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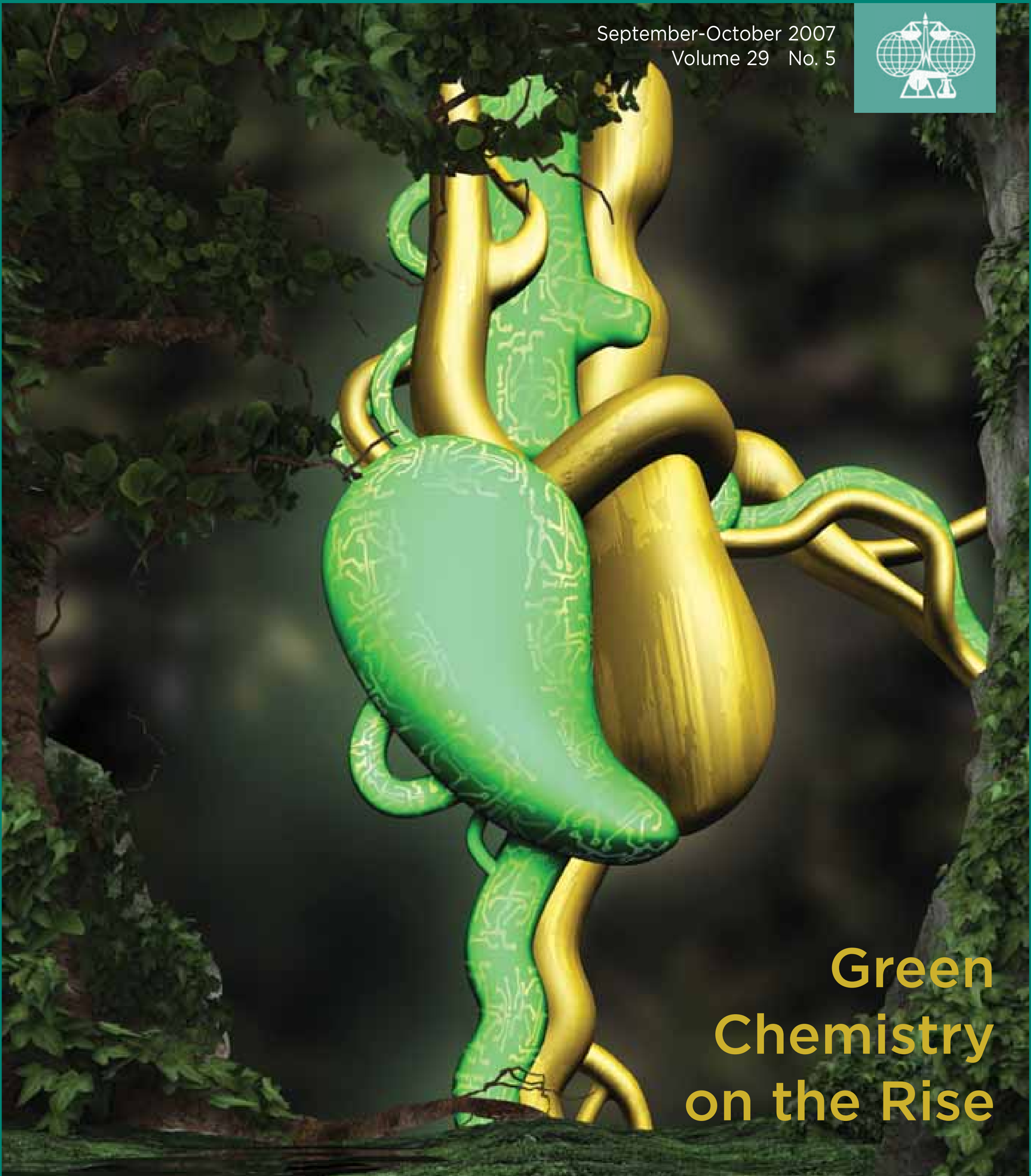

Green Chemistry on the Rise

From the Editor

CHEMISTRY International

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

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Today, the application of chemistry in the service of Mankind is a matter of need and necessity. However, applied chemistry can and should preserve the environment and respect our relationship with, and dependence upon, Nature.

In this issue of *CI*, the ideas, concepts, and the relatively young history of so-called Green Chemistry or sustainable chemistry is reviewed by Pietro Tundo and Fabio Arico (see page 4). Enlightened by his own experience, Tundo describes how a combination of economic, regulatory, scientific, and social factors combined to make the 1990s the tipping point for the emergence of Green Chemistry as an important concept. The authors elaborate on the definition of Green Chemistry, which simply is “the invention, design, and application of chemical products and processes to reduce or eliminate the use and generation of hazardous substances,” and point out its multifaceted and straightforward implications. They also highlight how key events of the last 10 to 15 years have led to the establishment and recognition of the discipline, so that it is no longer a simple buzzword.

We asked an artist—Francesco Tundo—(yes, the son of Pietro) to reflect on these ideas. His view is that an equilibrium needs to be reinstated between human technology and the natural state of the environment to counter humankind’s overuse of nature’s finite resources. The original image that Franscesco created for this cover might be shocking for some, but what could be more appropriate than a heart to represent our connection with nature? He depicted the heart as a symbol of sustainability, pumping fluids through a system, while keeping nourishment separate from waste, and returning the waste back to where it becomes nourishment once again.

I hope that this cover will intrigue you and make you pause long enough to feel your own heart beat and your lungs breath in a few times. Artists have a way of questioning our conscience and arousing fears and hopes, which is important, since today, by necessity, mankind has a lot resting on chemistry.

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Cover: **Balance** ***by Francesco Tundo, chief of NuvoleQuadrate (SquareClouds) <www.nuvolequadrate.it>. Tundo is a computer graphics professional, whose works include cover illustrations, architectural projects, animations, and 3-D prototyping. He produced earlier covers for the Green Chemistry Series of books produced by IUPAC and INCA, and for*** **Pure and Applied Chemistry** ***(July 2000) and*** **CI** ***(July 2003 and March 2004).***

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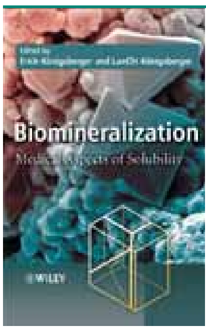


Treasurer's Column

Tenure Review and Outlook

by Christoph Buxtorf

After eight years of service, my term as treasurer of IUPAC will be over at the end of 2007. I have enjoyed a strong working relationship with the officers and with IUPAC in general, and I received much help from John Jost and his staff and, last but not least, from the Finance Committee. Therefore, I would like to thank everyone who made my work fruitful and who was so helpful in getting the Union's finances in good health.

In 1999, our investment portfolio was valued at about USD 3.9 million—the figures for 2006 are showing almost USD 5.6 million. This increase of almost 41 percent results from a rise in value of investments, additions to our portfolio from donors such as Samsung Total Petrochemical Co., Ltd., and savings from operations.

However, as your careful "Swiss banker," I have to acknowledge some changes in the financial environment. The Union was not untouched by downturns in the financial markets in 2000 and later, and by the increase in the value of the Euro against almost all other currencies, especially the U.S. dollar. IUPAC responded to these changes in many ways. In 2003, at the General Assembly in Ottawa, Canada, the Council adopted a change to billing in national currencies rather than in U.S. dollars, and agreed to provide financial support for delegates to attend the General Assembly. With these changes, many of the problems due to "exchange rates" and unequal treatment in national subscriptions were resolved.

Still, some of our members—Adhering Organizations—have problems paying their dues to IUPAC. In the past, we have only made very moderate increases in the national subscription rate recognizing the financial limitations of some of our members. These modest increases have been enabled, in part, by the income generated by our investment portfolio.

Meanwhile, activities to broaden the Union's national membership base and encourage more involvement from the chemical industry are in progress. Some very generous grants, such as those from Samsung Total Petrochemical Co., Ltd., noted above, and for the IUPAC-Richter Prize, were very helpful toward these efforts.

Looking at the financial future, I see some darker shades to the current bright picture. It seems that the present contributions from our members are at their limit. The change to the "project system" in IUPAC was the most important move in the last eight years. The system is now well established and requires a more-or-less constant amount of funding. After an initial period of trial and error, the project system consumes its allocated budget, which leaves no room for bigger opportunities and for real strategic moves.

To address this issue, the "divisional reserve" is being reallocated as a "strategic fund." While before the reserve was used to fund projects for which individual committees did not have adequate budgets, the fund will now require setting priorities and making choices about which projects will give IUPAC more visibility. This is, in my opinion, of the highest importance.

The environment for an organization like IUPAC is becoming more and more competitive, especially if we try to raise funds from third parties. We are still a recognized player in our field. For example, the development of the IUPAC International Chemical Identifier (InChI), which is used to define and recognize a chemical substance, is an outstanding achievement. Other outstanding examples include the Committee on Chemistry and Industry's activity in plant safety, the Committee on Chemistry Education's efforts, and the "color" books (e.g., the new XML "Gold Book"). Another of IUPAC's premier achievements is its central role in the Chemical Weapons Convention, organizing international workshops and helping to create networks of experts to communicate intelligently on this critical issue.

We need more outside funding if we want to continue to do these things in the future.

Let us do more of these fine things—mostly for free. On the other hand, we need more outside funding if we want to continue to do these things in the future. Our most valuable resources are the many volunteer experts in global chemistry. The increasing costs of travel and accommodations and the limitations of contributions from NAOs have already created some constraints. In the future, IUPAC has to think more broadly when soliciting funding for its work, without jeopardizing the idea of disseminating its know-how for free, especially to countries isolated from the mainstream of chemical knowledge. We may have to search more for contributions and grants from foundations to support specific activities that help to create "a better world." If we want IUPAC to become a more lively organization, we will need more financial help from the outside. And better visibility for IUPAC will only enhance its ability to advance worldwide chemistry.

Christoph F. Buxtorf <ch.buxtorf@dplanet.ch> is the current treasurer of IUPAC and a member of the Executive Committee. He is retired from Novartis Crop Protection where he was head of the Production and Technology Division.

FINANCIAL NEWS

Financial Reports were recently presented at the IUPAC Council on 12–13 August 2007. Details are included in the Council agenda book, which is available online at <www.iupac.org/symposia/conferences/ga07/council_agenda.html>. At its meeting, the Council approved the Budget for 2008–2009, including an increase in the total National Subscriptions of 3 percent per annum.

On January 2008, Dr. Buxtorf will be succeeded by Prof. John Corish from Ireland. Elected as the new Treasurer by the Council on 13 August 2007, Corish has served IUPAC in many functions since 1979, including a four-year term on the Finance Committee and earlier a four-year term as president of the Inorganic Chemistry Division.

Stamps International

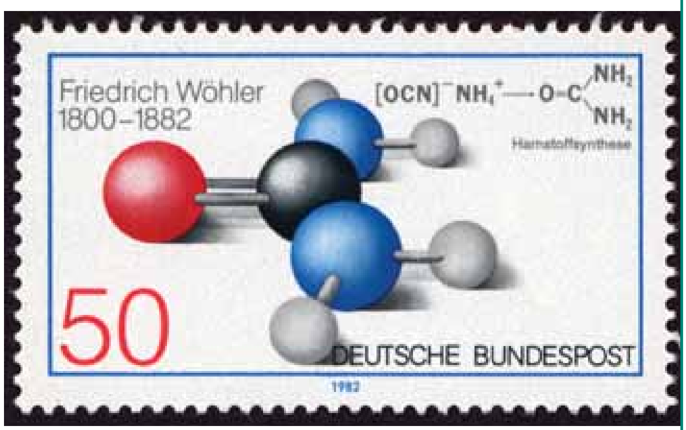
See also www.iupac.org/publications/ci/indexes/stamps.html

Wöhler's Masterpiece

Friedrich Wöhler (1800–1882), one of the most important German chemists of the 19th century, is best known for his serendipitous preparation of urea from ammonium cyanate in 1828. This momentous discovery happened at a time when most scientists believed that naturally occurring organic compounds such as urea, which was first isolated from urine by the French chemist Hilaire Marin Rouelle in 1773, could only be produced by living organisms. Thus, Wöhler's synthesis of urea not only helped to bridge the gap between organic and inorganic chemistry that prevailed then, but also played a key role in the demise of the vitalistic theory. It is also worth noting that Wöhler was a man of many talents: He discovered organic radicals with his lifelong friend and collaborator Justus von Liebig, he worked with Berzelius on the isolation of beryllium and silicon, he prepared the first (impure) sample of metallic aluminum, and he was a prolific writer and a dedicated teacher at the University of Göttingen for more than 45 years.

The 100th anniversary of Wöhler's death was commemorated with the stamp that illustrates this note, issued in Germany on 12 August 1982. It displays a beautiful ball-and-stick diagram of urea, clearly showing a carbon–oxygen double bond for the carbonyl group, and a balanced chemical equation for its synthesis from ammonium cyanate. Interestingly, the latter is a relatively unstable species that can be generated from the reaction of silver cyanate with ammonium chloride or the treatment of lead cyanate with aqueous ammonia, two of the methods originally reported by Wöhler. However, urea is nowadays obtained industrially on a massive scale from ammonia and carbon dioxide (i.e., the Bosch–Meiser process), and some 90 percent of the world production (more than 100 megatonne per year!) is used as a fertilizer.

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



Thoughts on the Short History of the Field*

by Pietro Tundo and Fabio Aricò

The adoption of green chemistry as one of the primary methods of pollution prevention is a fairly recent phenomenon. It is certainly reasonable to question why this fairly straightforward approach is only now taking hold. The answer is found in a combination of economic, regulatory, scientific, and even social factors, which coalesced in the 1990s to give rise to green chemistry. Since then, green chemistry has found implementation and commercialization on a wide scale.

Fabio Aricò (left) and Pietro Tundo.

Since the early 1960s, environmental statutes and regulations have proliferated at an exponential rate. With these regulations came costs, restrictions on the use of chemicals, and increased testing of chemical substances to determine their hazards. This provided powerful incentives for industry to find replacements, substitutes, or alternatives. The toxicity testing required by many of these statutes generated new knowledge and a new awareness about the types and degrees of hazard associated with many chemicals.

As this collective knowledge grew in scientific and industrial circles, there was corresponding growth in the public's demand for more information about chemicals that are present in their communities. For example, in the USA, this culminated in the 1980s with the passage of the Emergency Planning and Community Right-to-Know Act (EPCRA), which made public relevant data on chemicals being released to the air, water, and land by industry. As a consequence, industry has been confronted by tremendous pressure, not only to reduce the release of toxic chemicals to the environment, but also to reduce the use of hazardous chemicals overall. Thus, it is not surprising that since 1990, sustainable chemistry has been an official focus of the U.S. Environmental Protection Agency, involving a great deal of activity in research, symposia, and education.

