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Highlights in
Chemical Science

Transparent dyes could lead to 'smart' windows that convert light to energy

Bioinspired dye for solar cells

Chlorophyll has provided the inspiration for a transparent, cheap and environmentally friendly dye for use in dye sensitised solar cells (DSSCs).

The sun is an important inexhaustible and clean energy source and the conversion of sunlight to energy using DSSCs has proved to be an efficient option.

Ruthenium dye photosensitisers have given the highest power conversion efficiency in the past but they are not very eco-friendly and supply is limited, explains Eric Diau at the National Chiao Tung University, Hsinchu, Taiwan. Diau and his team took inspiration from nature by developing a dye based on porphyrin - a component of chlorophyll, which gives plants their green colour and allows them to convert sunlight into energy. They also replaced ruthenium with zinc, which is more abundant and costs less.

A light scattering layer is often added to a DSSC to improve the efficiency of the device. But Diau's group found that their porphyrin dye performed better than a ruthenium dye in devices without adding a scattering layer. The lack of a scattering layer made the device see-through, explains Diau so they could be integrated into windows in the buildings of the future.

An efficient artificial porphyrin dye is used to harvest solar energy in an organic photovoltaic device

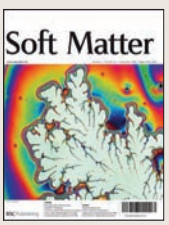
Emilio Palomares from the Institute of Chemical Research of Catalonia, Tarragona, Spain, says this represents 'a step further on the long-standing research into bio-inspired artificial leaves for photovoltaic applications'. He adds that 'the high efficiency achieved using fully transparent devices makes the dye suitable for applications in smart windows where people can see through, while the window acts as an active light-to-energy conversion system.'

Diau says that this type of light-weight, see-through and colourful DSSC could be very useful in the building industry. However, he sees some challenges ahead before it is commercialised: solar power conversion efficiency and the stability of the devices need to be improved, he says.

Fay Nolan-Neylan

Reference
H-P Lu *et al*, *Phys. Chem. Chem. Phys.*, 2009, 10270 (DOI: 10.1039/b917271h)

In this issue



A snapshot of the latest developments from across the chemical sciences

Research highlights

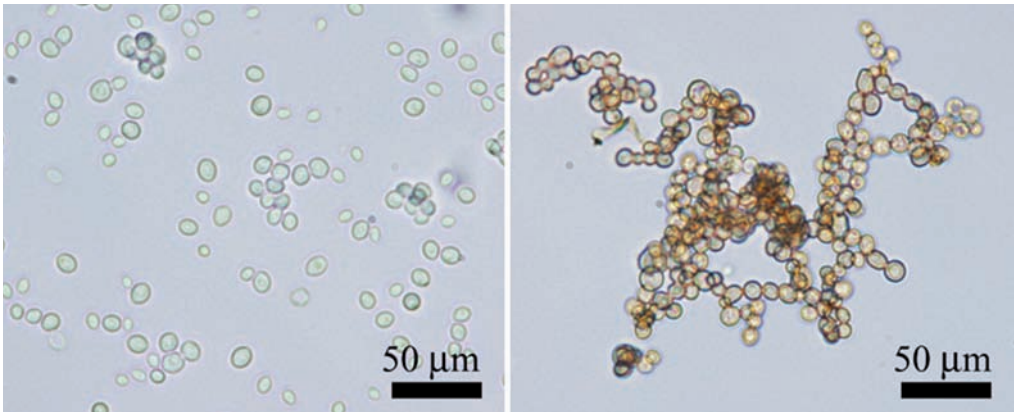
An easy method to position yeast cells inside chips

Magnetic yeast cells

A team of scientists from the UK and Tatarstan have developed a technique for functionalising yeast cells with magnetic nanoparticles. The cells remain alive after being modified, opening up the possibility of harnessing their magnetic properties for many biotechnological applications

Using a single step procedure the team led by Vesselin Paunov from the University of Hull, UK, coated *Saccharomyces cerevisiae* cells with magnetic nanoparticles. The yeast cells don't gather together unless there is a controlling magnetic field and can be easily separated once the field is removed, explains Paunov. Throughout the process the cell membrane remains intact, he adds, 'If the magnetic nanoparticles enter the cells there could be a variety of potential toxic effects which could compromise their viability.'

