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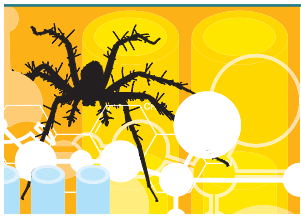
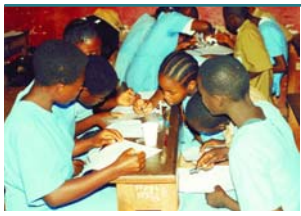




Treasurer's Column

A Balance—Difficult to Keep

by Christoph Buxtorf

As treasurer of IUPAC and as a chemist, I am constantly concerned with how things balance out. When it comes to the Union's bookkeeping, I try to ensure that the left and the right side of the balance sheet are equal, hopefully ending with positive earnings and a happy future. And as a chemist, I must think about chemical equilibrium, which is described succinctly in Le Chatelier's principle:

> "Every change of one factor of an equilibrium occasions a rearrangement of the system in such a direction that the factor in question experiences a change in a sensed opposite to the original change" (H.L. Le Chatelier, *Annales des Mines* 13(2), 157[1888]).

These days, all chemists must also be concerned with another kind of equilibrium—the fragile balance that exists in our environment. Our activities can have a deep and lasting impact on our water, soil, and air and it is our responsibility to minimize this impact. Maintaining the delicate equilibrium of nature is IUPAC's most noble task.

Maintaining the delicate equilibrium of nature is IUPAC's most noble task.

In this regard, the Union has a unique opportunity to cooperate on a global scale with organizations such as the International Council of Science to encourage sustainable development of our "blue planet." By setting strategic goals and planning multiple projects in this field, we can become recognized as a respected leader in the field of green chemistry.

In fact, our divisions and standing committees are already very active in this sense, with many projects on track. I think that IUPAC is well positioned in the fields of environmental protection, human safety, solutions to Africa's food crisis, chemical weapons cooperation, and crop protection, just to name a few.

One of the most powerful ways that IUPAC could promote sustainable chemistry would be through the transfer of technology to less developed countries. This would represent the "good side" of globalization. IUPAC, with the help of volunteer experts, could help spread knowledge and provoke change.

Although IUPAC is highly regarded for its work on nomenclature, standard setting, and organizing congresses, meetings, and workshops, it largely goes unnoticed for the other "good things" it does to help maintain the fragile equilibrium of our world.

Perhaps it is necessary to do more "selling" of our goods to the outside world. Maybe our closer cooperation with ICSU will result in more targeted activity. It should be our aim to change the way we are communicating, especially to decisionmaking bodies. On this very topic, I shall invite you to review the feature presented in this issue (p. 12) by Peter Mahaffy (Committee on Chemistry Education) in which he analyzes IUPAC's niche in promoting public understanding of science and carefully identifying who shall be IUPAC's best target audience.

My term as an officer will end in 2007. I think that sound strategic goals—reflecting on the sustainable development of our "blue planet"—will help my successor prioritize funding.

Is it not self-evident? Do we ask too much? Is it not important in the interest of our future on this planet? I wonder if you have suggestions for setting IUPAC's priorities. The officers and I will welcome your comments.

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

Resignation of Vice President

On 29 June 2006, Prof. Matsumoto informed IUPAC that, for personal reasons, she is resigning as vice president with immediate effect. The IUPAC Bureau will discuss this matter at its regular meeting on 7–8 October in Madrid, Spain. There will be separate elections for incoming president (2008–2009) and vice president at the Council Meeting in Torino, Italy, in August 2007, as provided for in the Statutes.

The Ice that *Burns**

Burning Questions about Gas Hydrates

by Barbara Maynard

Methane hydrates are nothing less than ice that burns. In an era of growing concern about energy prices and shortages, gas hydrates offer the potential of a vast new source of natural gas. These odd gas traps also are playing a role in the debate over global warming.

Chunks of gas hydrate recovered from a core taken in the Gulf of Mexico (USGS).

A Canadian fishing crew hauled in an unusual catch off the coast of Vancouver Island several years ago. Instead of fish, they netted what looked like a 450-kilogram chunk of ice. Unlike ordinary ice, however, it began to hiss and steam. If a crew member had struck a match, the chunk would have burst into flame.

The ship had unwittingly discovered a large reserve of methane hydrate, a strange conglomeration of water ice and methane packed with hopes and fears in this era of growing concerns about energy supplies and energy's impact on the environment.

Methane hydrates, on one hand, could supply the world with a new source of clean energy that could last for decades. Methane (CH_4) is the main component of natural gas. Deep-ocean hydrate deposits also are a prime candidate for storing waste carbon dioxide from industrial smokestacks, rather than allowing it to enter the atmosphere. On the other hand, there are concerns that huge amounts of methane released from deep-sea deposits could shift global warming into high gear.

Regardless of their economic and environmental implications, gas hydrates are undoubtedly fascinating. Methane hydrates look like ice—until you put a match to them. Then they burn, as some researchers love to demonstrate. Methane hydrates form at relatively low temperatures and high pressures—such as those found at 500 meters or more under the ocean, for example. Under these conditions, water forms a cage-like structure that is stabilized through Van der Waals forces by the insertion of a molecule of gas into the cage. Various small gases can be the guest molecule, but the most common naturally occurring gas hydrates contain methane. Methane hydrates are found under the sea floor along outer continental margins and in permafrost regions—locations that provide the high pressure, relatively low temperature, and large amounts of methane required for their formation. The margins are vast, relatively shallow areas of ocean floor along the continents.

The hydrate structure packs a lot of gas into a small volume: "The gas hydrate at 1 atmosphere of pressure will contain about 160 times the volume of methane as methane gas at that same pressure," said William Dillon, researcher emeritus with the U.S. Geological Survey (USGS). In contrast, liquefied natural gas has about 385 times the energy density of free gas.

Energy Resource Potential

Nobody knows exactly how much methane is frozen in hydrates, and the estimates range from about 1 Tt (1 Tt [terratonne]= 10^{12} t) of carbon in the form of methane to 22 Tt. Most experts put the figure at about 10 Tt. Earth's atmosphere contains about 0.7 Tt of carbon. Put another way, the USGS estimates that the amount of natural gas in hydrate form is somewhere between 2.8 x 10^3 and 7.6 x 10^6 Tm^3 (1 Tm^3 = 10^{12} m^3). That far exceeds remaining worldwide conventional natural gas resources, which are thought to total about 425 Tm^3.

In 2002, the United States used 0.76 Tm^3 of natural gas and global consumption totaled 2.6 Tm^3, according to the U.S. Energy Information Administration. Needless to say, hydrates have generated worldwide excitement about their potential as an energy source.

The U.S. Congress enacted the Methane Hydrate Research and Development Act of 2000, which charged the Department of Energy (DOE) with coordinating a national, collaborative effort toward the eventual exploitation of methane hydrates. Congress renewed the act in 2005 as part of the Energy Policy

*Reprinted from *Chemistry*, winter 2006 issue, pages 27–33.

Drilling equipment at the Mallik site in the Canadian arctic was used for the first production test of gas hydrates (USGS).

Act, which also included a new provision for royalty relief. It includes subsidies for producing hydrates commercially by 2018. However, more work must be done in order to tap this resource.

International collaborations for hydrate research have formed among organizations and agencies from the United States, Japan, India, Germany, Canada, and other nations. Japan, for example, started a 16-year methane hydrate exploitation program in 2001. "Generally, everything is going well for the research program and we have learned much," said Takashi Uchida, a senior researcher with the Japan Petroleum Exploration Company. "Whether and when methane hydrate extraction will be economically viable should be considered in the next phase. Offshore production testing is planned early in Phase II, which will be the first offshore production test."

Locating Hydrates

Seismic data are the mainstay of current efforts to find potential hydrate fields. A pattern called a bottom-simulating reflector (BSR) in the seismic profile indicates the presence of hydrates—the dark band represents free gas trapped underneath an impermeable hydrate cap. The tool is not perfect, however. Hydrates have been found in the absence of a BSR.

A consortium of industry scientists sponsored by DOE has been developing a better method for detecting and characterizing gas hydrates in the Gulf of Mexico. During the spring of 2005, the team took to the sea to test their new technique. "The cruise is one step in a process of trying to improve our ability to predict and quantify, for a number of reasons, where hydrates are located in the sediment," said Emrys Jones, research consultant with Chevron-Texaco. The new method involves reanalyzing existing seismic data. Jones continued, "We would very much like to be able to do that with just conventional-type seismic information that is available, rather than have to spend a great deal of time and effort to locate the hydrates in another fashion."

The month-long research cruise aboard the semisubmersible vessel *Uncle John* collected ground-truth data by drilling cores and wells. "What we're trying to figure out now with this cruise is just how good a job we've done," Jones explained. "I would say that it's pretty clear that it's not perfect yet, but I don't know how far off from perfect it is. I think that we're going to end up with more modifications to our predictive techniques because we're not precisely getting what we predicted we'd get."

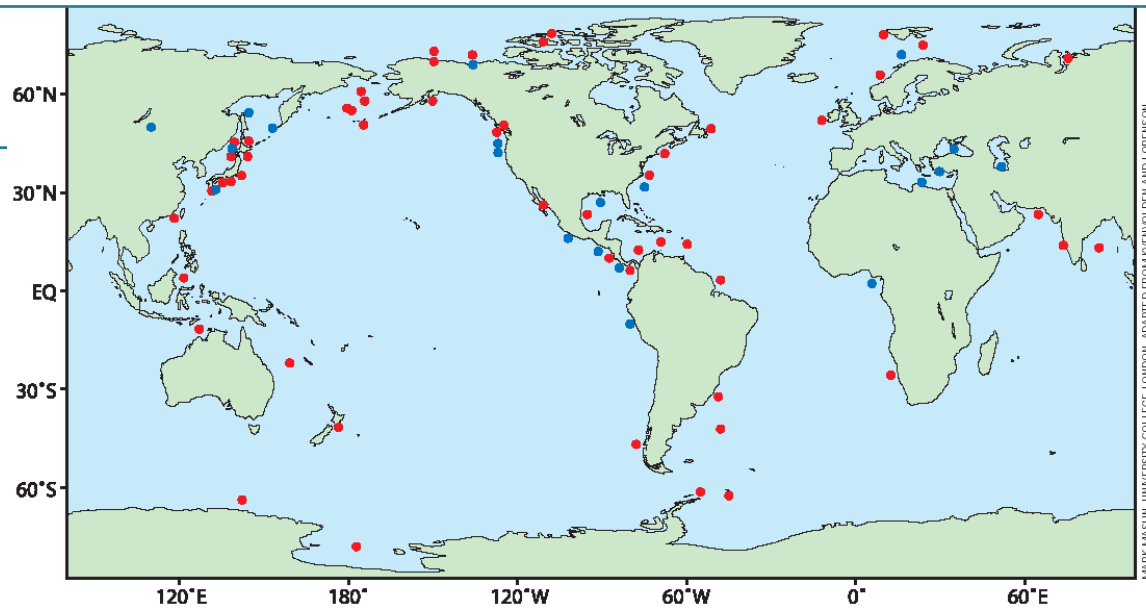
The semi-submersible vessel Uncle John *was used on a Spring 2005 research cruise to study gas hydrates in the Gulf of Mexico (National Energy Technology Laboratory).*

Other Variables Affect Hydrate Stability

While temperature and pressure curves are used to predict and describe regions of hydrate stability, other factors are also important. Carolyn Ruppel of the Georgia Institute of Technology argues that the spatial variability of salinity, temperature, and gas composition in the northern Gulf of Mexico deserve more attention in predicting hydrate reserves.

The Gulf of Mexico is rich with salt domes, old salt deposits buried deeply in sediments. "It's long been known that various salts, because of some ionic effects, inhibit the stability of gas hydrates," Ruppel said. "Once you start adding salt, you tend to make it more difficult to form gas hydrate or to keep it stable."

In addition to salt, heat might also play a bigger role in the northern Gulf of Mexico than previously considered. "Both of the sites we focused on in this paper [study] are mud volcanoes. People don't know a lot about mud volcanoes, but it appears that there's probably a lot of fluid coming from significant depths, and these are hot fluids," Ruppel said. "The other thing is



Red dots indicate locations where hydrate has been inferred from a BSR or other data. Blue dots indicate locations where gas hydrates have been recovered.

that the salt domes themselves actually contribute to raising temperatures in the sediments because salt has a very high thermal conductivity relative to the sediment. It seems that the northern Gulf has both things—both the temperature and salinity—working against it in terms of having a lot of gas hydrate in the sediments. It may be that the Gulf of Mexico is not the best target for looking for methane hydrates as a resource."

Ruppel is quick to point out the indirect nature of the study. "We didn't actually quantify the amount of hydrate," she said. "We were simply saying that if you look at where the stability field would be for hydrate, it's going to be a lot thinner than people have previously claimed and, therefore, there is likely to be less hydrate in these particular types of areas."

How to Produce Hydrates

While more work remains to be done to pin down exactly how much methane exists in hydrate form, there is little doubt that the final number will be large. Whether or not that methane will be economically viable to produce, however, remains to be seen.

Natural gas may have already been produced from hydrates in two permafrost areas. The Messoyakha gas field in Siberia was a conventional gas operation that tapped a reservoir trapped beneath hydrate. As gas was removed, starting in 1969, the site did not show the expected and typical decrease in production volume. Scientists have proposed that the years of continued production were maintained by the dissociation of hydrates, which broke down as the gas beneath them was extracted.

The first deliberate test of natural gas hydrate production took place in 2002 in the Mackenzie Delta of the Canadian Arctic. One production and two observation wells were drilled to almost 1 200 meters deep in the Mallik gas field. One of the highest concentrations of natural gas hydrates known worldwide, the Mallik field is buried beneath permafrost over 600 meters thick. The project demonstrated the technical feasibility of producing natural gas from hydrates.

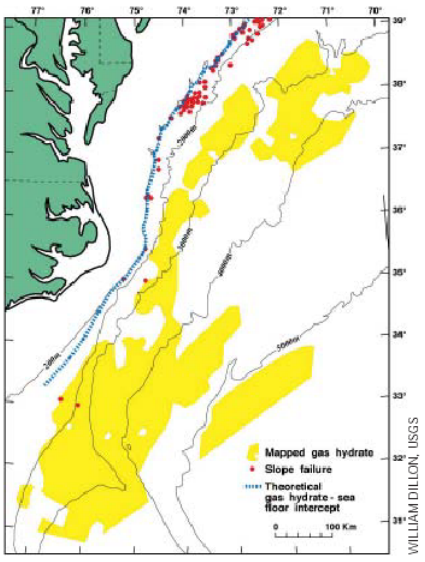
A Hazardous History

Hydrates first attracted attention in the 1930s, when natural gas pipelines started to clog in low temperatures, creating dangerous conditions and interrupting the flow of gas. Once researchers identified gas hydrates as the problem, they developed several strategies to deal with them. Insulating pipes from cold, heating them, or removing water from them can prevent hydrate formation, but these methods are not always feasible. Hydrate formation remains a major problem today. In the United States, for instance, the natural gas delivery system consists of 2.2-million miles of pipeline. If hydrate formation cuts off the flow, customers large and small that depend on natural gas face the consequences.

Adding either methanol or glycols inhibits hydrate formation, apparently by bonding to the hydroxyl group of the water molecules. However, this approach presents toxicity issues for the operator. Less toxic, low-dosage inhibitors are slowly gaining acceptance in the industry, according to Lynn Frostman of Baker Petrolite. The compounds incorporate themselves into the hydrate structure and prevent the growth of larger crystals. This allows hydrates to form, but prevents them from aggregating into large pieces that cause problems.

As conventional operations have pushed to drill deeper beneath the ocean floor in recent years, hydrates have presented new safety challenges. "When we are going after deeper hydrocarbons, we sometimes run across an area that has hydrates in it," Jones said. "The concern is how they will affect the sediments that we drill through, and how they will affect the sediments that we put production-type equipment on."

Drilling through hydrates can release the pressure or raise the temperature as hot fluids are piped up from underneath the hydrate layer. Either effect can rapidly dissociate hydrates, leading to gas blowouts, highly pressurized pockets of gas, or the collapse of sediments that support the drilling equipment.



The theoretical upper limit of gas hydrate occurrence coincides with known seafloor failures.

"The hazards to industry infrastructure could potentially be substantial," Ruppel said. "For example, theoretically we're pumping hot fluids from a conventional oil reserve up through the hydrate stability zone. We could destabilize hydrates in the hydrate stability zone, and that part of the seafloor is what is holding up our platform."

Cores and drilling logs gathered on the 2005 *Uncle John* cruise will help engineers address these stability and safety issues. "We were trying to collect information on hydrate-bearing sediments that would tell us what their mechanical transport and acoustic-type properties are, for various reasons," Jones said. "Those things are used for the modeling of the well bore stability to know that when we are drilling a hole, it doesn't slough off or fall in on us."

While industry is learning more about how to model the behavior of hydrates, researchers are also refining means to prevent hydrate dissociation. "What you want to do when you're drilling is avoid melting the gas hydrate," Dillon said. "You can do that by insulating the pipe, by chilling the drilling fluid, by using inhibitors that make the gas hydrate more stable. There are drilling techniques that can be used to make drilling in gas hydrates safer."