The year 1993 was formative for the green chemistry movement as Paul T. Anastas and Carol A. Farris published the first book of the ACS symposium series: *Benign by Design, Alternative Synthetic Design for Pollution Prevention* (ISBN-10: 0841230536). The book was based on a symposium sponsored by the Division of Environmental Chemistry at the 206th National Meeting of the American Chemical Society in Chicago (22–27 August 1993). Most importantly, this book provided an opportunity for several chemists who were pioneers in the field to present their basic research and encourage other scientists to become involved in environmentally responsible chemistry.

In the same year in Italy, the Consorzio Interuniversitario "La Chimica per l'Ambiente" (Interuniversity Consortium Chemistry for the Environment), or INCA, was established with the aim of uniting academic groups concerned with chemistry and the environment. One of its main focus areas became pollution prevention through the development of cleaner reactions, products, and processes. INCA organized its first meeting in Venice, Processi Chimici Innovativi e Tutela dell'Ambiente (Innovative Chemical Processes and Environmental Protection), in February 1993.

However, it was only between 1996 and 1997 that the term green chemistry was first used. The definition "green chemistry" or "sustainable chemistry" has been the subject of a long debate. Both expressions have been used for the same or very similar meanings, but each has its supporters and detractors. The word "green" is brightly evocative, but may assume unintended connotations,[1] whereas "sustainable" can be paraphrased as "chemistry for a sustainable environment," and may be perceived as a less focused and less incisive description of the discipline. Other terms have been proposed, such as "chemistry for the environment," but this combination of words does not capture the economic and social implications of the concept of sustainability. Herein, the term green chemistry will be used for the purposes of this article.

* This article is not intended to be exhaustive, but merely provide a brief overview of the ongoing research and events in the field of green chemistry. In that regard, the authors apologize in advance for unintentionally omitting any additional projects that have helped shape the field of Green Chemistry.

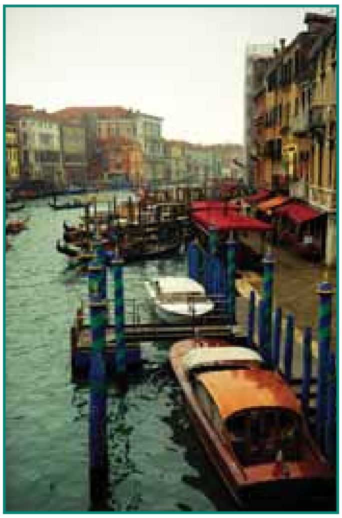
Green chemistry is defined by IUPAC as follows: "The invention, design, and application of chemical products and processes to reduce or to eliminate the use and generation of hazardous substances" (*Pure and Applied Chemistry*, 2000, Vol. 72, No. 7, pp. 1207–1228).

This definition is not only straightforward, but it also marks a significant departure from the manner in which environmental issues have been considered or ignored in the up-front design of the molecules and molecular transformations that are at the heart of the chemical enterprise. Paul Anastas, then of the EPA, and John C. Warner developed 12 principles of green chemistry, which illustrate the definition in a practical sense. The principles cover such concepts as:

Invention and design imply that the impacts of chemical products and chemical processes are included in the design criteria. This definition inextricably links hazard considerations to performance criteria.

Use and generation signify that green chemistry must focus not only on those undesirable substances that might be inadvertently produced in a process, but also on all substances that are part of the process. In this sense, green chemistry recognizes that there are significant consequences associated with the use of hazardous substances, including regulatory, handling and transport, and liability issues, to name a few.

Hazardous means that green chemistry is a way of dealing with risk reduction and pollution prevention by addressing the intrinsic hazards of the substances rather than those circumstances and conditions of their use that might increase their risk.



A conference on Challenging Perspectives on Green Chemistry was held in Venice in 1997.

In August 1996, IUPAC began its involvement in the green chemistry field with the creation of the Working Party on Synthetic Pathways and Processes in Green Chemistry (Seoul, Korea 1996). A year later, in September 1997, the First International Conference on Challenging Perspectives on Green Chemistry was held in Venice. The meeting was sponsored by IUPAC and co-sponsored by ACS, EPA, and UNESCO. Since then, IUPAC has been actively involved in several projects related to green chemistry:

- International Conference on Organic Synthesis ICOS 13, Mini Symposium on Green Organic Synthesis, Warsaw, Poland, 2000
- Special Topic Issue and Symposium-in Print on Green Chemistry, *Pure and Applied Chemistry*, 2000, Vol. 72, No. 7
- a CHEMRAWN (Chemistry Research Applied to World Needs) conference in Boulder, Colorado, USA, June 2001, titled Toward Environmentally Benign Process and Products
- 38th IUPAC Congress, Brisbane, Australia, 2001, which had as one of its five themes, Environmental Chemistry and the Greening of Industry
- Workshop on Education in Green/Sustainable Chemistry, Venice, Italy, 2001
- ICOS 14 in Christchurch, New Zealand, July 2002, at which there was a Symposium on Green Chemistry

This year, IUPAC organized the CHEMRAWN-XVII and ICCDU-IX Conference on Greenhouse Gases—Mitigation and Utilization, held in Kingston, Ontario, Canada, from 8–12 July 2007.

In July 2001, IUPAC approved the establishment of the Subcommittee on Green Chemistry (under the Organic and Biomolecular Chemistry Division, Division III). The committee's primary focus is to establish and carry out educational green chemistry programs. Since its conception, the subcommittee has actively organized international workshops, symposia, and conferences in addition to preparing and disseminating numerous books (the Green Chemistry Series) on global topics related to green/sustainable chemistry, which are specifically aimed at university students. Current projects and activities include:

- Global Climate Change—translation and dissemination of a monograph for secondary schools (IUPAC project 2005-015-1-300)
- an online Green/Sustainable Chemistry Directory (IUPAC project 2002-029-1-300, jointly with INCA) <www.incaweb.org/transit/iupacgcdir/INDEX.htm>

- Green Chemistry in the Arab region (IUPAC project 2003-043-1-300).

Another important step in the development of green chemistry was the foundation in 1997 of the Green Chemistry Institute (GCI) in the USA. After more than a year of planning by individuals from industry, government, and academia, GCI was incorporated in 1997 as a not-for-profit corporation devoted to promoting and advancing green chemistry. In January 2001, GCI joined the American Chemical Society in an effort to address global issues at the intersection of chemistry and the environment.

From its earliest days, the Institute has sought to be the premier change agent that has the knowledge, expertise, and capabilities to catalyze the movement of the chemical enterprise toward sustainability through the application of green chemistry principles. To fulfil its mission, GCI supports research, works to integrate green chemistry into all levels of chemical education, aides companies with industrial implementation, hosts conferences, and coordinates efforts with an international network of green chemistry advocates. The GCI also provides national recognition for outstanding student contributions to furthering the goals of green chemistry.

GCI offers two well-known awards established in memory of Kenneth G. Hancock and Joseph Breen. Hancock, former director of the Division of Chemistry at the National Science Foundation, was one of the earliest proponents of green chemistry and "environmentally benign chemical synthesis and processing." The Hancock Memorial Award in Green Chemistry allows undergraduate and graduate students an opportunity to compete for a prestigious award in recognition of their studies and/or research in green chemistry.

GCI and ACS also established the Joseph Breen Memorial Fund through the ACS International Endowment Fund in 2000. Breen was a founder of the worldwide green chemistry movement and the first director of the Green Chemistry Institute. This fund commemorates his commitment and accomplishments, and each year awards one or more fellowships.

In the late 1990s and at the beginning of the new millennium, interest in green chemistry spread all over the world. In 1998, following an EPA proposal, the OECD (Organization for Economic Co-operation and Development) issued a directive to develop a program on sustainable chemistry. The USA and Japan were nominated co-leaders in the field of research and development, while Italy was appointed leader of education. In particular, INCA was chosen as coordinator of the Educational Acts on Green Chemistry for OECD.

A year later, in 1999 the Royal Society of Chemistry (UK) introduced a new journal entirely dedicated to sustainable chemistry: *Green Chemistry*. Around the same time, similar projects were initiated in many other countries. Following are just a few examples:

- foundation of the Green Chemistry Institute of Spain in February 2000
- creation of the Green and Sustainable Chemistry Network in Japan in 1988 (officially operating since 2000), which in 2007 co-organized the first Asian-Oceania Conference on Green and Sustainable Chemistry
- the foundation of the Centre of Green Chemistry of Monash University in Australia, operating since January 2000

In addition, the German government has begun to dedicate special attention to renewable chemistry. In 2002, in connection with the Johannesburg's "World Summit for Sustainable Development," the government launched an international conference to promote the use of renewable energy in industrial and global development processes. The conference was held in Bonn and gathered 3600 participants.

In order to address the increasing need for green chemistry education, the Carnegie Group (the biannual meeting of the G8 Ministers for Research), which was held in Victoria, Canada (2–3 June 2005) and in New York (2–3 December 2005), founded a research and training network on green-sustainable chemistry called the International Green Network (IGN). The network was unanimously approved, following a proposal by the Italian minister for Education, Research, and University. INCA, located in Venice, Italy, was selected as the hub of IGN. INCA and the other research centers dedicate a space within their institutes to the IGN.

The IGN aims to provide know-how, coordination and sponsorship for scientific collaborations, proper training for the new generation of chemists, and support for sustainable use of chemistry in developing nations. INCA organized the kick-off meeting of the IGN on 1 December 2005 (Marghera, Venice). Delegates of all the G8 countries participated, as well as observers from other nations and prominent invited speakers. The purpose of the event was to officially inaugurate IGN, illustrate its goals (both scientific and political), and gather feedback from delegates. A document presented at the meeting, and approved shortly afterward by the Carnegie Group in New York, outlines the goals and mission of IGN.

Green Chemistry on the Rise

Another green chemistry network was founded in December 2005: the Mediterranean Countries Network on Green Chemistry (MEGREC). The network was created to further facilitate increasing collaboration between the European regions of the Mediterranean and North Africa on green chemistry issues. The official ceremony was held during the first board meeting at the University of Belgrade.

The MEGREC founding institutions include the Suez Canal University, Ismailia (Egypt); University Institute of Science and Technology, (Barcelona, Spain); Fez University (Morocco); Belgrade University (Serbia); Athens University (Greece); and INCA, Venice (Italy).

Among the objectives of the MEGREC program are the creation of a university master course (second level) on green chemistry and the recruitment of young researchers who will conduct research in the laboratories of partner institutions.

In Latin American countries, the scientific community is focusing intensively on green chemistry by developing a scientific collaboration called Chemistry for Clear Reactions and Processes: Green Chemistry. This joint project has already provided fellowship opportunities at an Italian university for researchers from Chile, Argentina, Brazil, Uruguay, Costa Rica, and Venezuela.

In 2006, INCA and the German Chemical Society organized the first international IUPAC conference dedicated to green-sustainable chemistry (see conference report, May-June 2007 *CI*, pp. 30–32). The meeting, held 10–15 September 2006, was organized under the auspices of IUPAC, the Italian Ministry of Research, Federal Ministry of Environment, Nature Conservation and Nuclear Safety, and the German Federal Environmental Ministry. The wide selection of topics offered at the conference attracted industrial researchers and representatives, university researchers, politicians, and students. The enormous effort of the organization committee fully paid off with over 450 participants attending from 42 countries. Upon conclusion of the conference, the organization committee extended an invitation to all delegates to participate in the Second International IUPAC Conference on Green Chemistry to be held aboard a luxury cruiseliner that will travel from Moscow to St. Petersburg. The conference is scheduled to take place in the last week of September 2008.

Another important step in the history of green chemistry has been realized with the introduction of REACH (Registration, Evaluation and Authorisation of Chemicals Regulation), which was formally adopted on 18 December 2006 by the European Council of Environment Ministers. This new regulation aims to improve the protection of human health and the environment through improved assessment of chemical substances. Thus, the REACH Regulation gives greater responsibility to industry as manufacturers and importers will be required to compile information on the properties of their substances and to register the information in a central database. This regulation ultimately calls for a progressive substitution of the most dangerous chemicals when suitable and greener alternatives have been identified, which is the main goal of green chemistry itself. REACH entered into force on 1 June 2007.

The "Floating Tree" by Francesco Tundo appears on the book cover of Green Chemistry Education*. Ref: Green Chemistry Series No. 3, INCA 2002 (ISBN 88 88214 00 5).*

Notes

1. In many countries the word "green" is associated with political parties primarily focused on environmental issues. In the United States, green symbolizes the color of money. Therefore, in areas that use the U.S. Dollar as currency, green carries a connotation of money, wealth, and capitalism. The flag of Libya is entirely green, the only current national flag of a single color. Green is considered the traditional color of Islam, likewise because of its association with nature. Green is a symbol of Ireland, which is often referred to as "the Emerald Isle" (Green represents also St. Patrick's Day). The color is particularly identified with the republican and nationalist traditions in modern times in balance with the Protestant orange. Green is thought to be an unlucky color in British and British-derived cultures, where green cars, wedding dresses, and theatre costumes are all the objects of superstition. In Dante's *Divine Comedy*, green is the color used to symbolize hope. In the Roman Catholic church, green is a traditional color symbolizing hope and the tree of life. The color green is often used as a symbol of sickness. In Japan, green indicates safety and luxury. In the Russian language, green is synonymous with "not ripe."

Pietro Tundo <tundop@unive.it> is a professor at the Università Ca' Foscari di Venezia (Italy) and a long-time member of the IUPAC Organic and Biomolecular Chemistry Division. Fabio Aricò <fabio.arico@unive.it> works with Pietro Tundo in Venezia where he is involved in a joint project between INCA and Imperial Chemical Industries PLC.

Recommendations from CHEMRAWN XV

Water is an essential resource for which there is no substitute. Yet, in much of the world, water resources are rapidly diminishing if not disappearing all together. In fact, around 5 000 children die every day due to a lack of clean water. Providing access to clean water is one of the keys to fighting extreme poverty as the World Summit on Sustainable Development (Johannesburg, 2002) made clear. Following are some of the alarming statistics from the World Health Organisation (WHO) related to water supplies throughout the world:

- There are 1.7 million deaths each year related to unsafe water, mostly among children under five.
- It is estimated that there are 4 billion cases of diarrhea annually, which represents 4.5 percent of the global burden of disease.
- One sixth of humanity currently lacks access to any form of improved water supply within one kilometer of their homes.

