by ensuring continuity. The Bureau normally meets once a year. It consists of the officers (president, vice president, secretary general, treasurer, immediate past president), the division presidents and chairs of the operational standing committees, and 10 other members elected by the Council. The elections should also allow for a fair geographical representation. In principle, no member country should have more than one elected member on the Bureau.

The principal duties of the Bureau—as quoted in the Statutes (S7)—are as follows:

- to ensure the strict observance of Statutes and Bylaws
- to prepare the agenda for meetings of the Council and in particular to make provision for elections
- to make recommendations thereon to the Council
- to attend the meetings of the Council
- to implement the decisions of the Council and execute the program of the Union as directed by the Council
- to take steps to ensure that international congresses of pure and applied chemistry are held
- to take decisions about the holding of scientific meetings as proposed by the division committees
- to take all other steps necessary for the good conduct of the affairs of the Union

See the Statutes and Bylaws for details.

IUPAC 2013 Distinguished Women in Chemistry or Chemical Engineering—Call for Nominations

The International Union of Pure and Applied Chemistry is pleased to announce the call for nominations for the IUPAC 2013 Distinguished Women in Chemistry or Chemical Engineering Awards. The purpose of the awards program, initiated as part of the 2011 International Year of Chemistry celebrations, is to acknowledge and promote the work of women chemists/chemical engineers worldwide. In 2011, 23 women were honored during a ceremony held at the IUPAC Congress in San Juan, Puerto Rico, on 2 August 2011. The event was sponsored by a challenge grant from the American Chemical Society and by support from Dow Chemical (see Nov-Dec 2011 *CI*, pp. 19–21). A similar award ceremony will take place during the 2013 IUPAC Congress in August 2013 in Istanbul, Turkey.

Awardees will be selected based on excellence in basic or applied research, distinguished accomplishments in teaching or education, or demonstrated leadership or managerial excellence in the chemical sciences. The Awards Committee is particularly interested in nominees with a history of leadership and/or community service during their careers.

Nomination

Each nomination requires a primary nominator and two secondary nominators who must each write a letter of recommendation in support of the nomination. A CV of the nominee is required. Self-nominations will not be accepted.

Nominations should be received by 1 April 2013 and submitted by e-mail to <info@iupac.org>.

Presentation

Awardees will be honored at the 2013 IUPAC World Chemistry Congress in Istanbul, Turkey. Each awardee will receive a certificate of recognition from IUPAC.

Additional Information

For additional information on the IUPAC 2013 Distinguished Women In Chemistry Awards, contact Fabienne Meyers at <info@iupac.org>.

www.iupac.org/news/news-detail/article/iupac-2013-distinguished-women-in-chemistry-or-chemical-engineering.html

Physical Chemistry Cartoon Student Competition 2013

The IUPAC Physical and Biophysical Chemistry Division is pleased to announce the Student Physical Chemistry Cartoon Competition for 2013. This is the second time this competition is being held; the first was during IYC 2011 (see Nov 2011 *CI* <www.iupac.org/publications/ci/2011/3306/6_iyc_cartoons.html>). For the 2013 competition, entries should clearly illustrate an aspect of physical chemistry in a manner that can enrich the teaching of physical chemistry.

Awards of USD 100 will go to five students whose cartoons are chosen as winning entries. Entries (one per student) will be accepted until 31 May 2013 from students enrolled at a secondary school or tertiary institution on the closing date of entries. Entry guidelines and entry form can be found online at address below.

Judging

The cartoons will be judged by a panel with members from the IUPAC Division of Physical and Biophysical Chemistry. Reviewing criteria (from most- to least-weighted) will include:

1. relevance to physical chemistry (research, instructional, and/or application)
2. creation of interest, novelty, entertainment value, etc.
3. clarity and educational content
4. presentation

Submission Instructions

Submit cartoon and entry forms to cartooniupac13@chemistry.otago.ac.nz in either of the following formats:

a. a scanned jpeg image on a single A4 page, with up to 5 panels
b. a PowerPoint presentation of up to 5 slides, each being a cartoon panel

Key Dates

- Submission Deadline: 31 May 2013
- Decision Notification: 30 June 2013

www.iupac.org/news/news-detail/article/pchem-cartoon13.html

Chemical World Tour

In coordination with the 2011 celebrations of the International Year of Chemistry two years ago, five French students travelled on the Chemical World Tour to find out more about five innovations in chemistry that are likely to shape the future. Season I of the Chemical Word Tour was so successful that the organizers, French Union of Chemical Industries and the Fondation Internationale de la Maison de la Chimie, decided in 2012 to launch Season 2 on "Chemistry and Sport" to coincide with the London Olympic Games.

The CWT Step by Step

The Chemical World Tour starts with a casting session. An initial shortlist is drawn up based on written applications. This is followed by video-conferences with the candidates and final selection by a jury of professionals as part of a filmed talent-contest-style session.

For the 2012 event, 10 students were selected: five chemistry students (from professional baccalaureate to Ph.D.) and five journalism students from the European Institute of Journalism. Participants were paired in journalist/chemist teams with the aim of mixing complementary talents and providing a mutually beneficial experience.

Following a day's training session (on how to operate a mini camera and prepare for video shoots, etc.), each team was sent on a two–three day shoot, supervised by staff from CAPA Entreprises. The shoot provided material for participants to post on their blogs at www.chemicalworld-tour.fr website, such as photos/video footage, their impressions, what they learned, etc.

Once shooting was finished, the reports were edited by CAPA Entreprises and posted online in August 2012. The voting period opened on 30 August 2012 and for a month, followers were asked to vote for their favorite report.

Objectives

The Chemical World Tour is an initiative of the French Union of Chemical Industries and Fondation Internationale de la Maison de la Chimie, under an agreement with the Ministry of Education and Ministry of Higher Education and Research. The CWT has two main objectives: to explain how the chemical industry helps to create a more sustainable, safe, and successful sporting environment; and to encourage talented youngsters to take an interest in a career in the chemical industry.

For the 2012 Tour, five teams produced five reports from all corners of the globe. Each team visited R&D facilities equipped with a camera and film crew. The five teams travelled to the following destinations between 2–13 July 2012 and returned with unique stories and reports:

- Nordine and Pauline went to Rhodia in Brazil and returned with a story on smart-fiber fabrics for use in sportswear.
- Nora and Loïc travelled to Arkema in Japan to report on athletic shoes and bio chemistry.
- Perrine and Mickaël went to Dow in Spain and learned about artificial grass surfaces for new athletic facilities.
- Sara and Tanguy went to Bayer in Germany and reported on the technology used to manufacture soccer balls.
- Pierre and Hélena travelled to BASF in Germany to prepare a report on Phthalate-free PCV compounds for athletic facilities.

To view each team's report, visit <www.chemical-worldtour.fr>.

It still remains to be seen if a CWT can be repeated again this year or next, but the feedback from participants has been encouraging. According to UIC Communications Director Hélène Méjean, "the objective of this operation is two-fold. To show what goes on behind the scenes by going to the source of the innovation to understand the role played by the chemical industry and to stimulate interest from our younger generation in chemistry."

The 2012 CWT received support from the following partners: Arkema, BASF, Bayer, The Dow Chemical Company, Rhodia—a member of the Solvay Group, CAPA Entreprises—a radio/TV subsidiary of CAPA Press, European Institute of Journalism, and MCE—student television channel.

Aside from the Chemical World Tour, the UIC and the Fondation Internationale de la Maison de la Chimie have also collaborated onthe development of two serious games: "Super Kimy" (www.superkimy.com), for 7–11 year olds, and "Projet M2C" (www.projetm2c.com), for children 12 and over.

www.chemicalworldtour.fr

Harmonized Ecological Risk Assessment Framework for Nano-Pesticides in the Environment

Nanotechnology is emerging as a highly attractive tool for formulation and delivery of pesticide active ingredients. For example, nanocapsules based on polymers are being designed for controlled release of active ingredients as well as enhanced delivery by way of improved penetration through leaves. Some active ingredients are being reformulated to harness the extraordinary properties of nanomaterials. While a clear definition of nano-pesticides is still being sought, the term commonly refers to application of nanotechnology in delivery or formulation of pesticides. It is, however, not clear how the fate, behavior, and ecological risks of nano-pesticides differ from conventionally formulated pesticide active ingredients. There is a need to assess potential risks associated with nano-pesticides in a harmonized and scientifically sound way. Therefore, it is essential to develop a set of criteria or guiding principles on the basis of which the environmental risk of nanopesticides can be evaluated. Owing to the complexity of nano-pesticide formulations, the current approach applied to conventional non-nanopesticides is not directly applicable to nano-pesticides. This IUPAC project aims to address that gap by developing a set of guiding principles for informing the ecological risk assessment of nano-pesticides in the environment.

This project brings together international scientists from around the world (Europe, North America, Australia, Asia) including researchers, regulators, and industry. Links have also been established with the OECD Working Party on Manufactured Nanomaterials Steering Group 6 through Phil Reeves (APVMA, Australia). Although OECD is focusing mainly on human health and the manufacturing environment, its framework and materials on risk assessment are highly relevant to this project.

The key activities associated with the project include two specialist workshops, one each in 2013 and 2014. It is proposed that the 2013 workshop be held in Europe in May 2013, coinciding with the SETAC Europe meeting in Glasgow. The workshop is being organized in York (UK) and will be hosted by the University of York. The second major event would be held in San Francisco, a special symposium at the 13th IUPAC International Congress of Pesticide Chemistry in August 2014.

For more information, contact Task Group Chair Rai Kookana <Rai.Kookana@csiro.au>.

www.iupac.org/project/2012-020-3-600

Volumetric Properties: Liquids, Solutions, and Vapors

This new project is a companion to an earlier IUPAC project Heat Capactities: Liquids Solutions, and Vapors, which was published as a book with the same name by the Royal Society of Chemistry in 2010 (ISBN 978-0-85404-176-3). After the success and publication of *Heat Capacities*, RSC felt there was a need to bring together chemical thermodynamics topics, which are related to volume properties. This new project will also be collated and produced as a book (to be published by RSC) with the aim of publishing it by the end of 2013 or early in 2014.

The two companion projects have their origin in the committee meetings of the International Association of Chemical Thermodynamics. The new project, which only recently got off the ground, so far has commitments for 24 chapters from some of the most important researchers in their respective fields. They come from 13 countries: Austria, Australia, Canada, Czech Republic, France, Germany, Israel, Japan, Poland, Spain, South Africa, UK, and the USA. The project is ongoing and new topics and authors could well be added before the deadline for submission of manuscripts, which is at the end of September 2013.

One of the objectives of the book is to bring together research from disparate disciplines that is related to volume properties. Having the related topics in one volume, the editors believe, could have a synergistic effect leading to new ways of solving problems.

The book is also aimed at highlighting the very latest approaches to problems related to volumes and presenting new data in a constructive manner. It will be ideal for anyone working in any of the fields discussed or for those thinking of entering one of these fields.

The book will include:

- a presentation of the underlying theory
- the most important experimental techniques
- thermophysical characterization
- volume properties of liquids vapours and mixtures including electrolyte and non-electrolytes
- volume properties involving ionic liquids and molten salts
- gases in liquids
- high-pressure effects
- virial coefficients
- speed of sound measurements
- compressibilities
- critical behavior
- protein solutions
- data on aqueous solutions

- presentations of different modeling and computer simulations, density standards
- up-to-date references to mid–2013

The authors will adhere to the nomenclature and symbols of the IUPAC "Green Book" and any deviations will be defined and explained.