Hydrates and Global Warming

Using natural gas for energy has environmental benefits. Burning pure methane produces carbon dioxide and water, and the high hydrogen-to-carbon ratio means less carbon dioxide is produced than from other fossil fuels. Therefore, natural gas is considered a relatively clean energy source. Hydrates, however, do have environmental drawbacks.

Because methane absorbs different wavelengths of energy than does carbon dioxide, it is 21 times more powerful as a greenhouse gas. Given hydrates' dependence on cold temperatures, this means not only that global warming can dissociate hydrates, but also that the subsequent release of methane can then exacerbate global warming, leading to a positive feedback loop—with negative consequences.

"The major recent finding from models of future climate change is that warming of the ocean 2–3 °C will cause gas hydrate to break down in the ocean sediments and this will release methane into the ocean and atmosphere," said Mark Maslin of the Environmental Change Research Centre at University College London.

"What we learn from the past is that gas hydrates can be released either by rapid drops in sea level of tens of meters or temperature rises of 2–5 °C. We are entering a climate change period when ocean temperature outweighs sea level and thus gas hydrate release will occur. The only thing we can hope for is that it occurs slowly and this released methane oxidizes in the water column and thus stays in the ocean. If these releases are explosive, then the methane will be able to come straight into the atmosphere and accelerate global warming."

Maslin suggests that hydrates found below permafrost may be especially important in the coming decades for two reasons. First, high latitude temperatures are expected to rise in the next one hundred years by up to 8 °C, and second, rising sea levels will flood areas of permafrost with water at -1 °C.

"Compared with -20 to -40 °C permafrost, this is a huge thermal shock, which will release any gas hydrate trapped there," Maslin said.

Methane hydrates have been implicated in past climate change and accompanying species extinctions. "I think they have played a major role in abrupt and massive climate changes like those at the K/T boundary (Cretaceous-Tertiary boundary, 65 million years ago) and also the PETM (Paleocene-Eocene thermal maximum, 55 million years go)," Maslin wrote. The K/T boundary marks the transition from the dominance of dinosaurs to that of mammals, and the PETM corresponds to the rise of terrestrial animals, including primates, and the fall of many deep ocean species.

Some scientists have thought that methane hydrates could mediate climate change if a rise in sea level caused by melting ice caps increased pressure enough to enlarge the hydrate stability zone. However, recent calculations predict that this will not happen with the current global warming pattern. "The sea level increase predicted for the next 100 years is too small (20–80 centimeters) to have any stabilizing effect on the gas hydrate reserves," Maslin wrote.

Cores recovered from the Mallik drilling operation were quickly preserved in liquid nitrogen to preserve them for later analysis of gas content, porosity, thermal conductivity, and other characteristics (USGS).

Dissociation of hydrates can also lead to undersea landslides as the solid "ice" that had cemented the sediment together disintegrates into liquid water and gas. Dillon made the connection between hydrates and landslides in work he did with Jim Booth of the USGS. "I had been mapping gas hydrates on the east coast of the United States," Dillon said. "We looked at the map of the gas hydrates and superimposed that on a map of the landslides off the east coast of the United States." The tops of the major landslides all occurred near the gas hydrate limit.

Hydrate-triggered landslides, in conjunction with the consequent release of more gas from beneath the hydrate, can in turn cause tsunamis. "We would expect these gas hydrate-caused failures to produce tsunamis in areas that normally do not experience them, for example, the North Atlantic," Maslin wrote. "The Norwegian Storegga slide of 8 000 years ago caused a 15-meter high tsunami (about the same height as the 2004 Boxing Day tsunami in southeast Asia)."

New Applications: Sequestering Carbon Dioxide and Storing Methane

Ram Sivaraman, principal scientist at the Gas Technology Institute (GTI), believes hydrates can be a source of energy while simultaneously reducing global warming. He is developing a strategy to sequester carbon dioxide and produce methane in the same process.

"When I did some calculations, the heat of formation for hydrates of carbon dioxide is close enough to the heat of dissociation for methane hydrates," he said. Therefore, it is thermodynamically possible to replace methane with carbon dioxide in deep-sea hydrate sediments. Sivaraman has successfully tested his idea in a high-pressure chamber at GTI. Under conditions that mimic those in the Gulf of Mexico, he injected carbon dioxide into methane hydrate-containing sediment. "The calculations indicated that the hydrate didn't dissociate, but still we are getting methane," he said. "There is only one way it can happen—if carbon dioxide is going in and displacing methane in the sediments." He said this process has two benefits: "No matter how much methane you get, still carbon dioxide has been sequestered."

Sivaraman is also working on a project to store natural gas in hydrate form. Promoters—the opposite of the chemical inhibitors used to prevent hydrate formation in pipelines—facilitate the formation of methane hydrates at room temperature, provided there is sufficient pressure. Development of this approach would enable storage of large reserves of natural gas efficiently, which he suggests will be a cost-effective way for large cities to weather periods of high demand and short supply of natural gas.

Barbara Maynard <bmaynard@nasw.org>, Ph.D., is a freelance science writer in Alaska, where she is getting firsthand exposure to both changing climate and growing excitement over the energy potential of methane hydrates.

Exploring Science Locally and Sharing Insights Globally

by Marianne Cutler

Young people everywhere are growing up in an increasingly global society. Issues such as diet and health, energy and climate change affect everyone everywhere. It is increasingly important that young people have an appreciation of the science behind these issues, from their own local perspective as well as a global one if they are to participate fully in this global society. The Science Across the World (SAW) program can help young people cultivate a global perspective on contemporary science issues by increasing their knowledge and allowing them to communicate with other young people across the world. This article explores aspects of the SAW program that both teachers and students find motivating and rewarding in developing a global dimension to their understanding of sciences issues.

It is well recognized that science and technological developments are essential for prosperous, sustainable global societies. Many governments clearly acknowledge the value of developing global science perspectives so that young people have an understanding of the world and their role within it. The United Nations Educational, Scientific and Cultural Organisation decade of education for sustainable development, which commenced in 2005, is an illustration of this recognition and commitment. However, it is sometimes difficult to translate government ideologies into outcomes for the everyday science classroom. Global science perspectives cannot and should not be seen as peripheral, but as natural extensions to the teaching and learning that takes place daily. It is perhaps easier to persuade teachers to take a step in this direction if they can clearly develop their students' key skills at the same time.

*SAW is an international education program developed and managed by the Association for Science Education (ASE) in the UK, in partnership with GlaxoSmithKline. A longer version of this article first appeared in *School Science Review*, Sep. 2004, 86(314), pp. 33-41. SSR is the flagship journal of ASE.

Format and Topics

Science Across the World topics and their Exchange Forms constitute the heart of the program. Box 1 (p. 9) outlines how it works. Each topic is primarily designed to cover a subject that is interesting and relevant to young people whatever their cultures and wherever they are living in the world. Of course, any topic must also relate to the science curriculum in a broad range of countries; it cannot be too specific, but concentrates instead on the broader issues, such as diet, health, and genetics that all young people will be covering to some degree in their science lessons.

Most important, the topics must give scope for exploring science issues that might differ from one region or culture to another, or from one country to another. So, SAW goes beyond finding facts: It explicitly explores science in its social context and that makes for interesting exchanges of information, ideas, and opinions among students from different countries. Topics involving exchanging views on the use of energy and methods for conserving it in different parts of the world, or comparing findings on sources of acid rain and how this problem is dealt with in different countries and regions, are motivating and provide a context for understanding physical laws of energy conservation or the periodic table. The topics are structured flexibly to suit adaptation for a wide range of curricula, ages, and abilities, stretching the more able and encouraging those with difficulties in attainment or lacking in motivation.

Ensuring that all these criteria are met is not easy. It can take many months to develop a new topic, pilot it in a broad range of schools around the world, and finalize it in the light of the pilot feedback. An enthu-

South African students working on the What Do You Eat? topic in a Durban, South Africa, fruit and vegetable market.

siastic and dedicated team of educators from around the world facilitates the development process.

Key Skills and Thinking Skills

In many countries the emphasis of the science curriculum is moving towards teaching knowledge and understanding of how science works through developing key skills and thinking skills. These skills, including communication, working with others, reasoning, inquiry, creative thinking, and evaluation are natural components of classroom teaching and learning when working on SAW topics. They also link to a global trend of developing and assessing "scientific literacy."

Students generally work through the students' pages of their topic in small groups. This can be done as part of classroom work or as an extra-curricular activity. Through a broad variety of activities students gather the ideas and information they need to share with other schools through the Exchange Form.

Topic activities involve some active research into questions such as "Are there any renewable energy resources in your country which people use but which do not get counted in the official statistics?" and "How is renewable energy used on a small scale in your neighborhood?" Both of these involve surveys of energy use and sources in homes, farms, and small businesses, etc. In the Biodiversity topic, students interview older people in the local community to explore changes in land use and natural habitats during their lifetimes. In the Genetics topic, students investigate genetically modified (GM) crops and foods by researching regulations on their use and how the media reports GM issues in their country. Younger pupils, working on the Eating and Drinking topic, survey the food they eat during a typical school day, investigate the role of labeling from foods in their kitchen cupboards, and analyze different advertisements for food.

For many students, conducting their own research is not a regular part of their science lessons but they often find it challenging and rewarding. Topic activities can involve "traditional" practical work, but it is always designed to require minimal specialist equipment so that schools in a wide range of situations can take part. For instance, in the Chemistry in Our Lives topic, students prepare their own chemical product and share their methods with others. For many of the students involved, opportunities for practical work are scarce and they enjoy sharing their recipes for prod-

How Does SAW Work?

1 **Join Science Across the World through <www.scienceacross.org>**
Lifetime membership for schools enables the students to communicate with other schools worldwide on a variety of science topics.

2 **Go to "MyZone"**
Schools use their email address and password to enter MyZone, a personalized area that enables them to:
- set up exchanges with schools across the world
- send Exchange Forms via the website in different formats
- keep up to date with our latest news and features
- access and edit their school membership information.

3 **Choose and sign up for your topic**
The school chooses a topic from the list on the website. Each topic includes teachers' notes, student pages and an Exchange Form.

4 **Study the topic**
Students work through the student pages, gathering ideas and information they need to share with other schools. This can be part of classroom work or an extra-curricular activity. Research takes approximately 3–6 hours, which may include a homework assignment.

5 **Complete the Exchange Form**
Students complete a single version of the Exchange Form that can be downloaded as a Word document, to share with other schools. Students need to compare notes and agree on the entries they make on the form.

6 **Select schools to exchange with**
Schools select schools from the online database that are working on the same topic, at the same time, and with similar-aged students. Students may communicate in one or more languages.

7 **Carry out the exchange**
Schools send their Exchange Form to their selected schools and to schools wanting to exchange with them.

8 **Discuss and report findings**
Once a number of Exchange Forms have been received students explore the different responses to the topic issues around the world and display and report their findings. The student pages for each topic suggest discussion points.

ucts, such as bright pink nail polish made from gumamela flowers in the Philippines and laundry soap from vegetable oil and banana stalks in Singapore.

After the background research, activities always involve discussion and debate. For example, in the Renewable Energy topic students discuss and debate the questions:

- What are the arguments for giving people a choice about "green electricity"?
- Is this an issue in your country?
- Would you be prepared to pay more for it?

In the Climate Change topic their arguments are steered by the following questions:

- What actions have already been taken by the government in your country to tackle global warming?
- What actions would you be prepared to take as individuals?

Teachers tell us that such contemporary issues are generally of interest to young people; some feel quite passionate about them and welcome the opportunity to develop and air their views in a well-managed atmosphere. In fact, it has been shown that discussions provide students with the opportunity to learn from someone other than their teacher and, healthily, to disagree with teachers and develop their own ideas.

Topic activities give plenty of opportunities for creativity and positive action. For example, in the Biodiversity topic, students design their own local Biodiversity Action Plan, which identifies a local problem and its consequences, their objectives in addressing the problem, their proposed actions, and the likely impact or effect of their actions. In the Domestic Waste topic, students plan and carry out actions to combat waste in their homes and school. Such decisions and consequent actions give a clear indication of active citizenship and are to be encouraged.

Science, Literacy, and Languages

The Science Across the World website and topics are in seven languages: Dutch, English, French, German, Italian, Portuguese, and Spanish. Many of the topics are also in additional languages such as Bulgarian, Catalan, Chinese, Farsi, Japanese, and Russian—with all translations provided by our team of enthusiastic teachers around the world who understand the language and literacy levels required for their students.

These resources make an ideal basis for Content and Language Integrated Learning and are used increasingly as curricular content by science teachers working in a bilingual context, and foreign language teachers perhaps working with colleagues in their science department.

The Exchange Form

Having completed the main activities, student groups then compare notes and agree on the entries they want to make on the Exchange Form. Small groups often make presentations to the whole class before the class comes to a consensus on the information and ideas that best represent the views of the class. This requires deliberation and constructive debate, which, when well managed, many students enjoy. The Exchange Form is a distinctive approach to encouraging international communications among students. Using a common Exchange Form for the whole class ensures that everyone focuses on the same issues for their activities and reporting. Communications between schools are constructive and related to the topic issues.

Having completed their Exchange Form, students then have the enjoyable task of selecting up to 20 schools to exchange with, usually through the SAW website. These will be schools where similar-aged students are working on the same topic at the same time, with the same language(s). Exchange Forms are sent to these selected schools and to those wanting an exchange with their own school. With sometimes hundreds of schools to select from and over 4000 teachers from over 120 countries currently participating in the program, the SAW online database of schools is an invaluable resource for teachers and students looking to develop constructive links beyond their country and culture.

ICT and Beyond

Although many schools still transfer their Exchange Forms by mail or fax, the vast majority now use our website. This creates a real purpose in using the Internet to communicate with schools in different countries. It also presents numerous opportunities for developing skills in information and communication technology (ICT). These include research using topic data and hotlinks, creating and using spreadsheets and graphs, setting up exchanges with schools across the world, completing and sending Exchange Forms

through the website in many different formats, and creating school websites related to the Exchange Form. All of this is supported by new personalized functionality under MyZone, MySchool, and MyExchanges for teachers, with restricted personalized functionality for students.

Amanda Ruiz Wilches, Chief of the Education Research Department, Education Secretariat Colombia, Latin America, commented that "The innovative methodology, and especially the possibility of sharing our culture with the rest of the world via the Internet, are aspects that make Science Across the World an excellent tool."

Developing Global Perspectives

For many participants, the most exciting part, and the main point of the exercise, comes next—receipt of Exchange Forms from across the world. These are then analyzed for similarities and differences, and patterns in response to the topic issues. Each topic suggests discussion points to help students develop global perspectives and better understand the issues in their own locality. For instance, younger pupils may compare their eating habits with others or discuss the science behind folklore and sayings from different parts of the world. Older students might explore the effect of the Convention on Biological Diversity at local and national levels in different countries. They may incorporate good ideas from different Biodiversity Action Plans into their own and perhaps explain whether or not the targets set by governments for using renewable energy are achievable or high enough. Such discussions may form a sound basis for interpreting these issues as they arise in the media.

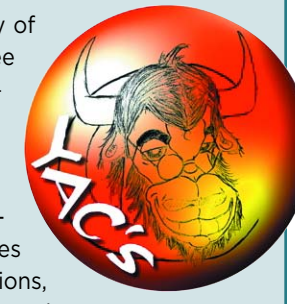
Exchanges and Collaborations

Feedback from teachers and students indicates that SAW can be a motivating and valuable experience. Many students personalize their topic work by sending colorful artifacts along with their Exchange Forms. Others use the topics as the basis for extensive projects and developing longer-term relationships between small groups of schools around the world, some with support from European Union Comenius funding for teacher travel and training. Others may benefit from attending SAW teacher workshops, which are based around the Genetics topic. Students might enter our regular online competitions, vote on different issues online, or perhaps get involved in our new **Young Ambassadors for Chemistry** (see box below) scheme in partnership with IUPAC. With some planning and commitment to communication with other schools, Science Across the World can be a rewarding experience for all.

Marianne Cutler <saw@ase.org.uk> is director of Curriculum Development at ASE, with overall responsibility for curriculum support, advice and initiatives such as Science Across the World.

www.scienceacross.org

Young Ambassadors for Chemistry



The YAC project—a joint activity of SAW and the IUPAC Committee on Chemistry Education (CCE)—aims to train teachers and provide resources to develop the communication skills of young people and teach them to be young ambassadors for chemistry. Project activities have focused on two SAW publications, *Chemistry in our Lives* and *Talking about Genetics*, and involve the following steps:

- translation of the materials into the languages to be used in the specific regions (e.g., Mandarin, Russian)
- local workshop for training teachers, followed by local workshops in which trained teachers train more teachers and Young Ambassadors for Chemistry
- local public awareness events run by Young Ambassadors for Chemistry
- presentations by the Young Ambassadors for Chemistry of their work and research to their peers

In recent months, YAC herds have stopped in Argentina, Russia, and Taiwan.