'What's really exciting about it is that the cells are still alive and potentially they could use magnetic fields to move live cells,' says Kimberly Hamad-Schifferli an expert in biological engineering at Massachusetts Institute of Technology, Cambridge, US.



The functionalised cells can be gathered together and separated using a controlling magnetic field

Paunov's team show that the yeast cells produce a fluorescent protein when exposed to genotoxic or cyctotoxic compounds. Producing foreign proteins in this way is an important ability for many biotechnological applications, explains Paunov and he sees many potential uses for the cells: 'The magnetic cells could be useful in biosensors and microfluidic devices to position cells inside the chip by using external magnetic fields.' And the technology also allows you to extract particular cells out of mixtures, he adds.

The method isn't restricted to yeast cells, says Paunov, and his team are now exploring it's use in bacteria and mammalian cells. *Russell Johnson*

Reference
R F Fakhrullin *et al*, *Soft Matter*, 2009, DOI: 10.1039/b914065d

Antibacterial coating effective against hospital superbugs

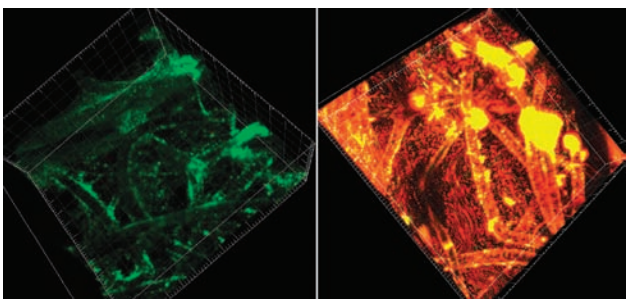
Silver coating gets gold star

Scientists from the UK are waging war on hospital 'superbugs' with a highly effective antimicrobial organo-silver coating.

Silver compounds have recently proved effective as antimicrobial coatings of medical implements, such as catheters and dressings. But usually these coatings must be put into a polymer matrix which makes them expensive for routine use. They can also have adverse effects on cell growth, which can slow down recovery from wounds such as burns.

Toby Jenkins and colleagues at the University of Bath have used a plasma to create a simple means to deposit a silver maleimide complex onto three-dimensional objects. An added benefit is that it can be done at room temperature so can be used on plastic and fabric, such as catheters and dressings.

'Our system is, to the best of our knowledge, the only one to use plasma to deposit an organo-silver film,' says Jenkins. And as only a small amount of the silver monomer is required to deposit the 30nm thick films, 'it should be easy to scale up for industry users and, most importantly, will be cheap,' he adds



Fluorescently stained dead bacteria show the effectiveness of the antimicrobial coating

Tests indicate that the coating has a much greater efficacy on *Pseudomonas aeruginosa* (a pathogen know to be implicated in urinary tract infections, dermatitis, and other health problems) than previous silver coatings, as measured by the minimum inhibitor concentration (MIC). However, Madeleine Ramstedt, who works on antibacterial surfaces at Umea University, Sweden, warns against comparing directly with literature values 'because these MICs can differ enormously depending on the experimental conditions.'

Jenkins used a stain that makes live bacteria fluoresce green and dead bacteria fluoresces red to confirm the high level of inhibition by the film. Also, the films do not appear to influence mammalian cell growth claims Jenkins.

The team now plan to carry out further testing with other strains of pathogenic bacteria, including MRSA.
Erica Wise