For more information, or if you are interested in being part of this Task Group and can contribute something new to the subject, please contact Task Group Chair Trevor Letcher <trevor@letcher.eclipse.co.uk>.

www.iupac.org/project/2012-038-1-100

Toward Higher Quality Chemistry Teacher In-Service Training in Croatia

In November 2010, the 1st Croatian Workshop on Chemical Education, held in the town of Split, focused on the quality of in-service teacher training, inquiry-based learning, and learner-oriented teaching strategies. The workshop was the outcome of a CCE Flying Chemists program intended to develop the process of in-service training of chemistry teachers in Croatia and the region and to catalyze the dissemination process of in-service experiences among neighboring countries.

The program of activities in Croatia followed a model used successfully by the Flying Chemists Program in the Philippines, India, and Sri Lanka, namely bringing together at the national level a critical mass of chemistry educators to improve chemistry education, facilitated by external resource persons with expertise in areas targeted by the country. The Croatian Flying Chemists Program was a partnership among the Ministry of Science, Education, and Sport; the Croatian Education and Teacher Training Agency; and the Croatian Chemical Society. The first workshop had 120 participants from around Croatia and a few from the neighboring countries of Macedonia and Bosnia, who came together to identify ways to strengthen chemistry education at the primary and secondary levels.

The 2nd Croatian workshop on Chemical Education was held in Split, 8–11 November 2012. Despite having a pronounced national prefix, the Croatian Workshop on Chemical Education was organized for an international audience of teachers to primarily discuss problems being regularly encountered in learning and teaching of chemistry at all levels of education. The 2nd CWCE was devoted to the following topics:

- Teaching Chemistry: guided-inquiry and student-oriented learning
- Communication: the "professional language" vs. the mind of the non-expert
- Research in Chemical Education: what to research in chemical education and why?
- The Interdisciplinary Attack: to the mathematics, physics, biology . . . and back
- Microscale and Green Chemistry: implementation in the classroom.

In summary, the first steps of the project have been a success, the main short-terms goals of the project have been accomplished, and good ground is now in place to sustain interest and development in chemical education in the region.

For more information, contact Task Group Chair Nenad Judaš (University of Zagreb) <judas@chem.pmf.hr>.

www.iupac.org/project/2009-055-1-050

Guidelines for Multinational Calls for Research Cooperation

In 2009, the first Transnational Call for Proposals in Polymer Chemistry, an IUPAC pilot call backed by several leading funding organizations, was announced and managed by an IUPAC call secretariat together with a call oversight committee from the IUPAC Polymer Division. The goal of this pilot call was to establish an efficient transnational funding program in chemistry, to transcend national/continental boundaries, to allow for minimal bureaucracy for the applicants, and to establish best practices for future calls of this type.

Teams of three or more principal investigators from three different participating nations were eligible to submit a single research proposal that underwent a single common scientific review and received a single funding decision. For each successful proposal, the individual applicants received funding from their respective national participating agency. Supporting this call were the IUPAC Polymer Division and seven national funding organizations that agreed to participate.

This call had a tremendous resonance: 35 letters of intent were received out of which 30 were approved; 28 full proposals were submitted out of which 7 were selected for funding (see details at www.iupac.org/polyedu/DivIVCall).

The task of monitoring the call and establishing best-practice guidelines was performed by a team consisting of IUPAC members and representatives of participating funding agencies in an IUPAC project.

Progress reports from the funded teams were presented at the 44th IUPAC World Polymer Congress in Blacksburg, Virginia, USA, June 2012. A feedback session with teams was also held at that congress.

The call monitoring team made a report on the outcome, benefits, and shortcomings of the pilot call and put together relevant documents from the pilot call, the report by the call secretary, and the minutes of the feedback session. These documents have already been used for the organization of the second international call for proposals, which was announced in November 2012. The set of documents and the report of the monitoring team are available from the following project page <www.iupac.org/project/2010-032-3-400>. They can be used as guidelines for similar international calls under the guidance of IUPAC or other organizations.

Behind the Pilot Call

IUPAC and participating national funding agencies recently issued a second international call for proposals, this time on Novel Molecular and Supramolecular Theory and Synthesis Approaches for Sustainable Catalysis.

Modeled after the earlier pilot, this call is intended to foster multinational cooperation in sustainable chemistry. The call is coordinated by the IUPAC Division of Chemistry and the Environment. See details in Jan-Feb 2013 *CI*, p.16 or at www.iupac.org/news/news-detail/article/international-call-for-proposals-in-sustainable-chemistry.html.

For more information about the monitoring task project, contact Task Group Chair Werner Mormann <mormann@chemie.uni-siegen.de>.

www.iupac.org/project/2010-032-3-400

Stamps International

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

Vauquelin's 250

Nicolas Louis Vauquelin (1763–1829) was undoubtedly one of the most versatile and accomplished chemists of the late 18th century and the first half of the 19th century, even though he may not be as well-known today as some of his contemporaries, such as Berzelius, Dalton, Davy, or Gay-Lussac. He was born 250 years ago in the small village of Saint-André-d'Hébertot in the region of Lower Normandy in northwest France, not far from the beaches that were used as landing sites on D-Day during World War II. Despite a humble upbringing, his ingenuity and diligence led to a remarkable career that conspicuously included the discovery of the elements chromium (1797) and beryllium (1798). He also held several academic positions, including simultaneous professorships at the School of Public Works (i.e., the renowned École Polytechnique near Paris) and the School of Mines, where he analyzed the chemical composition of dozens of minerals and gemstones. He was appointed professor of chemistry at the Collège de France in 1801 and director of the newly founded School of Pharmacy in 1803. The following year he became professor of applied chemistry at the Museum of Natural History and in 1811 he succeeded Antoine François de Fourcroy (1755–1809), his longtime mentor, research collaborator, and business partner, at the School of Medicine.

Vauquelin certainly had a wide range of interests that extended way beyond the fields of mineralogy and metallurgy. In 1806, with the assistance of Pierre Jean Robiquet (future discoverer of the red dye alizarin and the alkaloid codeine), he obtained from asparagus juice a white crystalline compound that he named asparagine, which was the first amino acid to be isolated in pure form. He also investigated the respiration of insects and published several papers on medical subjects, ranging from the composition of urinary stones and the human brain to the chemical properties of hair and semen.

While the postage stamp illustrated in this note was issued in 1963 on the occasion of Vauquelin's 200th birth anniversary, it remains to be seen if La Poste will honor the eminent chemist once again this year. In the meantime, readers of *Chemistry International* may enjoy knowing that a dessert—a flavored egg white foam microwaved for a few seconds—created by molecular gastronomist Hervé This called a Vauquelin!

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

Provisional Recommendations

Provisional Recommendations are drafts of IUPAC recommendations on terminology, nomenclature, and symbols made widely available to allow interested parties to comment before the recommendations are finally revised and published in Pure and Applied Chemistry. *Full text is available online.*

Definition of the Transfer Coefficient

This recommendation aims at clarifying and improving the definition of the transfer coefficient reported in the 3rd edition of the IUPAC "Green Book."

Comments by 31 March 2013
Professor Rolando Guidelli
University of Florence
E-mail: guidelli@unifi.it

www.iupac.org/project/2011-038-1-100

Glossary of Terms Used in Medicinal Chemistry Part II

Comments by 30 April 2013
Professor Derek Buckle
E-mail: drb@drbassoc.co.uk

www.iupac.org/project/2008-010-1-700

Terminology of Metal-Organic Frameworks and Coordination Polymers

Comments by 30 April 2013
Professor Lars Öhrström
Chalmers University of Technology
Dept. of Chemical & Biological Engineering
Physical Chemistry, Room 5023,
S-412 96 Göteborg, Sweden
E-mail: ohrstrom@chalmers.se

www.iupac.org/project/2009-012-2-200

Glossary of Terms used in Computational Drug Design, Part II

Computational drug design is a rapidly changing field that plays an increasingly important role in medicinal chemistry. Since the publication of the first glossary in 1997 (*Pure Appl. Chem.*, 1997, Vol. 69, No. 5, pp. 1137–1152. http://dx.doi.org/10.1351/pac199769051137), substantial changes have occurred in both medicinal chemistry and computational drug design. This has resulted in the use of many new terms and the consequent necessity to update the previous glossary. For this purpose a Working Party of eight experts was assembled. They produced explanatory definitions of more than 200 new and revised terms.

Comments by 31 May 2013
Yvonne Martin
E-mail: yvonnecmartin@comcast.net

www.iupac.org/project/2010-057-3-700

Abbreviations of Polymer Names and Guidelines for Abbreviating Polymer Names

This document provides some basic rules and guidelines regarding the use and creation of abbreviations for the names of polymers. An extended list of currently used abbreviations for polymers and polymeric materials is appended.

Comments by 31 May 2013
Jiasong He
E-mail: hejs@iccas.ac.cn

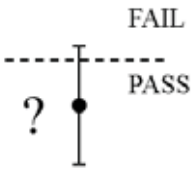
www.iupac.org/project/2006-004-1-400

Evaluation of Measurement Data: The Role of Measurement Uncertainty in Conformity Assessment

by D. Brynn Hibbert

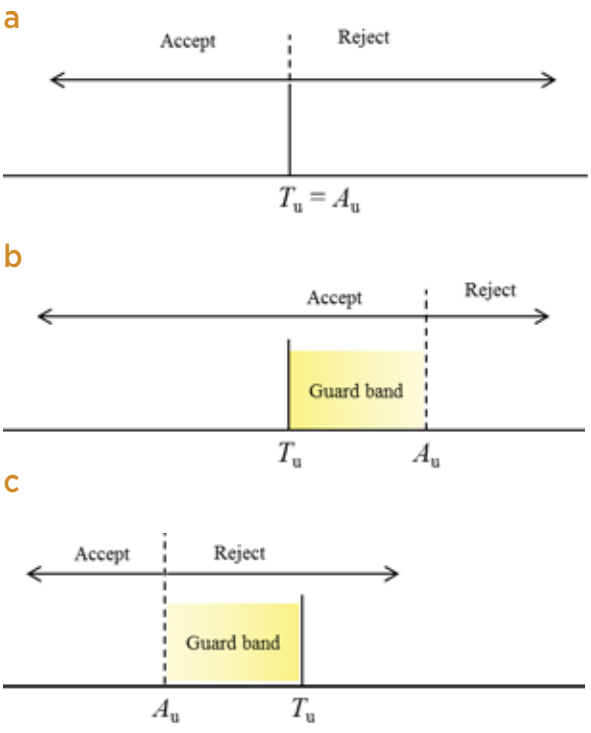
The reason for making a measurement often involves comparison of the measurement result with another result, a standard value, a legal limit, or perhaps a value written in a contract. The question addressed by the recently-published guidance document JCGM 106:2012, *Evaluation of Measurement Data—The Role of Measurement Uncertainty in Conformity Assessment*,[1] is how to take measurement uncertainty into account when deciding whether such comparisons are satisfactory. It was fashionable at one time, particularly in legal matters, to assert that there was no uncertainty of measurement and that a prescribed limit had already taken into account any concerns of measurement error (as it was then known). This is not a good idea. Leaving aside the faulty logic, this approach does not allow changes in methods that may lead to lowering of uncertainty. With the publication of ISO/IEC 17025[2] evaluation of measurement uncertainty became required, and its reporting mandatory when measurement results were being assessed against limits (5.10.3.(c) " ... information on uncertainty is needed in test reports ... when the uncertainty affects compliance to a specification limit;"). Thus, measurement uncertainty is now closely associated with conformity to limits, and it is not surprising that the Working Group charged with the stewardship of the GUM[3] turned its attention to this important aspect of measurement uncertainty.