For more information, contact the head of the YAC herd, Lida Schoen <amschoen@xs4all.nl>. For reports on previous YAC adventures, see the link below.

www.iupac.org/projects/2003/2003-055-1-050.html

Fear of All Snakes, Spiders, . . . and Chemicals

by David A. Evans

I admit to being terrified of snakes, even when I recognize a nonpoisonous species. My daughter will not enter a room if she suspects the presence of a spider—even though she knows that there are no harmful spiders in the UK where we live. We are both scientists, but to be provided with any amount of profound and convincing evidence that these species are benign does not remove our fear. It is not a matter of trust, it is simply an irrational response. But knowledge does help—we do not kill these species and we recognize their beneficial role in their environment.

Similarly, a section of the population has a fear of, or a dislike for, "chemicals." Whereas such a phobia is often based upon lack of knowledge or familiarity, the same irrationality governs the responses. Again, informative statements based upon faultless logic almost always fail to convince. For others, the root of chemophobia is in a dislike of meddling with nature—and this group is often unaware that natural products consist 100 percent of chemicals. Thus, my niece seeks to consume only "pure butter, free of chemicals of all sorts"—we also note that she has a problem with the concept of purity, but purity is very often taken to mean the absence of manufactured chemical additives!

I know that many colleagues share these experiences, but what can we do to gain a better appreciation of our work? Perhaps the most obvious, yet frequently ignored, aspect is absolutely never to rebut an irrational or emotive argument by bombardment with scientific data and explanations. "Don't you realize that these chemicals are safer than toothpaste" just doesn't convince the sceptics—and it besmirches the qualities of toothpaste! Similarly, we should try to resist stating that many natural products are much more poisonous than synthetic chemicals. For many of the public, this is akin to trying to compare apples with pears—they are not parts of the same argument.

We should also acknowledge that people are not always unjustified in their fear of chemicals and history teaches that some dangerous chemicals have slipped through the net. In the past, we have sometimes been less than straightforward with the public, with appalling consequences for our credibility. We should understand that to many people, including highly educated citizens, the term "chemical" is now exclusively synonymous with manufactured materials, presumed to be toxic or carcinogenic. These find their way either on purpose or accidentally into the products they buy, the food they eat, or into the air, water and soil—and questions should be asked and answers given.

In practice, I know of no all-encompassing answer to this problem, but one of the best ways to make progress in my experience is to describe the benefits of a chemical product or process, together with straightforward comments about costs and risks. Most people are best persuaded by a benefit that they themselves experience. Thus, healthcare products provide an easy win, but to state that pesticides help farmers' profitability is hardly a selling point!

Segmenting the Audience

Our positive messages need to be tailored to our audiences—the public is very heterogeneous. A win for one group might be an anathema for another. Let's consider some of the active groupings:

The Media

The prime objective of all media, with the possible exception of some public service broadcasting, is to sell advertising space—in which audience ratings and circulation figures dominate. In the UK, some of the newspapers have devoted themselves to tirades against chemical usage. They are aware that sensation sells and never fail to print alarmist reports of the slightest chemical incident with exaggeration and distortion adding to the mix. Conversely, erudite reports of progress in science attract only a few and thus command very few column inches. Nevertheless, a fascinating story about a new development will get printed in the quality newspapers. A win here demands persistence in which development of relationships between science reporters and, for example, the press officers of learned societies, is required. Good relationships also facilitate the rebuttal of the nonscientific scaremongering that is often peddled to the public. Some learned societies have taken the initiative by assembling a rapid-response panel to deal with urgent press inquiries.

But scientists have an important part to play, too.

When addressing the media, we are prone to raise unrealistic expectations and to exaggerate. We sometimes are guilty of providing support for our pet project by unjustly denigrating an alternative—and the result is the debasing of all science. Whereas critique and debate are a part of the scientific method, public rancor amongst members of our profession is very damaging.

Government

The prime aim of a ruling political party is to stay in power, for example by re-election in a democracy. It is naïve to hope that politicians will rally to a cause that is unpopular with the public electorate, although there are notable exceptions to this. The paradox is that the actions of governments affect generations, but elections occur every few years. Small wonder therefore that political decisions are often short-term expedients. So what can long-termist scientists do about this? In my experience, the fostering of regular liaisons between the political office of a learned society and the appropriate government body can be mutually beneficial. The provision of authoritative and consistent information, independent of vested interests, is highly appreciated by politicians. This brings into focus the potential for IUPAC to act as an NGO. As an organization that is dedicated to accuracy, standards, and the principles of scientific method, IUPAC is well placed to provide leadership in this arena. Its freedom from bias, coupled with the formidable breadth, expertise, and authority of its membership, means that IUPAC is splendidly placed to act as an independent NGO, in contradistinction to many of the single-issue pressure groups that currently masquerade under this banner. It must also be mentioned that trade associations, however well intentioned, will not be regarded as neutral by governments, again underscoring a role for IUPAC.

The Education Sector

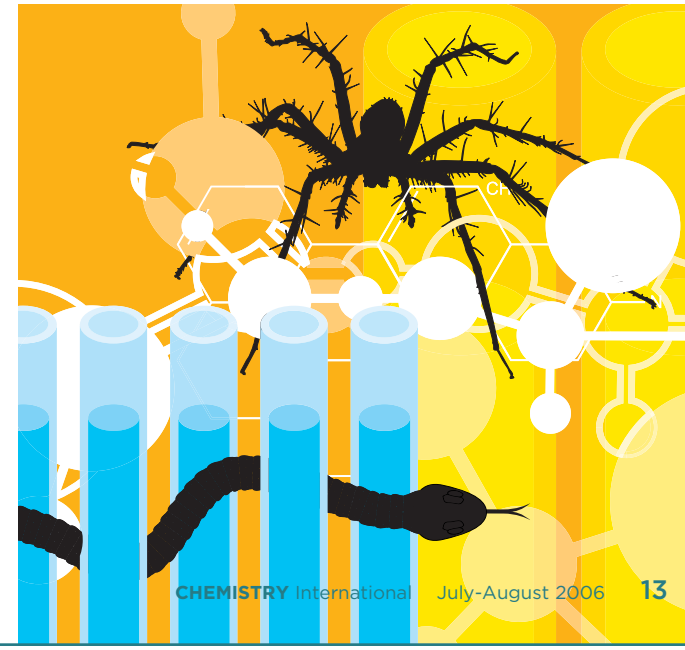
Here we meet our biggest opportunity for influence—and also a major challenge. Perhaps the best returns are to be gained from involvement in teacher training and by supporting teachers with learning aids and materials. The IUPAC Committee on Chemistry Education (CCE) has spawned or supervised many powerful initiatives in chemical education, many of which have already been described in *Chemistry International*. The National Adhering Organizations (NAOs) that support IUPAC often carry out major initiatives in this sphere and there is no shortage of commitment to continuing this work. This is clearly a major area for contributions from IUPAC in the future.

Scientists

It must be recognized that we scientists are ultimately collectively responsible for the esteem in which our profession is held by the public. In addition to the comments above, mention must be made of our past failures in engaging the public adequately. We have often insufficiently explained our purpose and our work. Our public attitude to risk has often been to deny its existence. Our openness when faced with emergencies and accidents has been at fault. In short, science communication has been suboptimal and IUPAC is poised to play a major role here.

IUPAC's Key Role

Whereas IUPAC's scope for involvement in the public understanding of chemistry is broad, it needs to clearly establish its niche alongside the numerous bodies with interest in this topic. At the 2005 General Assembly in Beijing, Peter Mahaffy, now Chair of CCE, prepared and presented a seminal report entitled *Chemists and "The Public": IUPAC's Role in Achieving Mutual Understanding*. This paper sets the direction for IUPAC's efforts to enhance public understanding based upon an analysis of best practices for science communication (see p. 14). The intention is to help scientists identify and understand their publics, to support science education systems, and to influence international organizations. To quote the report:



> "IUPAC is just one of many actors in public understanding of science, and will frequently need to work collaboratively with the other scientific unions and other bodies. IUPAC cannot cover the full range of possible activities and address all audiences, not least because it is remote from the general public. IUPAC's primary targeted public should be IUPAC chemists and educators, and IUPAC's most important role is to help them understand and work with a variety of other publics."

Furthermore, we need to be aware that our notion of public understanding often overlaps with public awareness of, and public appreciation for chemistry. These are rather separate topics encompassing different processes—the report clarifies the distinction.

The public understanding arena is characterized by numerous well-informed and substantive contributions, but there is an evident lack of coordination leading to much duplication of work. Within IUPAC, it is vital to have a focus for our work and I believe that CCE should be that focus. Whereas the Committee on Chemistry and Industry (COCI) has a program in this area, it is agreed that COCI should concentrate on the industrial perspectives with a greater focus upon public appreciation. Many NAOs will pursue their own national programs, and indeed several have pointed

Did You Say PUC or *PAC*?

Chemists derive great benefit from precision in the use of terminology in their scientific work and IUPAC uses a variety of terms for science communication as do other organizations. The practical definitions proposed for the purpose of science communication are:

Public understanding of chemistry: Understanding of chemistry matter by non-chemists, including chemistry content, the nature and methods of chemistry (as a social enterprise), and the roles and uses of chemistry in society.

Public awareness of chemistry: General knowledge of chemistry content, processes and societal roles, without detailed and precise understanding.

Public appreciation of chemistry: A positive attitude to chemistry, including respect and/or admiration for its methods and its contributions (and potential contributions) to society.

This is an extract from Mahaffy's draft report.

Chemists' Understanding of the Public

by Peter Mahaffy

Perhaps you read the title above as a test for dyslexia, as the chemistry profession usually inverts the order of those words to highlight the challenges associated with winning increased public understanding of and appreciation for chemistry. And, as outlined in the accompanying article (p. 12), those challenges are profound.

A task group of the Committee on Chemistry Education (CCE) is completing a project aimed at clarifying IUPAC's niche in meeting the global challenges of increasing public understanding of chemistry. One significant recommendation is that we turn the phrase "public understanding of chemistry" around, and focus considerable attention on helping IUPAC chemists identify and understand their diverse publics, so focused and effective strategies for science communication can be developed.

An overarching goal for the project is to provide a framework that will bring the same level of intellectual rigor to IUPAC's science communication activities as to IUPAC's scientific activities. Thus, work began with a careful review of the extensive literature on the public understanding of science and paid careful attention to the nomenclature used to describe these activities. The report recommends that IUPAC clearly define its most appropriate target audiences, clearly articulate goals and motives for IUPAC public understanding of chemistry (PUC) initiatives, and design PUC projects with a plan for rigorous evaluation of outcomes.

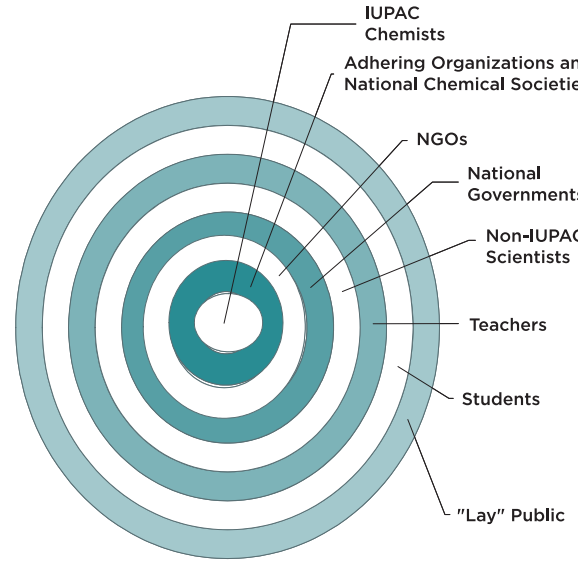
The project task group included CCE members Peter Mahaffy (chair), Tony Ashmore, Bob Bucat, Choon Do, and King's University College undergraduate student Megan Rosborough, who carried out an extensive literature review and assisted in the development of the project report. The report was presented in a well-attended joint workshop at the 2005 General Assembly in Beijing, and will be finalized following the 19th International Conference on

out the diversity of perceptions across the world. Here, the imperative is to share best practices and learn from past successes and mistakes.

From an industry-based COCI perspective, we feel that we need to help improve public image by directly and honestly confronting the issues of safe and responsible manufacturing, handling, and use of chemicals. Hence, we are engaged in initiatives such as the Safety Training Program and Responsible Care. We need to better inform the public about what we are doing to make improvements and to acknowledge what has gone wrong—and to engage the public to collaborate on good ideas to improve even further.

One thing is for sure, in IUPAC we have the skills and the determination to tackle this problem. It is now a matter of getting ourselves organized to play a pivotal global role in advancing our cause—and to begin to rationalize the irrational!

David A. Evans <dae.jeevans@btopenworld.com> is a member of the IUPAC Committee on Chemistry and Industry (COCI). Evans' interest in public appreciation of science predates his retirement as Head of Research & Technology at Syngenta and makes him a leader within COCI to coordinate such activities.



"IUPAC has neither the resources, nor the expertise to address all of these 'publics'. It needs to concentrate its activities with those publics with which it is well placed (and perhaps better placed than others), while interacting indirectly with those publics that are more remote (and who are better addressed by others)." —Extract from Mahaffy's draft report.

Chemical Education in Korea, 12–17 August 2006, before being formally submitted to IUPAC for approval. A few highlights from the report, followed by conclusions and recommendations are listed below. The full task group report is available from the project webpage at <www.iupac.org/projects/2004/2004-047-1-050.html>.

Many organizations and associations consider themselves stakeholders in the public understanding and appreciation of science. One of the task group challenges was to think about the strengths and limitations of IUPAC as an organization for communicating chemistry to the public. Strengths include IUPAC's international make-up, with special attention given to the needs of developing countries; IUPAC's considerable scientific credibility in setting global standards on nomenclature, physical constants, and other areas; IUPAC's links to other unions and international organizations; and IUPAC's track record of support for formal chemistry education through the work of the former Committee on Teaching of Chemistry and the present CCE.

On the other hand, IUPAC's effectiveness in public understanding of chemistry initiatives may be limited by lack of IUPAC chemists' understanding of the public(s) who might be served by initiatives; limited knowledge within IUPAC of the research base for educational and PUC initiatives; insufficient articulation of motives, goals, and outcomes for PUC initiatives; limitations of a largely volunteer organization without central resources to support substantial PUC initiatives; and lack of public knowledge about IUPAC.

The task group felt it helpful to clarify nomenclature. The report gives generally accepted meanings for terms such as: public understanding of chemistry, public awareness of chemistry, and public appreciation of chemistry (see box p. 14), and notes that confusion is created because these terms are often used interchangeably.

Insights are drawn from the research literature on public understanding of science, including observations that the general public in highly developed countries often has a remarkably high level of expressed and demonstrated interest in science-related programs—higher than scientists in these countries perceive to be the case. Despite this, there is evidence that

the mass media are an ineffective vehicle for enhancing understanding of science among adults. It appears that the role of school-level (K-12) formal education is far more important than subsequent exposure to science communication.

Building on insights from the literature review, the task group articulates the following motivation for IUPAC's involvement in PUC initiatives, and notes that the media and the public will see through any imbalance or confusion of motives and will spot anything that is self-serving.

- IUPAC wants to provide leadership to enable chemists to address global issues that involve the molecular sciences.
- IUPAC acknowledges that the public ultimately decides whether and to what extent the benefits of chemistry are realized.
- Chemists therefore need to engage with the public to create a climate in which the potential benefits of chemistry can be realized.
- To create and support effective two-way communication, chemists need to understand the needs and concerns of the public.
- Good decision-making in society depends on mutual understanding and trust among chemists and the public.
- IUPAC needs strategies to promote this mutual understanding.

Noting that "one size fits all messages" are ineffective, the report addresses the question: Who are the public(s) IUPAC should be trying to reach? IUPAC can be considered to be at the center of a set of concentric circles, each of which represents a "public" with which IUPAC may wish to interact in relation to the public understanding of chemistry (see figure p. 15).

IUPAC is closest to and/or can readily interact with its own adhering bodies and national chemical societies, other multinational organizations, and the scientific and educational arms of national governments. It is relatively remote from most chemists, who are members of national bodies rather than of IUPAC itself, and very remote from teachers, students, and the general public.

IUPAC's primary targeted public should be IUPAC chemists and educators

IUPAC has neither the resources, nor the expertise to address all of these "publics." It needs to concentrate its activities with those publics with which it is well placed (and perhaps better placed than others), while interacting indirectly with those publics that are more remote (and who are better addressed by others).

This final point brings us back to our title: "Chemist's Understanding of the Public." Primary publics for IUPAC are those chemists who are closely associated with IUPAC, and one of the first steps for IUPAC is to assist its chemist-members in understanding the needs and aspirations of their target audiences.