Reference
N Poulter *et al*, *Chem. Commun.*, 2009, DOI:10.1039/b915467a

An efficient catalytic process to make valuable industrial chemicals

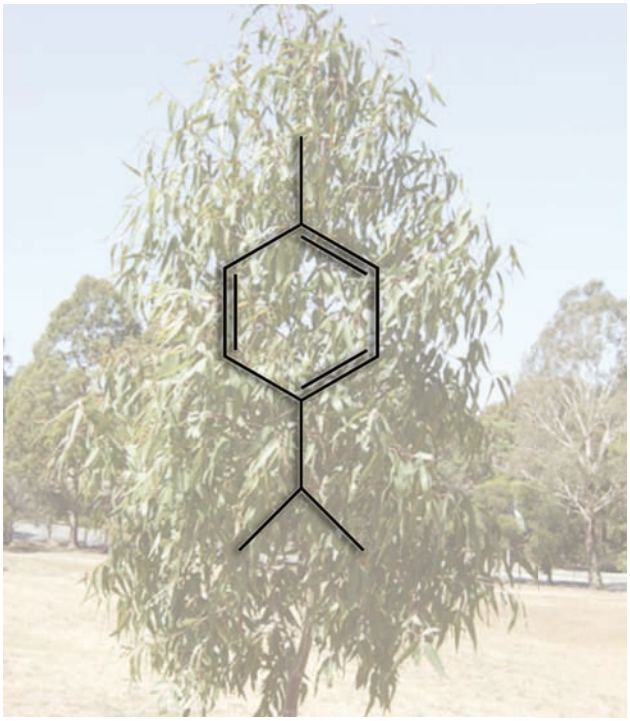
Efficient eucalyptus chemistry

Eucalyptus leaves can be used as a green source of a valuable chemical used in fragrances and pharmaceuticals.

p-Cymene is a significant feedstock used in the production of fragrances, pharmaceuticals, herbicides and fine chemicals and is currently obtained from crude oil. Now, Benjamin Leita and colleagues at CSIRO Molecular and Health Technologies, Clayton, Australia, have developed a method to produce it from the main component of eucalyptus oil.

The team used a continuous catalytic process that could easily be scaled up to mass production levels, says Leita. As well as using a biorenewable feedstock, the process is extremely efficient, using no solvents, and producing no costly wastes that need disposing. The main by-products being water, hydrogen, carbon monoxide and carbon dioxide.

'There is a growing need for the production of functionalised aromatics from renewable resources to replace traditional petrochemical feeds, for use in industry, particularly in the production of polymers,' which inspired the team to carry out this research, explains Leita.



***p*-Cymene can be produced from eucalyptus oil with no costly waste products**

Justin Hargreaves, who specialises in catalysis research at the University of Glasgow, UK, comments, 'This is a very worthy study which outlines the production of two valuable products, hydrogen and *p*-cymene, by the combination of dehydration and dehydrogenation of a renewable feedstock under solvent-free conditions.'

Research is now underway to optimise the catalytic conditions of the reaction and increase the selectivity and yields of this promising green solution as an alternative feedstock to fossil fuels, adds Leita.

Rebecca Brodie

Reference
B A Leita *et al*, *Green Chem.*, 2010, DOI: 10.1039/b916460j

Highly concentrated metal ion solutions for electrodeposition have been made

Ionic liquids share ions for the common good

Scientists in Italy have found a way to make ionic liquids more useful for electrochemistry.

Ionic liquids have long been thought promising media for electrochemical reactions, such as metal plating and finishing of a wide range of products, because they are non-volatile and environmentally friendly. However, highly concentrated solutions containing transition metal ions are required. Previously this has not been possible due to the energy cost of disrupting the ionic liquid's highly organised structure.

Now, Cinzia Chiappe at the University of Pisa, Italy, and her team have exploited a phenomenon known as the common ion effect to produce highly concentrated ionic liquid solutions.

Using a common organic anion allows metal ions to dissolve in ionic liquids

Normally, the common ion effect - where the cations in a mixture of two salt solutions share the same type of anion - has the opposite effect, reducing the concentration of the cation, but Cinzia Chiappe and her team were able to generate much higher concentrations than before for silver, nickel, aluminium, chromium, cobalt, yttrium, and copper ions, by using anions common to the ionic liquid.

Chiappe was taken aback by the results, saying 'We expected our ions to be more soluble, but we were actually surprised by the quantities of salts that the liquids were able to dissolve.' She suggests that the disruption to the solution is minimised by using an organic anion that is common to the existing ionic liquid.

Andrew Abbott, an expert on electrodeposition using ionic liquids from the University of Leicester, UK, predicts that this area of research is fast becoming a hot topic. 'The ability to process metals using ionic fluids is a subject that will undoubtedly expand in the near future. The area of concentrated ionic solutions is one that is fascinating and relies undoubtedly on speciation and a lot more work needs to be done to understand this phenomenon.'