The approach to evaluating measurement uncertainty taken by the original authors of the GUM and maintained by the JCGM-WG1 in its preparation of further guides and, at present, the second edition of the GUM itself, is that a measurement result can be expressed in terms of a probability density function (PDF), the form of which gives the value to be reported (usually the mean of the distribution) and a coverage interval in which the value of the measurand is believed to lie with a stated probability. Strategies for obtaining information about the PDF depend on the measurement problem and the data available, but the package of approaches is loosely called "Bayesian," after the 18th century English cleric who is credited with providing the first description of the inductive probabilistic reasoning that later led Laplace to write down what is now known as Bayes Theorem.



Comparing a measurement result with a limit provides a nice example of this probabilistic approach, as one of the often-asked questions is, "what is the probability that I will make a mistake if I accept/reject this item based on my measurement result." In the world of process control the probability of accepting an item when it should have been rejected is known as the

Figure 1. Acceptance or rejection of an item on the basis of a measurement result. T_u is an upper tolerance limit with which a measured property must comply (the true value must be less than T_u). A_u is the upper acceptance limit of the measured value. (a) shared risk (or simple acceptance) where the tolerance and acceptance limits are equal; (b) guarded acceptance, which reduces the producer's risk; (c) guarded rejection, which reduces the consumer's risk. The nomenclature follows from guidance document JCGM 106:2012.



"consumer's risk," and the probability of falsely rejecting the item is known as the "producer's risk." Each of these can be modelled in terms of the measurement result and associated measurement uncertainty, and appropriate acceptance limits can be chosen so as to balance the risks. Methods for calculation of these risks are a central focus of JCGM 106.

Simply deciding to accept a value that is within the prescribed "tolerance limit," and to reject one that is outside shares the risk between consumer and producer. The probability of false acceptance or false rejection is equal (assuming a symmetrical PDF) for a measurement exactly at the tolerance limit. Such a "decision rule" is called simple acceptance in JCGM 106, and is often accompanied by a requirement that the expanded measurement uncertainty be no greater than a specified value.

Another decision rule described in JCGM 106 is called "guard banding." If the consequences arising from the two errors are different, life and death in some health or forensic situations, a second limit, offset from the tolerance limit, is often prescribed (an "acceptance limit") which defines a "guard band." The use of a guard band reduces the probability of error for one or other of the risks and in doing so increases the probability of the other, less seriously consequential, risk. See Figure 1.

An example of guarded acceptance is found in testing race horses for administration of sodium bicarbonate, a so-called "milk shake" which raises the concentration of carbon dioxide in blood. The limit published in the rules of racing is that a horse must not be presented for racing with greater than 36 mmol L^{-1} "total carbon dioxide" (TCO_2). TCO_2 is measured by an electrochemical gas analyser with an uncertainty of about 0.2 mmol L^{-1}. In Australia, a prosecution is not brought until the measured concentration is greater than 37 mmol L^{-1}. The example is therefore one of Figure 1 (b) with T_u = 36 mmol L^{-1} and A_u = 37 mmol L^{-1}. Knowing that the standard uncertainty of the measurement is 0.2 mmol L^{-1} and assuming a normal distribution for the PDF of the measurement result, the odds that a sample with a measured concentration of 37 mmol L^{-1}, causing the trainer of the horse to be liable to prosecution, actually being legal at 36 mmol L^{-1} or less, are about 3½ million to one against. In contrast, a horse with 37 mmol L^{-1} TCO_2 in its blood has a one in two chance of getting away with this transgression. (For the actual uncertainty budget and calculations see reference 4).

Acknowledgement

The author thanks Dr. Tyler Estler, the principal author of JCGM 106, for his advice on this manuscript.

D. Brynn Hibbert <b.hibbert@unsw.edu.au> is a professor at the School of Chemistry at University of New South Wales in Sydney, Australia. He has been a member of the IUPAC Analytical Chemistry Division since 2002 and is currently the vice president.

References

1. Joint Committee for Guides in Metrology. *Evaluation of Measurement Data—The Role of Measurement Uncertainty in Conformity Assessment*, JCGM 106:2012:2012 BIPM, Sèvres, www.bipm.org/utils/common/documents/jcgm/JCGM_106_2012_E.pdf
2. ISO/IEC. *General Requirements for the Competence of Calibration and Testing Laboratories*, 17025:1999 International Organization for Standardization, Geneva.
3. Joint Committee for Guides in Metrology. Evaluation of Measurement Data—Guide to the Expression of Uncertainty in Measurement, JCGM 100:2008:2008 BIPM, Sèvres, www.bipm.org/en/publications/guides/gum.html
4. D.B. Hibbert, A. Stenhouse, C. Murphy, M. Jarrett, R. Osborne, J. H. Vine, L. Glowacki, C. Russo. *Accred. Qual. Assur.* 13 (2008).

IUPAC is one of eight organizations that comprise the Joint Committee for Guides in Metrology (JCGM), a committee of BIPM, the Bureau international des Poids et Measures: IUPAC, IUPAP, IFCC, OIML, ISO, BIPM, ILAC, and IEC. The JCGM includes two working groups: WG1 responsible for the GUM (Evaluation of Measurement Data—Guide to the Expression of Uncertainty in Measurement) and WG2 responsible for the VIM (International vocabulary of metrology – Basic and general concepts and associated terms); both documents are available at <www.bipm.org/en/publications/guides>. Paul De Bièvre is the IUPAC representative on the JCGM. He and René Dybkaer are the representatives on WG2, and Brynn Hibbert and René Dybkaer are IUPAC's representatives on WG1.

IUPAC has recently endorsed and adopted the JCGM guide, Evaluation of Measurement Data—The Role of Measurement Uncertainty in Conformity Assessment (JCGM 106:2012), written by WG1.

Materials for a Sustainable Future

edited by Trevor M. Letcher and Janet L. Scott
The Royal Chemical Society of Chemistry, 2012
ISBN 978-1-84973-407-3

reviewed by Michael Droescher

Materials have always played a central role in human culture and development. Besides wood and other biological materials such as wool, mankind first used materials like flint stone before moving on to metals like bronze and iron. Historians even base their timetable of human development on the materials used at the time, Stone, Bronze, and Iron Ages. The second half of the 20th century is sometimes called the Plastics Age.

Unfortunately, the production and consumption of metals, which are mined, and plastics, mostly made from fossil fuel, are not sustainable in the long term. Even mining fertilizer from deposits of phosphor minerals cannot go on forever. But, as always, there are two sides to the coin. Sustainability involves more than one's carbon footprint, climate change, or resource depletion. Sustainability is based on three pillars, ecology, economy, and social stability, or the three Ps, people, planet, and profit. With seven billion people on the earth in need of food, water, shelter, and medical treatment—not to mention communication, mobility, and comfort—it will become imperative to develop more sustainable materials to meet these needs.

In Materials for a Sustainable Future, Trevor Letcher and Janet Scott ask, what do we know about these materials today, what do we need to use them in a more sustainable way, or even in a *really* sustainable way? They tackle these questions from a positive point of view, based on the fact that humankind has always invented new ways and found better solutions to cope with new challenges. They invited 42 authors from 12 countries and all five continents to contribute their knowledge and discuss what should be done in the future. The authors are a good mix of young and experienced scientists, both academic and industrial. The book, supported and sponsored as IUPAC project 2011-042-1-022, was initiated to mark the International Year of Chemistry 2011.

This is not a book you read like a novel from start to end. The 22 chapters go deep into their respective subjects as they stand today, with data and multiple references, but they also provide a good introduction, a look forward, and most of them also a short conclusion. Thus, industrialists, investors, or policy makers will find what they need to know, as will students, teachers, and researchers. It is, as claimed, a readable format for scientists as well as nonscientists.

This book will open the eyes of many a policy maker, when they recognize that there are more challenges than fossil resource depletion, energy and climate influencing gases. The book cover shows a periodic table, where 16 elements are colored red, meaning that they are already very scarce or a rising threat is observed, and many more in yellow, where the availability is limited and a future scarcity of supply is expected. The cover also shows a graph of a bio-refinery scheme. Bi-based value chains are also a major topic in this book.

The book is built on five themes. The first focuses on elements that could soon be in short supply, followed by the second giving a view on sustainability related to biomass, and the third on sustainability related to the feedstock CH_4 and CO_2. The fourth theme reports on materials related to energy conversion, storage, and distribution. The fifth theme relates sustainability to materials in the urban environment and to water. With limited space, not all topics in the field of sustainability could be included, but the selection covers most of the field.

The chapters focus on single issues related to sustainability, providing detailed information on geology, chemistry, technology, history, and economic data—much more information than expected in a typical handbook. It is clearly a view of today, a snapshot, but always with recent data incorporated.

Chapter 1 discusses base metals and their uses. Copper, lead, zinc, and nickel are treated from mining to consumption data and uses. Also, related greenhouse gas emissions are discussed. The conclusion is that base metals will not be in short supply in the medium term but it is clear that sustainability of production will be governed more by the environmental costs and risk in mining than simply the tonnage remaining.

Rare earths, chapter 2, is a well-discussed topic these days since these materials are key for many electronic applications and for electro mobility, and because political issues impact the world trade. Thus, new sources are being sought, with the number of projects under development outside China rising. The chapter also discusses the increasing interest in finding substitute materials for rare earths.

Chapter 3, which examines the supply of gold, provides some sobering statistics: 168 kt of gold have ever been mined, 104 kt remains in private hands, and it is

estimated that only 50 kt remains available in mineral reserves underground. However, demand is rising since gold is also an important material in electronic devices. In the future, it could be especially important to nanotechnology applications.

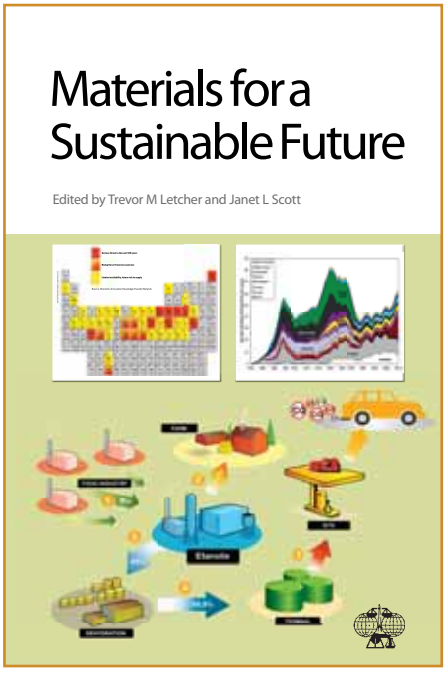
Platinum group metals, covered in chapter 4, are mainly found in South Africa, with the remaining resources estimated to be around 90 kt globally, compared to an annual production of about 465 t. Sincethese precious metals are very important for catalysis in many ways, they are also of high value for a more sustainable chemistry.

Helium is a strategic element because its cryogenic properties are unique, and for many applications there are no substitutes, as discussed in chapter 5. It is only available from natural gas wells and it might be depleted in 100 years. We should be very careful with the remaining amounts.

In chapter 6 we learn that phosphorus might start to become scarce, even though it is the eleventh most abundant element in the earth's crust. Given our dependence on phosphorus fertilizer for food production, we will need to make changes to our agriculture, production, wastewater treatment, nutrient recovery, and behavior.