In response to the mounting problems of water management around the world, exacerbated by an ever-growing population and increasing needs, coupled with a finite natural resource, IUPAC decided to mobilize its skills and strengths to meet the many water-related challenges facing the world. To do this, IUPAC and its CHEMRAWN (Chemical Research Applied to World Needs) Committee held an international conference on Chemistry for Water from 21–23 June 2004 in Paris at the Maison de la Chimie (see conference report, Sep-Oct 2004 *CI*, pp 26–28). The "CHIMIE et EAU" Association (ACE) was responsible for organizing the event, which attracted 300 specialists who saw inspiring and highly informative presentations and exchanged valuable information related to water.

CHEMRAWN XV highlighted the emergence of a new chemistry that is an essential component of sustainable development. This new chemistry implies more science, more technology, more innovation, more solidarity. It requires the simultaneous combination of basic research, technological research, environmental research, and sociological research within strategies centered on major objectives such as water.

The primary goal of the conference was to engage the chemical community in addressing the question of how to ensure that everyone has an adequate quantity and quality of water for public use, sustainable agriculture, and industrial activities. The theme **Chemistry for Water** was almost aggressive. It shocked many accustomed to a more discreet attitude on the part of chemists. Yet, chemists must be conscious of the positive role they play in cooperating with water experts. They bring solutions to defined or obvious problems. The chemical world—academia and industry—must strengthen its commitment to dealing with water issues. And chemical engineering must be recognized by policy-makers as a major partner in water management, especially its security.

As with all CHEMRAWN conferences, Chemistry for Water was intended to recommend specific actions that should be taken by the global scientific community. These recommendations are reproduced in part below.

The original version of this publication, written by ACE, is longer and includes sections on Societal Issues and Ethics. The entire text is available for free online. Printed reprints are available upon request from the IUPAC Secretariat.

Scientific Matters

The recommendations that follow will not be accomplished without a worldwide mobilization of chemists and biochemists and a solid partnership with physical scientists, engineers, social scientists, policy makers, and business representatives. The knowledge and talents of chemists are necessary to understand the basic causes of the problems and to develop innovative techniques to provide safe drinking water and adequate sanitation systems for all people. This effort requires the expertise of all of the chemical sciences: analysis, biochemistry, environmental sciences, green chemistry, material science, nanoscience, physicochemistry, polymer chemistry, and process engineering.

The risk of a dispersion of efforts exists between chemistry disciplines and between chemistry organizations. Emulation is useful, but an international agenda for the main research and development objectives of "chemistry for water" is necessary, with incentives, evaluations, and public recognition.

➡ **The chemical community is able to, and must help to, meet the Millennium Development Goals <www.un.org/milleniumgoals>.**

Water is a complex material with surprising properties that are still being intensively studied. Better knowledge of the intimate structure of the water "molecule" will certainly be useful for a more profound understanding of its properties (e.g., its capacity to dissolve inorganic and organic substances and the mechanism of its chemical reactivity). This perspective is clearly academic, but some industrial applications might soon be exploited because water is a non-pollutant solvent or reagent. It is a major agent of the developing "green chemistry."

➡ **We must encourage all fundamental research on water-related problems and attract and retain more top students, scientists, and engineers in that field.**

Water is the only substance present in nature in three physical phases: solid, liquid, and gas. The natural "water cycle" is the only real source of water in all parts of the world. However, not all characteristics of that cycle are fully understood. The energy involved in that cycle determines the mean temperature of the planet.

Water is the most important substance in the atmosphere involved in creating the so-called "greenhouse effect" (not CO_2), but it is generally ignored in weather studies because data on the water cycle are insufficiently known, fluctuate too much, and are too difficult to use in models. The water cycle strongly depends on the oceanic currents, their flows and their temperatures, and on the characteristics of the clouds, the nucleation process, and their thermal effects on Earth temperature. There is growing interest in the accelerating decay of ice sheets in Greenland and in West Antarctic observed during the last decade. The decay is due to the melting of the ice sheets in summertime, as well as the acceleration of the glaciers as they move into the oceans. This phenomenon is not well understood, and there is a vast domain of research only partly covered.

➡ **A better understanding of the water cycle is necessary for a credible evaluation of Earth warming, not only in the atmosphere but also in the oceans.**

Groundwater represents another huge domain of research. An inventory of the available reserves is uncertain in many places. The intensive use of this water for agriculture may lead to its exhaustion in a number of years. However, this is difficult to evaluate without more knowledge about the natural capacity of ecosystems to restore the water layer. Another major concern is pollution of the upper layers of groundwater by agricultural or industrial pollutants.

➡ **A complete understanding of underground hydrology is necessary to avoid excessive use of groundwater. This is mandatory for preserving water for future generations.**

Surprisingly, pure water does not exist in nature because of its powerful dissolving power. To be "drinkable," pure water must be "remineralized." Natural "mineral waters" are appreciated for their taste due to certain dissolved mineral ions and because of the absence of organic or bacterial contamination.

The quality of water distributed by public networks is regularly controlled for its content. All types of pollution entering these water supplies must be immediately detected and stopped. CHEMRAWN XV demonstrated the diversity of research occurring in the field of water analysis: the identification of micro-traces of heavy elements and of new organic micro-polluants; the study of synergetic effects of different species in water (molecules, complexes; solid particles, etc.); the study of the fate of chemical pollutants (e.g., methyl mercury) and medicinal residues and their elimination in-situ; the development of in-situ methods and metrology; the Fourier Transform-Ion Cyclotron Resonance-Mass spectrometry; and development of new simulation and modeling methods.

➡ **Priority must be given to all aspects of research into water analysis. Chemists are able to detect and evaluate ever-increasing microtraces of numerous pollutants in ever-more-dilute concentrations in**

water. The methods must be reliable, automatized, and rapid. At a greater scale, chemists are asked to develop a more precise knowledge (nature and chemical behavior) of the different classes of organic compounds present in water from natural or anthropogenic origins. This raises questions about the transport and reactivity of pollutants in aquatic systems.

Developing countries have the potential, within existing universities and engineering schools, to study water problems. Their laboratories can be re-oriented toward local issues, such as pollutants, natural products, and tropical diseases. This can be accomplished by developing and using low-cost equipment and methods adapted to real local needs and possibilities, and through international cooperation as needed.

➡ **An international policy effort is necessary to enhance water-related research activities in laboratories in developing countries. International support is necessary for such programs to be successful.**

Presently, research on chemical aspects of water-related problems is spread among a very large number of teams that are generally small and often isolated. There is a serious need to facilitate the exchange of information among researchers nationally and, more importantly, internationally, especially in developing countries. Still more important is to provide adequate training of specialists in developing countries. In addition, more conferences on water chemistry should be organized every year in various parts of the world. Above all, some ambitious quantitative and qualitative objectives, with datelines, should be proposed by an authoritative body. This body should provide real incentives for meeting these objectives, such as prestigious international prizes, chairs, or fellowships.

➡ **Information dissemination should be coordinated internationally, particularly when planning research objectives.**

Technology

(recommmendations only; see full text for details)

Water is different from any other chemical: Under all circumstances, water is never fully consumed, only polluted. After any use, its quality, essentially its purity, is degraded. Historically, the purification process was left to natural processes. That is still the case in a large part of the world, but this has become less and less sufficient. Physical and chemical treatments, that are a substitute for or that accelerate natural processes, are necessary for health reasons before any public distribution of water and for all types of used waters before disposal.

➡ **Water is undervalued the World over. Water must be valued and priced appropriately, especially for irrigation. Users must pay a fair price for it. If they can't, a national or international subsidy could be established. An equitable distribution of the resource, a sustainable system operation and a clear and honest pricing system might be the conditions for having a better sense of economy of water in the public, particularly for agricultural uses.**

➡ **The quality of water can be controlled before distribution only if correct equipment, prescribed chemical additives, and a complete analytical protocol are available and are used. Microbial risks, a serious public health concern, must certainly be evaluated.**

➡ **Advances are still occurring in the technology used to control persistent organic and inorganic pollutants, and to minimize the presence of disinfection byproducts. Removing more particles and organic matter before treatment is always advisable. New processes using membranes are under study: Ultrafiltration and reverse osmosis show considerable promise.**

➡ **The present international effort to remediate arsenic contamination, not only in Bangladesh but also in Argentina, Chile, India, western USA, and other**

areas, is a clear illustration of the nature of water problems: Work must be done locally, yet it demands the talents of many experts difficult to find in an underdeveloped country. International cooperation becomes a necessity.

➡ **The main challenge when treating used waters is evaluating the health risks from micropollutants, especially endocrine disrupters, for which new analytical and removal methods are under study.**

➡ **Membranes materials and technology are active subjects of chemical and process research not only for desalination but for other uses (e.g., nanofiltration) as well.**

➡ **The role of chemistry in a desalination plant could be greater than just technical support. The unit could in fact be the nucleus of an entire chemical complex that exploits the valuable elements present in the brine.**

➡ **New chemical processes must be developed that are more economical in water use, more adaptable to remote places, friendlier to the environment, and more attentive to water quality.**

Thermal power generation uses huge amounts of water as does oil refining. Critical to addressing water issues is having the energy needed to transport, manage, treat, and desalinate water resources. In the future, nuclear and renewable energies are likely to play a major role in that domain.

➡ **Water and energy are tightly linked. Saving water is always saving energy.**

Water is too cheap to be exported over long distances. For example, Egypt doesn't import actual water, but it imports it another way, by importing half of its grain, where each tonne of grain represents 1000 tonne of water. Several countries are already including this "virtual water" in their energy and water policies. For example, Saudi Arabia reduced its grain production from 4.1 millions tonne in 1992 to 1.2 million tonne in 2004. A similar approach can be observed in Japan, which imports aluminium metal, rather than bauxite, to save national energy resources.

➡ **For arid countries, "virtual water" is an interesting new concept in international business.**

The original recommendations also include sections on societal issues and ethics. See full text online for details.

As a conclusion, the report cites this optimistic comment of Michel Camdessus: "The dream of pure water for all is within the reach of humanity. It can be attained by continuing for a further 10 years the effort to which we are committed from now to 2015. This is the challenging task for the generation of people now running the world!"

CHEMRAWN XV showed that the chemical community is ready to face that challenge.

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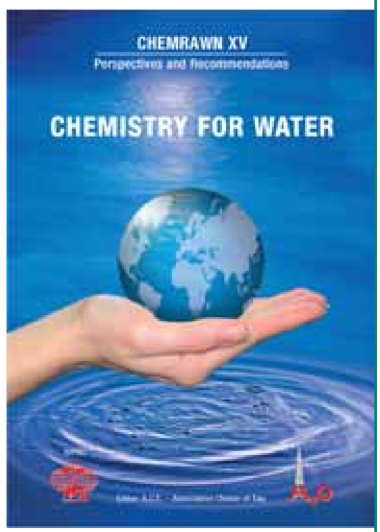


www.iupac.org/publications/books/author/ACE06.html

Lessons from the Past*

by Hitoshi Ohtaki†

This article briefly reviews the development of science and technology in Asia, mainly in Japan. It focuses on why science and technology in Japan were able to develop after the catastrophic damage of the Second World War. Since this paper was read at the 9th Eurasia Conference on Chemical Sciences, an emphasis is placed on the relationship between Asian and Western countries.

Japan was an underdeveloped country in science and technology 150 years ago, although mathematician Kowa Seki and physicist Gennai Hiraga did make important contributions around that time. Japan had been isolated from other countries for 300 years during the Tokugawa Period until the Meiji Era, which began in 1852. During this period, Japan had practically no exposure to European and American science, technology, or culture. On the other hand, the characteristic culture of Japan had been blooming during this period.

Other Asian countries, which were controlled by suzerain states at that time, were much more enriched in modern science and technology than Japan. However, in most case the science and technology were exclusively used by the suzerains, and the native people did not share in its benefits.

Modern Chemical Sciences in Japan

Many technological advances occurred in Asia before the advent of modern chemistry. For example, gunpowder originated in China in the 7th century—much earlier than in Europe where it was not produced until the 13th century. Further improvements in gunpowder were made by Masachika Shimose (1859–1911), who used picric acid instead of nitrocellulose. This advance is credited with helping the Combined Fleet of Japan, commanded by General Togo, beat the Baltic Fleet of Russia in a 1905 Japan Sea battle at the end of the Russo-Japanese War.

A Period of Modernization

A systematic investigation of the chemical sciences of Japan was started by Yoan Udagawa (1798–1846; right), who was influenced by the books of Antoine Laurent Lavoisier. In 1837 he published the first Japanese chemistry textbook, which was entitled *Seimi-Kaiso* or "Opening of Chemistry."("Seimi" comes from the pronunciation of "chemie" in Dutch. See photo on page 13.)

Yoan Udagawa

The Isolation Policy of Japan started at the beginning of the 17th century and ended in 1854. In 1853, four Black Ships directed by U.S. Commodore Matthew C. Perry (1794–1858) visited Uraga, a small town near Yokohama. Commodore Perry's superior military force enabled him to negotiate a treaty allowing American trade with Japan, ending a 200-year period in which trading with Japan was only allowed to the Dutch, Chinese, and a few other small groups. The following year, at the Convention of Kanagawa, Perry returned with seven ships and forced the shogun to sign the "Treaty of Peace and Amity," establishing formal diplomatic relations between Japan and the United States.

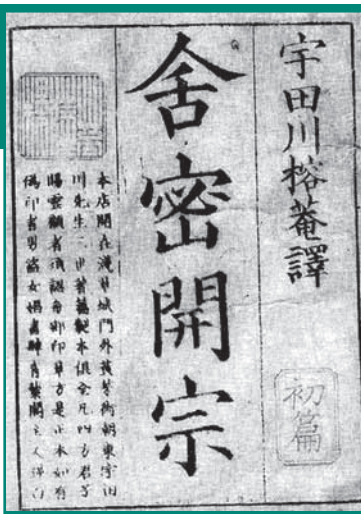
Foreign Teachers of Science and Technology

In 1867, soon after the end of the Tokugawa Period (Edo Era), a new government under the Meiji Emperor began. During this era, the government launched a campaign to modernize the country and elevate Japanese culture to the level of European culture, especially in the area of science and technology. As part of this effort, the government invited about 3 000 foreign teachers to private schools in various parts of Japan. Their monthly payments were comparable to those of government ministers. In 1868, the first university in Japan was established: the Imperial University of Tokyo.

