Chem Soc Rev

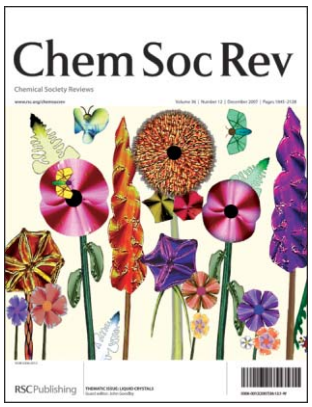
Chemical Society Reviews

www.rsc.org/chemsocrev

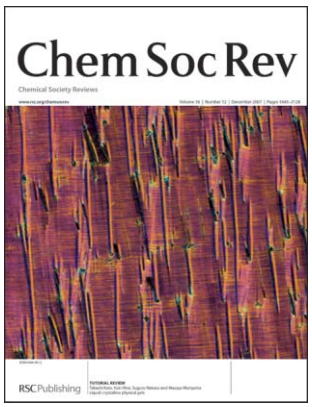
RSC Publishing is a not-for-profit publisher and a division of the Royal Society of Chemistry. Any surplus made is used to support charitable activities aimed at advancing the chemical sciences. Full details are available from www.rsc.org

IN THIS ISSUE

ISSN 0306-0012 CODEN CSRVBR 36(12) 1845–2128 (2007)



Cover
See J. W. Goodby *et al.*, page 1971.
eLCies liquid crystals garden. The collage is created using liquid crystal textures seen in the polarising microscope. Image reproduced by permission of J. W. Goodby, V. Görtz, S. J. Cowling, G. Mackenzie, P. Martin, D. Plusquellec, T. Benvegnu, P. Boullanger, D. Lafont, Y. Queneau, S. Chambert and J. Fitremann from *Chem. Soc. Rev.*, 2007, **36**, 1971.



Inside cover
See Takashi Kato *et al.*, page 1857.
Liquid-crystalline physical gels form anisotropic composite structures *via* cooperative self-assembly of liquid crystals and low-molecular-weight gelators. Image reproduced by permission of Takashi Kato, Yuki Hirai, Suguru Nakaso and Masaya Moriyama from *Chem. Soc. Rev.*, 2007, **36**, 1857.

CHEMICAL SCIENCE

Drawing together the research highlights and news from all RSC publications, *Chemical Science* provides a 'snapshot' of the latest developments across the chemical sciences showcasing newsworthy articles, as well as the most significant scientific advances.

Chemical Science

December 2007/Volume 4/Issue 12

www.rsc.org/chemicalscience

EDITORIAL

Editorial – liquid crystals

J. W. Goodby*

Guest editor John W. Goodby introduces the reviews in this themed issue of *Chemical Society Reviews* on Liquid Crystals.

The underlying theme of this collection of articles on Liquid Crystals is that of controlled and predictive self-organization. Through this process the basic rules developed by Nature for the creation of structured multifunctional materials are being learned.

Chemical Society Reviews (print: ISSN 0306-0012; electronic: ISSN 1460-4744) is published 12 times a year by the Royal Society of Chemistry, Thomas Graham House, Science Park, Milton Road, Cambridge, UK CB4 0WF.

All orders, with cheques made payable to the Royal Society of Chemistry, should be sent to RSC Distribution Services, c/o Portland Customer Services, Commerce Way, Colchester, Essex, UK CO2 8HP. Tel +44 (0) 1206 226050; Email sales@rscdistribution.org

2007 Annual (print + electronic) subscription price: £504; US$953. 2007 Annual (electronic) subscription price: £454; US$857. Customers in Canada will be subject to a surcharge to cover GST. Customers in the EU subscribing to the electronic version only will be charged VAT.

If you take an institutional subscription to any RSC journal you are entitled to free, site-wide web access to that journal. You can arrange access via Internet Protocol (IP) address at www.rsc.org/ip. Customers should make payments by cheque in sterling payable on a UK clearing bank or in US dollars payable on a US clearing bank. Periodicals postage paid at Rahway, NJ, USA and at additional mailing offices. Airfreight and mailing in the USA by Mercury Airfreight International Ltd., 365 Blair Road, Avenel, NJ 07001, USA.

US Postmaster: send address changes to: Chemical Society Reviews, c/o Mercury Airfreight International Ltd., 365 Blair Road, Avenel, NJ 07001. All dispatches outside the UK by Consolidated Airfreight.