The last chapter under the first theme is on uranium. Nuclear power is viewed very differently around the world. Germany, the home of the reviewer, will terminate all nuclear power generation by 2022 due to the risks involved and unsolved waste questions. Other countries plan to use even more nuclear power. For the authors, nuclear power is a viable strategy to address global climate gas emissions, due to increasing mining efforts, which produce more and more climate gas emissions by themselves.

The biomass theme starts with chapter 8 on aquatic biomass for the production of fuels and chemicals. Producing energy from algae might not be the right path, but for chemicals it is a different story, since high value chemicals can be produced. Chapter 9 discusses using sugarcane as the source for carbon. This well-established route for ethanol production is being extended to other chemicals.



Chapter 10 covers chemicals from biomass at large. The authors clearly state that "bio-based" does not automatically imply "sustainable." Bio-based chemicals are widely developed. Drop-in solutions, where chemicals from biomass are introduced into existing production pathways, are on the way.

This brings us to the next theme, feedstocks based on CH_4 and CO_2. Methane for transportation fuel and chemical production is discussed in chapter 11. Natural resources as well as chemical methods of production are discussed. The conclusion is that CH_4 will play an important role in future feedstock, either from natural gas or synthetic routes.

In Carbon Capture and Storage, chapter 12, the authors find that the process is not yet feasible, as it costs about 20 percent of energy output. More development of materials and process engineering is needed. Carbon dioxide utilization in the production of chemicals is the topic of chapter 13. The article discusses CO_2 as a building block in polyesters and other polymers and the production of fuels. Polycarbonates are the focus of chapter 14 on carbon dioxide in the manufacture of plastics. Carbon dioxide as a sustainable industrial solvent to replace organic solvents (chapter 15) is a well-established technology, which surely will be extended to other processes.

The topic of chapter 16 is battery and fuel cell materials and related issues of energy conversion, storage, and distribution. There is already large-scale production of batteries. The limiting factors are degradation and lifetime.

Materials for photovoltaics are covered in chapter 17. Here, the strong demand will lead to acute supply problems. Substitution, where abundant elements are essential, is a key issue. The dream reaction is water splitting, discussed in chapter 18. In this field we need much more research. Also, the transformation of hydrogen to liquid fuel will become an important focus of research.

The final theme is sustainability related to materials in the urban environment and to water. Chapter 19,

continued on page 27

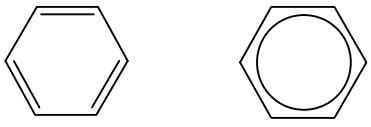
Drawing Chemical Structures

by Jeffery Leigh

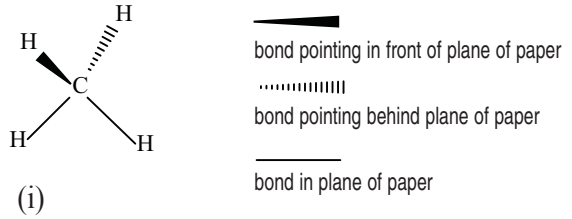
Although the drawing of chemical structures is not strictly a nomenclature matter as usually understood, it is a way of conveying the structure of a chemical compound just as is an IUPAC systematic name, though using a visual language rather than a verbal one. Consequently, it is necessary to use certain widely-accepted conventions when drawing a chemical structure, particularly if that structure is three-dimensional and the representation of that structure as drawn on a sheet of paper is necessarily in two dimensions. IUPAC has attempted to define preferable methods for achieving this, and the new edition of *Principles*, unlike its predecessor, contains a summary of what is currently considered to be best practice to this end.

Certain recommendations are almost self-evident. For example, it is common, but not mandatory, to use the same font and font size in your structural diagrams as in your text. *Principles* uses Times New Roman, which was this editor's choice. Some people prefer to use sans serif fonts such as Arial, though this can lead to minor confusion between symbols, such as l and 1(Times New Roman) with l and 1(Arial). Unusual abbreviations used in a diagram label should be defined somewhere in the article being written. It is not enough to assume that everyone will know what thf stands for, though this is probably acceptable for Ph. Bond lengths, thicknesses, and angles should be used consistently in all your diagrams. You should decide whether to represent aromatic rings as localized systems, as in (a) below, or as delocalized systems as in (b). Which you choose is not important, as long as your symbolism is clearly understood and is used consistently.

(a) (b)

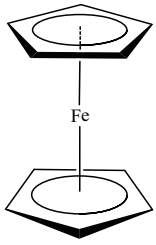


In the past, a variety of methods has been employed to portray a three-dimensional structure in two dimensions, for example, to show whether a bond which does not lie in the plane of the paper is pointing behind that plane or forwards towards the reader. In *Principles*, we have settled for conventional methods, as shown below in (i) for the tetrahedral molecule CH_4.



(i)

Principles also introduces adaptations of this convention, for example, in order to represent certain ring structures, as in the representation for the ferrocene molecule shown below (ii).



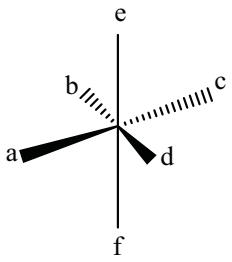
(ii)

More complicated polyhedral shapes than tetrahedral are frequently encountered in chemistry, and these are also discussed in *Principles*, which introduces the most common three-dimensional structures found in coordination chemistry and also the most common projections used to represent the three-dimensional structures of organic molecules. For the beginner, these are sometimes not easy to understand.

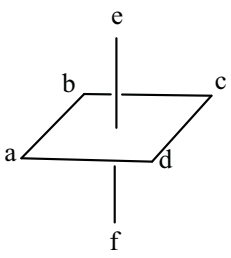
The octahedron is a shape very often found in coordination chemistry, but the manner in which it is represented depends upon the circumstances. In the representation (iii) below of a coordination complex formally written as [Mabcdef], the bonds between the ligands (a, b, c, etc.) to the central metal [not specifically indicated in diagrams (iii)-(v)] are represented using the formalism described above in (iii), but in (iv) the principal plane of the octahedron is drawn, but only the bonds to ligands e and f. Finally, in (v), only the octahedron is delineated and no bonds. The edges of the solid octahedron invisible to a viewer are represented by dashed lines. Yet, all three are acceptable representations of the molecule [Mabcdef], and should be equally comprehensible to the informed reader.

Organic chemists have related problems when representing organic structures in three dimensions, and they use a variety of projections to do this, the prin-

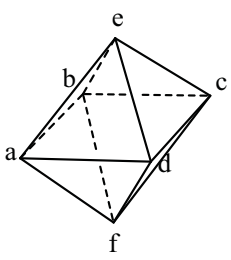
The next topic in this series will be organometallic nomenclature.



(iii)

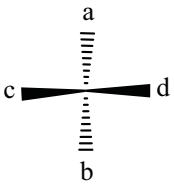


(iv)

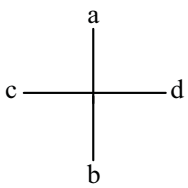


(v)

cipal ones being named after their inventors: Fischer, Haworth, and Newman. These particular projections are usually applied to specific classes of molecule. In a Fischer projection, the bonds to the carbon at the center of the tetrahedron are not represented as in the drawing of Cabcd (vi), but in a plane as in (vii), the convention being that bonds drawn vertically are pointing behind the plane of the paper, and the horizontal ones in front. The central carbon atom is not specifically represented. This type of projection is used primarily for carbohydrates and amino acids.

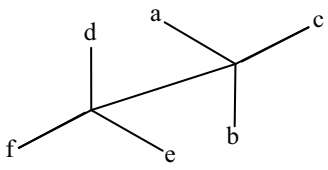


(vi)

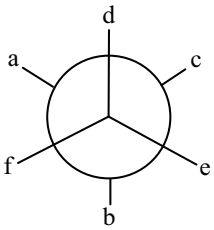


(vii)

A Newman projection is employed to represent more complex molecules, such as an ethane-type molecule C_2 abcdef, where different conformations with respect to a selected carbon-carbon bond may be present. This is illustrated in (viii) and (ix) below. Finally, Haworth projections are often applied to compounds such as monosaccharides and polysaccharides.



(viii)



(ix)

The use of all these devices and more, including various ways to represent conformations, are discussed in the new volume of *Principles*, together with appropriate examples and literature references.

Jeffery Leigh is the editor and contributing author of *Principles of Chemical Nomenclature—A Guide to IUPAC Recommendations*, 2011 Edition (RSC 2011, ISBN 978-1-84973-007-5). Leigh is emeritus professor at the University of Sussex and has been active in IUPAC nomenclature since 1973.

www.iupac.org/publications/ci/indexes/nomenclature-notes.html

continued from page 25

which discusses membranes used for water purification, provides a good overview of existing materials and developments.

Glass is not a new material. Nevertheless, new technologies open new opportunities for sustainability, as shown in chapter 20. Examples are thermo-chrome and photo-chrome functionalities and self-cleaning properties. Cost effective solutions must be developed.

The book is well illustrated and chapters are well documented with up to 150 references. Unfortunately, not all figures and tables reveal the data source. The subject index is large and allows easy access to all topics.

The book is valuable in more than one way. It covers a wide field of materials. For a given subject the reader finds extensive data. With a look at the conclusions he or she will get an understanding of what we can do to become more sustainable. It is a large book and not cheap. But the density of information and the different views it provides on an important subject make it worth the money. I thank and congratulate Trevor Letcher and Janet Scott for their effort in publishing this book.

www.rsc.org/shop/books/2012/9781849734073.asp

WMFmeetsIUPAC

by Hans van Egmond and Rudolf Krska

Under the intriguing name **WMFmeetsIUPAC**, a large international conference was organized in Rotterdam, the Netherlands, 5–9 November 2012. The unique conference was a merger of the 7th Conference of the World Mycotoxin Forum and the XIIIth IUPAC International Symposium on Mycotoxins and Phycotoxins. Mycotoxins and phycotoxins are classes of natural toxins, produced by fungi and algae respectively, that are of significant concern to the health of humans and animals. Whereas exposure is largely caused by the ingestion of toxin-contaminated food and feed, other routes (inhalation, dermal contact) cannot be neglected.

Panel discussion, moderated by Rudolf Krska and Hans van Egmond.

The IUPAC symposia on Mycotoxins and Phycotoxins has existed since 1972. They were held for the first time approximately a decade after the discovery of mycotoxins. Traditionally, the IUPAC symposia, which had a strong focus on (applied) chemistry and were held at intervals of three to four years all over the world, attracted in particular attendees from academia, research institutes, and government agencies. The World Mycotoxin Forum (WMF) is a younger series of conferences somewhat smaller in size than the IUPAC symposia. They have been organized since 2001 by Bastiaanse Communication, usually in the Netherlands, once every two years. WMF conferences put more emphasis on issues such as prevention and control, whereas practical solutions for the food and feed industry got a more prominent place in the conference programs compared with IUPAC symposia.

The conference WMFmeetsIUPAC aimed to increase awareness of human and animal health risks due to natural toxicant contamination in agricultural commodities and seafood, and of potential risk-management options, technologies, and strategies for minimizing contamination. The event focused on mycotoxins, phycotoxins, and plant toxins. The latter group of toxins was included in the scope of the conference because it is of increasing concern to the health of both humans and animals. The conference attracted approximately 450 attendees, representing 42 countries. With the support of authoritative scientific and advisory committees, a program was built which included more than 100 invited lectures and oral contributions in 2 plenary meetings and 12 parallel sessions; over 200 posters; various workshops and satellite meetings; spotlight presentations, case studies, and industry updates; and an instrument/manufacturers exhibition.