The report concludes with the following recommendations:

1. IUPAC has an important role to play in enhancing public understanding of chemistry.
2. Public understanding of chemistry activities aimed at supporting teachers and students within the formal school system are often more effective than those aimed at the general public.
3. IUPAC's primary targeted public should be IUPAC chemists and educators, and IUPAC's most important role is to help them understand and work with a variety of other publics.
4. We propose IUPAC's niche as focusing on activities that indirectly enhance public understanding, such as the following:
   a. helping scientists identify and understand their publics
   b. influencing international organizations
   c. supporting science education systems, particularly in countries in transition
   d. supporting scientists and educators by communicating relevant findings from IUPAC projects and activities at an appropriate level
   e. suporting national chemical societies and other organizations, particularly in countries in transition

One of the important steps in the project is to disseminate findings broadly to the IUPAC membership for suggestions—this communication to you is one step in that process, and you are invited to send comments to <peter.mahaffy @kingsu.ca>. Following a review of feedback, the project group will meet at the 19th ICCE in August 2006 and prepare a final report.

Peter Mahaffy <peter.mahaffy@kingsu.ca> is a professor at King's University College in Edmonton, Alberta, Canada, and the current chairman of the IUPAC Committee on Chemistry Education.

www.iupac.org/projects/2004/2004-047-1-050.html

2006 IUPAC Prizes for Young Chemists

On 4 May 2006, IUPAC announced the winners of the 2006 IUPAC Prizes for Young Chemists, which are awarded for the best Ph.D. theses in the chemical sciences as described in 1000-word essays.

The winners are:

- **Michelle Nena Chrétien**, University of Ottawa, Ontario, Canada
- **Valentina Domenici**, University of Pisa, Italy
- **Matt Law**, University of California, Berkeley, USA
- **Emilio M. Pérez**, University of Edinburgh, Scotland, United Kingdom
- **Dunwei Wang**, Stanford University, California, USA

The winners will each receive a cash prize of USD 1000 and a free trip to the IUPAC Congress, 5-11 August 2007, in Torino, Italy. Each prizewinner will also be invited to present a poster at the IUPAC Congress describing his/her award winning work and to submit a short critical review on aspects of his/her research, which will be published in *Pure and Applied Chemistry*.

The essays describing the 2006 winners' theses can be found on the IUPAC website:

- Dr. Chrétien, "Photochemical, Photophysical, and Photobiological Studies of Zeolite Guest-Host Complexes"
- Dr. Domenici, "Structure, Orientational Order, and Dynamics of Rod-Like and Banana-Shaped Liquid Crystals by Means of ^{2}H NMR: New Developments"
- Dr. Law, "Oxide Nanowires for Sensing, Photonics, and Photovoltaics"
- Dr. Pérez, "Hydrogen-Bonded Synthetic Molecular Machines"
- Dr. Wang, "Synthesis and Properties of Germanium Nanowires"

There were 49 applicants from 19 countries. The Prize Selection Committee was comprised of members of the IUPAC Bureau with a wide range of expertise in chemistry. The committee was chaired by Prof. Leiv K. Sydnes, IUPAC past president.

In view of the quality of many applications, the committee decided also to give two Honorable Mention awards to:

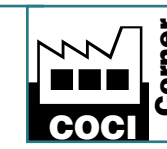
- Elena S. Chernetsova, Lomonosov Moscow State University, Russia
- Fiorenzo Vetrone, Concordia University, Montreal, Quebec, Canada

The Honorable Mention Award winners will receive a cash prize of USD 100 and a copy of the *Compendium of Chemical Terminology*, the IUPAC "Gold Book." The awards to the winners of the 2006 prize and those of 2007 will be made during the Opening Ceremony of the 2007 IUPAC Congress in Torino.

www.iupac.org/news/prize/2006_winners.html

Applications for the 2007 Prize are now being solicited, as described on the IUPAC website <www.iupac.org/news/prize.html>.

COCI Corner



The chemical industry has been integral to IUPAC since the earliest days of the Union. Leaders of industrial chemical societies helped create IUPAC in 1919, and committees representing industry and applied chemistry have been an important part of the Union ever since. Now, more than ever, advances in industrial chemistry are critical to progress in the chemical sciences.

The IUPAC **Committee on Chemistry and Industry** (COCI) is the focus within IUPAC for issues of importance to the global chemical industry. COCI is developing new programs and projects on emerging topics. It is also the conduit for communications between IUPAC and National Adhering Organizations (NAOs), Company Associates (CAs), and individual scientists. This issue of *Chemistry International* introduces a new feature called the **"COCI Corner,"** where COCI will present the committee's work on topics of urgency to IUPAC and the chemical industry. In this installment, Mark Cesa (USA), chairman, introduces COCI programs.

COCI "kicked off" the new biennium with a project planning and strategy meeting at the IUPAC Secretariat in April. Continuing the organizational structure developed by past chair David Evans (UK), five programs have been established within which members will generate and carry out new projects, communicate with IUPAC leadership and the chemical industry, and foster liaisons with trade associations,

The IUPAC Secretariat office and surrounding area provided a good retreat for COCI members; from left, back row: Charles Gwaza (Nigeria), Mark Cesa (USA), David Evans (UK), Bernard West (Canada), Alexander Pokrovsky (Russia); front row: Aldo Alles (Uruguay), Michael Booth (South Africa), Alan Smith (UK), Akira Ishitani (Japan), and Jonas Unger (Sweden).

chemical societies, and international scientific and development bodies. One particular emphasis will be on capacity building in the developing world. Titular Member (TM) Aldo Alles (Uruguay) coordinates COCI's projects.

The Safety, Health, and Environment Program houses the IUPAC-UNESCO-UNIDO Safety Training Program (STP), the flagship project of COCI <www.iupac.org/standing/coci/safety-program.html>. In October, Prof. Said Mohammed Bayomi of Egypt became the ninth STP Fellow since 2000 when he trained at AstraZeneca facilities in the UK. Eight new trainee candidates are now being vetted by Alles and Secretary/Treasurer Mike Booth (South Africa). Highly successful STP workshops have been held at the last two IUPAC Congresses, where STP Fellows have gathered to share their experiences with improving chemical safety in their home countries. A workshop has been proposed for the IUPAC Congress in Torino next year. STP Fellow Kelvin Khisa (Kenya) is organizing a Conference on Occupational Health and Safety Management in East Africa, scheduled for September 2006 <www.iupac.org/symposia/2006.html#270906>, and STP Fellow and Associate Member Esma Toprak (Turkey) is planning a future workshop on chemical safety for Eastern Europe and the Middle East.

In collaboration with Peter Mahaffy and the Committee on Chemistry Education, TM David Evans leads COCI's efforts in the public appreciation of chemistry. David's article in this issue of *CI* offers a provocative discussion of how the chemical industry can influence this important effort (see p. 12).

Recruitment and retention of Company Associates is the responsibility of TM Akira Ishitani (Japan), along with TMs Jonas Unger (Sweden) and Evans. There are currently 92 IUPAC Company Associates. Khalida Al-Dalama (Associate Member, Kuwait) has set the standard for CA recruitment, single handedly landing two new CAs from the Middle East in 2005 (Nov-Dec 2005 *CI*, p. 19). There are also two new CAs from the UK (Jan-Feb 2006 *CI*, p.20). COCI and the Secretariat plan to work together in this biennium to recruit and retain more CAs.

To fulfill COCI's role to communicate with NAOs and CAs, Unger has proposed a regional meeting for European National Adhering Organizations and Company Associates for early 2007. National Representative and Bureau member Alan Smith (UK) has issued the latest compilation of IUPAC Projects of Interest to Industry. At the April COCI meeting, members visited the laboratories of Company Associate Syngenta at Research Triangle Park (North Carolina, USA), where we learned about current research in biotechnology that has led to great improvements in barley, cotton, soybeans, and other important crops.

In April, COCI members visited the laboratories of Syngenta, located in Research Triangle Park, North Carolina, USA.

Under the leadership of TM Colin Humphris (Belgium), the NGO/IGO/Trade Associations Program is working with IUPAC leadership to secure NGO status with key worldwide organizations. TM Alexandre Pokrovsky (Russia) leads collaborations with UNESCO and similar organizations. Humphris and Pokrovsky are uniquely positioned to bring the leaders of chemical industry to the table to participate in the World Chemistry Leadership Meeting and other important IUPAC activities.

Smith also coordinates COCI's program on collaborations with IUPAC divisions and standing committees. New representatives of divisions and standing com-

mittees have been appointed. COCI is exploring new project ideas in Responsible Care (National Representative Bernard West, Canada), nanotechnology, and biomonitoring, and will work with the divisions to strengthen and expand on these ideas.

COCI is building a portfolio of projects at the interface of the chemical sciences and industry. In future issues of *CI* we'll describe our efforts in more detail. Watch this space!

For more information, contact COCI Chairman Mark Cesa <mark.cesa@innovene.com>.

www.iupac.org/standing/coci.html

Permanent Access to Scientific Information in Southern Africa

The final report, executive summary, and presentations from the September 2005 CODATA Workshop on Strategies for Permanent Access to Scientific Information in Southern Africa: Focus on Health and Environmental Information for Sustainable Development are now freely available online at <http://stardata.nrf.ac.za/html/workshopCodataPublications.html>.

This workshop was one of a series focused on issues related to the preservation of and access to scientific information resources in developing countries. This most recent workshop was co-organized by the U.S. National Committee for CODATA in collaboration with the South African National Committee for CODATA, the National Research Foundation of South Africa, and the CODATA Task Group on Preservation of and Access to Scientific and Technical Data in Developing Countries. The reports and presentations are also available on a CD, which may be obtained through the "Order a CD" e-mail link at the URL provided above.

Questions or comments about this workshop or the reports may be sent to Paul Uhlir <puhlir@nas.edu>, director of the U.S. National Committee for CODATA at the U.S. National Academies, or by phone at +1 202-334-2807.

www.codata.org/taskgroups/Tgpreservation

Memorandum on Cooperation with UNESCO

On 21 December 2005, IUPAC and the Division of Basic and Engineering Sciences of UNESCO—the United Nations Educational, Scientific, and Cultural Organization—signed a *Memorandum on Cooperation in Pure and Applied Chemistry*. The two organizations, which have a history of close and successful cooperation, will focus their joint activities on capacity building and information sharing in Africa. The Memorandum lists a number of specific areas of cooperation:

- addressing global and ethical issues that necessitate international expertise and/or action in the field of chemical sciences
- advancing the chemical sciences through the fostering of international and regional cooperation in research projects, in particular through networks of national centers of excellence
- promoting the services of chemical sciences for the development of technologies, engineering, wealth creation, and improvement of the quality of life
- improving training of young scientists, both men and women, particularly those from the least-developed countries
- sharing scientific information and knowledge

This agreement recognizes the need to follow-up on recommendations in *Science Agenda—Framework for Action*, adopted by the World Conference on Science, particularly those relating to fundamental research, basic human needs, and the sharing of scientific information and knowledge, and the recommendations from the WCS follow-up symposium on "Harnessing Science for Society: Further Partnerships" (Venice, 2005).

The Division of Basic and Engineering Sciences is responsible for promoting international partnerships in science that encourage sustainable development, basic and engineering sciences, renewable energy, and disaster mitigation.

For more information, contact IUPAC Executive Director John Jost <secretariat@iupac.org>.

www.unesco.org/science

>Basic and Engineering Sciences

International Funding for Chemical Research

Science knows no international boundaries, but *funding* for support of scientific research is mostly provided by national organizations. This is particularly true for the chemical sciences, where most research projects are relatively small—not the mega-projects characteristic of high-energy physics, climate change, or biomedical research.

Three years ago, Arthur Ellis, Director of the Chemistry Division of the U.S. National Science Foundation, suggested to the U.S. National Committee for IUPAC that the Union might be able to convene representatives of organizations from several countries that support research in chemistry. They would explore the benefits of exchanging information and developing better mechanisms to encourage international research collaboration.

The result was an IUPAC project, organized by former Secretary General Ted Becker, that brought together a dozen participants in the one-and-a-half day Workshop on International Research Funding in the Chemical Sciences, held 18–19 August 2005, during the IUPAC General Assembly in Beijing. The agenda focused on:

- national research funding philosophies, conditions, and guidelines
- trends and priorities in chemical research
- tracking chemical research and measuring its impact
- programs in chemical research that encourage international partnerships
- resources that can be shared through international partnerships
- education and workforce in the chemical sciences

Particular attention was given to *ERA-Chemistry*, a program in Europe to develop cooperative research projects in different countries <www.erachemistry.net>, which may serve as a model for broader global cooperation. Other highlights included the use of mapping techniques to demonstrate the interrelation of various areas of science and their funding. Also of interest was the emerging discipline of cyber-enabled chemistry, which uses world-wide computer networks to permit remote control of instruments and to bring together a vast array of databases, modeling capabilities, and high-speed communications that can be used to attack chemical problems of great complexity. A report of the workshop is available at <www.iupac.org/projects/2004/2004-014-1-020.html>.

The participants, along with a number of others who could not attend the workshop, were eager to continue meetings and online interactions under IUPAC sponsorship. A follow-up project, recently approved by the Executive Committee, is designed to continue this communications forum for three years and to study the feasibility of a more permanent structure within IUPAC to facilitate the funding of international research in the chemical sciences by governmental and other organizations. Leaders in chemistry funding from more than 20 countries are being invited to a meeting on 29 August 2006 in Budapest, which will be held in conjunction with the 1st European Chemistry Congress. Tentatively, a second workshop will be held in Torino, Italy, during the IUPAC General Assembly in 2007.

For more information and comments, contact the task group chairman, Karlheinz Schmidt <Karlheinz.Schmidt@dfg.de>.

www.iupac.org/projects/2006/2006-013-1-020.html

Distance Learning in Toxicology: Effective Teaching through Technology

On 6 March 2006, a roundtable discussion about distance learning, especially as it pertains to toxicology, was held in San Diego, California, USA, at the 45th Annual Meeting of the Society of Toxicology (SOT). The roundtable, which was jointly sponsored by SOT and IUPAC, focused on the quality of a number of online offerings in toxicology.

One of the major frustrations felt by many educators who are engaged in distance learning in toxicology (or related disciplines) is the perceived lack of quality of such programs, which are often considered "diploma mills" (i.e., methods for making money with no real educational value). One objective of this roundtable discussion was to provide several examples of very high-quality distance learning programs in toxicology and to provide a forum for discussing how these programs were developed as well as their efficacy.

Five speakers presented their respective programs,

including John Morris (Drexel University, USA), Kristie Willett (University of Mississippi, USA), Jane Huggins (Drexel University, USA), John Duffus (Edinburgh Centre for Toxicology, UK), and Paul Wright (RMIT University, Australia).

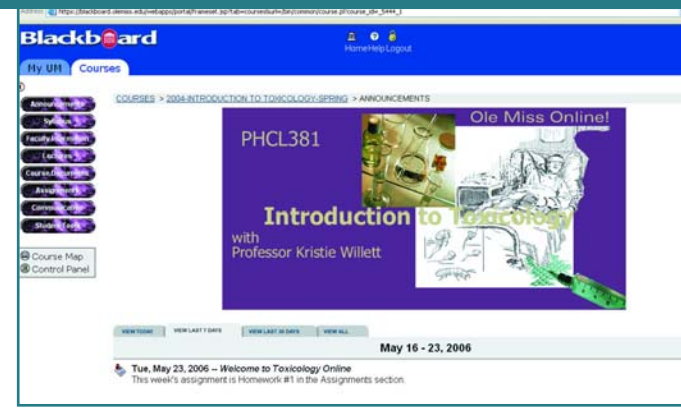
John Morris keynoted the session with his discussion of the many ways in which technology can be utilized for learning purposes. He highlighted the fact that effective distance learning endeavors recognize different teaching and learning styles and different levels of proficiency with electronic communication. He emphasized *engagement* of both student and teacher as integral to successful online education.

Kristie Willett presented her perspective on distance learning in toxicology, drawing from her experiences teaching toxicology online to undergraduate and graduate students. She put forth data from a series of surveys given to students while taking their online courses in which their experiences in both traditional and online environments were queried. Her results indicated that students value the opportunity to study online. However, these students exhibited a certain degree of ambivalence with regard to equating online courses with traditional face-to-face courses.

Jane Huggins described the series of online toxicology courses she has taught to undergraduate and graduate students as portals through which students can advance their understanding of the basic concepts of toxicology. She emphasized various features of WebCT® content management software, the electronic tool with which she teaches. Students in these courses are encouraged to engage in a range of activities utilizing chatroom, assignment, e-mail, and discussion group utilities. Moreover, students have access to a collection of audio/video materials including archived lectures and virtual seminars.

John Duffus presented a summary of IUPAC's teaching activities internationally in which online learning is utilized to a large extent via educational modules available on the IUPAC website. The main thrust of these teaching endeavors is to provide training in toxicology to chemists. Duffus, who participated in development of these modules, discussed their efficacy in teaching individuals from diverse backgrounds. He also talked about using glossaries to supplement the online teaching of technical disciplines, including toxicology.

Paul Wright discussed the fully online postgraduate programs he has developed for Graduate Diploma or Masters in Applied Science in Toxicology. He described stimulating the engagement of both student and teacher through use of online breakout groups and discussions, distance co-supervision of research projects for minor theses, use of learning journals and workplace practical applications, and other distance learning modalities. Moreover, he emphasized the international component of these programs, indicating that students from both developed and developing countries participate in them.



The homepage of the online toxicology course taught by Prof. Kristie Willett of the University of Mississippi (Ole Miss), USA.