PRINTED IN THE UK

Advertisement sales: Tel +44 (0) 1223 432243; Fax +44 (0) 1223 426017; E-mail advertising@rsc.org

Chem Soc Rev

Chemical Society Reviews

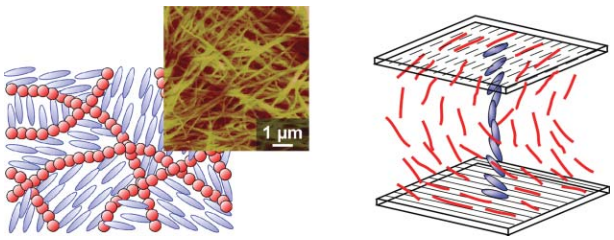
www.rsc.org/chemsocrev

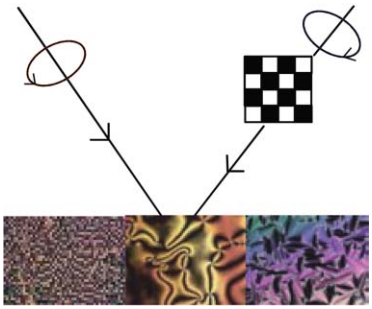
Chemical Society Reviews publishes accessible, succinct and reader-friendly articles on topics of current interest in the chemical sciences. The promotion of international and multidisciplinary awareness and cooperation is particularly encouraged. Chemical Society Reviews publishes two article types: tutorial reviews, which present an accessible introduction to the topic, and critical reviews, which provide a deeper evaluation of the current literature.

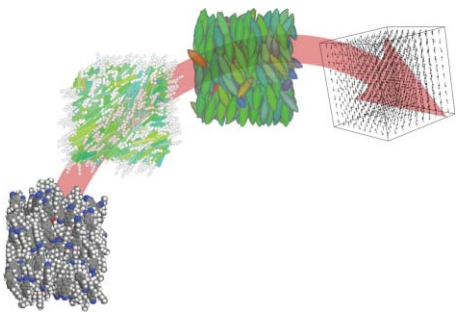
INFORMATION FOR AUTHORS

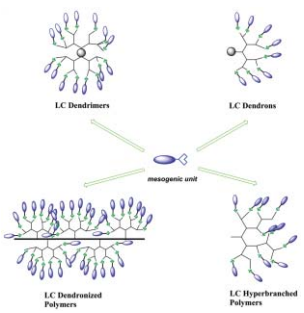
The Editorial Board commissions articles that encourage international, interdisciplinary progress in chemical research. The Board welcomes proposals for new tutorial reviews or critical reviews and the appropriate synopsis pro forma should be requested from the Editorial Office (csr@rsc.org). Full details of how to submit material for publication in Chemical Society Reviews are given in the Instructions for Authors (available from http://www.rsc.org/authors). Submissions should be sent *via* ReSourCe: http//www.rsc.org/resource

Authors may reproduce/republish portions of their published contribution without seeking permission from the RSC, provided that any such republication is accompanied by an acknowledgement in the form: (Original Citation) – Reproduced by permission of The Royal Society of Chemistry.









IMPACT FACTOR 4.39

"It is **no surprise** that *Soft Matter* is **doing so well**- we simply **need** a journal such as this in our community"

Christos Likos,
The Heinrich Heine University of Düsseldorf

Soft Matter's impressive first **impact factor*** of **4.39** places it firmly at the **top** of its field. With the new immediacy index of 1.183, the journal also maintains its position as **number one** publisher of topical and urgent soft matter research.

With a **vibrant mix** of article types (including communications, articles, reviews and highlights), **rapid publication** (typically 100 days from receipt), **global circulation** and an **interdisciplinary audience** *Soft Matter* is first choice for authors and readers alike.