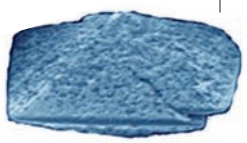
Chiappe and colleagues now plan to investigate the electrochemical behaviour of their solutions.

Hilary Burch

Reference
C Chiappe *et al*, *Green Chem.*, 2010, DOI: 10.1039/b919111a

Crystallisation of calcium oxalate crystals can be directed by green tea

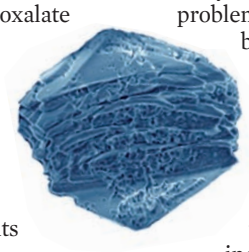
Green tea prevents kidney stones



Drinking green tea can help prevent the formation of large kidney stones claim Chinese scientists.

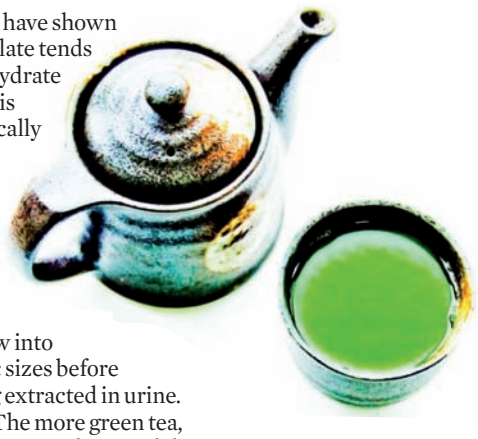
Kidney stones affect more than 5 per cent of the world population, and the prevalence is rising says Xudong Li at Sichuan University, Chengdu, China. The key component of kidney stones is calcium oxalate crystals and Li has found green tea is effective in directing the crystallisation to form less stable crystals.

The team grew calcium oxalate crystals under different conditions and studied them using a variety of analytical techniques. Unusually, they found that the dihydrated form of calcium oxalate was formed when large amounts of green tea were present.



Previous studies have shown that calcium oxalate tends to form a monohydrate structure which is thermo-dynamically stable and can lead to large kidney stones forming. The dihydrated form is less stable and less likely to grow into problematic sizes before being extracted in urine.

The more green tea, the more elongated the bipyramidal shape of the crystals becomes, says Li. He proposes that this change is due to the phenol groups in the green tea hydrogen bonding to the oxalate groups. This inhibits the nucleation and growth of the monohydrate crystal, forcing the growth of the flat tetragonal bipyramids and creating a layered effect.



Green tea changes the shape of calcium oxalate crystals

Reference
Z Chen *et al*, *CrystEngComm*, 2010, DOI: 10.1039/b913589h

'Our results suggest that drinking green tea might be a good habit for the prevention of human stone formation,' says Li.

He continues that his team, 'are now focusing on the evaluation of green tea extract based modifiers on calcium oxalate crystallization and very interestingly have obtained spherical calcium oxalate dehydrate crystals.' The team are now planning to investigate this phenomenon with other biomimetic crystals, such as calcium carbonate and hydroxyapatite. *Charlotte Beard*