Several presentations focused on the engagement of students participating in online courses, something that is often taken for granted in face-to-face, traditional classroom formats. However, both teachers and students find that engagement becomes a much more central issue when the usual visual and audio cues between teacher and student are not present, as is the case with many distance-learning endeavors. Many critics of distance learning have stressed that it severely limits the breadth and depth of expression between teacher and student. However, recent innovations allow audio and visual interactions between teachers and students, sometimes in real-time.

Two of the presentations in this roundtable discussion (John Duffus and Paul Wright) were about courses populated with international students. These talks highlighted a deeper issue related to distance learning: how to create a community in which individuals from many different cultures may participate. Online classes of any kind can rapidly become communities in which knowledge (and wisdom) is freely shared between teacher and student, or student and student. In fact, the boundaries between teacher and student often become blurred because everyone becomes engaged in the learning process. Although this phenomenon is

not unique to online courses, the argument can be made that because online courses are asynchronous, a community of greater breadth may evolve. This breadth is the result of the inclusive nature of asynchrony which allows individuals with many different time schedules and physical locations to engage in the learning process, adding depth and, at the same time, variety, to electronic classroom experiences. The phrase, "distance learning," can imply learning at a distance, but may also suggest closing that distance through shared learning experiences.

Overall, the roundtable discussion on distance learning sponsored by SOT and IUPAC provided an opportunity for exploration of the many issues facing individuals who are developing or taking courses online. All of the presentations exemplified the inspiration and perspiration that underlie any endeavor of this kind. If nothing else, these presentations provided evidence that, indeed, distance learning courses of quality do exist and thrive as do the teachers and students who participate in them. Further technological innovation will, no doubt, continue to support the development of community through distance learning and enhance the learning experience for all of us.

For more information and comments, contact the Task Group Chair Jane Huggins <dona.jane.huggins@drexel.edu>.

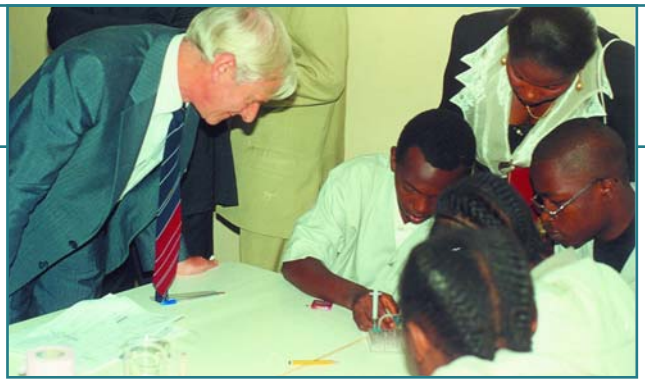
www.iupac.org/projects/2005/2005-013-1-700.html

Putting Experimentation Back into Science Education

Nearly a decade after the Global Microscience Project was launched by UNESCO and IUPAC in 1996, the microscience approach has been introduced into about 75 countries, many of them in Africa. In some countries, UNESCO-Associated Centres have been established to further develop the microscience project.

Prof. John Bradley headed this project for IUPAC for many years, and he remains deeply involved as a consultant for the microscale program for the IUPAC Committee on Chemistry Education.

The prime objective of this project is to introduce to teachers, inspectors, and education officials the advantage of performing chemistry experiments on a small scale. This is done through introductory workshops in developing countries and countries in transition where hands-on experience is provided under expert guidance.



Prof. Bradley (left) observing some students at a microscience workshop.

To supplement this initiative, teaching and learning packages, including teachers' guides and students' worksheets, are now available online thanks to the UNESCO Global Microscience Project, developed and promoted by UNESCO via its strong relationships with different nongovernmental and intergovernmental organizations throughout the world.

These Web pages contain microchemistry materials, soon to be followed by microelectricity, water quality, micro-electrochemistry, biology, and primary microscience resources. In addition, new materials as well as new language versions and national adaptations of existing materials will also become available on this site.

These materials are freely accessible by teachers and students to use as basic practical science resources. They can all be adapted easily to suit the needs of each national curriculum in accordance with national education standards.

For further information on the Global Microscience Project, contact UNESCO Coordination: Julia Hasler, programme specialist, SC/BES <j.hasler@unesco.org>. The technical partner is Beverly Bell <bellbct@radmaste.wits.ac.za>, executive director, International Foundation for Science Education, UNESCO-Associated Centre for Microscience Experiments, The RADMASTE Centre, University of the Witwatersrand, Johannesburg, South Africa.

www.iupac.org/projects/2001/2001-046-1-050.html

Cameroonian children carrying out experiments with the microchemistry kits.

IUPAC Seeks Your Comments

www.iupac.org/reports/provisional

Glossary of Terms Used in Toxicology—Expanded and Revised from "Glossary for Chemists of Terms Used in Toxicology" (IUPAC Recommendations 1993)

This glossary is a revision of the IUPAC *Glossary for Chemists of Terms Used in Toxicology*,[1] which incorporates new and redefined terms from the Glossary of Terms Used in Toxicokinetics.[2] It contains definitions and explanatory notes, if needed, for terms frequently used in the multidisciplinary field of toxicology. The glossary is compiled primarily for those scientists and others who now find themselves working in toxicology or who require knowledge of the subject, especially for hazard and risk assessment. 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**(9), 2003–2122, 1993
2. *Pure Appl. Chem.* **76**(5), 1033–1082, 2004

Comments by 30 September 2006

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www.iupac.org/reports/provisional/abstract06/duffus_300906.html

Guidelines for Potentiometric Measurements in Suspensions—Practical pH Measurements in Soil Suspension

The measured cell potentials for suspension potentiometric cells have been interpreted and explained by a detailed analysis of the schemes for these cells (Part A). Some former disagreements amongst investigations have been clarified in this document. A new unambiguous operational definition of the Suspension Effect is presented. It is defined as the difference in cell potential for two suspension potentiometric cells, one with both electrodes in the separated equilibrium solution and the other with both electrodes in the sediment or suspension. This potential difference is the sum of the change in the indicator electrode potential and the change in the liquid junction potential of the reference electrode, when the electrodes are used for measurement, once in the sediment of the suspension and then in its equilibrium solution.

Comments by 30 September 2006

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www.iupac.org/reports/provisional/abstract06/oman_300906.html

Definitions of Terms Relating to the Structure and Processing of Inorganic and Polymeric Gels and Networks

This document defines terms related to the structure and processing of inorganic, polymeric, and hybrid inorganic-polymeric materials from precursors, through gels, to solid products. The document is divided into four sections—Precursors, Gels, Solids, and Processes—and the terms have been restricted to those most commonly encountered.

Comments by 31 July 2006

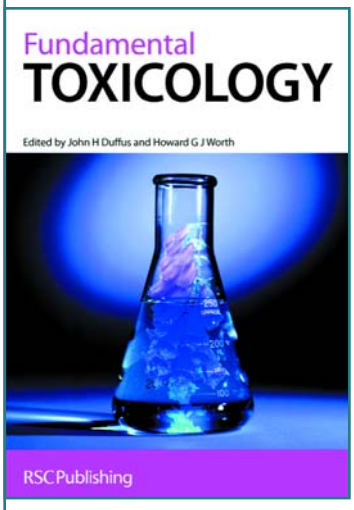
See May-June 2006 *CI*, p. 19, for contact information.

www.iupac.org/reports/provisional/abstract06/jones_310706.html

Fundamental Toxicology

J.H. Duffus and H.G.J. Worth
The Royal Society of Chemistry, 2006
ISBN 0 85404 614 3

Fundamental Toxicology is a concise and comprehensive review of toxicology. It is based on the highly successful *Fundamental Toxicology for Chemists* (J.H. Duffus and H.G.J. Worth, The RSC, 1996) and has been enriched and expanded. Every chapter in this new edition has been revised and updated, and four new chapters have been added. With contributions from internationally recognized experts in their field, this broad-based introduction to the topic covers both well-established and rapidly developing areas of toxicology, such as toxicogenomics, reproductive toxicology, behavioral toxicology and ecotoxicology.



Fundamental Toxicology is ideal for students and includes extensive pedagogical features, such as an extensive glossary, a bibliography after each chapter, and recommended further reading. It is also designed for teachers and lecturers, especially those who may be teaching toxicology for the first time. Included is a suggested curriculum for using the text to teach toxicology to students from various scientific disciplines. Professionals working in toxicology and related fields will find this an invaluable guide.

This book represents the outcome of the IUPAC project of the same title. The textbook also complement the editors presentations on "Essential Toxicology." which are educational resources available on the IUPAC website <www.iupac.org/publications/cd/essential_toxicology>.

www.iupac.org/publications/books/author/duffus06.html

Definitions of terms used in toxicology and in toxicokinetics are regularly being evaluated and updated by IUPAC task groups coordinated by the Subcommittee on Toxicology and Risk Assessment. See provisional recommendations currently under public review or the subcommittee Web page for more information <www.iupac.org/divisions/VII/VII.C.2>.

Macromolecular Symposia—recent volumes

Fillers, Filled Polymers, and Polymer Blends
P. Dubois, G. Groeninckx, R. Jerome,
R. Legras (editors)
Macromolecular Symposia, Vol. 233
Wiley-VCH, 2006, pp. 1–236

About 300 scientists from 35 countries attended this first joint meeting between the 8th European Symposium on Polymer Blends and Eurofillers 2005, held in Bruges, Belgium, from 9–12 May 2005. The conference featured 16 plenary/keynote lectures, 44 oral communications, and more than 200 poster presentations. This volume of *Macromolecular Symposia* covers most of the plenary and oral contributions presented at the meeting.

"Materials Design, Performance and Problem Solving" was the general theme of this meeting, which was meant to stimulate dialogue among specialists in complementary fields, such as physics, chemistry, and engineering, who have expertise in both organic and inorganic materials. The topics covered during the meeting included:

In the field of polymer blends:

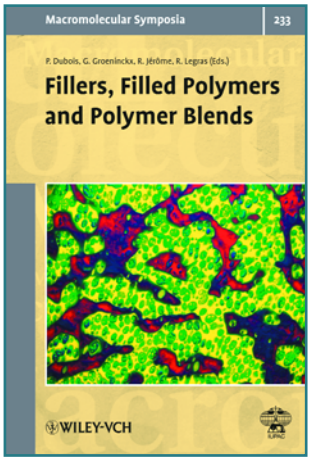
- innovations in generation and control of phase morphology, including theoretical approaches and numerical simulations
- reactive processing, including reactive compatibilization, dynamic crosslinking, and polymer chemistry in the melt
- control, characterization, and modeling of interfaces and interphases

—structure-mechanical performance relationships

—specific polymer blends (including recycling) and their applications

In the field of fillers and filled polymers

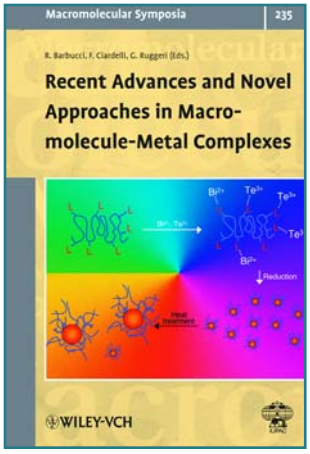
- preparation and characterization of (nano) fillers of all shapes and functions
- formulations of (nano)fillers with polymers, including nanocomposites, natural fiber composites, and organic-inorganic hybrid materials



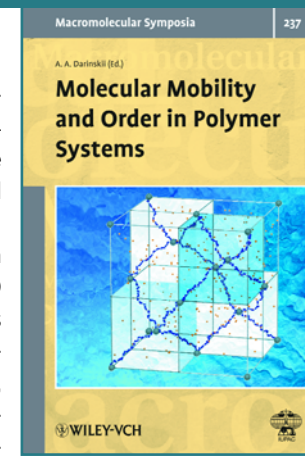
—adhesion between (nano)fillers and polymers
—structure-property relationships of (nano)composites, including confined crystallization issues
—industrial applications of filled polymers in automotive, electronic, biomedical, and packaging

www.iupac.org/publications/macro/2006/233_preface.html

Recent Advances and Novel Approaches in Macromolecule-Metal Complexes
R. Barbucci, F. Ciardelli, G. Ruggeri (editors)
Macromolecular Symposia, Vol. 235
Wiley-VCH, 2006, pp. 1-253



This issue of *Macromolecular Symposia* contains selected papers, presented at the 11th International Symposium on Macromolecule-Metal Complexes (MMC-11), sponsored by IUPAC, that was held in Tirrenia (Pisa, Italy) from 10–13 September 2005. The symposium, chaired by R. Barbucci (Siena) and F. Ciardelli (Pisa), was part of the series of regular biennial meetings of the MMC group that focus on the synthesis of artificial combinations of metal ions/metals, ligands, and macromolecules, with the aim of developing new materials with a variety of properties. This issue features 14 review-style papers, which are now reported in an extended manner.



The interest and progress in the field was apparent, as 170 participants from 30 countries attended the event. Topics covered included biological aspects, synthesis; formation and characterization; environmental applications; binding of small molecules; sensors; catalysis and photocatalysis; conductivity, photoconductivity, and ionic conductivity; electronic, optical, and magnetic applications; and alternative processes of energy conversion. Twenty lectures were presented by invited speakers and almost 100 oral and poster presentations were provided by the other participants.

www.iupac.org/publications/macro/2006/235_preface.html

Molecular Mobility and Order in Polymer
A.A. Darinskii (editor)
Macromolecular Symposia, Vol. 237
Wiley-VCH, 2006, pp. 1–138

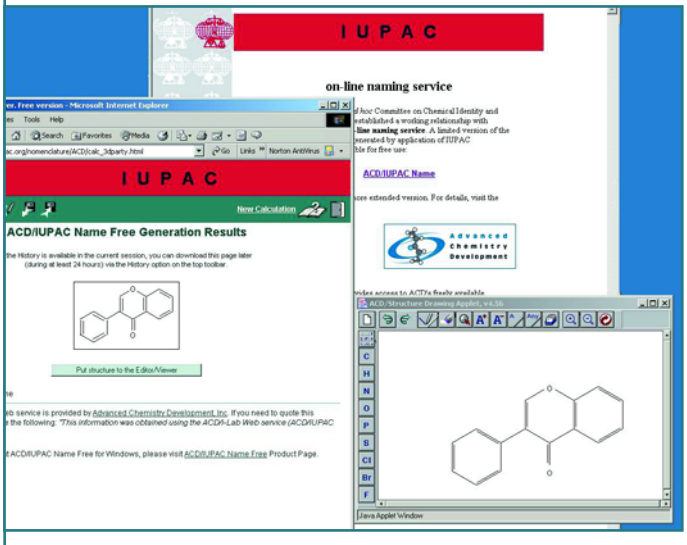
www.iupac.org/publications/macro/2006/237_preface.html

The following review is the first in a series of articles surveying free online resources of potential interest to chemists. The author plans to cover general resources, chemical informatics, mathematical applications, and journals and publications.

Free Information Resources for Chemists

by Leslie Glasser

As chemists, we need generic software (e.g., Web browsers, word processors, spreadsheets, and general graphics programs) as well as specialized information and software (e.g., for naming compounds, communicating and receiving chemical information in the form of structures and data, accessing databases, and performing symbolic mathematics). Although there is considerable commercial software available to meet all these requirements, this article focuses on specialized chemical software that is currently available free for the taking on the Internet. Because the scope of this topic is vast and is changing continuously, only some of the more well-known or potentially valuable products will be mentioned. Although much of the material discussed in this article is free across the board, some is free only for noncommercial use.



Access the ACD/IUPAC online naming service at www.iupac.org/nomenclature.

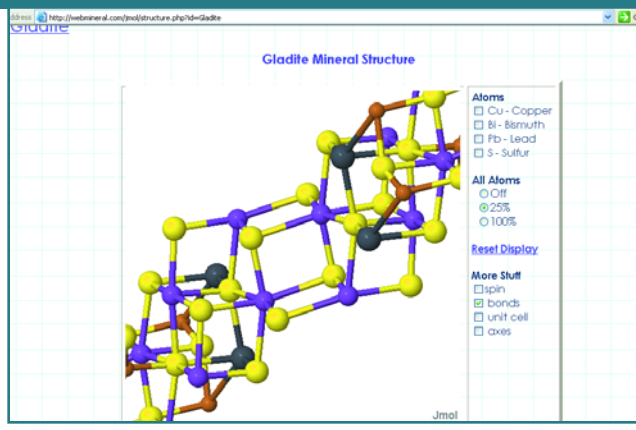
A comprehensive and useful general source of information is the textbook *Chemoinformatics*[1] and its related *Handbook*.[2] The website <www2.chemie.uni-erlangen.de/publications/ci-book/tb_websites.html> provides links to a number of sources (although the site was last updated 19 October 2003). The U.S. National Institute of Standards & Technology (NIST) provides access to many free database resources <www.nist.gov/srd> and lists internationally recommended values of fundamental physical constants at <physics.nist.gov/cuu/Constants>. ChemIndustry.com labels itself as "the worldwide search engine of the chemical industry" and provides an extensive chemical listing and searching facility especially (but not solely) directed toward industrial application. One of their recent newsletters <www.chemindustry.com/newsletter> lists "Chemistry Software Resources" (Number 57) and "Free Chemical Information Resources, Parts 1, 2, and 3" (Numbers 58-60). A further important link to a wide range of commercial scientific material is <www.fiz-informationsdienste.de>.