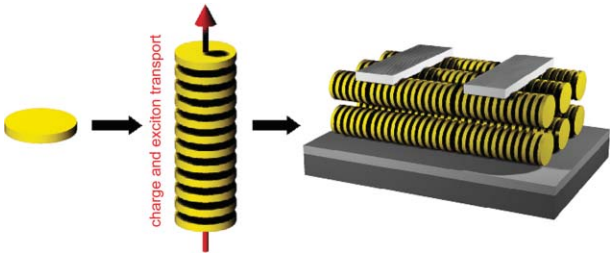
* As *Soft Matter* was launched in mid-2005, the 2006 impact factor is a partial value. Impact factor and immediacy index taken from 2006 Thomson Scientific (ISI) Journal Citation Reports ®

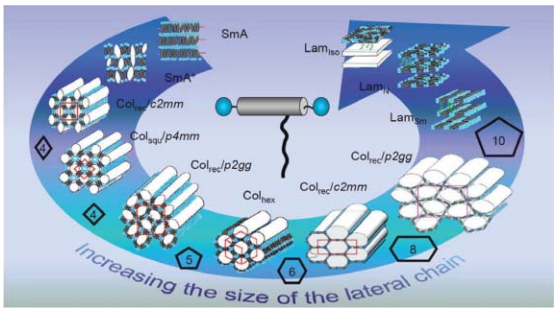
where physics meets chemistry meets biology

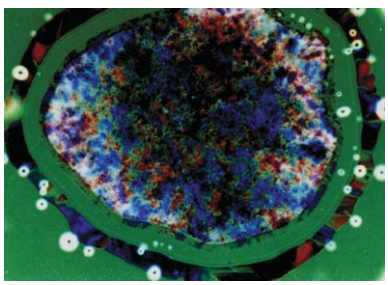
RSC Publishing

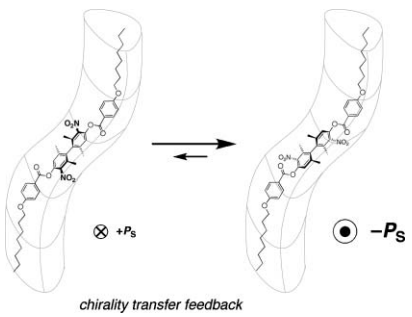
www.softmatter.org

Registered Charity Number 207890

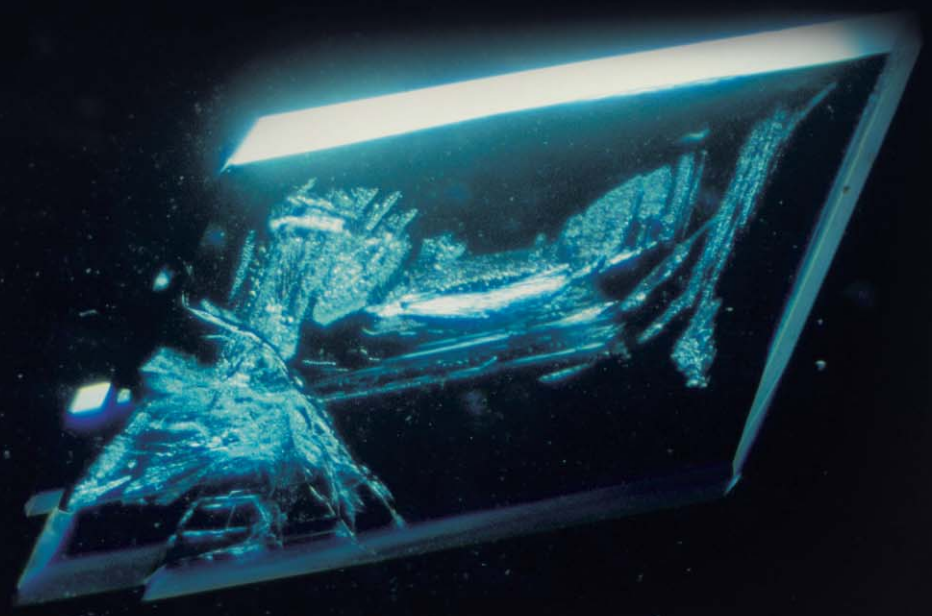


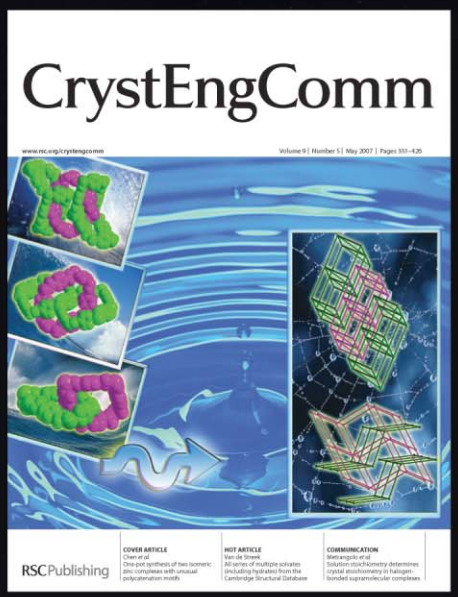






Crystallising all the best research





10080741

CrystEngComm brings you fast breaking research on all aspects of crystal engineering including properties, polymorphism, target materials and new or improved techniques and methods.