Science and Technology Textbooks in Japanese

*The full version of this paper is included in the *Proceedings of the 9th Eurasia Conference of Chemical Sciences*, to be published by Springer-Verlag, under the title "Innovations in Chemical Biology." (See conference report in Mar-Apr 2007 *CI*, p. 24.)

†Hitoshi Ohatki passed away on 5 November 2006, a few days after submitting this paper to *CI*. Ohtaki was a professor in the Department of Applied Chemistry of the Faculty of Science and Engineering at Ritsumeikan University, in Kusatsu, Japan.



***Seimi-Kaiso**, the first Japanese chemistry textbook.*

Chemistry textbooks were introduced to Nagasaki by Dutch, German, and French doctors. Some of them were translated into Japanese. In 1861, Komin Kawamoto (1810–1871) published *Kagaku Shinsho* (New Chemistry), which is a Japanese translation of *The School of Chemistry* (1846), written by J.A. Stöckhardt (Germany), which was translated from the Dutch book *Inorganic and Organic Chemistry* by J.W. Genning (Holland) in 1850. *Teizo Kono* (1817–1871) published 14 volumes of *Seimi Binran* (Handbook of Chemistry) in 1856.

Students Study Science and Technology Abroad

During the Meiji Period, many students were sent to European countries to study in various fields. The Japanese government's investment in these educational activities amounted to about one-third of the total budget of the Ministry of Education. However, the investment paid off as a number of these students went on to become scientific leaders during the Meiji (1868–1912) and Taisho (1912–1926) Eras. Among them was Nagayoshi Nagai (1845–1922, left) who studied chemistry in the laboratory of A.W. Hofmann (1819–1892) at the University of Berlin, Germany, and discovered ephedrine in 1885.

Nagayoshi Nagai.

Another of these students was Joji Sakurai (1858–1939), who went to London in 1878 to study chemistry under A.W. Williams (1824–1904). When he returned to Japan in 1881, he was immediately appointed a lecturer and soon promoted to a professor at the Imperial University of Tokyo. His contributions to the development of chemistry, especially his leadership as president of the Chemical Society of Japan, which was established in 1878, and as the president of the Japan Academy (established in 1879), are especially noteworthy.

Kikunae Ikeda (1864–1936, right) was interested in physical chemistry, a new and rapidly progressing field of chemistry in Europe, and studied reaction kinetics and catalytic reactions in the laboratory of F.W. Ostwald (1853–1932) of the University of Leipzig, Germany, from 1899 to 1901. Ikeda became a professor of physical chemistry at the Imperial University of Tokyo, but he is much better known as the discoverer of glutamic acid, which he extracted from sea weed, and as inventor of the seasoning "Aji-no-Moto" or sodium glutamate.

Kikunae Ikeda.

In 1900, after Umetaro Suzuki (1874–1943, below) had graduated from the Agricultural College of the Imperial University of Tokyo and became an associate professor, he went to ETH of Zurich, Switzerland, to work with E.A. Schlze. Next he worked in the laboratory of E. Fischer (1852–1910) of the University of Berlin from 1901 until 1906. After this, he was appointed as a professor at the Agricultural High School of Morioka. His observations of the nervous system disorder beriberi in chickens resulted in the discovery of oryzanin (vitamin B1) in 1910, which is an extract from rice bran.

Umetaro Suzuki.

After WWII

After the United States dropped atomic bombs on Hiroshima and Nagasaki in 1945, the damage was so catastrophic in all parts of Japan that schools and universities were almost completely closed. Eventually, with support from the U.S. government and U.S. nongovernmental organizations, these schools were able to reopen. This kind of support was extended to scientific studies. One of the most well-known U.S. organizations to help was the Fulbright Foundation, which made it possible for many young and middle-aged scientists to study in the USA. Prior to WWII, most Japanese scientists who studied abroad went to Europe. After World War II, probably more than 80 percent of Japanese researchers went to the USA to study science and technology.

In 1955, the Japanese economy was so bad that the monthly stipend for a university research associate who was about 30 years old was only USD 30. The rapid recovery that the Japanese economy achieved by the 1970s was supported by science and technology development.

Today, the Japanese government still understands the importance of fundamental research, applied science, and technology. Funding for the promotion of scientific research was 188 billion Yen (USD 1.65 billion) in 2005. However, as an increment of the total government budget,

continued on page 18

See also
www.iupac.org/publications/ci/indexes/tools-of-the-trade.html

The Red Book—Nomenclature of Inorganic Chemistry

IUPAC Recommendations 2005*

by Richard Hartshorn

Nomenclature is a core area of IUPAC activity, and nomenclature may indeed be the context in which most chemists first become aware that IUPAC exists. High school pupils are introduced to basic concepts in systematic nomenclature, and many teachers and textbooks will rightly attribute these nomenclature recommendations to IUPAC, or perhaps, depending on student reaction, try to shuffle blame onto IUPAC!

Today, it is the Division of Chemical Nomenclature and Structure Representation that is responsible for devising, revising, and codifying nomenclature recommendations for existing and new compounds, or classes of compounds. Indeed, the establishment of the division in 2002 is a reflection of the ongoing commitment of IUPAC to nomenclature, and the importance attached to such activities. Previously, nomenclature commissions within other divisions carried the responsibility for nomenclature recommendations within their areas of interest and, more particularly, for the preparation of the "color books" in which these recommendations are collected. The Red Book is an example from Division II, Inorganic Chemistry.

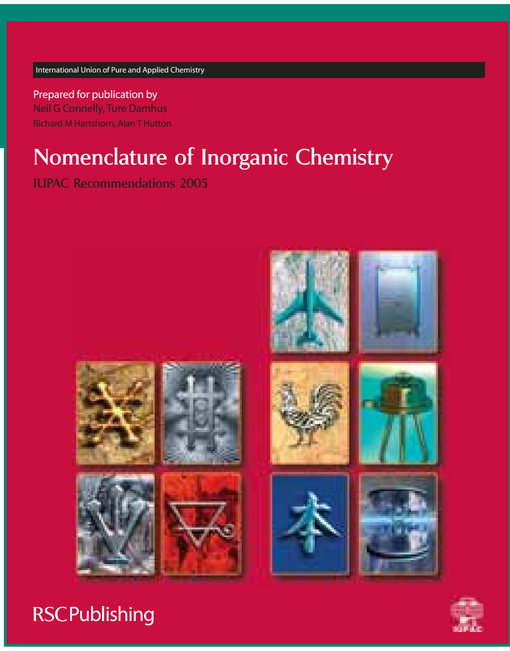
Preparation of what became the 2005 Recommendations (RSC Publishing 2005, ISBN 0854044388) began in 1998, under the auspices of the Commission for Nomenclature of Inorganic Chemistry, as the field had moved on considerably since the 1990 Recommendations were prepared (which was significantly before the 1990 publication due to the extensive nature of the review process to which all such recommendations must be submitted). The task of preparing the new recommendations was transferred to the new Division of Chemical Nomenclature and Structure Representation during the 2001 restructuring of IUPAC activities, and regular meetings over the next several years allowed work to progress. The need to align the content of the new recommendations as closely as possible with those being developed in a parallel project to update the Blue Book (Nomenclature of Organic Compounds) led to additional meetings as part of an alignment project in 2001 and 2002.

Perhaps the most significant addition to the recommendations is the chapter on the nomenclature of organometallic compounds. Previously this had been treated in a short section of the chapter covering coordination compounds. The huge growth in the area of organometallic chemistry in the 1980s and 1990s and the different nomenclature that is required for π-bonded ligands was the justification for devoting a chapter to this kind of system. Another innovation is the introduction of flowcharts to assist in choosing between the different kinds of nomenclature that are available, and in the application of the additive nomenclature that is widely used and recommended for coordination and organometallic compounds.

Development of nomenclature recommendations can be a balancing act, as there are demands to reflect common practice while at the same time retaining the kind of consistency and logical structure that will both make it easy to learn and apply, and to extend to new systems without ambiguity. The problem is that nomenclature methods are often developed in an ad hoc way in order to describe new compounds or classes of compounds. The resulting rules are not always as easily generalized as may be desirable and, in some cases, may lead to ambiguous names (i.e., names for which more than one structure could be drawn). A complicating factor is that the existence of such ambiguities may only become obvious some time after the initial invention. At that point, nomenclaturists face a dilemma: Either make the nomenclature more complicated by introducing some new exception, rule, or convention that resolves the ambiguity, or adopt an entirely new approach and create a new kind of nomenclature. Of course adopting new nomenclature systems then creates complications at a different level, as it becomes possible to produce a number of quite different, but still systematic, names for the same compound. Addressing that kind of complication is the goal of a separate IUPAC initiative, introduction of Preferred IUPAC Names (PINs). Two projects are currently active in developing rules to select PINs for different classes of compounds.

The Red Book can help chemists create names from structures, or decipher names to give structures. Clearly, it is desirable to ensure that changes to the recommendations are minimized so that existing

*The Royal Society of Chemistry, 2005
[ISBN 0 85404 438 8]



names can be deciphered consistently and without ambiguity in the future. However, we believe that there are occasions where recommendations should be changed as attempts are made to strike the balance between reflecting common usage, and making the recommendations as simple and straightforward as possible. There are particular examples of this kind of change made in the 2005 recommendations, and it is perhaps instructive to consider some of the issues that underlie the choices that have been made as these recommendations have been formulated. Some of the changes are less controversial than others, some may be widely adopted, and some may even be largely ignored! Here are a few examples:

Kappa and Eta Conventions

The kappa and eta conventions are used to describe the bonding of ligands to central atoms. The kappa convention (page 155) has its roots in coordination chemistry and allows the donor atom(s) in a ligand to be specified and, in the case of polynuclear systems, it is also used to indicate the central atom to which the donor atom is bound. The eta convention (page 216) is widely used in organometallic chemistry to describe ligand binding modes, particularly those where the bonding is through π-electron donation to the central atom from unsaturated hydrocarbons.

Clearly, there is an overlap in the way these conventions could be used, and with that comes the possibility for confusion regarding which convention should be used in a particular set of circumstances. The 2005 recommendations therefore provide an explicit comparison of the two conventions (page 161), in which the eta convention is used to describe bonding in which contiguous atoms in a ligand are bound to the same central atom, while the kappa convention is used for cases where an isolated donor atom is bound to one or more central atoms.

New Ordering Rules in Names—Central Atoms

In additive nomenclature, the name for a coordination entity is produced by listing the ligand names (along with the appropriate multipliers) in alphabetical order, followed by the name of the central atom to which they are attached. In the case of polynuclear compounds, those with more than one central atom, the ligand names are again listed first in alphabetical order, and the central atom to which they are attached is identified using the kappa convention that incorporates a priority number for the central atom (pages 162–163). The central atoms are assigned their priority number based on their position in the periodic table, or, if they are of the same element, by the numbers and kinds of ligands attached (page 168). The central atom names are listed together after the ligand names, according to their priority number, but in the 1990 recommendations they were listed alphabetically. The following example is taken from the Red Book.

The recommended name for the complex $[(OC)_5ReCo(CO)_4]$ is nonacarbonyl-$1\kappa^{5}C,2\kappa^{4}C$-rhenium-cobalt, where the first kappa term, $1\kappa^{5}C$, indicates that five of the carbonyl ligands are coordinated to central atom 1 through their carbon atoms. Rhenium is assigned the central atom number 1 because it is reached last on following the arrow shown in Figure 1 (see next page). Since the listing of the central atoms is based on this same sequence, the reader can interpret the 1 as meaning that the kappa term relates to the first central atom in the list of central atoms at the end of the name. The reader can decipher the name without needing to know or use the complicated sequence of rules that may be required to assign central atom numbers (particularly if the central atoms are of the same element but have different ligand sets). The 1990 recommendations, on the other hand, listed the central atoms alphabetically. This meant that the reader could only work out which central atom each kappa term referred to by applying the rules that the author also used.

Chloro vs. Chlorido

In the names of coordination entities, anionic ligand names are generally modified so that -ide ligands become -ido and -ate ligands become -ato. However, common practice and past recommendations provided for a number of exceptions to this rule, so that, for

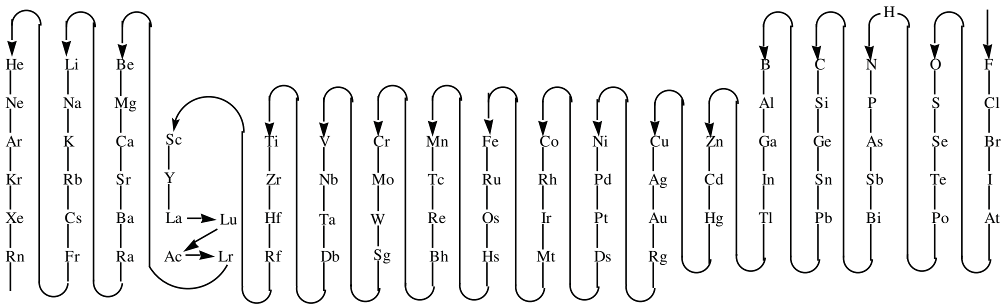


Figure 1. The element sequence depicted in this table is also adhered to when ordering central atoms in polynuclear compounds for the purpose of constructing additive names.

example, chloride ligands were represented by chloro in the name, nitrite ligands by nitro (if bonded through the nitrogen atom), and cyanide ligands by cyano. The 2005 recommendations remove these exceptions, so that the general rule is applied to all ligands (page 151). A principal purpose of this change is to make the nomenclature more systematic and easier for novices to learn. An additional benefit is that there is a clearer differentiation between parts of a name that are produced using substitutive nomenclature (commonly used in the nomenclature of organic chemistry, and therefore for organic ligands) and those that relate to the additive nomenclature used when describing a ligand bound to a central atom. Thus, under the new recommendations, chloro is used to indicate a chlorine atom substituent within a ligand that is named substitutively, while chlorido is used to indicate a chloride ligand that is bound directly to a central atom. Under the new recommendations, the phrase chloromethyl in a name would refer to one ligand, but chloridomethyl would refer to two. Under the previous recommendations the differentiation would be critically dependent on the appropriate placement of enclosing marks, as chloromethyl would be used in both cases. This recommendation therefore reduces the potential for names to be ambiguous.