Following the introductory presentations on the first day of the conference, four keynote speakers shared their views on the challenges for the coming years in the areas of mycotoxins, phycotoxins, and plant toxins. This plenary session was rounded off by a panel discussion in which the keynote speakers were complemented with three leading representatives from a research institute, a university, and the European Commission. A summary of the first day's conclusions:

- Rare mycotoxicoses have shown that we need to expect the unexpected, symbolized with "black swans."
- More research is needed on the synergistic adverse effects of mycotoxins, and the influence of external weather conditions on their formation.
- Modern instrumental analytical methods for phycotoxins offer superior performance over (official) animal tests.
- Plant toxins cause major economic losses to the livestock industry, and should be given more attention.

A reception in Rotterdam's elegant Town Hall hosted by the city of Rotterdam and the vice mayor Mrs. Kriens, completed the day.

On the second day of the conference, several parallel sessions were held on subjects ranging from "Emerging Toxins and New Occurrence Data," "Human and Animal Health Implications," "Prevention and Reduction" through to "Analytical Solutions in the Spotlight." During the latter session many commercial companies were given the opportunity to display their products in a nutshell. From the second day's presentations and discussions the following general statements could be derived:

- Risk assessment of mycotoxins needs to include scenarios based on mechanisms of action and on

exposure to multiple contaminants.
- Biomarkers of exposure and effect advance our understanding of health effects of mycotoxins.
- Toxicological data are needed to clarify health effects of "masked mycotoxins."
- Successful biocontrol of aflatoxins is a reality in developing countries.

The third conference day involved five parallel sessions, which included the ever popular session "Sampling and Novel Analytical Tools" and the session "Novel Integrated Strategies for Worldwide Reduction," where outcomes of the Large Collaborative EU-project MycoRed were disseminated. Sessions on "Factors Affecting Toxin Formation in the Environment," "Airborne Exposure to Mycotoxins in Indoor and Occupational Settings," and "Contemporary Issues on Phycotoxins" attracted many attendees as well. This day was rounded off with a boat trip through Rotterdam's harbor followed by a magnificent conference dinner in the underwater world of the Rotterdam Zoo. Scientifically, the third day's conclusions included the following:

- MycoRed created massive interaction in mycotoxin research at a global level.
- Biosensors have a great potential in view of the rapid developments in nanomaterials and recombinant antibodies.
- Weather conditions form a crucial factor for mycotoxin formation, hence preventive actions should be based on these.
- There is an increased need for reference materials and toxicological data for phycotoxins.
- In damp buildings a great variety of microbial secondary metabolites can be found.

Three parallel sessions on the fourth day included topics such as "Monitoring and Quality Assurance" and "Inexpensive Detection for Control of Exposure." These sessions focused on the accomplishments of the EU-Network of Excellence MoniQA and the Large Collaborative EU-project CONffIDENCE. Modern 'omics were the subject of attention in the parallel session "Mycotoxin Management: The Genomic Approach." Together with the final plenary session "Facing the Future" where the focus was tuned towards several exciting international challenges and developments, the sessions on this last day of the conference led to the following conclusions:

- Mycotoxins remain a challenge for industry, authorities, and research.
- MoniQA and CONffIDENCE deliverables show that EU-funding of strong scientific networks leads to tangible output and is most rewarding.
- Genomics is an ideal tool to understand plant-fungi interactions.
- For comprehensive risk management of natural toxins several knowledge gaps are still to be addressed.
- More research is needed to overcome these gaps which is of interest to human and animal health worldwide!

The last day also included the traditional ceremony of the IUPAC Best Poster Award. The winning poster "Neurotoxicity of T-2 and HT-2 toxin? New Experimental Hints for an Influence on the Blood Brain Barrier in Vitro" was prepared and presented by Maria Weidner, Institute of Food Chemistry, Westfälische Wilhelms-Universität Münster, Germany.

At the close of the conference, several upcoming international conferences of relevance to the audience were announced. Despite the significant progress made in various fields of research and their practical applications, issues associated with mycotoxins, phycotoxins, and plant toxins are expected to stay with us for a long time, which warrants continuous concern and joint, multidisciplinary efforts to combat and control the problems. This has also led the organizers of the Rotterdam conference to disclose their plans to organize a next WMFmeetsIUPAC conference in Asia in late 2016.

A post-conference activity was the excursion "Sampling and Import Control," a practical workshop on import control in the Port of Rotterdam. Participants were able to visit a warehouse and to see the sampling of a consignment of nuts. In addition they visited the Dutch Customs Office.

The instrument/manufacturers exhibition area.

Hans van Egmond <hans.vanegmond@wur.nl> is a senior scientist at the RIKILT Institute of Food Safety, Wageningen University and Research Centre, Wageningen, the Netherlands. Rudolf Krska is head of the Department for Agrobiotechnology in Tulln (IFA-Tulln), which is part of BOKU University, Vienna, Austria.

Chemical Thermodynamics

by Watson Loh and Ron Weir

The first International Conference on Chemical Thermodynamics (ICCT), organized by the IUPAC Commission on Thermodynamics (Commission I.2), was held in Warsaw, Poland, from 31 August–4 September 1969. Subsequently, the ICCT meeting has been held every two years, with one exception for the 6th ICCT meeting, which was held during August 1980 in Merseburg of the former German Democratic Republic.

The **2012 International Conference on Chemical Thermodynamics** was held in the pleasant city of Búzios, on the north coast of the state of Rio de Janeiro, Brazil, from 5–10 August, marking the first time this traditional conference moved south of the equator. In addition, this ICCT2012 was organized in conjunction with the 67th Calorimetry Conference. With a feeling of freshness and anticipation, a robust program was prepared to highlight not only the latest achievements in thermodynamics and calorimetry, but also how they have expanded to encompass other related areas of science and technology.

The general program was divided into thematic sessions: Energy, Ionic Liquids, Molecular Energetics and Databases, Phase Equilibria and Solutions, Thermodynamics of Materials, Education and Thermodynamics Frontiers, Biothermodynamics, Pharmaceuticals, Modelling and Simulation, and Thermal Studies and Phase Transitions. Plenary lectures on these themes were delivered by the following distinguished scientists: Peter L. Privalov (The Johns Hopkins University), Peter Atkins (Oxford University); Joan F. Brennecke (University Notre Dame), Aline Auroux (Institut de Recherches sur la Catalyse et l'Environnement de Lyon), Kamel Bennaceur (Schlumberger), Rafiqul Gani (Technical University of Denmark), Edward Maginn (University Notre Dame), Gabrielle Sadowski (Technical University of Dortmund), and Duncan Craig (University of East Anglia).

The ICCT2012 program also included invited lectures, oral contributions, and two well-attended poster sessions, accounting for more than 150 presentations and around 150 posters. The conference was attended by close to 300 participants from more than 30 different countries.

The ICCT2012 was preceded by a two-day Workshop on Biothermodynamics, which started with tutorials on basic calorimetry principles and techniques delivered by specialists Verna Frasca (from GE HealthCare) and Caleb McDonald (from TA Instruments). These sessions were followed by lectures by experts Lee D. Hansen, Carlos H.I. Ramos, Lucia Bianconi, Peter L. Privalov, Gerhard Klebe, Glyn Williams, Michale K. Gilson, and John Ladbury on recent developments and applications of calorimetry focused mainly on how these measurements could be used to understand biological processes and for the development and design of new and more efficient drugs. These presentations were followed by fruitful discussions moderated by Carlos Montanari and David P. Remeta, and the feeling among the nearly 80 participants was of complete satisfaction, affirming the importance of continuing this more recent tradition associated with organizing workshops prior to the main calorimetry conference.

The ICCT2012 was opened on the evening of 5 August with a lecture by Carlos H. Brito Cruz (FAPESP and UNICAMP), who presented an overview of the field and perspectives of Biofuels and Bioenergy, mostly focused on developments in Brazil, but also addressing issues that should be considered for their wider use and impact.

An important part of the conference is the awarding of prizes to recognize the careers and scientific contributions of outstanding scientists. This year, the IACT presented the Rossini award to Keith E. Gubbins (North Carolina State University), who presented the Rossini lecture on "Thermodynamics of Confined Nanophases." Two awards were presented at the Calorimetry Conference: the Hugh M. Huffman Memorial Award went to Alfred Blume (Martin Luther University at Halle-Wittenberg), who presented a lec-

ture on "Interaction of Cationic Surfactants and Oligo/Polypeptides with Anionic Lipid Model Membranes," and the James J. Christensen Award went to George Makhatadze (Rensselaer Polytechnic Institute) who talked on "Pressure Perturbation Calorimetry and Structural Biology of Proteins."

Another highlight of the program was a session organized by Jean-Pierre Grolier and Yasuhiro Nakazawa on "New Developments in Thermal Analysis and Calorimetry" in memory of Tooru Atake, who was always an enthusiastic supporter of the of the ICCT conferences. He chaired the ICCT held in Tsukuba, Japan, in 2010.

The aim of the ICCT conferences, supported by IUPAC sponsorship, is to provide a forum to discuss the latest advances, to foster collaboration, and to advance and extend the impact of the discipline. Our evaluation, supported by the comments we received from participants at the end of the conference, is that this goal was fully satisfied. Therefore, we believe that its success confirms the correct choice of moving this conference to new locations. The 23rd ICCT, scheduled for Durban, South Africa, in 2014, will be the first ICCT held within Africa.

Professors Watson Loh <wloh@iqm.unicamp.br> is director of the Institute of Chemistry at the Universidade Estadual de Campinas (UNICAMP). Ron Weir, a professor at the Royal Military College of Canada in Kingston, Ontarior, is currently chair of the Interdivisional Committee on Terminology, Nomenclature and Symbols (ICTNS) of IUPAC.

Novel Materials and their Synthesis

by Anning Zhou, Min Zhang, and Yuping Wu

The **IUPAC International Conference on Novel Materials and Synthesis** (NMS), initiated in 2005 in Shanghai, was held 14–19 October 2012 in Xi'an, China. Since then, it has been jointly held with the International Symposium on Fine Chemistry and Functional Polymers (FCFP). The latter began in 1987 in China and has been held on an almost annual basis since then. This year marked the eighth time both conferences were jointly held.

The conference, attended by 300 participants from 32 countries, received 292 abstracts. Xi'an University of Science and Technology, Shaanxi University of Science & Technology, and Fudan University collaborated to organize NMS-VIII & FCFP-XXII, which was sponsored by IUPAC, the National Natural Science Foundation of China, and Division of Science and Technology of Shaanxi Province.

The main topics of the conference were novel materials related to carbon, organic compounds, bio- and biobased materials, polymers, energy materials, nanomaterials, ceramic materials, metallic materials, and other novel materials. Among the lecturers were eminent scientists such as Wei Huang (member of Chinese Academy of Sciences, Nanjing University of Posts and Telecommunications, China), Masahiro Yamashita (Tohoku University, Japan), Hans-Joachim Knöker (Technische University Dresden, Germany), Gordon G. Wallace (Members of Australia Academy of Engineering and Australia Academy of Sciences, University of Wollongong, Australia), Gang Wei (CSIRO, Australia), Jieshan Qiu (Dalian University of Technology and Xi'an University of Science and Technology, China), Bao-Lian Su (Member of Belgium Academy of Science, The University of Namur, Belgium), John Texter (Eastern Michigan University, USA). Speakers from companies also discussed the latest developments in novel materials.

Three participants from Japan, Sweden, and China won the IUPAC Poster Prize. In addition, the 2012 Distinguished Award for Novel Materials and their Synthesis was given to Sachio Asaoka (Japan), Christoph Bubeck (Germany), Hui-Ming Cheng (China), and Takayoshi Nakamura (Japan).