With extremely fast publication times (typically within 8 weeks of receipt), fully interactive graphic features, a rigorous peer review procedure and an impact factor of 3.729, *CrystEngComm* publishes only the best research and offers a multitude of benefits to authors and readers alike.

Go online to find out more

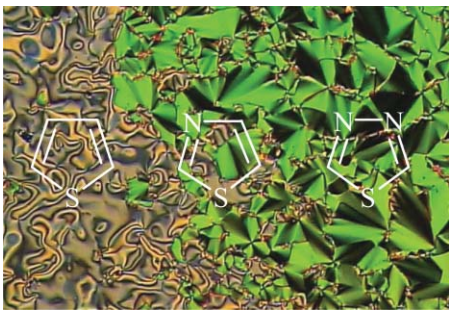
Crystal image reproduced courtesy of the RSC Library & Information Centre

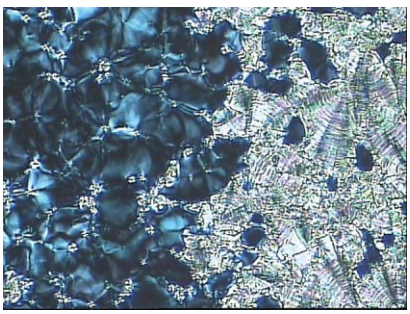
*2006 Thomson Scientific (ISI) Journal Citation Reports ®

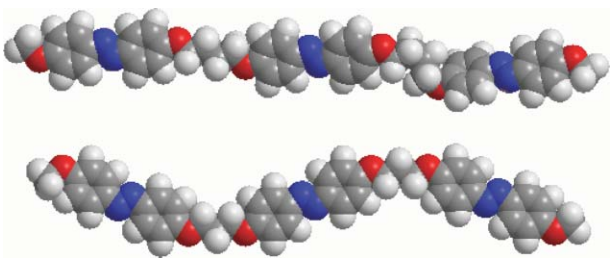
RSC Publishing

www.crystengcomm.org

Registered Charity Number 207890







FREE E-MAIL ALERTS AND RSS FEEDS

Contents lists in advance of publication are available on the web *via* www.rsc.org/analyst – or take advantage of our free e-mail alerting service (www.rsc.org/ej_alert) to receive notification each time a new list becomes available.

Try our RSS feeds for up-to-the-minute news of the latest research. By setting up RSS feeds, preferably using feed reader software, you can be alerted to the latest Advance Articles published on the RSC web site. Visit www.rsc.org/publishing/technology/rss.asp for details.

ADVANCE ARTICLES AND ELECTRONIC JOURNAL

Free site-wide access to Advance Articles and the electronic form of this journal is provided with a full-rate institutional subscription. See www.rsc.org/ejs for more information.

* Indicates the author for correspondence: see article for details.

Electronic supplementary information (ESI) is available *via* the online article (see http://www.rsc.org/esi for general information about ESI).

December 2007 / Volume 4 / Issue 12 / ISSN 1478-6524 / CSHCBM / www.rsc.org/chemicalscience

Chemical Science

Banning of herbicide had 'no discernable effect' on its levels in the environment

Pesticide persists in German rivers

Levels of the pesticide terbutryn in German rivers have not fallen, despite having been banned in 2003, say environmental researchers.