New Recommendations for Formulae—Ordering, Donor Atoms

The recommended order of symbols in formulae of coordination entities is to place the central atom symbol first, followed by the ligand symbols (which may be line formulae, abbreviations, or acronyms) arranged in alphabetical order (noting that element symbols are treated as a single character—so CO precedes Cl, because C alphabetically precedes Cl). There is no longer any requirement to list the anionic ligands before neutral ligands, which should make producing formulae more straightforward, as there is now only one ordering principle being applied, and there is no need to decide if a ligand is anionic (page 153).

It should be noted that there is an explicit statement that these ordering recommendations should be violated in order to provide additional structural information. Thus, for example, bridging ligand symbols should be placed between the relevant central atom symbols wherever possible. In addition, some ligand symbols might be placed first in a formula, as a way of grouping ligands bound to one central atom separately from those that are bound to another (see the formula given for the rhenium-cobalt complex, above).

In addition, when line formulae are used for ligand symbols, the line formula should be altered so that the donor atom is closest to the central atom symbol wherever possible. The rationale for these recommendations is that formulae are rather limited in the way in which they can describe structural information and identify donor atoms, particularly in more complicated cases such as polynuclear systems. This is because the kappa convention is not generally applied to formulae. Careful location of ligand/element symbols in formulae can go some way to replacing that convention, at least in the case of systems with two central atoms.

These are just some examples of the issues that are faced by those revising nomenclature. Hopefully the resulting decisions make a useful tool for those who need to use nomenclature for inorganic compounds.

Acknowledgements

The author wishes to thank his coeditors—Neil G. Connelly, Ture Damhus, and Alan T. Hutton—for their useful comments on this article and for the fun times spent working on the Red Book revision.

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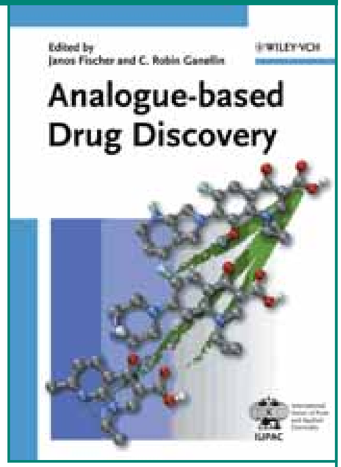
www.iupac.org/publications/books/author/connelly.html

Great Demand for *Analogue-Based Drug Discovery* Results in Reprint

Eighteen months ago, the book *Analogue-Based Drug Discovery*,* edited by Janos Fischer and C. Robin Ganellin (Chemistry and Human Health Division), was first published by Wiley VCH in Europe and then in the overseas markets of the Americas, Australasia, and Africa. From the publisher's point of view, the first 18 months after a book is published determines its overall success in the market. Wiley VCH sold out the initial print run of 800 copies of this book, and is undertaking a first reprint.

According to Frank Weinreich, Wiley-VCH representative, the fact that demand for the book continues to be so high testifies to its great concept and quality, which is the result of the dedication of the two editors, Fischer and Ganellin, as well as the many authors who have contributed to it. It also indicates that there is great interest among those in the global drug development community to educate themselves from books like this one. Wiley believes that a companion volume with new case studies of analogue-based drug development will enjoy the same outreach and popularity as the first book. The task group is being encouraged to again assemble a team of well-known experts from the community to begin working on a follow-up volume.



www.iupac.org/publications/books/author/fischer.html

Jürgen Gmehling Awarded the 2008 Rossini Lecture

The recipient of the 2008 Rossini Lectureship Award, selected by the Board of Directors of the International Association of Chemical Thermodynamics (IACT), is Jürgen Gmehling of the University of Oldenburg, Germany. This highly esteemed award is given by IACT in recognition of a significant contribution to the field.

Professor Gmehling's career started with an apprenticeship as a laboratory technician, after which he studied chemistry at the Technical College in Essen, Germany, where he obtained his degree of Diplom-Chemiker in 1970. He attained a doctoral degree in 1973 at the University of Dortmund. He was appointed chair of Reaction Engineering in the Department of Chemical Engineering at the University of Dortmund and, in 1989, he joined the faculty of the University of Oldenburg as professor of Chemical Engineering.

Gmehling's research activity has been directed at understanding the various processes in a chemical plant such as the preparation of feedstocks, the reaction itself, and the effects of temperature and pressure, energy and mass transfer, and the separation process, be it distillation, extraction, absorption, or crystallization. This requires accurate experimental thermodynamic measurements, reliable thermodynamic models for the prediction of thermodynamic properties, and an extensive data bank of reliable data, which can be used to derive the model parameters.


Jürgen Gmehling.

Gmehling has made an outstanding contribution in each of these three areas. His laboratory has produced a large amount of reliable experimental data, which include measurements of phase equilibria for pure substances and binary and multicomponent systems, measurements of activity coefficients at infinite dilution, measurements of heats of mixing and heat capacity, and measurements of the kinetics of chemical reactions.

The thermodynamic models, which he has developed and tested, include the group contribution methods UNIFAC, ASOG, and modified UNIFAC, and the predictive Soave-Redlich-Kwong equation of state (PSRK). These models are well-known worldwide, and are integrated in most of the commercially available process simulators (such as ASPEN and CHEMCAD) used throughout the world for the synthesis and design of the different processes in chemical industry.

Gmehling began a systematic evaluation of the scientific literature in the 1970s, with the goal of building a data bank for vapor-liquid equilibria. This data bank, which has expanded dramatically in recent decades, is still named the Dortmund Data Bank, although it is now maintained by a company which Gmehling founded in Oldenburg. It contains pure component property data for about 12 000 compounds, vapor-liquid equilibria data for some 20 000 mixtures, about 35 000 activity coefficients at infinite dilution, 42 000 sets of azeotropic data, and 13 500 heats of mixing.

It is through his measurement facilities, his systematic experimental work, and his extensive data bank that Gmehling has been able to determine the advantages and disadvantages, the weaknesses, and the range of validity of the various thermodynamic models.

The Rossini award is presented at the Biennial IUPAC Conference on Chemical Thermodynamics, where the recipient delivers the Rossini Lecture (see ICCT announcement on page 31). Recipients in the past decade have been Robert A. Alberty (1996), Stanley I. Sandler (1998), William A. Wakeham (2000), John M. Prausnitz (2002), Jean-Pierre E. Grolier (2004), and Alexandra Navrotsky (2006).

For more about IACT, see Jan-Feb 2004 *CI*; for more about the Rossini lecture, see Mar-Apr 2003 *CI*.

http://iactweb.org/

continued from page 13

Chemistry in Japan

funding has been decreasing in recent years.

Recently, the policy of the Japanese government shifted slightly to favor scientific research and applications that have industrial uses. The university system was changed and national universities were restructured to become universities of independent corporation. The results of the restructuring will probably not be known for a decade.

Despite these recent developments, one of the lessons from Japan's economic and technological achievements in the second part of the 20th century, is that large investments in education and research made more than 100 years ago—at the beginning of the modernization period—can still bear fruit today. Financial support for fundamental research is essential for the development of science and technology, which then can be applied to industries. Nations should not be too short sighted about the long-term investments in science and technology.

Peaking into the Future

There are a number of ways in which the current state of chemistry research in Japan could be improved. To start, Japanese scientists at international meetings are often said to behave according to the three Ss: smile, silence, and sleep. The Japanese must say goodbye to the three Ss. Now, the author would like to propose a new three Ss: spirit, scope, and sincerity to be active members in international societies[1] meetings.

It has been said that the 21st century is the century of Asia. This recognition was slightly delayed by the economic downturn that started in 1997 in Japan, but the recent economic growth of China, India, and Malaysia has been remarkable. After 1990, Korea and Singapore were no longer developing countries, and are in fact economic leaders in Asia.

Relationships among many Asian countries have been strengthened through economic cooperation and scientific discussions at many international conferences. The Science Council of Asia intends to play a leading role in the development of fundamental social and natural sciences and technologies through discussions at international meetings. The Eurasia Conference of Chemical Sciences and the Asian Chemical Congress, both organized by the Federation of Asian Chemical Societies, are other examples of support for the chemical sciences in Asia.

Cooperation among Asian and European countries, and the USA, is essential for establishing the Asian century. The Eurasia Conference has helped realize the dream of developing the chemical sciences in Asia with the close cooperation of European countries.

Acknowledgments

The author thanked Prof. Tetsuo Shiba[2] and Prof. Akio Yamamoto[3] who described the history of chemistry in Japan in *Chemistry Archives,* published by the Chemical Society of Japan. Many descriptions and photographs in the book are quoted in this review article. The article "History of Solution Chemistry of Japan"[4] is also referred to.

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4. H. Ohtaki, *J. Solution Chem.*, **33**, 575 (2004).

Glossary of Thermal and Thermomechanical Properties of Polymers

This project aims to identify the most important terms concerning thermal effects properties of relevance for polymers, and to give recommendations of unequivocal definitions for these terms. In literature and practical use it is obvious there is a significant lack of such a collection of terms. Some terms are even used in entirely different contexts or with different meanings to those intended.

The terms that have been selected for the preliminary list (see project web page) are those used in the conventional thermal (calorimetric) and thermomechanical (static or dynamic) characterization of polymeric materials. The project will be based to some extent on earlier reports related to nomenclature and terminology of thermal analysis published by the International Confederation for Thermal Analysis and Calorimetry <www.ictac.org>. The project will be carried out in collaboration with ICTAC.

For more information and comments, contact the Task Group Chair Michael Hess <michael.hess@uni-duisburg-essen.de>.

www.iupac.org/projects/2006/2006-041-1-400.html

An Introduction to Computer-Assisted Drug Design

A new project of the Chemistry and Human Health Division is to prepare a book that will provide a broad overview of the useful computational methods in drug design. The book will be for self-study and will also function as a guide in advanced biochemistry or medicinal chemistry courses.

The book will be organized along the steps of drug discovery. That is, the first chapters will address the design of screening libraries, the next will address following up high throughput screening hits, and the final chapters will address optimizing a series. Topics will be introduced when first needed, but referenced and expanded as needed for later discussions.

The level of detail in the main body of the book will be conceptual; however, for the more eager reader, additional details will be provided in set-aside boxes. The discussion will not include the details of all the computer programs available for a particular purpose. In particular, it will not include discussions of how to run the programs. In a similar vein, the citations will generally be to review articles. Every topic will be illustrated with examples.

For more information and comments, contact the Task Group Chair Yvonne C. Martin <yvonnecmartin@comcast.net>.

www.iupac.org/projects/2007/2007-006-1-700.html

Wet Surface Vibrational Spectroscopy Experiments

In recent years, there have been important developments in vibrational spectroscopic techniques applicable to studies of the wet interfaces which surround us in nature and in technology. Methods that can provide vibrational spectroscopic information about monolayers at surfaces are powerful tools in revealing the molecular basis of the observed macroscopic behavior of such systems. Surface enhanced Raman spectroscopy (SERS), which gives remarkable enhancement of typically weak Raman scattering, was at first observed from silver and gold electrodes. SERS is now more widely observed in other contexts and is even used for single molecule detection.[1] Surface enhanced infrared absorption spectroscopy (SEIRAS) is a related technique which gives enhancements of infrared absorption and is used mainly in electrochemical contexts.[2] The deposition of thin films of colloid-like particles on prisms used in attenuated total reflection infrared spectroscopy (ATRIRS) provides signal enhancements due to the high surface area and facilitates wet adsorption studies of diverse materials.[3] Presently, the most exciting surface-sensitive spectroscopic technique is vibrational sum frequency spectroscopy (VSFS).[4] This nonlinear optical technique provides vibrational spectra of molecules at "buried" interfaces and is highly surface selective due to symmetry changes at interfaces.

The aim of this project is to promote the application of ATRIRS, SEIRAS, and SERS to problems in interfacial chemistry by selecting, testing, and disseminating a collection of experiments suitable for undergraduate teaching laboratories, which are able to be performed with relatively inexpensive equipment. Undergraduate experiments in interfacial chemistry are presently dominated by measurements of macroscopic quantities such as surface tension and amount adsorbed when increasingly spectroscopic and microscopic data are presented in the corresponding lectures. This project takes a lead in encouraging a more modern molecular approach to interfacial physical chemistry teaching experiments by compiling and testing a series of appealing experiments which can be readily carried out in undergraduate laboratories. The relatively high cost and technical sophistication of VSFS precluded its inclusion in this project.

This project brings together leading physical chemists in the fields of attenuated total reflection infrared spectroscopy (ATRIRS), surface enhanced infrared spectroscopy (SEIRAS), and surface enhanced Raman spectroscopy (SERS), to select and test practicable experiments which can be carried out in teaching situations throughout the world. Both SERS and SEIRAS employ finely divided metal surfaces while the ATRIRS particle film approach can be applied to any particulate solid. All of the chosen surface spectroscopies are applicable to solid/aqueous interfaces that are of considerable interest in studies of natural and technological systems. Examples include the study of adsorbed electrode intermediates and the investigation of adsorbed collectors used as flotation agents for mineral extraction.

The experiments will include the basis of the different spectroscopic techniques, the preparation of surfaces to which the techniques can be applied, and several experimental systems as examples. Most undergraduates have access to infrared spectrometers in teaching laboratories so that the ATRIRS and SEIRAS experiments are expected to find more widespread use. SERS experiments have been included because Raman instruments are decreasing in cost and are now more frequently found in undergraduate laboratories.

The experiments will be tested and refined in their laboratories of origin, followed by testing in university undergraduate laboratories elsewhere under normal laboratory conditions. The project outcomes will be disseminated through the IUPAC website which will provide a means of assessing the uptake of the developed material.

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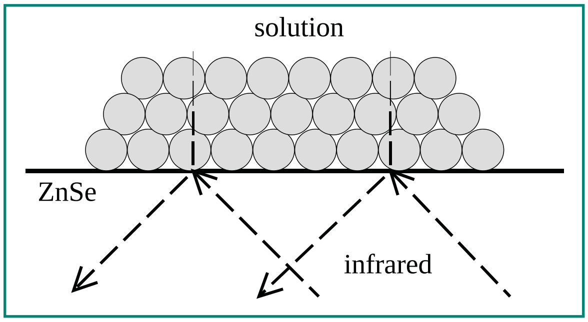


Internal reflection of infrared radiation and penetration of evanescent wave through wet particle film in ATRIRS. (Reproduced from reference 3 with permission.)