Instant insight

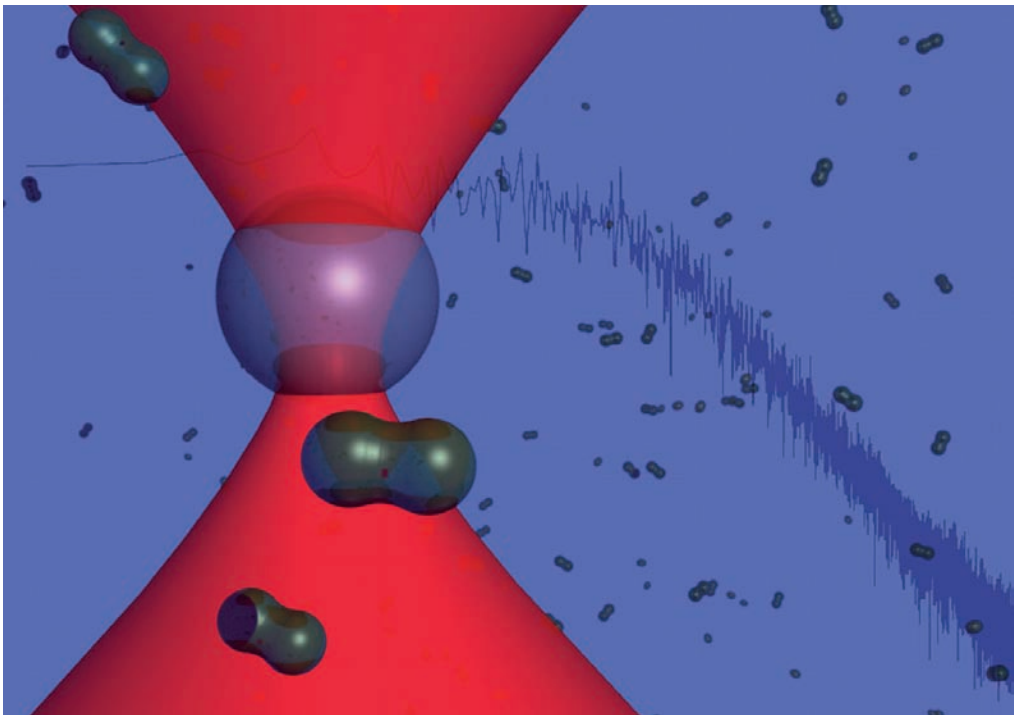
Sensing the biological world

Jonathan Cooper and Manilo Tassieri at the University of Glasgow explain how mechanical phenomena in biological systems can be studied at very small scales

Studying biological systems at the micro and nanoscale can give important information about cellular processes responsible for respiration, reproduction and signalling. But, while there are many methods for performing measurements at a surface, techniques for measuring interactions between biomolecules in solution are limited. In fact, current methods for measuring biomolecular interactions in solution, such as fluorescent labelling require complex chemistry, and such methods give only limited biophysical data on the molecular mechanics of any interaction.

Microrheology is the study of the flow of materials over small scales. It is based on observing the free or driven motion of micrometer-sized beads suspended in solution. The time dependent positional changes of the beads can be directly related to the mechanical properties of the molecules and their solvent. The technique is an important new addition to bioanalysis as it can characterise the mechanical interactions between complex biomaterials in solution. Biophysicists have been quick to take advantage of microrheology techniques, using them to measure the compliance of bacterial tails, the forces exerted by single motor proteins and the stretching of single DNA molecules.

Combining microrheological techniques and optical tweezers with lab-on-a-chip technology, has made it possible to produce sensitive sensors for measuring the changes that occur when molecules interact with each other. Optical tweezers use beams of light to hold and manipulate microscopically small objects such as biological samples including living cells. They are now an invaluable tool in biological and physical sciences with wide ranging applications, allowing studies such as protein folding and denaturation in DNA, nucleotide interactions between proteins and RNA amongst others.



Optical tweezers can hold and manipulate microscopically small samples and living cells

A particularly exciting emerging area for their use is to study the self-assembly of protein fibres in the brain – an irreversible process that is strongly implicated in Alzheimer's disease. Using microrheology could allow the kinetics of the fibrous assembly in solution to be measured. Also, drug interactions with the fibres could be probed to study both a preventative role inhibiting their formation and in a therapeutic role to reverse those that have already formed.

Nanotechnology could also be advanced using microrheology, as exploring the dynamics of molecular self-assembly in solution could lead to more well-defined functional nanostructures. An improved understanding of these assembly processes could lead to a wealth of versatile peptide-based self-assembled nanostructures whose properties could be engineered to create artificial lubricants for joints, new tissue scaffolds and drug delivery systems.

Reference
A Yao *et al*, *Lab Chip*, 2009, **9**, 2568 (DOI: 10.1039/b907992k)

Read more in the review 'Microrheology with optical tweezers' in Lab on a Chip.