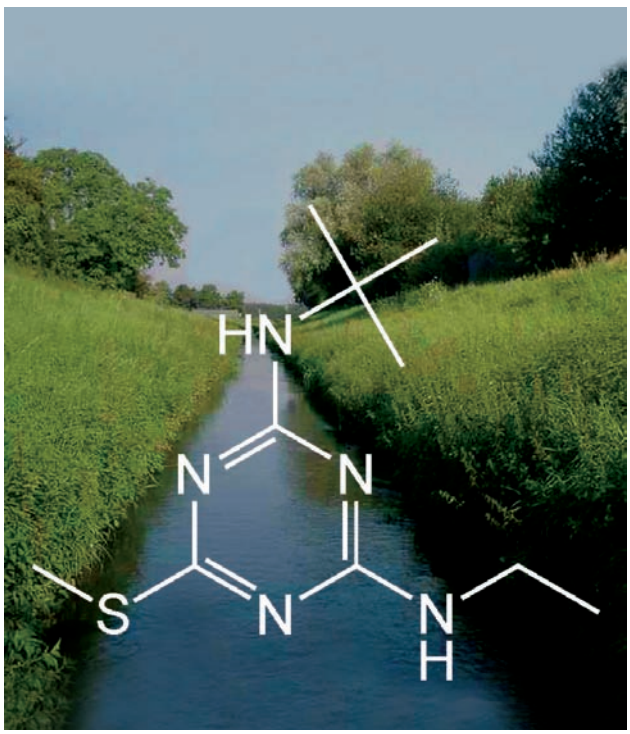
Terbutryn belongs to the group of triazine herbicides, which work by inhibiting photosynthesis, and were once widely used for agricultural weed control. However, due to their persistence in aquifers and consequent threat to drinking water, many triazine herbicides were banned in the 1990s. Terbutryn itself, which is slightly toxic to humans, was banned from agricultural use in Germany in 2003, but it seems that levels of the pesticide in rivers have not fallen.

Kristin Quednow and Wilhelm Püttmann from J W Goethe University, Frankfurt, Germany, took water samples from four tributaries of the river Rhine in southern Germany from 2003 to 2006, and analysed them for the presence of terbutryn. Although concentrations varied between sites, they exceeded threshold levels in more than half of the samples, said Quednow.

The researchers conclude that the ban has had 'no discernable influence' on terbutryn levels, and suggest several reasons for this. Illegal agricultural application and run-off from farm equipment could be one factor. Another is that terbutryn is still permitted for use in garden ponds, aquaria, and in antifouling paints, said Quednow, which could explain its presence in river water in winter, when farm application typically ceases. She added, 'other sources, such as the leaching of terbutryn from river sediments and groundwater, will be the subject of further investigations.'

Kate Heppell, a hydrochemist from Queen Mary, University of London, UK, highlights the importance of this field of research. 'Identifying the provenance of different pesticides in watercourses is vital to ensure that the most appropriate management decisions are made when trying to reduce pesticide concentrations,' she said.

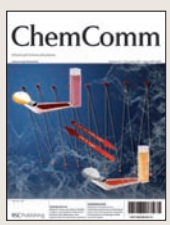
David Barden

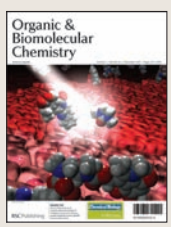


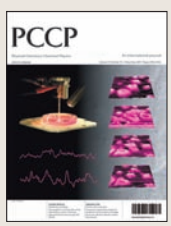
Terbutryn is still permitted for some limited uses, going some way to explain its stubbornly high concentration in German rivers

Reference
K Quednow and W Püttmann, *J. Environ. Monit.*, 2007, DOI: 10.1039/b711854f

In this issue







A snapshot of the latest developments from across the chemical sciences

Research highlights

Vase-shaped molecule gives a perfect fit

Catalysis in a cavity

Chemists in the US have created a molecular vase that mimics an enzyme's catalytic activity.

Chemical catalysts are chemoselective – they are able to recognise and transform a particular functional group – but few are capable of differentiating differently sized or shaped molecules with the same functional groups.

This is where enzymes have an advantage. They are usually very specific about which reactions they catalyse: the shape of the starting material and its interaction with the enzyme being important factors in that specificity.

Julius Rebek, Jr. and Richard Hooley from the Scripps Research Institute, La Jolla, California, have set themselves the goal of creating chemical systems that match the selective catalytic abilities of enzymes whilst retaining the properties of normal chemical catalysts.

The researchers synthesised a vase-shaped molecule, called a cavitand, and used it to catalyse a Diels–Alder reaction between an unsaturated imide and an aromatic alcohol.

Rebek's system mimics an enzyme in that the cavitand has a cavity in which only an appropriately sized starting material can fit.