For more information and comments, contact the Task Group Chair Jim McQuillan <Jmcquillan@chemistry.otago.ac.nz>.

www.iupac.org/projects/2006/2006-050-3-100.html

Guidelines for Modulated-Temperature Differential Scanning Calorimetry

A project to establish and propose guidelines and recommendations for using modulated-temperature differential scanning calorimetry has been approved by the International Association of Chemical Thermodynamics to become a project of the Physical and Biophysical Chemistry Division. An international task group (including experts from France, Germany, Japan, Poland, and USA) has been set up to prepare documented recommendations on methods of operation and guidelines on standardized ways of selecting the different parameters of modulation in the use of modulated-temperature differential scanning calorimeters.

Modulated-temperature differential scanning thermal analysis techniques are widely used in many fields. Particularly in pharmaceutical, food, and polymer studies where first order transitions, glass transitions, and polymorphism are key issues. All sorts of relaxation phenomena, as well as coupled thermal and kinetic contributions, can be investigated advantageously and selectively studied with such techniques. Typically, calorimetric measurements are subject to systematic errors, especially when they depend upon the choice of physical parameters such as amplitude and period of modulation and the temperature scanning rate. It is not only the instrument used that is important, but the sample itself that requires the parameters to be tuned to optimize the response of the instrument in order to eliminate systematic errors and get full unambiguous information. It has to be recognized that whatever the instrument and the associated methodology used, the same quantitative information must be obtained on a given sample.

Extension will be made to thermal analysis techniques, where a modulation is superimposed to the temperature ramp, underlying the basic principles and the derived mathematical description of the data treatment. The different methods of measurement and calculation of the main thermodynamic quantities, such as specific heat capacities, first order transitions, and glass transitions, will be carefully analyzed. Clear descriptions will be given of the operating procedures and methodologies for the different typical aspects associated with the techniques. The project should provide a consistent set of internationally accepted recommendations for the use of modulated-temperature calorimetry.

For more information contact Task Group Chairman Jean-Pierre E. Grolier <j-pierre.Grolier@univ-bpclermont.fr>.

www.iupac.org/projects/2007/2007-002-1-100.html

Making an imPACt

Recent IUPAC technical reports and recommendations that affect the many fields of pure and applied chemistry. See also www.iupac.org/publications/pac

Glossary of Terms Used in Toxicology, 2nd Edition (IUPAC Recommendations 2007)

John H. Duffus, Monica Nordberg, and Douglas M. Templeton

Pure and Applied Chemistry
Vol. 79, No. 7, pp. 1153–1344, 2007
doi:10.1351/pac200779071153

In 1993, the importance of toxicology to chemists was recognized by the publication in *Pure and Applied Chemistry* (*PAC*) of the "Glossary for Chemists of Terms Used in Toxicology."[1] This glossary has been widely accepted and used, but, inevitably, with the continuing development of both chemistry and toxicology, terms have changed their meanings as a result of altered usage and new terms have been coined. Further, some important terms were overlooked, notably those relating to toxico-kinetics, and a supplementary glossary has already been published in *PAC*.[2] The revised and extended glossary presented here includes all new terms identified as relevant by the Working Party, together with those in toxicokinetics previously omitted. As before, the glossary is compiled primarily for chemists who now find themselves working in toxicology or requiring a knowledge of the subject. However, there are also many other scientists as well as regulators and managers who have to interpret toxicological information and need ready access to internationally accepted definitions of relevant terms in common use.

In order to make this a convenient one-stop glossary, the terms included in this glossary have come from a wide range of disciplines that contribute to toxicology. For some of the entries, alternative definitions are given in order to display the significant differences in their use that occur in practice. Many medical terms are included because of their frequent occurrence in the toxicological literature. There are three annexes, one containing a list of abbreviations and acronyms used in toxicology, one containing a list of abbreviations and acronyms used by international bodies and by legislation relevant to toxicology and chemical safety, and one describing the classification of carcinogenicity according to the weight of evidence available.

1. *Pure Appl. Chem.* **65**, 2003 (1993)
2. *Pure Appl. Chem.* **76**, 1033 (2004)

www.iupac.org/publications/pac/2007/7907/7907x1153.html

Bookworm

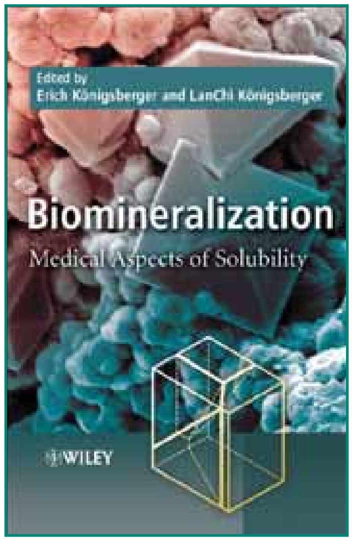
Books and publications hot off the press.
See also www.iupac.org/publications

Biomineralization—Medical Aspects of Solubility

edited by Erich Königsberger and LanChi Königsberger
John Wiley & Sons, 2006
ISBN 978-0-470-09209-5

Solubility phenomena are fundamental to living organisms and range from gas solubilities (e.g., oxygen in blood) to biomineral formation in body fluids. This book comprises five chapters that offer various perspectives on normal and pathological biomineralization in humans.

- Chapter 1 (Erich Königsberger and LanChi Königsberger) gives an overview of experimental and modeling methods, recommends solubility data for selected stone-forming substances, and describes recently discovered, unusual dissolution and crystallization phenomena involving nano-sized biomaterials.
- Chapter 2 (Félix Grases and Antonia Costa-Bauzá) presents a general classification of renal and salivary calculi based on their formation mechanism.
- Chapter 3 (M. Clara F. Magalhães, Paula A.A.P. Marques, and R.N. Correia) reviews the solubilities of calcium and magnesium phosphates and discusses their relevance to normal and pathological mineralization in terms of stability field diagrams.
- Chapter 4 (Fairland F. Amos, Matthew J. Olszta, Saeed R. Khan, and Laurie B. Gower) proposes a new paradigm for biomineralization—liquid phase precursors—and their possible roles in the formation of bone and kidney stones.
- In Chapter 5 (Wanida Chua-anusorn and Timothy G. St Pierre), various aspects of the biomineralization of iron and its relation to iron overload diseases are discussed.



Aimed at chemists interested in solution chemistry, thermodynamics, kinetics, crystallization, biochemistry, biomineralization, and medicinal chemistry, this book is also relevant to doctors and biologists interested in research in urology, nephrology, clinical chemistry, and chelation therapy.

Fine Chemicals—The Industry and the Business

by Peter Pollak
John Wiley & Sons Inc., 2007
ISBN 978-0-470-05075-0

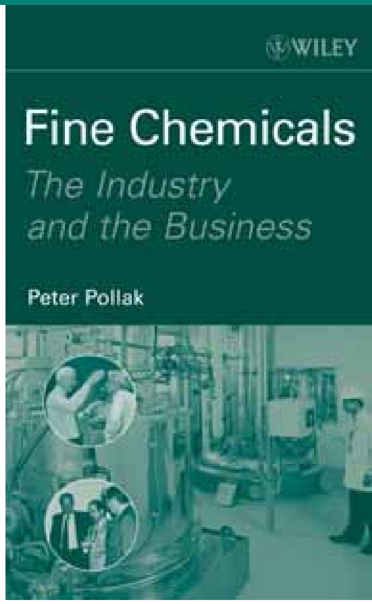
reviewed by Alan Smith

This is a really excellent book, as one might expect from Peter Pollak, who has a wealth of experience in fine chemicals. The first section of this three-part book, "The Industry," begins with essential definitions for commodities, specialty chemicals, and fine chemicals, before considering the technologies involved, the manufacturers and their facilities, R&D, and challenges being faced. The notes and comments added in smaller print are especially welcome, providing examples and small case studies to illustrate points made in the main text. Also provided is a fascinating insight into all the dramatic changes in this sector, including mergers and acquisitions and the growth of Chinese and Indian companies.

The second part, "The Business," focuses on the main markets and strategies for fine chemicals, with emphasis on pharmaceuticals and agrochemicals. This section discusses the best targets to focus on and provides particularly useful comments on pricing, intellectual property rights, and contracts. Throughout the book, the author tables the pros and cons of decisions facing those involved in fine chemicals.

The final part, "Outlook," examines the trends and future growth by industry segment, with interesting tables and speculation on patent expirations. Increasing manufacturing costs for European companies, through the implementation of REACH (registration, evaluation, and authorization of chemicals) legislation, is predicted to have a major effect on activities in Europe. Scenarios for cooperation between Asian and Western fine chemical companies are explored. The author concludes by giving a rating scheme for European companies to judge how fit they are for the future.

Although the decrease in demand for fine chemicals for the agrochemical sector, brought about by GM crops, is discussed, it is too early to consider the effect of new technologies on fine chemicals for the pharmaceutical sector. Perhaps the next edition could speculate about the impact nanotechnology is starting to have on healthcare. Reformulation of drugs at the nanoscale is just beginning to provide lower loading of "actives," and new concepts for accurate targeting of specific sites are being examined. A lot of research is being conducted in nanotechnology-based diagnostics, which potentially will detect diseases before they have taken a hold on the body. These will surely affect the fine chemical industry.



I can wholeheartedly recommend this book to anyone who is working in the fine chemical industry or is in any way connected with it. Peter Pollak has provided an in-depth review in a logical style that is both easy to read and extremely interesting.

Dr. Alan Smith <SmithAZT@aol.com> is a former director of BDH/Merck, where he ran the Advanced Materials business, which included liquid crystals. He was also head of Group Technology for Laporte during its growth in specialty chemicals. Smith is a member of the IUPAC Committee on Chemistry and Industry and an elected member from the UK on the IUPAC Bureau.

The Investigation of Organic Reactions and their Mechanisms

edited by Howard Maskill
Blackwell Publishing, Ltd., 2006
ISBN 1-4051-3142-X

reviewed by Markus Etzkorn

This is an impressive "guidebook" that bridges specialized monographs and more descriptive surveys on this fundamentally important topic. The foreword by Claude F. Bernasconi and the editor's preface discuss the aim of the subsequent 12 chapters, written by a group of 15 European experts, and place this book within the broader context of physical organic chemistry.

After the editor's brief outline in chapter 1, the next five sections develop, explain, and explore investigation techniques for studying and mechanistically interpreting reaction kinetics. The following three contributions cover diverse methodologies such as electrochemical, computational, and calorimetric techniques. The book concludes with two chapters on reaction intermediates and two chapters describing catalytic processes. A detailed 17-page index helps with navigating through this beautiful investigation of organic reaction mechanisms.

With a generally high scientific quality, each chapter can stand on its own and provides the necessary background to enjoy the numerous case studies that demonstrate the strength, and occasionally the weakness, of the discussed method. Each article closes with a reference list. Five chapters provide an additional bibliography as well, and the electrochemical chapter offers an appendix with some experimental advice. Throughout the entire book the quality of pictures, schemes, and equations is high, thus enhancing the reading pleasure. Overall, a clear presentation facilitates an easy browsing through the monograph.

In conclusion I highly recommend this book to every practicing researcher in industry or academe who needs a broad and thorough understanding of organic reaction mechanisms. Furthermore, this treatise gives an exciting and contemporary snapshot of the topic to any chemist with an interest in physical organic chemistry, ultimately reminding us that a mechanism is our current best interpretation of experimental data in terms of describing a chemical transformation.

Markus Etzkorn <metzkorn@uncc.edu> is an assistant professor at the University of North Carolina at Charlotte, in Charlotte, North Carolina, USA.

Global Scientific Challenges: Perspectives from Young Scientists

by Cristina Airoldi

An international conference was held in celebration of 75 years of the ICSU (International Council for Science) from 4–6 April 2007 in Lindau, Germany. ICSU is an international organization whose mission is to strengthen international science for the benefit of society. It takes part in the U.N. Commission for Sustainable Development, representing, together with WFEO (World Federation of Engineering Organisations), the science and technology community.

The vision of ICSU is "A world where science is used for the benefit of all, excellence in science is valued, and scientific knowledge is effectively linked to policy-making. In such a world, universal and equitable access to scientific data and information is a reality and all countries have the scientific capacity to use these . . . . " The ICSU strategy is structured around three overlapping themes where it has historically been active:

- International Research Collaboration
- Universality of Science
- Science and Policy

The conference brought together 147 young scientists from 71 different countries, and from different research areas, to discuss some of the key challenges for science in the 21st century. The agenda was structured around four main topics:

- building bridges within the scientific community
- building bridges between science and the world
- working with the private sector
- scientific freedom and responsibility

An additional section, titled "A "Carbon Neutral" Conference: Overview of the Concept, and Discussion of Options for Offsetting Emissions from this Event," was dedicated to discussing CO_2 emission-related problems. Each conferee had to pay 30 € (included in conference fees) to offset the greenhouse gases emitted through his/her travel and the electricity consumed at the conference venue. The conference attendees were informed that, under Dr. Daniele Cesano's (LEAD Fellow) coordination, the carbon offsetting would occur through the purchase of high-value carbon credits (carbon credits that come from a project giving a high contribution to sustainable development), either from individual project developers or from an established emission offsetting program. During the discussion it emerged that one of the great problem with CO_2 emissions is that developing countries, whose emissions will increase considerable in coming years, do not utilize advanced technologies to limit greenhouse gas emissions.

Building Bridges within the Scientific Community

From the presentations and discussions on this topic, which had two sections, international cooperation and trans-disciplinary collaboration, it emerged that the most significant problems are the following:

- Scientists working in different fields very often speak "different scientific languages."
- It is difficult to publish in journals that are "good" for all participants.
- It is hard to publish quickly, as transdisciplinary collaboration takes a lot of time. This is especially limiting for young researchers, because the number and quality of publications are particularly critically for their academic carriers.
- This kind of approach is "educationally demanding" because it is hard to bring together scientists who are experts in different disciplines (academic education is generally highly specialized and "specializing").