Generic Products

The Sheffield ChemDex <www.chemdex.org> functions as a directory to chemistry on the Web (e.g., websites, chemistry departments, and chemical information), while the Royal Society of Chemistry <www.chemsoc.org> provides a general chemistry resource .

ACD/IUPAC Name Free 8.05 is a free application (with some imposed limitations) available from the IUPAC website that enables users to name chemical structures according to IUPAC Recommendations <www.iupac.org/nomenclature/ACD/calc_3dparty.html>. This service is provided jointly by IUPAC and Advanced Chemistry Development, Inc. The full commercial version is available from ACD/Labs itself.

An important recent development is the IUPAC International Chemical Identifier (InChI™) <www.iupac.org/inchi>, which is a text-based, nonproprietary, unique identifier for chemical substances that can be used in printed and electronic data sources, thus enabling easier linking of diverse data compilations. InChI names have already been associated with tens of millions of chemical entities, thus rendering searching the Web for references to such materials as simple as any other text search.[3] InChI can be generated online on the website <pubchem.ncbi.nlm.nih.gov/edit> (scroll down to



The mineral structure of gladite as seen on webmineral.com.

choose from SMILES, SMARTS, or InChI). Alternatively, and for local use, a copy of the InChI software can be downloaded from the IUPAC website.

Links to published scientific material (which itself may not always be free) can be found using Google Scholar <scholar.google.com> and PubMed <www.pubmed.gov>, which provides links to about 16 million citations. Other literature search engines include Scirus <www.scirus.com>, Scopus <www.scopus.com>, and ScienceDirect <www.sciencedirect.com> (ScienceDirect has limitations for guest users). Chmoogle <www.chmoogle.com> provides many links to sources of materials. The Google Science Directory <www.google.com/Top/Science/Chemistry> provides links to nearly 5 500 chemistry-related sites—useful for broad assessments.

An important and reliable source of chemical data is NIST's Chemistry Webbook <webbook.nist.gov/chemistry>. WebElements <www.webelements.com> provides detailed information on the chemical elements. A comprehensive listing of mineral information is at <webmineral.com>. Structural mineral databases are maintained at <database.iem.ac.ru/mincryst> and <www.minsocam.org/MSA/Crystal_Database.html>. Protein structural information can be obtained from the Protein Databank <www.rcsb.org/pdb>.

References

1. *Chemoinformatics: A Textbook*, Gasteiger, J; Engel, T., eds., Wiley-VCH, Weinheim, Germany, 2003.

2. *Handbook of Chemoinformatics: From Data to Knowledge*, Gasteiger, J., ed., Wiley-VCH, Weinheim, Germany, 2003, 4 vols.

3. The utility of the selectivity of an InChI search in Google is shown by the fact that a search for "InChI=1/C2H6O/c1-2-3/h3H,2H2,1H3" yields 12.4 million hits, whereas a search for "InChI=1/C2H6O/c1-2-3/h3H,2H2,1H3" yields fewer than 100 hits, including an elaborate description and discussion on Wikipedia <en.wikipedia.org/wiki/Wikipedia:About>, the collaborative—hence nonauthoritative—online encyclopedia.

Leslie Glasser <lesliеglasser@yahoo.co.uk> is chairman of the IUPAC Committee on Printed and Electronic Publication (CPEP). He is a professor in the Department of Applied Chemistry, Nanochemistry Research Institute, of the Curtin University of Technology, in Perth, Australia.

TOXNET—Information Resources and Services in Toxicology

by John Duffus

TOXNET (TOXicology data NETwork), a Web portal established by the United States National Library of Medicine (NLM) <http://toxnet.nlm.nih.gov>, is a cluster of databases covering toxicology, hazardous chemicals, environmental health, and related areas. It is managed by the Toxicology and Environmental Health Information Program in the Division of Specialized Information Services of NLM.

TOXNET provides free access to and easy searching of the following databases:

HSDB® (Hazardous Substances Data Bank)

A factual database focusing on the toxicology of over 4 900 potentially hazardous chemicals.

IRIS (Integrated Risk Information System)

A database from the U.S. Environmental Protection Agency (EPA) containing carcinogenic and noncarcinogenic health risk information on over 500 chemicals.

ITER (International Toxicity Estimates for Risk)

This database contains data in support of human health risk assessments. It is compiled by Toxicology Excellence for Risk Assessment, and contains over 600 chemical records.

CCRIS (Chemical Carcinogenesis Research Information System)

A scientifically evaluated and fully referenced data bank, developed and maintained by the National Cancer Institute. It contains over 8 900 chemical records with carcinogenicity, mutagenicity, tumor promotion, and tumor inhibition test results.

Internet Connection

GENE-TOX (Genetic Toxicology)
A toxicology database created by the U.S. EPA containing genetic toxicology test results on over 3 000 chemicals.

Tox Town
An interactive guide to commonly encountered toxic substances, your health, and the environment.

Household Products Database
This database provides information on the potential health effects of chemicals contained in more than 5 000 common household products used inside and around the home.

Haz-Map®
An occupational toxicology database designed primarily for health and safety professionals, but also for consumers seeking information about the health effects of exposure to chemicals and biologicals at work.

Drugs and Lactation Database (LactMed)
A peer-reviewed and fully referenced database of drugs to which breastfeeding mothers may be exposed. Among the data included are maternal and infant levels of drugs, possible effects on breastfed infants and on lactation, and alternate drugs to consider.

TOXMAP
A website from the National Library of Medicine (NLM) that uses maps of the United States to show the amount and location of toxic chemicals released into the environment.

TOXLINE®
A bibliographic database providing comprehensive coverage of the biochemical, pharmacological, physiological, and toxicological effects of drugs and other chemicals from 1965 to the present.

DART®/ETIC (Development and Reproductive Toxicology/Environmental Teratology Information Center)
A bibliographic database covering literature on reproductive and developmental toxicology. DART is managed by NLM and funded by the EPA, the National Institute of Environmental Health Sciences and NLM. DART/ETIC contains references to reproductive and developmental toxicology literature published since 1965.

Toxics Release Inventory
A series of databases that describe the releases of toxic chemicals into the environment annually for the 1987–2004 reporting years.

ChemIDplus

A database providing access to structure and nomenclature authority databases used for the identification of chemical substances cited in NLM databases.

TOXNET databases are accessible free of charge at <http://toxnet.nlm.nih.gov>. Links are available from TOXNET to PubMed®, NLM's free Web interface to the world's biomedical literature, and to additional sources of toxicological information. These may be searched through ToxSeek, <http://toxSeek.nlm.nih.gov>, which is a meta-search engine that enables simultaneous searching of many different information resources on the Internet. Associated with these websites is WebWISER <http://wiser.nlm.nih.gov>, a system designed to assist first responders in hazardous material incidents. WISER provides a wide range of information on hazardous substances, including substance identification support, physical characteristics, human health information, and containment and suppression advice.

Since its inception, TOXNET has offered users a tutorial website, ToxTutor, in order to help them make the most of the available data. Recently, it became clear that this had to be updated and a project, ToxLearn, was started in order to update and expand the content of ToxTutor using current programming technology. The ToxLearn project is sponsored by the NLM and, as a U.S. government agency, all materials they develop are in the public domain. There are no ownership rights. NLM is providing support for the project, including staff time (Dr. Philip Wexler), and is underwriting the technological Web interface for the content through the Web developer, Patient Education Institute. The final product will be resident on the NLM server and maintained there. The *IUPAC Glossary of Terms Used in Toxicology* is integrated into the ToxLearn package and hyperlinked to text where appropriate. On this NLM server, the glossary is accessible at <http://sis.nlm.nih.gov/enviro/glossary-main.html> (see box).

The ToxLearn project plan has two phases. Phase 1 was the production of text and design of a pilot of the technology interface for the rest of the project. Dr. Mike Kamrin, Michigan State University (modules 1 and 2), and Dr. Paul Wright, RMIT University (module 3), are the authors of the pilot modules. ToxLearn has been adopted as a project of the U.S. Society of Toxicology (SOT) Education Committee, which is funding the project. SOT will soon issue an open call to authors for the phase 2 modules. The ToxLearn Working Group, which includes the author of this article, will recommend suitable authors chosen from those who apply. The Education Committee will make the final decision on their appointment.

John Duffus <j.h.duffus@blueyonder.co.uk> is the chairman of the Subcommittee on Toxicology and Risk Assessment and a titular member of the Chemistry and Human Health Division of IUPAC.

http://toxnet.nlm.nih.gov

IUPAC Glossary of Terms Used in Toxicology

The *IUPAC Glossary of Terms Used in Toxicology* was first published in *Pure and Applied Chemistry* in 1993[1] and has been supplemented since by the *Glossary of Terms Used in Toxicokinetics*[2] and the *Explanatory Dictionary of Concepts in Toxicology*. A revised and expanded version is currently under public review (see p. 23), and more than 260 terms have been added to it. The original 1993 glossary was the basis for the glossary incorporated in the textbook *Fundamental Toxicology for Chemists*, prepared with IUPAC support and published by the Royal Society of Chemistry.[3] A second edition of this textbook simply titled *Fundamental Toxicology*[4] was recently published by the Royal Society of Chemistry and includes an extended version of the original glossary (see Bookworm, p. 24). Another extended version has also been included in the *Encyclopedia of Toxicology*.[5]

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Polymer Gels and Networks

by Miroslava Duskova and Michal Ilavsky

Polymer Gels and Networks was the 44th Microsymposium in the series of Prague Meetings on Macromolecules. The conference, organized by the Institute of Macromolecular Chemistry of the Academy of Sciences of the Czech Republic, took place in Prague from 10–14 July 2005—a fitting tribute to the 75th birthday of Prof. Karel Dusek. The event was sponsored by IUPAC, the Polymer Networks Group, and NANOFUN-POLY, the European Network of Excellence.

The conference, which attracted 188 scientists from 32 countries, featured 43 lectures over four days and 112 posters presented during two evening poster sessions. During the opening session, Prof. R.F.T. Stepto (UMIST, Manchester, UK), president of the IUPAC Polymer Division, introduced IUPAC aims and gave a very good overview of activities of the Polymer Division. The presentations covered a wide range of topics pertaining to synthetic and natural gels, and to crosslinked polymers addressed from the point of view of synthesis, structure, properties, applications, and modeling. Special attention was focused on the application of hydrogels in medicine. From the early history of poly(N-isopropylacrylamide) (PNiPAAm), to how Karel Dusek and others influenced the scientific community, to more recent work, all the lectures were engaging. The closing lecture, "Fifty Years with Polymer Gels and Networks and Beyond," presented by Karel Dusek, was joyfully applauded by the audience.

IUPAC Poster Prizes were awarded at both evening poster sessions. The best posters were selected by an international committee chaired by Prof. Henryk Galina from Rzesow Technical University in Poland. The poster prizes went to T. Gotoh from the Department of Chemical Engineering of Hiroshima University, Japan, and to Irena Kroutilova of the Prague Institute of Macromolecular Chemistry of the Academy of Sciences.

Some of the lectures and posters will appear in a special issue of *Polymer Bulletin*. Dr. Petr Stepanek of the Institute of Macromolecular Chemistry in Prague is organizing the 45th Microsymposium on "Structure and Dynamics of Self-Organized Macromolecular Systems," which will be held 9–13 July 2006.

Miroslava Duskova <m.duskova@imc.cas.cz> and Michal Illavsky <ilavsky@kmf.troja.mff.cuni.cz> are both professors in the Department of Polymer Networks at the Institute of Macromolecular Chemistry of the Academy of Sciences in the Czech Republic. The two served as co-chairs of the meeting.

Ionic Polymerization

by S. Sivaram

The biennial **IUPAC Symposium on Ionic Polymerization** was held 23–28 October 2005 in Goa, India—the first time this specialized symposium was held in India. The conference provided an opportunity for the Indian scientific community to interact with leading scientists from around the world working in the area of ionic polymerization. A total of about 150 participants from USA, France, Germany, Poland, United Kingdom, Japan, South Korea, and India attended the symposium, which took place at The Leela, a resort hotel near Colva Beach in Southern Goa.

Dr. S. Sivaram, director of the National Chemical Laboratory in Pune, India, gave a brief welcome

Participants at the 68th Microsymposium on Polymer Gels and Networks 2005.

Dr. Sivarim (left), Prof. J.P. Kennedy, and Prof. Kubisa during the inaugural session of IP 2005, Goa, India.

address on the first day of the symposium. IUPAC representative, Prof. Kubisa gave an introduction to IUPAC and discussed the activities of the polymer division. Prof. J.P. Kennedy gave brief opening remarks, highlighting the evolution of the field of ionic polymerization and its present relevance.

The elegance of ionic polymerizations is the ability to synthesize polymers with well-defined architectures without any side reactions such as termination and transfer. The topic of atom-transfer radical polymerization which has similar attributes of ionic polymerization with respect to control of the polymerization was also included in the symposium.

The technical program, which was organized into morning and afternoon sessions, consisted of 52 oral presentations and 38 posters presentations. Each session was chaired by two eminent scientists, one from India and another from abroad. The order and sequence of presentations were carefully blended so that each session consisted of established and young practitioners in the fields of anionic, cationic, and controlled radical polymerization. Several scientists from India involved in these areas were also invited to speak at various technical sessions.

The symposium also featured well-received evening lectures, which covered topics such as the emergence and growth of the polymer industry in India and the emergence of India as an R&D hub for the global chemical and polymer industry. In order to provide maximum opportunities for interaction among participants, the symposium was held with no parallel sessions and speakers were provided with 25 minutes for their presentations.

The papers presented at the symposium will be published in a future issue of *Macromolecular Symposia*. In the meantime, a conference report has been published in *Macromol. Chem. Phys.* 2006, **207**, 637–639 (2006).

Dr. S. Sivaram <sivaram@ems.ncl.res.in>, director of the National Chemical Laboratory in Pune, India, served as the conference chairman.

European Science Education Research

by Roser Pintó

The 5th International Conference of the European Science Education Research Association (ESERA) was held in Barcelona, Spain, from 28 August to 2 September 2005. More than 500 researchers in science education from around the world, but mainly from Europe, met at this biannual event.

The conference was organized by Prof. Roser Pintó, from Universitat Autònoma de Barcelona. The executive committee of ESERA, a local organizing committee, a scientific committee, and a honor committee helped in the organization of the event.

The main topic of the conference was "Contributions of Research to Enhancing Students' Interest in Learning Science." In many western countries there has been a decrease in students' interest in learning science and choosing scientific careers, in particular in the physical sciences. The goal of the conference was to enable the science education research community to address this issue through research-based insights. At the conference, more than 400 contributions of research—organized around 20 different foci, such as teacher education, new curriculums, gender issues, environmental education, informal education, ICTs—were presented and discussed.

The conference program included six plenary sessions from internationally well-known keynote speakers; a panel session with editors of high-impact international research journals, nine parallel sessions for the presentation of research results, and a final open debate about "Where the Research in Science Education is Going On."

Other activities included social events, an ESERA general assembly and the formal opening and closing ceremonies, with the assistance of different educational and research policy authorities, representatives from the four catalan organizing universities (Universitat Autònoma de Barcelona, Universitat de Barcelona, Universitat Politècnica de Barcelona and Universitat Pompeu Fabra) and representatives from the European Commission Research Directorate. The conference was sponsored by the Educational and Research administrations of Catalonia, ESERA and IUPAC.

Prof. John Leach, from the University of Leeds (United Kingdom), discussed the potentiality of science education research in his lecture "Contested

Territory: The Actual and Potential Impact of Research on Teaching and Learning Science on Students' Learning." Prof. Andrée Tiberghien, from the University of Lyon (France), presented research results in "Studying Science Teaching Practices in Relation to Learning." Prof. David Treagust, from Curtin University of Technology (Australia), discussed "Research-Based Innovative Units for Enhancing Student Cognitive Outcomes and Interest in Science." Prof. Ivo Cap, from the University of Zilina (Slovakia), discussed informal education in his talk. Prof. Paolo Guidoni, from the University Federico II (Italy), introduced in his talk a possible model for dealing with students' understanding. Finally, Prof. Yasmin Kafai, from the University of California (United States), discussed "Children's Apprenticeship in Learning Science by Design."

The quality of participants' presentations was ensured by a double-blind review process performed by more than 80 reviewers and organized by 20 chairpersons, experts in each of the conference subtopics. Around 10 simultaneous parallel sessions took place for each of the 9 sessions for participants. These were generally arranged around specific topics to promote significant discussion among participants.

One of the important aims of the conference was to provide opportunities for training young researchers, 150 of whom were able to attend. Conference organizers provided a reduced early registration price and provided extra panel session time to encourage young researchers' active participation. A roundtable with different editors from a variety of international research journals in the field was also organized to provide an opportunity for "face to face" interaction, with the aim of motivating and facilitating young researchers to publish their research results in high-level publications.