The social program of the conference included a nighttime cruise along the ancient walls of Xi'an City, a historical performance, and a day-long city tour that included the famous Terra-cotta Warriors and Horses Museum.

The next conference in this series will be held in Shanghai, China, 17–21 October 2013, and the following one in Zhengzhou in October 2014.

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www.nms-iupac.org

Green Chemistry—Exchanging Experiences

by Arlene G. Corrêa and Vânia G. Zuin

Foz do Iguaçu, Brazil, whose falls were considered one of the seven natural wonders of the world, was the location for the **4th International IUPAC Conference on Green Chemistry** (4th ICGC), which took place 25–29 August 2012. Under the auspices of IUPAC and the Brazilian Chemical Society, the 4th ICGC was organized around the theme "Exchanging experiences towards a sustainable society taking care of natural resources in their socio-economic development."

The 4th ICGC counted around 600 participants from 40 countries from academia, industry, government and chemistry societies. More than 35 sponsors from different governmental and industrial sectors supported the event and contributed to creating a pertinent agenda. The 4th ICGC focused on broad topics such as benign synthesis/process, green chemistry for energy/production, chemicals from renewable resources, green engineering, education in green chemistry, and engineering and policy.

Welcome cocktail of the 4th ICGC Opening Ceremony. From left: Sumbal Saba, Vânia Zuin, Arlene Corrêa, and Rashmi Sanghi.

Ten plenary lectures built the framework of the conference:

- The Future of Molecular Design, Paul Anastas (Yale University, USA)
- Designing of a Chemistry beyond Chlorine, Pietro Tundo (Ca' Foscari University of Venice, Italy)
- Green Chemistry Education: Toward a Systems Approach, Adelio Machado (Porto University, Portugal)
- From Waste to Wealth Using Green Chemistry, James Clark (University of York, UK)
- Sustainable Transition Metal Nanoparticle Catalysis in Ionic Liquids, Jairton Dupont (University of Rio Grande do Sul, Brazil)
- Thermodynamic Properties of Green Solvents and Applications in Green Chemistry, Buxing Han (Chinese Academy of Sciences, China)
- Greener Routes to Organics and Nanomaterials: Sustainable Applications of Nano-Catalysts, Rajender S. Varma (EPA, USA)
- Fluorescent World of the Green Chemistry, Anita Marsaioli (University of Campinas, Brazil)
- Sustainable Valorization of Waste Biomass: The New Frontier, Roger Sheldon (Delft University, the Netherlands)
- Unique Roles for Ionic for Liquids in a Biorefinery: Extraction, Separation, and Processing of Lignin, Cellulose, Hemicellulose, and Chitin, Robin Rogers (University of Alabama, USA)

The program also included 15 invited lectures:

- Education for Sustainability: The Role of Green Chemistry, Mary Kirchhoff (Director, Education Division American Chemical Society, USA)
- Education for Sustainable Development and Chemistry Education, Franz Rauch (Alpen-Adria University, Austria)
- Progress of Chemical Technology Innovation toward a Sustainable Society in Japan, Takashi Ushikubo (Japan Association for Chemical Innovation, Japan)
- Industrial Policy, Reverse Logistics and Sustainability, Clayton Campanhola (The Brazilian Agency for Industrial Development, the Ministry of Development, Industry and Foreign Trade, Brazil)
- Critical Factors of CO_2 Adsorption on Molecular Sieves, Jiri Cejka, J. Heyrovsky (Academy of Sciences of the Czech Republic)
- Supported Iron Nanoparticles as Catalysts for Sustainable Production of Lower Olefins, Harry Bitter (University of Utrecht, Netherlands)
- Switchable Water, Phillip Jessop (Queen´s University, Canada)
- Direct Production of Molecules in the Fuel Range by Selective Tailoring of Biomass Fast Pyrolysis, Fabio Ribeiro (Purdue University, USA)
- Mimicking Processes and the Use of Metalloporphyrins, José Cavaleiro (Aveiro University, Portugal)
- Sustainable Organic Synthesis in Continuous Flow

Pietro Tundo, Ca' Foscari University of Venice, Italy.

Environments, Christian Oliver Kappe (University of Graz, Austria)

- Self-Organization of Nanoparticles, Nicholas Kotov (University of Michigan, USA)
- Towards Greener Approaches for the Extraction and Analysis of Organic Compounds in Environmental and Food Matrices, Pedro Afonso P. Pereira (Federal University of Bahia, Brazil)
- About the Asymmetric Functionalisation of Carbonyls after the Advent of Cinchona-based Primary Amine Catalysis, Paolo Melchiorre (Institute of Chemical Research of Catalonia, Spain)
- Developing Nanotechnological Strategies for Green Industrial Processes
- Henrique Eisi Toma (University of São Paulo, Brazil)
- Uncovering Novel Biocatalysts: Isolation of Microorganisms vs Genomic Libraries, Sonia Rodriguez (University of the Republic, Uruguay)

Apart from the lectures, the 4th ICGC presented 4 short courses, 15 parallel sessions with 4 oral presentations each, 4 roundtables, and 2 poster sessions (with more than 300 works). Another aspect was the launch of the book titled *Contribution from Brazilian Postgraduate Studies to Sustainable Development: CAPES at Rio +20,* published by Coordination for the Improvement of Higher Education Personnel.

An impressive number of young scientists was observed, which created an excellent atmosphere for enthusiastic scientific discussions of the frontier topics in Green Chemistry. The CHEMRAWN VII Prize for Atmospheric and Green Chemistry was awarded to R. Sanghi (see Nov-Dec 2012 *CI*, p. 19). In addition, three IUPAC poster prizes were awarded:

- "Eco-Friendly One-Pot Synthesis of Benzoxazines from "Cashew Nut Shell Liquid" Components," Giuseppe Mele; Orazio Attanasi; Mohamed Behalo; Gianfranco Favi; Diego Lomonaco; Selma Mazzetto; Iolanda Pio; Giuseppe Vasapollo from Benha University, Egypt, Universidade Federal do Ceará, Brazil, University of Salento and University of Urbino Italy
- "Cellulose Recycling as a Source of Raw Chirality," Valeria Corne; María Celeste Botta; Enrique David Giordano; Germán Francisco Giri; David Fernando Llompart; Hernán Biava; Ariel Marcelo Sarotti; Ernesto Gabino Mata; Alejandra Graciela Suárez; Rolando Angel Spanevello from Universidad Nacional de Rosario, Argentina
- "Educational Possibilities through the Insertion of Environmental and Green Chemistry in Teaching Activities," Renan Vilela Bertolin; Milena Avancini; Andreia Pereira Matos; Vânia Gomes Zuin from Universidade Federal de São Carlos, Brazil

In addition, the Royal Society of Chemistry (UK) awarded a poster prize for "AuPd Nanoparticles: Reusable Magnetic Responsive Catalyst for Green Oxidation of Alcohols," Tiago Artur da Silva; Érico Teixeira-Neto; Liane Marcia Rossi from Universidade de São Paulo, Brazil.

The Opening Ceremony as well as Paul Anastas' plenary lecture are available on the 4th ICGC website at <www.ufscar.br/icgc4>.

The next IGCG will take place in in Durban, South Africa, 16–20 August 2014.

Arlene G. Corrêa <vaniaz@ufscar.br> and Vânia G. Zuin <icgc4@ufscar.br> are at the Federal University of São Carlos, Brazil.

Kathmandu Symposia on Advanced Materials

by Rameshwar Adhikari and Michael Hess

The **Kathmandu Symposia on Advanced Materials** (KαSAM) is an initiative of the Nepal Polymer Institute (NPI) under the auspices of the POLYCHAR World Forum on Advanced Materials. It was held for the first time from 9–12 May 2012 at the Park Village Resort and Hotel, Budhanilkantha, Kathmandu, Nepal.

The highly successful IUPAC-sponsored POLYCHAR 19 International Conference, held in Kathmandu, 20–24 March 2011, planted the seed for the first KαSAM. Under the motto, "Cross-Linking Science and Virtues," this new conference series is aimed at strengthening networking among materials scientists from South

Asian Countries and those from the rest of the world. The KαSAM is a long-term activity to be organized every two years in Nepal with the goals of promoting education and research in the field of advanced materials, in Nepal in particular, and fostering our endeavors in applied nanoscience and nanotechnology.

The KαSAM-2012 was organized in association with the Tribhuvan University, Kathmandu; the Kathmandu University, Kavre, and the Université de Rouen, France, under the auspices of the Ministry of Science and Technology, Nepal. The symposia focused on "Nanostructured and Biorelated Materials," providing a platform for presentation of innovations in materials science and engineering for scientist from across the globe: Asia, America, Africa, Australia, and Europe were represented by 17 countries. There were 210 registered participants, about 40 percent of whom were from foreign countries.

The Inauguration Ceremony on 9 May was jointly celebrated by Vishwanath Prasad Agrawal (senior chemistry professor at Tribhuvan University, member of Constituent Assembly); Suresh Raj Sharma (vice chancellor, Kathmandu University), and Jean-Marc Saiter (head of Materials Science Department, Rouen) in the characteristic Nepali tradition. Nicole Moreau, past president of IUPAC, was the special guest of the Inauguration Ceremony.

The conference was accompanied by a one day tutorial on "Recent Trends in Materials Science," which included eight lectures, and a special workshop on "All about Bamboo," which featured seven presentations. There were 87 oral presentations (including the tutorial and workshop) and 64 poster presentations. The tutorial targeted young scientists and students and also attracted the attention of many scientists from the region. The following lectures provided insight into recent trends in materials science and technology:

- Stoyko Fakirov (University of Auckland, Auckland, New Zealand) "Polymer Nanomaterials for Biomedical Applications: Preparation and Applications"
- Jatinder V. Yakhmi (Bhabha Atomic Research Centre, Mumbai, India) "Synthesis of Nanostructured Materials and their Application to Sense Toxic Gases"
- Shinichi Sakurai (Kyoto Institute of Technology, Kyoto, Japan) "Basis of Structural Analysis on Fiber or Polymer Films by X-Ray Scattering"
- Surendra Gautam (Tribhuvan University, Kathmandu, Nepal) "Structural Characterization of Nanomaterials"
- Heinz W. Siesler (University of Duisburg-Essen, Essen, Germany) "Characterization of Polymers by Vibrational Spectroscopy"
- Martin Steinhart (University of Osnabrück, Osnabrück, Germany) "Nanostructuring and Microstructuring"
- Jean-Marc Saiter (University of Rouen, France) "Green Material and Materials for Future"
- Suresh Valiyaveettil (National University of Singapore, Singapore) "Health and Environmental Implications of Nanomaterials and Nanotechnology"

It is difficult to choose outstanding presentations from the 72 excellent oral presentations and 64 poster contributions. As *pars pro toto,* the following contributions may be mentioned just to give an impression about the range of topics addressed:

- G. Michler (Halle-Wittenberg, Germany) "Role of Electron Microscopy in Developing Advanced Materials"
- H. Hasegawa (Kyoto, Japan) "Application of Block Copolymer Thin Films to Nanotechnology"
- S. Higashibayashi (Okazaki, Japan) "C3 Symmetric Buckyballs, Sumanenes"
- S. Valiyaveettil (Singapore) "Functional Materials for Water Purification"
- F. Tournilhac (Paris, France) "Semi-Crystalline Supramolecular Polymers and Their Use in the Design of Hot-Melt Adhesives and Smart Coatings"
- B. Bluemich (Aachen, Germany) "Non-Destructive Testing of Polymers Morphology by NMR"
- V. Popov (Moscow, Russia) "Supercritical Fluids: A New Approach to Advanced Biomaterials Processing and Modification"
- J.V Yaksmi (Mumbai, India) "Molecular Materials for Electronic Devices"
- A. Pathak (Kathmandu, Nepal) "Laboratory-Scale Synthesis of Geopolymers from Various

KΩSAM 2012, Closing Ceremony with Rameshwar Adhikari, convener of KΩsAM 2012 (3rd from the left, sitting), Nicole Moreau, IUPAC past president (4th from the left, sitting), Michael Hess, secretary IUPAC Polymer Division (2nd from the right, sitting), and the conference assistants.