In conclusion, there is a great "fragmentation of knowledge" that makes it very difficult to realize collaborations between groups belonging to diverse disciplinary areas. To solve these problems it is important for scientists to develop:

- synthesis capacity
- methodological pluralism
- models coupling
- foresight capacity
- the ability to enjoy and develop complexity

It is important that universities:

- develop transdisciplinary programs in higher education
- act on supporting transdisciplinary research
- promote mission-oriented research
- change organizational structure

Building Bridges between Science and the World

This topic was divided into discussions **about public engagement and science for policy.** One of the great challenge for scientists is to communicate their knowledge and discoveries to layman. In fact, scientists should share their knowledge with the community. They should interact not only with other investigators, but with local governments and the general population, because often information that scientists have can improve or even save the lives of people. But this task is not so easy because:

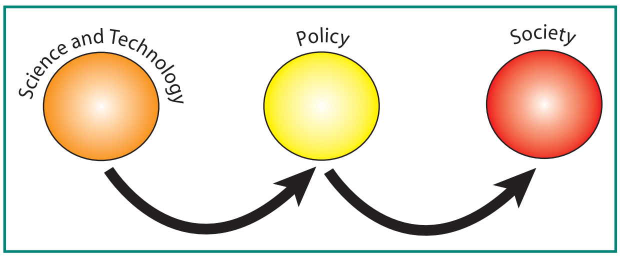
- scientific language is usually very difficult for a lay audience to understand
- some information can create panic

During discussions about this topic, it appeared clear it is necessary to develop new communication strategies. In particular, the scientific community should follow these fundamental guidelines:

1. use simple language (i.e., do not use scientific terminology)
2. speak clearly, slowly, and concisely
3. understand what the audience wants to know
4. be honest and natural
5. be entertaining, not boring

Some speakers suggested the internet as a good tool to make scientific resources available to the world. But nowadays, the public get science information mainly from the media, in particular from TV, newspapers, and radio. For this reason, engaging the media is an important part of engaging the public in disseminating science information.

Regarding the science for policy topic, the discussion began with the evidence that science, technology, innovation, and engineering are fundamental for economic growth, competitiveness, and quality of life. In addition, investments in technological capacity are critical not just for advanced countries, but for developing countries as well. The ideal model that describes the relationship between science and policy/society is the linear one, represented by the following scheme (from Pablo Guerra's presentation):



According to this model:

- science produces new policy-relevant knowledge
- knowledge is transferred to policy
- a decision is made

At the end of the process, society reaps the benefits of scientific knowledge through science-based policy. Unfortunately, this model does not reflect the following reality:

- sound decisions are based on normative components (different ethical/political frameworks)
- "society-at-large" does not exist per se (there are in fact many different groups with different interests)
- translation is not trivial (different languages)
- knowledge flows are multilateral (lay-knowledge, legal-knowledge, and economic knowledge, etc.)

In such a situation, science can contribute since it can mobilize resources (lobbying, education, etc) and generate *interactional expertise* within the policy community with the aim of providing the most comprehensive image possible. In fact, there is a need to have informed public opinion about the potential of scientific and technological knowledge, but this requires the development of a scientific culture that ensures democratic participation in the decision processes related to scientific policy. Second, it appears clear that an increase in investments in research and development is required, both in advanced and developing countries to allow science to find solutions to societal problems.

Working with the Private Sector

This section did not prove to be very interesting. Different experiences of young researchers employed in the private sector were reported, but important topics were omitted. For example, no one discussed how industry can really participate and promote science and technology development, how public-private partnerships are essential for creating new education and training models, or how industry and university research activities can be complementary and cooperation very useful for solving societal problems.

Scientific Freedom and Responsibility

This section opened with a magisterial talk by Bengt Gustafsson, who has written a book on this subject. According to Gustafsson, science and technology are among the most positive forces for change at humankind's disposal. Universal and equitable access to scientific knowledge is crucial, he said, in bridging the socio-economic divide between the North and the South of the world. For this reason, in a rapidly changing world, the Principle of Universality of Science (ICSU Statute 5, section 2.5.2) provides an important model of equity, nondiscrimination, and cross-cultural cooperation. However, he pointed out that not all of the impacts of science and technology are equally beneficial, nor are they universally seen to be so.

As Gustafsson sees it, the scientific community and society have to confront some great challenges:

1. Advances in genetics and the life sciences are not accepted by many because they feel threaten by the risk of nature alteration, and even though advances in genetic promise to cure disease and alleviate hunger.
2. Pollution and environmental degradation continue to be among the unintended consequences of many beneficial technologies (e.g., increasing dependence on fossil-fuel-based technologies is changing the planet climate).
3. In several countries, research into new and more deadly weapons is still being pursued.

In addition, new concerns have been raised about the ethics of research and the accountability of science to its sponsoring governments and publics, especially as more research is conducted across national political boundaries. Questions for science now seem to come, to an increasing degree, from the needs or interests of states and society, rather than exclusively from scientists' own curiosity. Moreover, there is an increasing presence of the private sector in scientific practice, as well as increased collaboration, sometimes mandated by law and policy, among universities, industry, and government. While this development has generated more resources for science and strengthened ties between research, development, and commercialization, it also carries possible risks to academic freedom and research ethics.

This conference provided a very important experience for young researchers from different countries to compare their situations, in particular to those of people who conduct research in developing countries. It was evident that we have to face diverse realities and difficulties, but a lot of problems, such as those related to scientific cooperation, collaboration, scientific freedom, and responsibility, are the same. Certainly, the goal of the conference was to sensitize young researchers to their roles and functions in society. No final solutions to discussed problems were provided.

The only negative aspect of this conference was the duration; two days appears to have been too short a time to discuss such complex topics.

Cristina Airoldi <cristina.airoldi@unimib.it> received her Bachelors degree in biotechnology in November 2003 from the University of Milano-Bicocca; she received her Ph.D. degree in chemistry, under the supervision of Prof. Francesco Nicotra, in January 2007 from the Department of Biotechnology and Biosciences.

www.icsu.org/10_icsu75/75ANNIV_Young.html

Mycotoxins and Phycotoxins

by Hamide Senyuva

On the 44th year of its establishment, TUBITAK hosted the **XIIth International IUPAC Mycotoxin and Phycotoxin Symposium** in the Askeri Museum in Istanbul, Turkey, from 21–25 May 2007. This symposium was the biggest ever in terms of participation, number of papers presented, and size of the scientific exhibition.

The opening ceremony of the symposium included speeches by the vice president of TÜBITAK, Ömer Cebeci, IUPAC representative Elke Anklam, and the chair of the organizing committee, Hamide Z. Senyuva. During the symposium, there were 12 main sessions with presentations from 27 invited and 2 keynote speakers who are well-known worldwide and have renowned expertise in their fields. There were 105 oral presentations and 300 poster presentations chosen by the symposium scientific committee, an exhibition of analytical instruments and food manufacturing companies' products. Moreover, workshops, satellite meetings, and many parallel meetings of international and European companies were held on the same campus.

Opening Ceremony (from left): Omer Cebeci (vice president of TUBITAK), Hamide Senyuva (symposium chair), Elke Anklam (IUPAC Division of Chemistry and the Environment), and John Gilbert (chair of the Scientific Committee).

Approximately 580 participants from 65 countries attended the symposium. These researchers and representatives of universities, research institutes, governmental establishments, and industry all had concerns with mycotoxins and phycotoxins, from the perspective of human and animal health, toxicology, food chemistry, food engineering, and risk analysis.

The symposium achieved its aim. Food and feed are essential to the progress of human and animal life. Healthy living requires foods free of microorganisms like molds, bacteria, and viruses, as well as the secondary metabolites they produce. Molds and their secondary metabolites such as mycotoxins, as well as seafood-derived phycotoxins, were discussed in terms of their identification, toxicology, and prevention. The symposium focused in particular on disseminating the latest knowledge and research about foods regularly consumed by people, such as coffee, hazelnut, pistachios, and chilli pepper, which are prone to the production of mycotoxins.

All invited papers will be published in a dedicated issue of *Food Additives and Contaminants*. The next symposium will be held in Chile in 2010.

The Askeri Museum in Istanbul was the symposium venue.

IUPAC funding, awarded under its program to support chemists from scientifically emerging regions, was used to support the following lecturers:

- Benjamin Suarez (Chile), "The Need for New Functional and Analytical Methods for Marine Biotoxins"
- Gordon Shephard (South Africa), "The Impact of Mycotoxins on Human Health in Developing Countries"
- Rebeca López-García (Mexico), "Design and Implementation of an Integrated Management System for Ochratoxin in the Coffee Production Chain"

The following IUPAC poster prizes were awarded at the symposium:

John Gilbert (center) and Hans van Egmond (right) thank the Symposium Chair Hamide Senyuva during the Closing Ceremony.

- First Prize: "Influence of Agriculture Practices on Occurrence of Fusarium Mycotoxins in Cereals," Marta Kostelanska, Technicka 3, Prague, Czech Republic
- Second Prize: "Assessment of Prototypes of a New LFI Assay for DSP Toxins with Several Naturally Contaminated Bivalves from the Portuguese Coast," Susana Margarida Rodrigues, Instituto Nacional de Investigaçã Agrária e das Pescas, Lisboa, Portugal
- Third Prize: "Fumonisins Impair Macrophage Immune Functions and Gene Expression of Cytokines in Broilers," Yeong-Hsiang Cheng, Institute of Biotech., Dept. Animal Sciences, National 1-Lan University, Lan, Taiwan

Hamide Senyuva <hamide.senyuva@tubitak.gov.tr> was the chair of the XIIth IUPAC Symposium on Mycotoxins and Phycotoxins. She is an analytical chemist who has worked for 11 years in food safety and is presently active in screening fungi for metabolite production using LC-TOF/MS. She is committed to analytical quality assurance and has been actively promoting proficiency testing and method validation in Turkey.

Heterocyclic Chemistry

by Lisa McElwee-White

The **8th Florida Heterocyclic Conference** was held 11–14 March 2007 in Gainesville at the University of Florida. Attendees had the opportunity to participate in an excellent program that included 11 plenary lectures, 20 invited lectures, 5 short courses, and a poster session. Short courses were taught by Eric Scriven (University of Florida) on the reactivity of heterocycles, John Joule (University of Manchester) on heterocyclic ring synthesis, Mikael Begtrup (University of Copenhagen) on regioselective introduction of substituents, Gordon

Gribble (Dartmouth College) on the applications of lithium and palladium in heterocyclic chemistry, and Grace Venier (CEM)/Nicholas Leadbeater (University of Connecticut) on microwave synthesis.

Plenary lectures were presented by the following scientists:

- Jan Bergman, Royal Institute of Technology, Sweden
- Hans-Ulrich Reissig, Freie Universität Berlin, Germany
- Barry Snider, Brandeis University, USA
- Alain Krief, Universitaires Notre Dame de la Paix, Belgium
- Christopher Moody, Nottingham University, UK
- Alan Whittle, Thermo Fisher Scientific, UK
- Nicholas Meanwell, Bristol-Myers Squibb, USA
- Rob Larsen, Amgen, USA
- Fraser Stoddart, University of California, Los Angeles, USA
- Paul Knochel, Ludwig Maximilians Universität, Germany
- Peter Vollhardt, University of California, Berkeley, USA

There were over 200 attendees at the symposium, including approximately 45 graduate students and postdoctoral students, along with academic and industrial research chemists from more than 20 countries. Heterocyclic compounds are of particular importance to the pharmaceutical industry, so many of the industrial delegates came from this area. The conference attracted a number of commercial exhibitors, including publishers, chemical suppliers, and instrument makers.

Scene from the poster session at the 8th Annual Florida Heterocyclic Conference.

Proceeds from the conference are used to support ARKIVOC (Archive for Organic Chemistry), a free peer-reviewed online journal covering all aspects of organic chemistry. The journal is available at <www.arkat-usa.org>.

Lisa McElwee-White <lmwhite@chem.ufl.edu> is a professor of chemistry at the University of Florida and a former titular member of the Organic and Biomolecular Chemistry Division.

Where 2B & Y

Announcements of conferences, symposia, workshops, meetings, and other upcoming activities

Microwave-Assisted Organic Synthesis

3–4 October 2007, San Francisco, California, USA

A two-day conference on **Microwave-Assisted Organic Synthesis** will be held in San Francisco, California, USA, from 3–4 October 2007. MAOS 2007 will feature invited and contributed oral presentations from renowned experts in the field of microwave synthesis, a poster session, and an exhibition where all the major instrument vendors will display the latest in microwave reactor technology. In addition, an optional one-day short course for newcomers to this field and experienced users will be organized on 2 October at the same site.

Confirmed speakers are as follows:

- Jonathan Ellman (Berkeley, USA)
- Bruce H. Lipshutz (Santa Barbara, USA)
- Michael Organ (York University, Canada)
- Mats Larhed (Uppsala University, Sweden)
- Nicholas E. Leadbeater (University of Connecticut, USA)
- Bruce Clapham (Abbott Laboratories, USA)
- Scott Wolkenberg (Merck Research Laboratories, USA)
- Hansjoerg Lehmann (Novartis, Switzerland)
- Jesus Alcazar (Johnson & Johnson, Spain)
- Daiusz Bogdal (Politechnika Krakowska, Poland)
- Wendy Sandoval (Genentech, USA)

www.maos.net

Natural Products

4–7 November 2007, São Pedro, São Paulo State, Brazil

The **1st Brazilian Conference on Natural Products** (1st BCNP), organized by the Natural Products Division of the Brazilian Chemical Society, will be held 4–7 November 2007 in São Pedro, Brazil. The 1st BCNP—a tribute to Otto R. Gottlieb for his outstanding contributions to the field—will promote plants and other natural resources for their chemistry, function, biosynthesis, and effects on the physiology and pathology of living organisms, as well as their agricultural and pharmaceutical applications. The purpose of the 1st BCNP is to bring together renowned specialists, researchers, and students from all over the world to meet, discuss, and exchange views and experiences on recent advances in natural products.

The scientific program will focus on:

- Biodiversity and Natural Products
- Biological and Pharmacological Activity of Natural Products
- Manufacturing and Quality Control of Herbal Drugs and Essential Oils
- Biosynthesis and Molecular Biology of Natural Products
- Recent Advances in the Isolation and Structure Elucidation of Secondary Metabolites

The Organizing Committee strongly encourages the participation of young scientists.

http://bcnp.ufscar.br/abertura.html

Heterocyclic and Synthetic Chemistry

IUPAC SPONSORED

9–12 March 2008, Gainesville, Florida, USA

The **9th Annual Florida Conference on Heterocyclic and Synthetic Chemistry** (Flohet 9) will be held at the University of Florida, Gainesville, from 9–12 March 2008. The conference will include 12 plenary speakers chosen from academe and industry, together with 24 invited speakers, five short courses in heterocyclic/synthetic chemistry, and a poster session.

All the plenary speakers enjoy international reputations in their field and the short courses are designed to reflect highly topical areas of organic research. The courses are run in parallel with the invited lectures, thus offering a choice of teaching or research. The timing of the conference is likely to afford some of Florida's best weather and is designed to coincide with the undergraduate Spring Break, thus guaranteeing a relatively quiet campus.