The next ESERA conference will be held in Malmo, Sweden, 21–26 August 2007. More information is available at <www.naturfagsenteret.no/esera/conference.html>.

Prof. Roser Pintó <roser.pinto@uab.es> was part of the organizing committee for ESERA and is a professor at the Universitat Autònoma de Barcelona.

www.esera2005-cresils.org

New Directions in Teaching, Learning, and Evaluating the Chemical Sciences at the Tertiary Level

by Neelakanthi E. Gunawardena

Towards Modernizing Chemical Science Education in Sri Lankan Universities was held 11–12 March 2006 in Colombo. The conference, which attracted nearly 80 percent of Sri Lankan academics in the chemical sciences, is the first step toward replacing the current knowledge-based education system with modern teaching methods.

Four experts in chemistry education were brought in under the sponsorship of IUPAC's Flying Chemists Program* and its Scientifically Emerging Regions program. The Royal Society of Chemistry, UK, and the University Grants Commission of Sri Lanka were the other two sponsors. The conference was organized by the Department of Chemistry of the University of Kelaniya in collaboration with the Chemical Sciences Section of the Sri Lanka Association for the Advancement of Science and the Sri Lankan branch of the Royal Society of Chemistry.

The conference provided timely assistance to the country's effort to upgrade undergraduate chemistry education. Currently, the quality of university graduates does not match the needs of the labor market in Sri Lanka. Further, the conference was of historical significance for no such gathering of academics in the chemical sciences has ever been held. Thus, a great enthusiasm was evident among the academics who participated in the conference.

The opening session was attended by the minister of science and technology of Sri Lanka, the vice chancellor of the University of Kelaniya, and the chairman of the University Grants Commission of Sri Lanka. In this session, Prof. Peter Atkins (University of Oxford, UK), introduced IUPAC as the body that governs and sets standards in chemistry. He also described the Flying Chemists Program and introduced the other major sponsor of the conference, the Royal Society of Chemistry, UK.

The first plenary lecture, titled "Educating a Chemist; the Challenge and the Opportunity," was

*For more information about the FCP see <www.iupac.org/standing/cce/FCP.html> or <www.iupac.org/projects/2005/2005-030-1-050.html>.

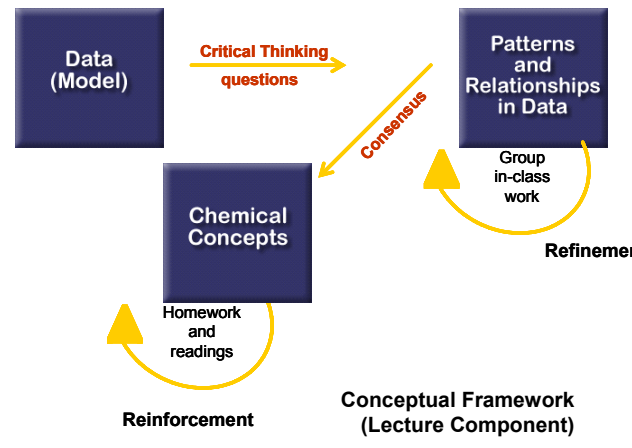
Honoring the national anthem at the Inauguration Session (from left): Mr. Premasiri de Silva, chairman-RSC SL section; Prof. M.J.S. Wijeyaratna, vice chancellor, University of Kelaniya; Prof. Tissa Vitarana, Hon. Minister of Science & Technology; Prof. N.E. Gunawardena, conference chairperson; and Prof. P.W. Atkins, University of Oxford, UK., representing IUPAC and the RSC, UK.

delivered by Prof. Atkins. He pointed out that even though chemistry is a complex subject, underlying principles are simple and that should shine through teaching. Using several examples, he showed how concepts can be taught effectively by relating them to real-life experiences. He discussed how abstraction, mathematics, and complexity are challenges in teaching chemistry and then showed how curriculum, concepts, and graphics provide ways to overcome the challenge. While highlighting the power of mathematics in understanding chemistry, Atkins said integration of mathematics in chemistry on a need-to-know basis would be more helpful to students.

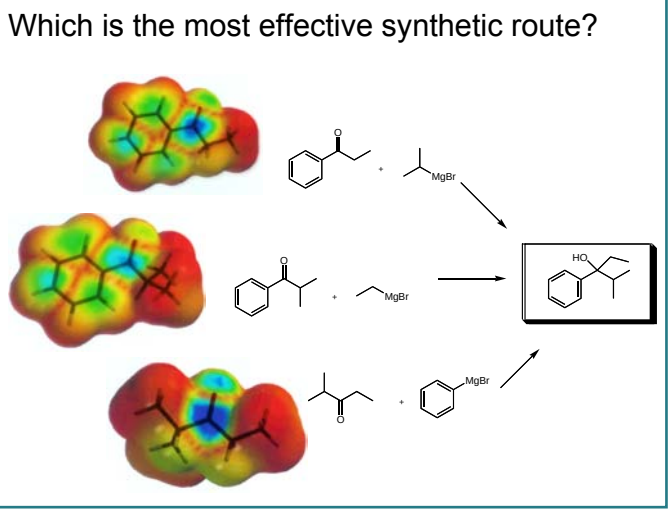
Prof. Ram Lamba (University of Puerto Rico), who delivered the second plenary lecture, titled "Why Do Students Resort to Rote Memory and Recipe Following?" said that even though the lecture model remains the preferred form of introducing new material to a class it does not automatically result in efficient learning. Quoting recent research, Prof. Lamba said that we tend to be linear thinkers, and pattern seekers. When problems break linearity, or a pattern does not fit into the known, students resort to rote-memory or reject the information. To provide meaningful learning, he said it is important to design the activities in a sequence that is compatible with the learning cycle (i.e., exploration, invention of concept, and application).

On the second day, Prof. Ingrid Montes (University of Puerto Rico) presented her lecture on "New Directions in Teaching Organic Chemistry: An Inquiry-Based Approach." She introduced three intertwined branches in chemical education: instruction, practice, and research. For the present generation of students, Montes said, the professor should not just be a source of knowledge. Instead, students should be involved in an active teaching-learning experience. A lecture course should incorporate active learning, technology, and interactive demonstrations, she said. Inquiry-based laboratory experiences and creative project proposals are effective tools and methods she recommended for the development of creativity and critical thinking . Using an ethnographic study, she showed how her newly designed inquiry-based organic experiments that address different learning styles affect the teaching-learning process in the laboratory course.

The last plenary lecture, "Introducing Environmental Chemistry and Classroom Discussion Methods into the Curriculum," was presented by Prof. Norman Colin Baird (University of Ontario, Canada). He showed how to use environmental issues in chemistry classes to generate interest among students. Some of the examples he sited were pollution by heavy metals such as mercury, arsenic, lead, acid rain, dioxins, PCBs, PAHs, and CFCs and their replacements. Analytical applications include the determination of low concentrations of atmospheric



How can we provide meaningful learning? was a question posed by Ram Lamba during his presentation.



Ingrid Montes gave examples of how to use an inquiry-based approach while teaching organic chemistry.

constituents and of pesticides and heavy metals. He showed ways to conduct interactive discussions using environmental issues to improve the learning process.

Each plenary lecture was followed by a discussion session, which was divided into four groups: organic, inorganic, physical, and miscellaneous (mostly environmental chemists and biochemists). Utilizing the material presented in the lectures, the groups focused on finding solutions to problems. Plenary lecturers in each group provided assistance with the discussions. At the concluding session, the following general conclusions were agreed upon: define a common core curriculum for the B.Sc. degree course, have a greater focus on teaching the essentials, reduce over teaching, include more technology in teaching, and include teaching of mathematics.

The conference created a high level of satisfaction among participants, especially those who came from remote universities. In response to a questionnaire, 94 percent of participants wanted to have follow-up meetings. It was a rewarding experience to the organizers too. The common bond formed within discussion groups has generated sufficient energy to initiate e-mail communication about curriculum development. The physical chemistry group is in the lead, while other groups are getting ready to do the same.

Neelakanthi E. Gunawardena <neela@kln.ac.lk> served as the conference organizer. She is a professor at the University of Kelaniya.

New Science Education Assessment: The Challenge

by Laure Joumel

The Chemical Heritage Foundation (Philadelphia, Pennsylvania, USA), which treasures the past, was focused on education for a better future during the **6th Annual Leadership Initiative in Science Education (LISE6)**, held 26–27 April 2006. The theme of the conference was "What Our Students Know: Assessment and Accountability in Science Education."

The American educational challenge for the 21st century is to improve the teaching of science in grades K-12. The federal No Child Left Behind Act (NCLBA) of 2001 requires teachers to use research-based teaching methods and to measure student's progress regularly. That gives huge importance to assessment. Assessments are the only way for teachers to check their success. Assessment sets the rhythm of a child's life at school. Assessment is the key to teaching. So how can it best be accomplished? Teachers and administrators comprised the audience for the eight speakers at the conference, all well known personalities in their fields, who covered different angles of the topic.

Teachers in students' shoes

The conference opened with an active workshop session conducted by George DeBoer, who is deputy director for Project 2061 of the American Association for the Advancement of Science and a professor of educational studies at Colgate University. DeBoer led attendees through a two-hour practical exercise that introduced them to Project 2061. Launched in 1985, this plan helps reform K-12 education by building an online collection of assessments aligned to standards.

During the second part of DeBoer's workshop, the teachers go back to school. He used the following example to illustrate the misconceptions that children often have: What is the smallest? A: an atom, B: a bacterium (micro-organism), C: a cell in your body, or D:

Project 2061 began its work in 1985-the year Halley's Comet was last visible from earth. Children starting school now will see the return of the Comet in 2061-a reminder that today's education will shape the quality of their lives as they come of age in the 21st century amid profound scientific and technological change. <www.project2061.org>.

the width of a hair? "We assume that they know something they don't," he said. The workshop provided a good opportunity for teachers to have an animated discussion.

Elisabeth Stage, director of the Lawrence Hall of Science at the University of California, Berkeley, presented a talk titled "Who Wants to Know and Why?" She pointed out the importance of the context and the motivation surrounding learning and assessment.

Teachers in students' shoes . . .

Discuss, Argue, and Tip

The second day focused exclusively on assessment in the science classroom. The director of the Learning and Teaching Research Center at the Educational Testing Service, Dylan Wiliam, explained how to use assessment to improve learning. "Pose, Pause, Bounce" is his motto! His best teaching tips are to make the students participate and to compensate them for good work in the classroom. "You are here to make them smarter," he insists, and repeats, "motivation is really a necessity." "I think we need to change the way teachers teach and not what they teach," he said.

After learning how to perform better in the classroom, it was time to learn about tools that can make it more effective. And that's Libby Cohen's specialty: using technology to support Universal Design Assessment. She is the principle investigator for the Eastern Alliance in Science, Technology, Engineering, and Mathematics. She calls this generation of students the "Neomillionials" or "media multi-mavens." "They need visual images" she pointed out, such as the one you can find on <http://vcell.ndsu.nodak.edu>, the virtual cell educational animation website. Although Libby Cohen cited some tools like video, CD ROM, and the Internet, she insisted on the advantages of digital text: "that is malleable, transformable, and transferable" and encouraged teachers to use it.

Keynote speaker Elizabeth Stage.

For another angle, Amelia Maurizio, executive director of Global Educational Alliances for SAP America, described how the Partnership for 21st Century Skills works to create a better high school learning environment. She pointed out that according to a 2004 report by the American Diploma Project, "40 percent of high school graduates feel inadequately prepared for college or the workplace." "What you measure really matters," said Maurizio. Kathleen Comfort, principle investigator and director of the Partnership for the Assessment of Standards-Based Science at WestEd, put the teachers in children's shoes again with an effective exercise. Comfort showed how increasing teacher understanding and use of data, coupled with instructional interventions, contribute to improved student learning and achievement in science.

Meryl Bertenthal, visiting director of research programs for the Center for Learning, Instruction, and Teacher Development at the University of Illinois at Chicago, spoke about the NCLBA and spurred discussion by asking "Should science be included in the Adequate Yearly Progress calculation?" The conference ended with a question and answer session in which the idea of a national test was debated. "Will a student from Kansas and another one from New York really need different science skills in their life?" wondered Donna Cleland, assistant director for science in Wallingford, Pennsylvania. Bertenthal had the last word, and claimed that "It's impossible to have a national test."

Laure Joumel <laurejoumel@gmail.com> is a freelance writer and native of France. She currently studies in the United States and will spend part of her summer at the Chemical Heritage Foundation reviewing the Ray G. Neville collection in the Othmer Library. Photos credit (inlcuding issue cover): Douglas Locker, CHF.

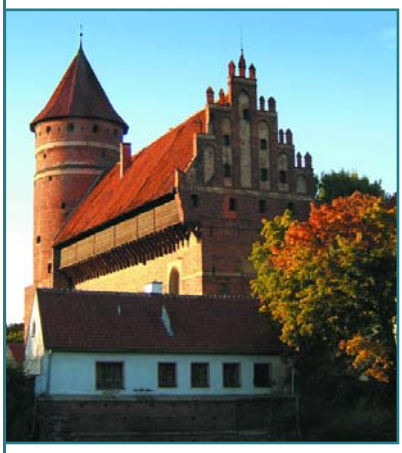
www.chemheritage.org/events/lise6

Environmental Best Practices

7–10 August 2006, Olsztyn, Poland

The First International Environmental Best Practices Conference (EBP) will be held 7–10 August at the University of Warmia and Mazury in Olsztyn, Poland. The EBP is being organized in collaboration with Sam Houston University, Huntsville, Texas, USA.

The objective of the conference is to bring together researchers from academia, government, and industry to discuss new developments and results in the fields of environmental remediation, wastewater treatment, solid waste management, alternative energy sources, and environmental stewardship. The conference will cover a broad spectrum of environmental applications and solutions to the challenges facing the world today.



Olzsztyn Castle.

This conference is best suited for individuals working in the fields of biology, chemistry, engineering, government, and project management.

The conference will consist of:

- invited plenary and survey papers, each giving a representative overview of a problem area with case studies
- submitted papers
- poster sessions
- discussion sessions on selected topics

Conference Topics

- environmental remediation (in situ and ex situ, bioavailability and genotoxicity of compounds, mycotoxins, monitoring of pollutants, modelling contamination)
- wastewater treatment (centralized and decentralized systems, sewage sludge processing and disposal)
- solid waste management (strategies, resource recovery and reuse, landfilling, pretreatment)
- alternative energy sources (fuel cell, biofuels, organic solid waste, solar power, liquefied natural and petroleum gas, wind, tidal, geothermal, hydroelectric)
- environmental stewardship (agriculture, ecotourism, native flora and fauna, invasive species, water quality and environmental indicators, impact assessments of engineering and biotechnological undertakings)

The social program includes a reception at Olsztyn Castle, a banquet at the lake shore, and a post-conference tour to Gdansk and surrounding anti-flood installations.

See Mark Your Calendar on page 39 for contact information

www.uwm.edu.pl/wosir/EBP

Supramolecular Assemblies with Nucleic Acids

16–17 October 2006, Bordeaux, France

Recent advances in supramolecular assemblies with nucleic acids will be reviewed during a two-day workshop to be held at the European Institute of Chemistry and Biology in Bordeaux, France. The workshop will cover a large spectrum of supramolecular systems involving nucleic acids, including the following topics:

- **Hybrid Amphiphile-Nucleic Acid Structures**
  The workshop will examine recent progress achieved in the synthesis of supramolecular self-assemblies that mimic the molecular recognition functionalities found with nucleic acids. This topic will include hybrid bio-inspired molecules bearing both nucleic acid and amphiphilic moieties.

- **Nucleic Acids Transport**
  This topic includes artificial systems currently developed to carry nucleic acids into cells using a synthetic supramolecular assembly. In addition, transport of double strand RNA (siRNA, miRNA), and single strand RNA and/or DNA aptamers, will be covered.

- **Biomaterials Derived from Nucleic Acids**
  Soft materials using bio-macromolecules are find-

ing applications in areas ranging from drug delivery technology to nanofabrication.

- **Functional Supramolecular Systems**
  Functional devices that use the intrinsic nature of these biomolecules (nano-switch properties of aptamers, nanoengines, detection devices...) will be covered in this topic.

Accommodations are limited and it is recommended that attendees make plans early. Please contact the primary organizers if you plan to attend: Philippe Barthélémy <barthelemy@bordeaux.inserm.fr>:

Tel +33 (0)5 57 57 10 14, Fax +33 (0)5 57 57 10 15
INSERM U386, Université Victor Segalen Bordeaux 2

www.iecb.u-bordeaux.fr/fileadmin/IECB/HTML/workshop-sa

Inorganic Chemistry—Metal-Nucleic Acid Interactions

12–17 November 2006, Athens, Greece

This **ESF-COST High-Level Research Conference** will deal with several aspects of the interactions of metal ions and nucleic acids and their relevance for the treatment and diagnosis of diseases. The conference is organized in partnership with European Cooperation in the field of Scientific and Technical Research (COST), a program of the European Science Foundation (ESF), and with support from the John S. Latsis Public Benefit Foundation.