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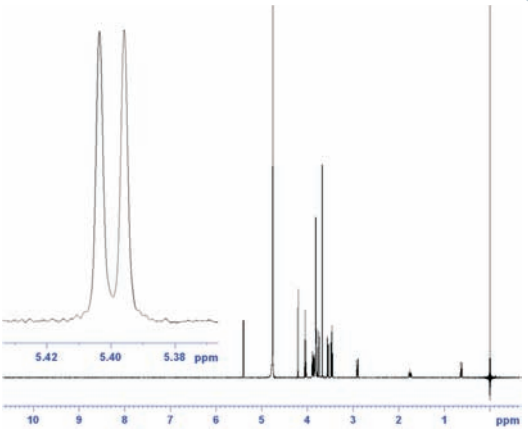
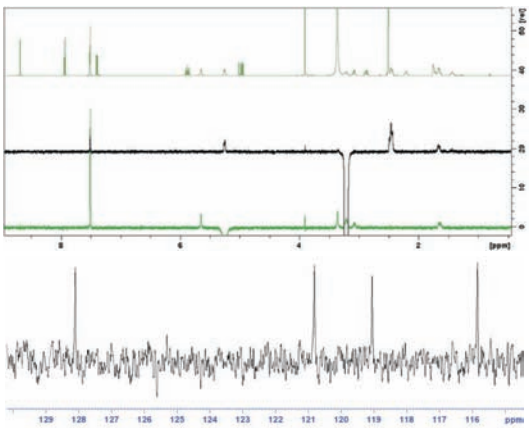


2 mM sucrose in water (measured under presaturation): S/N 239:1, resolution = 11% splitting



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Interview

Inorganics and beyond

Ian Manners talks about polymerisation, interfaces and living in Wales. Interview by Marie Cote

Ian Manners

Ian Manners is a professor of chemistry at the University of Bristol, UK. His research focuses on the molecular, polymer, supramolecular, and materials chemistry of inorganic elements.

What inspired you to become a scientist?

My dad was an organic chemist, and worked in industry. He had a lot of old chemistry and science books which I used to read. I found the inorganic chemistry books the most interesting of all. I liked that it seemed to be unpredictable and that you could often see very different chemistry for different elements – even those in the same group.

As time has gone on, I have become increasingly interested in other areas of chemistry too. Especially, macromolecular chemistry, self assembly and the interfaces with materials science and biology.

What key projects are you working on at the moment?

Our group is broadly interested in inorganic chemistry and we try to use inorganic elements to make new types of materials. To do this we try to develop new types of chemical reactions. For example, we are really interested in polymerisation, and also new catalytic chemistry that allows us to make interesting inorganic molecules. We are also very interested in supramolecular materials. There are many new synthetic challenges involved in making nanoscopic supramolecular materials, particularly examples that are well defined and where the structure can be controlled. If you can control supramolecular structure, you should be able to create materials with interesting functions such as light emission, liquid crystalline behaviour, enzyme-like catalytic activity, or nanowires.

Which of your previous research results are you most proud of?

We recently developed examples of living polymerisations that are photo-controlled, where you can switch the polymerisation on and off with light. With collaborators we have also made supramolecular structures using a living process controlled by crystallisation. This was an unexpected and exciting discovery.

Last year, we made the first high molecular weight boron-nitrogen analogues of polyolefins. This allows polymers such as poly(methylaminoborane), which is isostructural with polypropylene, to be made. The analogy between boron-nitrogen compounds and organic compounds is well known. For example you can make borazine, which is a six-membered ring of alternating boron and nitrogen atoms that is isostructural to benzene (C_6H_6). We were excited to find that we could extend this analogy to polymers.

Your work involves many facets of chemistry. What would you say is the importance of multidisciplinarity work?

30 years ago scientists only focused on their own discipline and didn't interact much with other areas. Now it's certainly the case that many of the most exciting challenges in science are actually at the boundaries between disciplines; for example, at the boundaries of materials science and chemistry, and biology and chemistry. But I think it is also important to remember that there are still lots of exciting and important challenges also within the centre of disciplines. These days it is sometimes forgotten.

Do you enjoy being back in the UK after 20 years away in Canada?