See Mark Your Calendar on page 32 for contact information.

www.arkat-usa.org

Natural Products

25–29 February 2008, Kasane, Botswana

The International Organization for Chemical Sciences in Development and the International Society for the Development of Natural Products are organizing a joint international symposium on **Natural Products: Unlimited Resources for the Development of Drugs, Cosmetics, and Food.** The meeting will be held from 25–29 February 2008 by the majestic Chobe River in Kasane, one of the most scenic places in Botswana.

The aim of the symposium is to bring together scientists from Africa and other areas who are involved in the investigation of African plants. An update will be provided on different aspects of research concerning the chemistry, pharmacology, and clinical studies of African plants. Special lectures are planned on the current state and future trends of African traditional medicine. Participants from academia, public health organizations, and industry will attend. The symposium will feature 20 plenary lectures—from Africa and from other parts of the world. In addition, there will be contributions in the form of oral presentations and poster sessions. A two-day Workshop on Hyphenated HPLC Techniques will be held at the Department of Chemistry, University of Botswana, Gaborone, before the symposium (22–23 February 2008).

For further information, please contact the chairmen of the Scientific Committee: Prof. B. Abegaz <abegazb@mopipi.ub.bw>/<babegaz@gmail.com> or Prof. Kurt Hostettmann <Kurt.Hostettmann@pharm.unige.ch>.

www.iocdisdnp2008.org

Photochemistry

28 July–1 August 2008
Gothenburg, Sweden

The **XXIInd IUPAC Symposium on Photochemistry** will be held in the Gothenburg Convention Centre, Gothenburg, Sweden, from 28 July to 1 August 2008. This will be the latest in a long series of successful symposia, carrying on a tradition of premier biennial gatherings of scientists with interests in photochemistry and related subjects.

The symposium will provide a framework for the presentation and discussion of ideas and information on the interaction of light and matter, drawn from the following areas:

- organic and inorganic photochemistry from a synthetic and mechanistic point of view
- solar energy conversion
- materials science and engineering
- supramolecular chemistry and nanotechnology
- photobiology and biophysics
- photomedicine
- photonics and imaging
- spectroscopy and instrumentation
- photochromism
- industrial applications of photochemistry and photophysics

The scientific program comprises plenary lectures, invited lectures, contributed oral presentations, and poster sessions. Presenters will be drawn from a wide variety of countries. The official language will be English.

Founded in 1621, Gothenburg, Sweden's second largest city, is a port on the West coast, in the heart of Scandinavia. It is the home of Chalmers University of Technology and Gothenburg University. The climate is mild at the end of July. The Convention Centre is centrally located close to hotels restaurants and shops. The city has an extensive and reliable public transportation system. A variety of excursions for accompanying persons are planned.

See Mark Your Calendar on page 33 for contact information.

http://photoscience.la.asu.edu/Goteborg2008/

Chemical Thermodynamics

3–8 August 2008, Warsaw, Poland

The series of International Conferences on Chemical Thermodynamics (ICCTs) have been held under the auspices of IUPAC since 1969, rotating between Europe, North America, and Asia. The first conference, held in Warsaw, Poland, in 1969, was named the 1st International Conference on Calorimetry and Thermodynamics. Now, the circle has been closed as the **20th International Conference on Chemical Thermodynamics**, 3–8 August 2008, will again be held in Warsaw. The 20th ICCT will be organized under the auspices of the International Association of Chemical Thermodynamics.

The 20th ICCT will cover a broad scope of issues related to chemical thermodynamics, both experimental and theoretical. The conference will be opened by two introductory general lectures. One will be devoted to the actual theoretical problems in chemical thermodynamics as seen from a physicist point of view and the other one to the recent and prospective industrial applications of chemical thermodynamics. The scientific program will host symposia and workshops ranging from classical subjects such as molecular energetics to ionic liquids and supercritical phase equilibria, to the most recent topics, such as thermodynamic approaches to nanotechnologies and nanodevices and environmental thermodynamics.

The program will include major award lectures, plenary lectures, invited lectures, oral presentations, poster papers, database and software demonstrations, and scientific exhibitions. Among the highlights of the program are the Rossini Lecture, the highest award of the ICCT. The recipient of the 2008 Rossini Lectureship Award is Jürgen Gmehling of the University of Oldenburg, Germany (see Wire section, p. 17).

The 20th ICCT will be hosted in the Gromada conference center, which offers in one location everything that is needed for a good conference (air conditioned conference facilities, hotel rooms at varied prices). Located in a green area near the airport, it offers easy access to downtown Warsaw, which offers a number of interesting excursions. Tourists can learn more about Chopin and hear his famous music.

The opening session will feature two plenary lectures:

- Wolfgang Arlt (Erlangen)—on recent and prospective industrial applications of chemical thermodynamics
- Robert Hołyst (Warsaw)—on current theoretical problems in chemical thermodynamics

See Mark Your Calendar on page 33 for contact information.

www.icct2008.org

Solar Chemistry and Photocatalysis

4–8 October 2008, Palermo, Italy

The **Fifth European Meeting on Solar Chemistry and Photocatalysis: Environmental Applications** (SPEA 5) will be held in Palermo, Italy, from 4–8 October 2008. The conference will deal with the following topics:

- water treatment and disinfection
- air treatment
- soil remediation
- green synthesis by solar-chemistry
- development of new materials for photochemistry and photocatalysis
- developments and perspectives in environmental photochemistry
- commercial applications
- environmental management
- experimental standardization
- models for photochemistry and photocatalysis
- general questions

http://spea5.altervista.org

Mark Your Calendar

2007 (later than 20 September)

IUPAC poster prizes to be awarded

23–28 September 2007 • Transactinide Elements • Davos, Switzerland
Third International Conference on the Chemistry and Physics of the Transactinide Elements (TAN'07)
Prof. H.W. Gäggeler, Paul Scherrer Institut, Radio- und Umweltchemie, CH-5232 Villigen, Switzerland, Tel.: +41 (0)56 310 24 01, Fax: +41 (0)56 310 44 35, E-mail: heinz.gaeggeler@psi.ch

23–28 September 2007 • Mendeleev Congress • Moscow, Russia
XVIII Mendeleev Congress on General and Applied Chemistry
Prof. Natalia P. Tarasova, D. Mendeleev University of Chemical Technology, Miusskaya Square, 9, RU-125047 Moscow, Russia, Tel.: +7 495 9732419, Fax: +7 495 2004204

30 September–5 October 2007 • Physical Organic Chemistry • Los Cocos, Cordoba, Argentina
9th Latin American Conference on Physical Organic Chemistry (CLAFQO 9)
Prof. Elba I. Bujan, Dpto. de QuÃmica Organica, Universidad Nacional de Cordoba—INFIQC, Fac. de Ciencias Quimicas, Medina Allende y Haya de la Torre, X5000HUA, Argentina, Tel.: +54 351-4334170, Fax: +54 351-4333030, E-mail: elba@fcq.unc.edu.ar

1–3 October 2007 • Systems for Energy Conversion • Moscow, Russia
International Conference and Exhibition "Molecular and Nanoscale Systems for Energy Conversion"
Prof. Sergey Varfolomeev, Emanuel Institute of Biochemical Physics, Russian Academy of Sciences, Kosygin St. 4, Moscow 119991, Russia, Tel.: +7 495-137-6420, Fax: +7 495-137-4101

9–13 October 2007 • Crop Protection Chemistry • Beijing, China
7th International Workshop on Crop Protection Chemistry and Regulatory Harmonization
Prof. Dr. Xiongkui He, China Agricultural University, Beijing 100094, P.R. China, Tel: +86 10 6273 1446, Fax: +86 10 6218 0142, E-mail: xiongkui@cau.edu.cn, <www.iupac.org/projects/2006/2006-017-2-600.html>

17–21 October 2007 • Novel Materials • Shanghai, China
3rd International Symposium Novel Materials and their Synthesis (NMS-III)
Prof. Yuping Wu, Department of Chemistry, Fudan University, Shanghai, 200433 China, Tel.: +86 21 55664223

5–7 November 2007 • Infrared Spectroscopy • Buenos Aires, Argentina
International Workshop on Infrared Spectroscopy Applied to Biological and Biomimetic Systems: From the Isolated Molecule to the Cell
Prof. Andrea Gómez-Zavaglia, Universidad de Buenos Aires, Facultad de Farmacia y Bioquímica, Catedra de Quimica General e Inorganica, Junin 956. 2 P, C.P. 1113. Buenos Aires, Argentina, Tel.: +54 11 4964 8249, E-mail: angoza@interar.com.ar

28 November–1 December 2007 • Metallomics • Nagoya, Japan
International Symposium on Metallomics
Prof. Hiroki Haraguchi, Department of Applied Chemistry, Graduate School of Engineering, Nagoya-University, Furo-cho, Chikusa-ku, Nagoya 464-8603, Japan, Tel.: +81-52-789-5288, Fax: +81-52-789-5290, E-mail: haraguch@apchem.nagoya-u.ac.jp

2–5 December 2007 • Food Security in Africa • Stellenbosch, South Africa
CHEMRAWN XII—The Role of Chemistry in Sustainable Agriculture and Human Well-being in Africa, Ms. Christelle Snyman, Tel.: +27 21 938 9245, Fax: +27 21 933 2649, E-mail: conference@chemrawn.co.za

2008

IUPAC poster prizes to be awarded

8–11 January 2008 • Agrochemicals • New Delhi, India
International Conference on Agrochemicals Protecting Crop, Health and Natural Environment,
Dr. N.A. Shakil, Division of Agricultural Chemicals, IARI, New Delhi 110 012, India, Tel.: +91 009818196164, Fax: +91 11-25843272

9–12 March 2008 • Heterocyclic Chemistry • Gainesville, Florida, USA
9th Florida Heterocyclic Conference
Prof. Alan R. Katritzky, University of Florida, Dept. of Chemistry, Gainesville, FL 32611-7200, USA, Tel.: +1 352 392 0554, Fax: +1 352 392 9199, E-mail: katritzky@chem.ufl.edu

2–6 June 2008 • Molecular Order and Mobility in Polymer Systems • Saint-Petersburg, Russia
6th International Symposium on Molecular Order and Mobility in Polymer Systems,
Prof. T.M. Birshtein, Institute of Macromolecular Compounds, Russian Academy of Sciences (IMC RAS), Bolshoi pr. 31, Saint-Petersburg, RU-199004 Russia, E-mail: birshtein@imc.macro.ru

22–27 June 2008 • Organic Synthesis • Daejeon, Korea
International Conference on Organic Synthesis (ICOS-17)
Prof. Sung Ho Kang, Department of Chemistry, KAIST, Daejeon 305-701, Korea, Tel.: +82-42-869-2825, Fax: +82-42-869-2810, E-mail: shkang@kaist.ac.kr

28 July–1 August 2008 • Photochemistry • Gothenburg, Sweden
XXII IUPAC Symposium on Photochemistry
Prof. Devens Gust, Department of Chemistry and Biochemistry, Arizona State University, Tempe, AZ, USA, 85287-1604, USA, Tel.: +1 602 965 4547, Fax: +1 602 965 2747, E-mail: gust@asu.edu

3–8 August 2008 • Chemical Education • Pointe aux Piments, Mauritius
20th International Conference on Chemical Education: Chemistry in the Information & Communications Technologies Age, (20th ICCE)
Dr. Ponnadurai Ramasami, Department of Chemistry, University of Mauritius, Reduit, Mauritius, E-mail: p.ramasami@uom.ac.mu

3–8 August 2008 • Chemical Thermodynamics • Warsaw, Poland
20th International Conference on Chemical Thermodynamics
Questions should be addressed to E-mail: info@icct2008.org. Comments, concerns, proposals, etc., should be addressed to E-mail: secretariat@icct2008.org.

14–20 September 2008 • Green Chemistry • Moscow, Russia
2nd IUPAC Conference on Green Chemistry
Prof. Valery V. Lunin, Chairman Russia Chemistry Department, M.V. Lomonosov Moscow State University, Leninskiye Gory 1, build. 3, 119992 Moscow Russia, Tel.: +7-495-9394575, Fax +7-495-9394575, E-mail: vvlunin@kge.msu.ru

12–17 October 2008 • Biotechnology • Dalian, China
13th International Biotechnology Symposium (ISB 2008): "Biotechnology for the Sustainability of Human Society"
Prof. Fengwu Bai, Dept. of Bioscience & Bioengineering, Dalian University of Technology, 2 Linggong road, Dalian 116023, China, Tel.:+86 411 84706329, Fax:+86 411 84708083, E-mail: fwbai@dlut.edu.cn

26–30 November 2008 • Soil Science • Pucon, Chile
International Symposium of Interactions of Soil Minerals with Organic Components and Microorganisms
Dra. Maria de La Luz Mora, Universidad de La Frontera, Ciencias de Recursos Naturales, Temuco, Chile, Tel: +56 45 325479, Fax: +56 45 325053, E-mail: mariluz@ufro.cl

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.

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/symposia/application.html>.

Thieme Publishers, IUPAC, and the Editors of Synthesis, Synlett, Synfacts, and Science of Synthesis announce the

2008 **Thieme–IUPAC Prize** in Synthetic Organic Chemistry

Call for Nominations

The Thieme–IUPAC Prize is presented every two years on the occasion of the International Union of Pure and Applied Chemistry – International Conference on Organic Synthesis (IUPAC–ICOS). The 2008 ICOS will be held in Daejeon, Korea, on June 22–27. The prize is awarded to a scientist under 40 years of age whose research has had a major impact in synthetic organic chemistry.

Prize € 5000

The Thieme–IUPAC Prize has been awarded to Stuart L. Schreiber in 1992, Paul Knochel in 1994, Eric N. Jacobsen in 1996, Andrew G. Myers in 1998, Alois Fürstner in 2000, Erick M. Carreira in 2002, John F. Hartwig in 2004, and David W. C. MacMillan in 2006.

The prize will be awarded on the basis of scientific merit for independent research dealing with synthesis in the broadest context of organic chemistry, including organometallic chemistry, medicinal and biological chemistry, designed molecules, and materials. Candidates must be under 40 years of age as of January 1 of the year in which the prize is awarded.

Proposals must be accompanied by a biographical sketch of the nominee, a list of the candidate's ten most significant publications, and a statement of how the candidate's research has had a major impact on the field of synthetic organic chemistry. The material will be confidentially forwarded to an independent selection committee.

Deadline: December 7, 2007

For further information please visit www.thieme-chemistry.com

ICOS-17
June 22–27, 2008
Daejeon, Korea

Nomination materials (8 copies)

should be submitted by December 7, 2007 to

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