The inorganic chemistry approach (i.e., the metal) will be a central issue of the conference. Half-day sessions will be held on the following subtopics: new drugs that bind to and distort DNA; methods for studying M-DNA interactions, cell division controlled by metal ions, labeling of nucleic acids with metals, artificial, nanostructured materials built from DNA fragments and metals, and DNA and cation binding: can it act as a wire?

The conference will feature main lectures (45 minutes), short lectures (30 minutes), and selected short talks from submitted abstracts (15 minutes), in addition to posters (which will be up the entire meeting).

The application deadline (and for abstract submission) is 24 July 2006. The conference program and application form are available online.

For further information, please contact Mr. Rachid Adghoughi <radghoughi@esf.org> from the ESF.

www.esf.org/conferences/pc06018

Gas Analysis Symposium & Exhibition

14–16 February 2007, World Trade Center, Rotterdam, The Netherlands

GAS2007 is an event that brings research and standardization into the practical world of calibration gases and their use. GAS2007 will take place 14–16 February 2007 in Rotterdam, Netherlands. The symposium will offer six lecture sessions, held in parallel, and 800 m^2 of exhibition and scientific poster space. It will focus on environmental protection and safety.

The following sessions are planned.

- natural gas: from reservoir to value
- trace contaminants
- chemometry
- sampling
- on- and off-line analysis
- metrology and accreditation issues

For more information, contact NEN-Energy Resources, Mr. O. Costenoble, +31 (0)15 2 690 330.

www.gas2007.org

Modern Physical Chemistry for Advanced Materials

26-30 June 2007, Kharkiv, Ukraine

An international conference on **Modern Physical Chemistry for Advanced Materials** will be held in Kharkiv, Ukraine, 26-30 June 2007. The conference, held in commemoration of the 100th anniversary of Prof. Nikolai Izmailov, is organized by the V.N. Karazin Kharkiv National University (Ministry of Education and Science of Ukraine) and the L.M. Litvinenko Institute of Physico-Organic Chemistry and Coal Chemistry (National Academy of Sciences of Ukraine) in cooperation with the Physical Chemistry Department of the Ukrainian Chemical Society. The conference is sponsored by IUPAC and EuCheMS.

The International Organizing Committee and International Scientific Committee consists of outstanding scientists from France, Japan, Germany, Great Britain, Brazil, Russia, and Ukraine.

The main goals of the conference are as follows:

- evaluate the status of physical chemistry in Ukraine and compare it to other countries
- strengthen the international collaboration of Ukrainian physical chemists
- develop the physico-chemical foundations of modern material science and technology

The scientific program will consist of plenary lectures, invited guest lectures, contributed oral presentations, and poster sessions. The official language will be English. The conference program will cover the following main topics:

- physical chemistry of true and organized solutions (thermodynamics, physico-organic chemistry, electrochemistry, spectroscopic methods)
- supramolecular chemistry, nanochemistry, microreactors, macromolecules, sensors
- physical chemistry of interfaces, chromatography, catalysis, hybrid materials
- theoretical methods in modeling molecules and molecular assemblies, computer synthesis, design of materials

See Mark Your Calendar on page 41 for contact information

http://izmailov2007.univer.kharkov.ua

Particle Separation

9–12 July 2007, Toulouse, France

The **IWA International Conference on Particle Separation (PS 2007)** will take place in Toulouse, France, 9–12 July 2007. This conference will provide experts in this field (academics, engineers, researchers) with a chance to exchange the latest results. Students and young professionals will get an overall idea of what is going on and be able to meet the most eminent specialists. The small number of parallel sessions will enable attendees to make contacts more easily.

Main topics of the conference include particle characterization, innovative approaches, numerical simulation, and new challenges, from ultra-pure water to the reuse of wastewater.

This conference will be held under the aegis of the Particle Separation Group of IWA, which was initiated by Ken Ives in the 1970s. The last conference was held in Seoul in 2005.

The deadline for abstracts is 30 September 2006. Those who are approved will be notified by 10 January 2007. Papers to be published in the proceedings must be received in camera-ready form by 1 March 2007.

http://particle-separation.inp-toulouse.fr

Mark Your Calendar

Upcoming IUPAC-sponsored events
See also www.iupac.org/symposia
for links to specific event Web site

2006 (later than 9 July)

IUPAC poster prizes to be awarded

9–13 July 2006 • Self-Organized Macromolecular Systems • Prague, Czech Republic
45th Prague Meeting on Macromolecules 'Structure and Dynamics of Self-Organized Macromolecular Systems
Dr. Petr Stepanek, Institute of Macromolecular Chemistry, Heyrovsky Sq. 2, 162 06 Prague 6, Czech Republic, Tel.: +420 296 809 211, Fax: +420 296 809 410, E-mail: stepan@imc.cas.cz

16–21 July 2006 • Macromolecules • Rio de Janeiro, Brazil
41st International Symposium on Macromolecules—IUPAC World Polymer Congress MACRO 2006
Prof. Ailton de Souza Gomes, Caixa Postal 68525, Rio de Janeiro, 21945-970, Brazil, E-mail: asgomes@ima.ufrj.br or macro2006@linkway.com.br

23–28 July 2006 • Biodiversity and Natural Products • Kyoto, Japan
ICOB-5 & ISCNP-25 IUPAC International Conference on Biodiversity and Natural Products
Prof. Michio Murata, Department of Chemistry, Osaka University, Graduate School of Science, 1-16 Machikaneyama, Toyonaka, Osaka, 560-0043, Japan, Tel.: +81 6 6850 5437, Fax: +81 6-6850-5774, E-mail: iscnp25@ch.wani.osaka-u.ac.jp

24–29 July 2006 • Solubility Phenomena • Freiberg, Germany
12th International Symposium on Solubility Phenomena and Related Equilibrium Processes (12th ISSP)
Prof. Wolfgang Voigt, Technische Universitat Bergakademie Freiberg, Institut fur Anorganische Chemie, Leipziger Strasse 29, D-09596 Freiberg (Sachs), Germany, Tel.: +49 3731 39 4338, Fax: +49 3731 39 4058, E-mail: wolfgang.voigt@chemie.tu-freiberg.de

30 July–4 August 2006 • Chemical Thermodynamics • Boulder, Colorado, USA
19th IUPAC Conference on Chemical Thermodynamics
Dr. Michael Frenkel, Physical and Chemical Properties Division, National Institure for Standards and Technology, 325 Broadway, Mail Stop 838.0, Boulder, CO 80305-3328, USA, Tel.: +1 303 497 3952, Fax: +1 303 497 5044, E-mail: frenkel@boulder.nist.gov

6–11 August 2006 • Pesticide Chemistry • Kobe, Japan
11th International Congress of Pesticide Chemistry
Dr. Hisashi Miyagawa, Division Applied Life Sciences, Graduate School of Agriculture, Kyoto University, Kyoto 606-8502, Japan, Tel.: +81 75 753 6118, Fax: +81 75 753 6123, E-mail: miyagawa@kais.kyoto-u.ac.jp

7–10 August 2006 • Environmental Best Practices • Olsztyn, Poland
The First International Environmental Best Practices Conference
Prof. Miroslaw Luczynski, Department of Environmental Biotechnology, University of Warmia and Mazury in Olsztyn, Sloneczna 45G, Olsztyn 10-709, Poland, Tel.: +48 89 5234119, Fax: +48 89 5234119, E-mail: mirekl@uwm.edu.pl

12–17 August 2006 • Chemical Education • Seoul, Korea
19th International Conference on Chemical Education
Prof. Choon H. Do, Sunchon National University, Department of Polymer Science and Engineering, 315 Maegok-dong, Sunchon, Chonnam 540-742, Korea, Tel.: +82 61 750 3565, Fax: +82 61 750 3565, E-mail: choondo@sunchon.ac.kr

13–18 August 2006 • Coordination Chemistry • Cape Town, South Africa
37th International Conference on Coordination Chemistry
Prof. K.R. Koch, Department of Chemistry, Univsersity of Stellenbosch, Private Bage X1 Matieland, Stellenbosch 7602, South Africa, Tel.: +27 21 808 3020, Fax: +27 21 808, E-mail: krk@sun.ac.za

20–25 August 2006 • Physical Organic Chemistry • Warsaw, Poland
XVIII International Conference on Physical Organic Chemistry: New Interactions, New Materials, New Prospects in Physical Organic Chemistry
Prof. Tadeusz Marek Krygowski, Department of Chemistry, University of Warsaw, ul. Pasteura 1, PL-02093 Warsaw, Poland, Tel.: +48 22 822 28 92, Fax: +48 22 822 28 92, E-mail: tmkryg@chem.uw.edu.pl

20–25 August 2006 • Raman Spectroscopy • Yokohama, Japan
20th International Conference on Raman Spectroscopy (ICORS 2006)
Prof. Hiro-o Hamaguchi, Department of Chemistry, University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo, 113-0033 Japan, Tel.: +81 3 5841 4327 | Fax: +81 3 3818 4621, E-mail: hhama@chem.s.u-tokyo.ac.jp

Mark Your Calendar

3–7 September 2006 • **Polymer Networks** • **Sheffield, UK**
Functional and Biological Gels and Networks: Theory and Experiment
Prof. J. L. Stanford, School of Materials, University of Manchester, Grosvenor Street, Manchester M1 7HS, United Kingdom, Tel: +44 0161 306 3573, E-mail: john.stanford@manchester.ac.uk

3–8 September 2006 • **Radical Polymerization** • **Il Ciocco/Castelvecchio Pascoli, Italy**
International Symposium on Radical Polymerization: Kinetics and Mechanism
Prof. Michael Buback, Institut für Physikalische Chemie, Universität of Göttingen, Tammannstraße 6 D-37077 Göttingen, Germany, Tel.: +49 5-513-931401, Fax: +49 5-513-93144, E-mail: mbuback@gwdg.de

4-8 September 2006 • **Nanostructured Composite Films** • **Warsaw, Poland**
E-MRS 2006 Symposium A on Nanostructured Composite Films
Prof. Yves Pauleau, CNRS-LEMD, National Polytechnic Institute of Grenoble, 25 Rue des Martyrs, B.P. 166, F-38042 Grenoble cedex 9, France, Tel.: +33 476 881071, Fax: +33 476 887945, E-mail: yves.pauleau@grenoble.cnrs.fr

9–13 September 2006 • **Chemical Biology** • **Antalya, Turkey**
9th Eurasia Conference on Chemical Sciences—Innovations in Chemical Biology at the Bridge of Eurasia
Prof. Bilge Sener, Department of Pharmacognosy, Gazi University, Maltepe, TR-03360 Ankara, Turkey, Tel.: +90 312 212 22 67, Fax: +90 312 213 39 21, E-mail: bilgesen@gazi.edu.tr

10–15 September 2006 • **Green Chemistry** • **Dresden, Germany**
First International IUPAC Conference on Green-Sustainable Chemistry
Prof. Pietro Tundo, Dipartimento di Scienze Ambientali, Ca' Foscari, University of Venice, Calle Larga S. Marta, Dorsoduro 2137, I-30123 Venizia, Italy, Tel.: +39 41 2348642, Fax: +39 41 2348620, E-mail: tundop@unive.it

18–22 September 2006 • **High Temperature Materials** • **Vienna, Austria**
12th International Conference on High Temperature Materials Chemistry (HTMC XII)
Prof. Dr. Adolf Mikula, Wahringstr. 42, A-1090 Vienna, Austria, Tel.: +43 4277 52606, Fax: +43 4277 52679, E-mail: Adolf.Mikula@univie.ac.at

27–29 September 2006 • **Occupational Health and Safety** • **Nairobi, Kenya**
Occupational Health and Safety Management in East Africa
Mr. Kelvin Khisa, Kenya National Cleaner Production Centre, P.O. Box 1360, Nairobi, 00200, Kenya, Tel.: +254 20-604870, Fax: +254 20-604871, E-mail: kkhisa@cpkenya.org

10–13 October 2006 • **Advanced Polymers** • **Busan, Korea**
Advanced Polymers for Emerging Technologies
Prof. Sung Chul Kim, Department of Chemical Engineering, Korea Advanced Institute of Sci. & Tech., 373-1 Guseongdong, Yuseong-gu, Daejeon 305-701, Korea, Tel.: +82 42 869 3914, Fax: +82 42 869 8435, E-mail: kimsc@kaist.ac.kr

16–20 October 2006 • **Chemistry for Life** • **Havana City, Cuba**
27th Latin American Congress on Chemistry and 6th International Congress of Chemistry and Chemical Eng.
Prof. Alberto J. Núñez Sellés, Center of Pharmaceutical Chemistry, Sociedad Cubana de Quimica, Ave 21 & 200, Rpto. Atabey, Apdo. 16042 Havana, CP 11600, Cuba, Tel.: +53 7 218 178, Fax: +53 7 273 6471, E-mail: alberto.nunez@cqf.sld.cu

20–23 November 2006 • **Polymers for Advanced Applications** • **Stellenbosch, South Africa**
9th Annual UNESCO/IUPAC Conference on Macromolecules: Polymers for Advanced Applications
Prof. Ron D. Sanderson, Department of Chemistry and Polymer Science, University of Stellenbosch Private Bag X1, Matieland, 7602, South Africa, Tel.: +27 21 808 3172, Fax: +27 21 808 4967
E-mail: rds@sun.ac.za

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IUPAC poster prizes to be awarded

***tba* February 2007** • **Clinical Laboratory** • **Barcelona, Spain**
Fourth European Symposium on Clinical Laboratory and In Vitro Diagnostic Industry,
Dr. Josep M. Queralto, Hospital de la Santa Creu i Sant Pau, Servei de Bioquimica, Av. S. Antoni M. Claret, 167 Barcelona, 08025, Spain, Tel.: +34 932919022, Fax: +34 932919196, E-mail: jqueralto@santpau.es

Mark Your Calendar

15–21 April 2007 • Phosphorus Chemistry • Xiamen, China
17th International Conference on Phosphorus Chemistry
Prof. Yufen Zhao, Xiamen University, Department of Chemistry, Xiamen, China 361005, Tel.: +86 5922185610 Fax: +86 5922186292, E-mail: yfzhao@xmu.edu.cn

21–25 May 2007 • Mycotoxins and Phycotoxins • Istanbul, Turkey
XIIth International Symposium on Mycotoxins and Phycotoxins
Dr. Hamide Z. Senyuva, Tubitak-Atal, Konya Yolu No. 67, Besevler, 06530, Ankara, Turkey, Tel.: +90 312 2124620/ext.14, Fax: +90 312 2123749, E-mail: hamide.senyuva@tubitak.gov.tr

26–30 June 2007 • Advanced Materials • Kharkiv, Ukraine
Modern Physical Chemistry for Advanced Materials (MPC'07)
Prof. Yuriy Kholin, Materials Chemistry Department, V.N. Karazin Kharkiv National University, Svobods Square 4, Kharkiv 61077, Ukraine, Tel.: +380 57 707 51 26, Fax: +380 57 705 12 61, E-mail: kholin@univer.kharkov.ua

16–20 July 2007 • Solution Chemistry • Perth, Australia
30th International Conference on Solution Chemistry
Prof. Glenn Hefter, School of Mathematical and Physical Sciences, Murdoch University, Murdoch, WA 6150 Australia, Tel.: +61 8 9360 2226, Fax: +61 8 9360 1711, E-mail: g.hefter@murdoch.edu.au

22–27 July 2007 • Novel Aromatic Compounds • Tsuna-Gun, Japan
12th International Symposium on Novel Aromatic Compounds (ISNA-12)
Prof. Yoshito Tobe, Division of Frontier Materials Science, Osaka University, Toyonaka, Osaka University, Japan, Tel.: +81 6 6850 6225, Fax: +81 6 6850 6229, E-mail: tobe@chem.es.osaka-u.ac.jp

2–6 August 2007 • Organometallic Chemistry • Nara, Japan
14th International Symposium on Organometallic Chemistry Directed Towards Organic Synthesis (OMCOS-14)
Prof. Kazuhiko Takai, Dept. of Applied Chemistry, Okayama University, Faculty of Engineering, Tsushimanaka 3-1-1, Okayama 700-8530, Japan, Tel.: +81 86 251 8097, Fax: +81 86 251 8094, E-mail: ktakai@cc.okayama-u.ac.jp

4–12 August 2007 • IUPAC 44th General Assembly • Torino, Italy
IUPAC Secretariat, Tel.: +1 919 485 8700, Fax: +1 919 485 8706, E-mail: secretariat@iupac.org

5–11 August 2007 • IUPAC 41st Congress • Torino, Italy
Chemistry Protecting Health, Natural Environment, and Cultural Heritage
E-mail: IUPAC.2007@unito.it

2–7 September 2007 • Ionic Polymerization • Bayreuth, Germany
International Symposium on Ionic Polymerization
Prof. Axel Müller, MC II / NW II, Universität Bayreuth, D-95440 Bayreuth, Germany, Tel.: +49-921-553399, Fax: +49-921-553393, E-mail: axel.mueller@uni-bayreuth.de

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

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 sponsorhsip is included in the AIS and is available upon request from the IUPAC Secretariat or online. <www.iupac.org/symposia/application.html>.