Construction Waste"

- N.L. Bhandari (Kathmandu, Nepal) "Comparative Study of Mechanical, Morphological, and Thermal Behaviour of Bamboo Flour Reinforced Plastics"
- T. Fujii (Kyoto, Japan) "Green Composites using Bamboo Fibres"
- M. Steinhart (Osnabrück, Germany) "Design of Soft-Matter Nanorod Arrays in Self-Ordered Nanoporous Aluminia Thin Hard Templates"
- S. Fakirov (Auckland, ,New Zealand) "From Polymer-Blends to Nanofiller Polymer-Polymer and Single Polymer Composites"
- J.-M. Saiter (Rouen, France) "Natural and Synthetic Polymer Composites Reinforced by Bamboo"
- A. Bhaw-Luximon (Reduit, Mauritius) "Bio-engineering Polymer Nano-Micelles for Controlled Drug Delivery"

During the Closing Ceremony on 12 May, Goerg Michler (University of Halle) was honored for his significant contribution to establishing materials science research in Nepal. Likewise, Santosh Thapa (Tribhuvan University, Kathmandu) was honored for his dynamic and overwhelming support of the activities of the Nepal Polymer Institute. Mangala Devi Manandhar (Tribhuvan University, Kathmandu) was honored for her untiring efforts toward establishing research activities in Nepal.

Ram P. Singh (former vice chancellor of Lucknow University, India), was the chair of the event. Michael Hess, secretary of the IUPAC Polymer Division (Chosun University, Gwangju, South Korea), was a special guest during this event. Akhtar Jahan Siddiqa (India), M.A. Yousuf (Bangladesh) and Jyoti Giri (Nepal) were awarded with the best poster presentation prizes. Nicole Moreau expressed her positive impression about content, quality, and performance of the conference in her closing remarks as IUPAC representative.

www.nepalpolymer.org

Eurasia Conference on Chemical Sciences

by Jan Reedijk

The **12th Eurasia Conference on Chemical Sciences** (Eurasia-12, EuAsC2S-12) was held from 16–21 April 2012 on the island of Corfu, Greece—the first time a conference in the series was held in Europe.

The first Eurasia Conference was held in Bangkok in 1988. Originally known as the First Eurasia Conference on Chemistry of Solutions, it emerged from the shared vision of Bernd M. Rode, Hitoshi Ohtaki, and Ivano Bertini who aimed to deepen relationships among chemists in the Eurasian supercontinent, and support them with the help of chemists throughout the world. The conference series encourages interactions among eminent scientists and young chemists, especially those from developing countries.

Eurasia 12 was held in Greece in order to attract more European scientists and make the series more popular in Europe. Nick Hadjiliadis, professor at the University of Ioannina, was the chair of the local organizing committee, while Susumu Kitagawa acted as the chair of the international organizing committee. The conference counted 393 active participants from 57 countries. Seven junior scientists from different countries were able to attend by way of scholarships sponsored by IUPAC. In addition, the Organisation of Islamic Cooperation's Ministerial Standing Committee on Scientific and Technological Cooperation (www.comstech.org) sponsored the attendance of four young chemists.

http://eurasia12.uoi.gr

Read the full article at www.iupac.org/publications/ci/2013/3502/cc6_160412.html.

Eurasia-12 Conference attendees leaving for an excursion to historic sites.

Heteroatom Chemistry

by Yoshiyuki Mizuhata and Norihiro Tokitoh

The **10th International Conference on Heteroatom Chemistry** (ICHAC-10) was held in Uji, Kyoto, Japan, 20–25 May 2012. In total, 371 scientists from 28 countries attended.

The ICHAC is a well-established international forum for the presentation and discussion of research results relating to the diverse fields of heteroatom chemistry. The major themes of ICHAC-10 covered synthesis, structure and reactivity (including catalysis), theoretical methods, and materials. The conference program contained 7 plenary and 17 invited lectures, as well as 43 short communications and 154 poster presentations. Plenary lectures were given by Wolf-Walther du Mont (Technische Universität Braunschweig, Germany), Vladimir Gevorgyan (University of Illinois, USA), Kimoon Kim (Pohang University of Science and Technology, Korea), Shigeru Nagase (Institute for Molecular Science, Japan), Philip P. Power (University of California Davis, USA), Zuowei Xie (The Chinese University of Hong Kong, China) and Yohsuke Yamamoto (Hiroshima University, Japan).

All presentations were of the highest quality and discussed the latest developments in their respective areas of expertise. The friendly and warm atmosphere of the conference ensured extended discussions afterwards, resulting in an unhindered scientific exchange among all participants.

Read the full article at www.iupac.org/publications/ci/2013/3502/cc7_200512.html.

Science—A Bridge to Peace

by Stanley Langer

The fifth conference in the biennial series **"Frontiers of Chemical Science: Research and Education in the Middle East" (Malta-V)** was held in Paris, France, from 4–9 December 2011. The venue was UNESCO, which had invited the organizers to hold the meeting at its headquarters as one of the final events of the International Year of Chemistry. Scientists from 12 Middle East countries attended and the conference was designed, in part, to forge stronger relationships with, and establish collaborations among, scientists in the region. As with previous conferences, the intention of the organizers was to draw the attention of national governments to the notion that improving scientific cooperation could act as a spur to sustainable growth and in promoting peace and political reconciliation through science diplomacy and cross-border scientific collaboration in an extremely volatile region of the world.

Read the full article at www.iupac.org/publications/ci/2013/3502/cc8_041211.html.

Director-General of UNESCO, Irina Bokova (right), and HRH Prince Hassan bin Talal of Jordan enter the lecture room for the opening ceremony of the Malta V Conference at UNESCO's headquarters.

4th International Chemical Assembly: Green Chemistry'2012 (ICA-2012)

by Ekaterina Lokteva

The **4th International Chemical Assembly: Green Chemistry'2012** (ICA-2012) was held 23–26 October 2012 in Moscow.

Until recently, sustainable, or green, chemistry has not been as popular in Russia as in many other countries. However, Russian chemists have come to understand that sustainable development, and even the question of our survival, is based, to a significant extent, on the "greening" of chemistry in a scientific and industrial respect. This is why the 4th International Chemical Assembly was dedicated to green chemistry. Sponsored by IUPAC and UNIDO, the exhibition was held 23–26 October 2012 in Moscow.

In his address to participants, Professor M. Egorov, academician of the Russian Academy of Science (RAS), said "At the first look, green chemistry is the chemistry of common sense, but in fact it is the new ideology, new culture of performing the chemical transformations, which will make possible the harmonization of the relationship between the humankind and the environment."

IUPAC President Kazuyuki Tatsumi delivers a talk at the Opening Ceremony of the 4th International Chemical Assembly: Green Chemistry '2012.

The exhibition included 130 firms from 10 countries. ICA-2012 was free for all visitors who registered online. More than 300 participants presented about 200 reports at this conference; the book of abstracts was published in two volumes. Attendees were attracted not only by the exhibition itself, but also by the broad and interesting business program.

Read the full article at www.iupac.org/publications/ci/2013/3502/cc9_231012.html.

Flow Chemistry and Microreactor Technology

by Lisa McElwee-White

The **13th Annual Florida Heterocyclic and Synthetic Conference** took place at the University of Florida in Gainesville, 4–7 March 2012. The theme of the conference was flow chemistry and microreactor technology. Eleven plenary lectures, four short courses, and 48 invited lectures were delivered. There was a poster session that attracted 56 posters and a small exposition at which publishers, chemical manufacturers, and scientific instrument companies exhibited. Over 200 delegates from academia and industry attended the conference.

www.arkat-usa.org/conferences-flohet-others

Read the full article at www.iupac.org/publications/ci/2013/3502/cc10_040312.html

Visas

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

Smarter Teaching—Better Learning

3–5 July 2013, Limerick, Ireland

This **5th Eurovariety in Chemistry Education Conference**, run under the auspices of the EuCheMS Division of Chemical Education and the RSC Higher Education Group, is concerned with the teaching and learning of chemistry at the third (university and college) level. Papers may deal with the practice of teaching chemistry or with research into the teaching and learning of chemistry at the degree or postgraduate level. This includes the secondary-tertiary transition, the promotion of chemistry to increase the uptake into third-level chemistry courses, and the training of chemistry teachers. The overall theme "Smarter Teaching—Better Learning" indicates an emphasis on the use of research findings to improve the teaching and learning of chemistry. The Eurovariety conferences follow the tradition of the UK Variety in Chemistry Education conferences in encouraging chemists involved in teaching third-level chemistry to share their experiences with and learn from colleagues from other institutions and other countries.

www.eurovariety2013.ul.ie

Calixarenes—Exploration and Discovery

14–17 July 2013, St. John's, Newfoundland and Labrador, Canada

The **12th International Conference on Calixarenes** (Calix 2013) will be held at Memorial University of Newfoundland in St. John's, Newfoundland and Labrador—Canada's most eastern and youngest province—from 14–17 July 2013. Exploration and Discovery, the theme of Calix2013, is also a tribute to the conference's location, Newfoundland and Labrador, which have a rich history of both.

Following the successful model of Calix11, held in Tarragona, Spainin 2011, the program for Calix2013 will consist of 30 keynote lectures (25 minutes + 5 minutes discussion), 10 short presentations (6 minutes without discussion) selected from among the abstracts submitted as contributions for the poster sessions, and 2 poster sessions (3 hours total). To make possible an extensive formal and informal discussion and sense of community, the number of participants will be limited to a maximum of 250 and the number of posters to 100.

The conference will be organized and hosted by Paris Georghiou, Shiofur Rahman, Graham Bodwell, Yuming Zhao, and Mary Flinn of the Chemistry Department, Memorial University of Newfoundland.

The International Advisory Board for Calix2013 includes Jerry Atwood (USA), Javier DeMendoza (Spain), Volker Böhmer (Germany), Alessandro Casnati (Italy), Jeffery Davis (USA), Bruce Gibb (USA), Michaele Hardie (UK), David Reinhoudt (The Netherlands), Olivia Reinaud (France), Colin L. Raston (Australia), John Sherman (Canada), Takehiko Yamato (Japan), Mei-Xiang Wang (China).

The conference is timed to follow 8-ISMSC, the 8th International Symposium on Macrocyclic and Supramolecular Chemistry which will be held in Crystal City, Virginia, USA, from 7–11 July 2013.

See Mark Your Calendar for Contact Information.

www.calix2013.org

How to Apply for IUPAC Sponsorship

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

www.iupac.org

Materials and Chemistry from Bench to Brand and Back

22–28 July 2013, Manchester, UK

The **24th International Congress of History of Science, Technology and Medicine** will be held 22–28 July 2013, in Manchester, the chief city of Northwest England, and the original "shock city" of the Industrial Revolution. The congress is the largest event in the field, and takes place every four years. Recent meetings have been held in Mexico City (2001), Beijing (2005), and Budapest (2009). Congress facilities will be provided by The University of Manchester, with tours and displays on local scientific, technological, and medical heritage coordinated by members of the University's Centre for the History of Science, Technology, and Medicine.