My wife and I really enjoy living in the UK, and South Wales in particular, because of the scenery and history. I am fortunate to work in an excellent department with great colleagues, and my research group has outstanding, highly motivated personnel and very high quality infrastructure. There are lots of exceptionally talented and dedicated people in universities in the UK. The system here is certainly better funded now than it was a decade or so back when UK science was really being pushed to the global periphery. A problem in the UK is still the need for more funding but, more importantly, a major issue is that the system is very bureaucratic and overly micromanaged at virtually every level.

What advice would you give to young people wanting to pursue a career in chemistry?

I think a key approach is to study as many different areas within the chemical science discipline as possible and to also look beyond chemistry. For example, areas that border chemistry, such as biology and physics, offer many fascinating opportunities. Many (but not all) of the most exciting problems that need to be addressed require a combination of areas to really tackle them.

Finally, if you were not a scientist, what would you be?

Maybe a musician, but I'd need much more training! I used to play piano and I used to write music for school plays, but I haven't done it since I was 11! So in a different world, I might have gone off in that direction.

Essential elements

A new generation of conferences

Does the chemistry community really need more events with several hundred international events already available in a tempting (and not so tempting) choice of venues?

Any new event has to offer something different - which is precisely what this new generation of conferences from the RSC does. Launching in 2010 to support the launch of the new RSC flagship journal *Chemical Science* and in association with *ChemComm* and *ChemSocRev*, the International Symposia on Advancing the Chemical Sciences (ISACS) is a significant new global symposia series. Ambitious in its scale and comprehensive in its coverage, the first three symposia will be held on three continents, over three sequential weeks in July 2010 and have already attracted support from some of the leading names in the respective fields.

Dr Richard Pike, Chief Executive of the RSC, is excited by the scale and high quality of the series: 'Each ISACS event will present a unique opportunity to hear from a new generation of dynamic, internationally renowned speakers. High quality presentations will review cutting edge developments and highlight future challenges in each research area. The global scale and wide coverage of this symposia series is very much aligned to the mission of the RSC, namely to 'advance the chemical sciences'.

Each ISACS event will feature a single stream of a minimum of eighteen plenary lectures complemented by extensive poster sessions with plenty of time dedicated to networking. The chance for young researchers to present their work alongside that of some of the leading and emerging names in the field is an opportunity not to be missed.

Sign up for news updates and find out more at www.rsc.org/isacs

New submission and peer review system

RSC will launch a powerful new web based submission and peer review system in 2010. The system powered by ScholarOne Manuscripts™ will provide expanded functionality, flexibility and a streamlined approach to web submissions and peer review.

Key benefits include:

- an intuitive, easy to use interface
- simpler refereeing and no need to remember username/password
- a consistent submission and peer review system across all journals
- real time, any time manuscript status checking

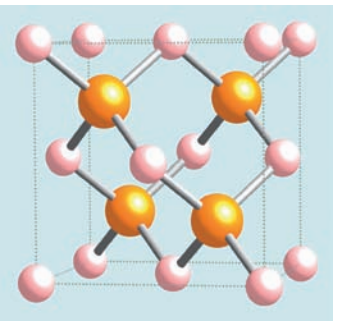
The beta-testing stage is now complete; the feedback received has helped to develop a robust system which offers an intuitive interface and easy navigation. The next step is a phased rollout across RSC publishing which will begin in January - the migration schedule has been devised to ensure all journals are moved across smoothly to the new system.

If you're an existing referee or author you will receive some more information about the new system shortly. In the meantime if you have any specific enquires please email the publishing department at rscpublishing@rsc.org

CIFs sorted

If you've ever written an article that reports a crystallographic structure determination, then you'll know how time-consuming and error-prone the process of copying and formatting CIF file data into a table or footnote can be.

With the RSC CIF Data Importer, you can now create a table or footnote automatically in a few clicks of your mouse. The new tool is available in the RSC Toolbar when using the RSC Word templates for authors. Simply click on the 'CIF Data Importer' button and follow the import steps to choose the relevant CIF file, the output format, and the structures and properties to report.



Currently only available for Word 2003/2004 operated on a PC, the CIF Data Importer is a Beta version for testing, and the RSC would welcome any feedback from users. Find out more at www.rsc.org/CIFdata.

Plus, look out for live links from CCDC and PDB structure references in RSC online articles to the relevant webpages of the WebCSD and Protein Data Bank where the structures can be visualised.

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