A symposium entitled "Materials and Chemistry from Bench to Brand and Back" is being organized by the Commission for the History of Modern Chemistry. (a Commission of the International Union of History and Philosophy of Science/Division of History of Science and Technology). The symposium aims to investigate itineraries of materials from bench research to consumer brands, as they spread through society and the natural environment, and the itinerary back, with a focus on the co-construction of materials and chemistry through specific case studies. Potential topics of interest are synthetic polymers, nanotechnologies, metallurgy, electronics, new and old materials like plastics or ceramics, as well drugs, fertilizers, and biomaterials.

Scholars interested in contributing to this symposium should contact one of the symposium organizers listed below.

For more information, please Brigitte Van Tiggelen <vantiggelen@memosciences.be> or Pierre Teissier <Pierre.Teissier@univ-nantes.fr>.

www.ichstm2013.com

Philosophy of Chemistry

31 July–3 August 2013
Montevideo, Uruguay

The Organizing Committee of the International Society for the Philosophy of Chemistry has annouced that its Summer Symposium 2013 will take place 31 July–3 August 2013 in Montevideo, Uruguay. The symposium is is being supported by the Universidad de la República, Uruguay, Facultad de Humanidades y Ciencias de la Educación and Facultad de Química (Universidad de la República, Uruguay).

The symposium will take place in the Communication Tower (Complejo Cultural de la Torre de las Telecomunicaciones) in downtown Montevideo. A trip to the city of Fray Bentos is being planned to visit the old installations of Liebig Extract of Meat Company.

Following tradition, the symposium will be devoted to specific key topics within the field of the philosophy and history of chemistry:

- Chemistry in the 19th century
- Chemistry and society
- What do orbitals mean to chemists?
- Modeling and structure in chemistry
- Is chemistry the fundamental science? Relationships with other disciplines

The abstract submission deadline is 28 April. Abstract acceptance notifications will be provided by 30 May.

www.ispc2013.fq.edu.uy

Mark Your Calendar

Upcoming IUPAC-sponsored events
See also www.iupac.org/home/conferences.html for links to specific event websites

2013 (after 1 May)

IUPAC poster prizes to be awarded

19–23 May 2013 • Clinical Chemistry & Laboratory Medicine • Milan, Italy
20th IFCC-EFLM European Congress on Clinical Chemistry & Laboratory Medicine; 45th Congress of the Italian Society of Clinical Biochemistry & Clinical Molecular Biology
Dr. Ferruccio Ceriotti, Instituto Scientifico Ospedale San Raffaele, Servizio di Medicina di Laboratorio, Via Olgettina 60, I-20132 Milano, Italy, Tel.: +39 10 226 432 282, E-mail: ceriotti.ferruccio@hsr.it

28–29 May 2013 • Clinical Laboratory • Barcelona, Spain
7th European Symposium on Clinical Laboratory and In Vitro Diagnostic Industry: Molecular Genetics in the Clinical Laboratory
Dr. Xavier Fuentes-Arderiu, Hospital L'University de Bellvitge, L'Hospitalet de Llobregat, E-08907 Barcelona, Spain, Tel.: +34 93 260 76 44, Fax: +34 93 260 75 46, E-mail: xfa@csub.scs.es

16–21 June 2013 • European Polymer • Pisa, Italy
Congress of the European Polymer Federation (EPF-2013)
Prof. Giancarlo Galli Università di Pisa Dipartimento di Chimica e Chimica Industriale Via Risorgimento 35 I-56126 Pisa, Italy, Tel.: +39 050 221 9272, Fax: +39 050 221 9240, E-mail: gallig@dcci.unipi.it

7–10 July 2013 • Polymer Chemistry • Northern Territory, Australia
34th Australasian Polymer Symposium (34 APS)
Dr. Kevin Jack, University of Queensland, Centre for Microscopy & Microanalysis, Level 1, AIBN, Bldg. 75 St. Lucia, QLD 4072, Australia, Tel.: +61 7 3365 1143, Fax: +61 7 3346 3993, E-mail: k.jack@uq.edu.au

7–12 July 2013 • Solution Chemistry • Kyoto, Japan
33rd International Conference on Solution Chemistry (ICSC 2013)
Prof. Toshio Yamaguchi Fukuoka University Department of Chemistry Nanakuma, Jonan, Fukuoka 814-0180, Japan, Tel.: +81 092 871 6631 ext. 6224, Fax: +81 092 865 6030, E-mail: yamaguchi@fukuoka-u.ac.jp

7–11 July 2013 • Polymer Spectroscopy • Prague, Czech Republic
19th European Symposium on Polymer Spectroscopy (ESOPS 19)
Prof. Jiri Spevacek Academy of Sciences of the Czech Republic Institute of Macromolecular Chemistry Heyrovsky Square, 2 CZ-162 06 Prague Czech Republic
Tel.: +420 2 9680 9380, Fax: +420 2 9680 9410, E-mail: spevacek@imc.cas.cz

7–11 July 2013 • Carbohydrate • Tel Aviv, Israel
17th European Carbohydrate Symposium
Prof. Timor Baasov, Technion Israel University of Technology, Faculty of Chemistry, Haifa, Israel
Tel.: +972 4 829 2590, Fax: +972 4 829 5703, E-mail: chtimor@techunix.technion.ac.il

8–12 July 2013 • Chemistry for Sustainable Growth • Pretoria, South Africa
12th International Chemistry Conference in Africa (ICCA-2013)
Prof. Mathew Muzi Nindi, Department of Chemistry, University of South Africa , P.O. Box 392, UNISA 0003 South Africa, Tel.: +27 12 429 8559, Fax: +27 12 429 8549, E-mail: nindimm@unisa.ac.za

14–17 July 2013 • Calixarenes • St. John's, Newfoundland, Canada
12th International Conference on Calixarenes (Calix 2013)
Prof. Paris Georghiou, Memorial University of Newfoundland, Department of Chemistry, St. Johns, NL A1B 3X7 Canada, Tel.: +1 709 864 8517, Fax: +1 709 864 4569, E-mail: parisg@mun.ca

25–27 July 2013 • Chemistry Literacy for Global Citizens • Pingtong City, Taiwan
5th International Conference Network for Inter-Asian Chemistry Educators (5th NICE)
Professor Shyan-Jer Lee, Department of Chemical Biology, National Pingtung University of Education, No.4-18 Minsheng Rd., Pingtung City, Pingtung County 90003, Taiwan (R.O.C.)
Tel.: +886-8-7226141 ext 33201, Fax: +886-8-7230305, E-mail: sjlee@mail.npue.edu.tw or 5thicnice@gmail.com

28 July–1 August 2013 • Organometallic Chemistry • Fort Collins, Colorado, USA
17th International IUPAC Conference on Organometallic Chemistry Directed Towards Organic Synthesis
Prof. E. Peter Kündig, Université de Genève, Département de Chimie Organique, CH-1211 Genève 4, Switzerland
Tel.: +41 22 379 6093, Fax: +41 22 328 7396, E-mail: peter.kundig@unige.ch

28 July–2 August 2013 • Novel Aromatic Compounds • Taipei, Taiwan
15th International Symposium on Novel Aromatic Compounds (ISNA-15)
Prof. Ken-Tsung Wong, Taiwan National University, Department of Chemistry No. 1, Sec. 4, Roosevelt Road, Taipei 10167 Taiwan, Tel.: +886 2 3366 1665, Fax: +886 2 3366 1667, E-mail: kenwong@ntu.edu.tw

4–9 August 2013 • Homogeneous and Heterogeneous Catalysis • Sapporo, Japan
16th International Symposium on Relations between Homogeneous and Heterogeneous Catalysis (ISHHC-16)
Prof. Atsushi Fukuoka, Hokkaido University, Kita 21-10, Sapporo 001-0021, Japan
Tel.: +81 11 706 9140, Fax: +81 11 706 9140, E-mail: fukuoka@cat.hokudai.ac.jp

11–16 August 2013 • IUPAC 44th Congress • Istanbul, Turkey
44th IUPAC Congress—Clean Energy Through Chemistry
Prof. Mehmet Mahramanlioglu, Turkish Chemical Society, Istanbul University, Department of Chemistry, TR-34320 Avcilar, Istanbul, Turkey
Tel.: +90 212 591 1996, Fax: +90 212 591 1997, E-mail: mehmah@istanbul.edu.tr, www.iupac2013.org

13–16 August 2013 • MacroMolecular Complexes • Clemson, South Carolina, USA
15th International Symposium on MacroMolecular Complexes (MMC-15)
Prof. Anthony Guiseppi-Elie, Clemson University, Department of Chemical & Biomolecular Engineering, 132 Earle Hall, Clemson, SC 29634, USA, Tel.: +1 864 656 1712, Fax: +1 864 656 1713, E-mail: guiseppi@clemson.edu

18–23 August 2013 • Advanced Polymers via Macromolecular Engineering • Durham, UK
10th International Conference on Advanced Polymers via Macromolecular Engineering (APME-2013)
Prof. Neil R. Cameron, Department of Chemistry, Durham University, Durham, DH1 3LE, UK
Tel.: +44 191 334 2008, Fax: +44 191 384 4737, E-mail: n.r.cameron@durham.ac.uk

25–29 August 2013 • Analytical Chemistry • Warsaw, Poland
XVIIth European Conference on Analytical Chemistry (EuroAnalysis XVII)
Prof. Maciej Jarosz, Warsaw University of Technology, Department of Analytical Chemistry, Ul. Naokowskiego 3, PL-00 664 Warsaw, Poland, Tel.: +48 22 234 7408, Fax: +48 22 234 7408, E-mail: mj@ch.pw.edu.pl

23–28 September 2013 • Ionic Polymerization • Awaji Island, Japan
21st International Symposium on Ionic Polymerization (IP2013)
Prof. Tatsuki Kitayama, Osaka University, Department of Chemistry, Toyonaka, Osaka 560-8531, Japan
Tel.: +81 6 6850 6230, Fax: +81 6 6841 0104, E-mail: kitayama@chem.es.osaka-u.ac.jp

28–29 September 2013 • Biorefineries • Brasília, Brazil
2nd Brazilian Symposium on Biorefineries (II SNBr)
Dr. Sílvio Vaz, Jr. , EMBRAPA Agroenergy Parque Estação Biológica, Av. W3 Norte, Asa Norte Brasília, DF 70770-901 Brazil, Tel.: +55 61 3448 2315, Fax: +55 61 3448 1589, E-mail: silvio.vaz@embrapa.br

17–22 October 2013 • Novel Materials • Shanghai, China
9th International Conference on Novel Materials and their Synthesis (NMS-IX)
Prof. Yuping Wu, Fudan University, Department of Chemistry, New Energy & Materials Laboratory Shanghai, 200433 China, Tel: +86 21 55 664 223, Fax: +86 21 55 664 223, E-mail: wuyp@fudan.edu.cn

8–13 December 2013 • Frontiers of Polymers • Auckland, New Zealand
12th International Conference on Frontiers of Polymers and Advanced Materials (ICFPAM 2013)
Prof. Paul Kilmartin, School of Chemical Sciences, University of Auckland, 23 Symonds Street, P.O. Box 92019, Auckland 1142 New Zealand
Tel.: +64 9 373 7599 x 88272, Fax: +64 9 373 7422, E-mail: p.kilmartin@auckland.ac.nz

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