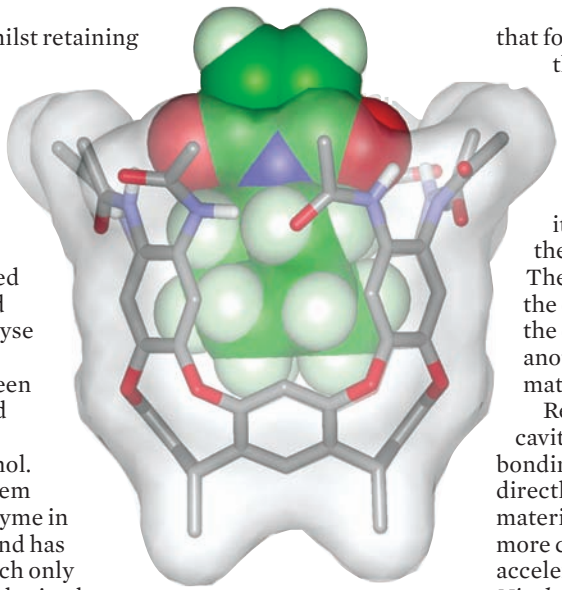
A hydrogen bonding network at the rim of the cavity, similar to that found in enzymes, activates the starting material – the unsaturated imide – by sucking electron density from the double bond.

This increases its reactivity and accelerates its Diels–Alder reaction with the aromatic alcohol.

The product is too big to fit in the cavity and is ejected, leaving the cavity free to activate another molecule of starting material.

Rebek aims to improve the cavitand so that its hydrogen bonding network is positioned directly at the bound starting material. This would allow more challenging reactions to be accelerated and catalysed.

Nicola Burton

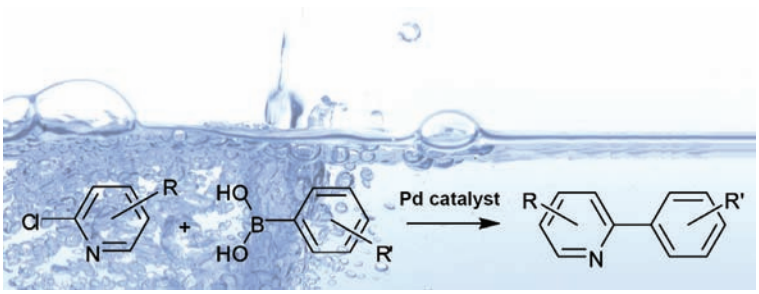


An imide molecule fits snugly in the molecular cavity, perfectly primed to react with an alcohol

Reference
R J Hooley and J Rebek, Jr., *Org. Biomol. Chem.*, 2007, **5**, 3631 (DOI: 10.1039/b713104f)

Water-soluble ligands speed up coupling reaction with less catalyst

Water – not just a solvent



Coupling reactions are widely used in organic synthesis

Scientists in Germany have used water to improve the catalytic activity of coupling reactions making them greener and faster.

The Suzuki–Miyaura coupling reaction is a powerful tool in organic synthesis, commonly used to make pharmaceutically active compounds. There has been recent interest in making the reaction greener by using water to eliminate the need for environmentally unfriendly organic solvents; however, until now this has not led to improvements in the coupling reaction.

Herbert Plenio and Christoph Fleckenstein at the Technical University of Darmstadt have successfully used water not only to make the reaction more environmentally friendly but also to improve the coupling rate.

'Water is primarily viewed as a green solvent,' said Plenio, 'but we wanted to show that water can be the solvent in which carbon–carbon bond forming reactions work much better than in organic solvents.'

'Previous catalysts employed were not optimised for use in water,' explained Plenio. By synthesising highly water soluble ligands for the Pd catalyst, the team were able to perform the coupling reactions in pure water with much smaller amounts of catalyst. The catalysts were found to be 10–100 times more active than other systems.

Plenio and Fleckenstein aim to develop this method for other reactions in the future. 'Improvements in catalysis will result in better synthesis – from an ecological as well as from an economic point of view,' said Plenio. 'The particular challenge is to design chemical transformations and chemical processes in such a manner that they produce a minimum amount of waste and require as little energy as possible. Catalysis is the tool to achieve just that.'

Sarah Dixon

Reference
C A Fleckenstein and H Plenio, *Green Chem.*, 2007, **9**, 1287 (DOI: 10.1039/b711965h)

Monomers swap bonds to create new polymer when heated

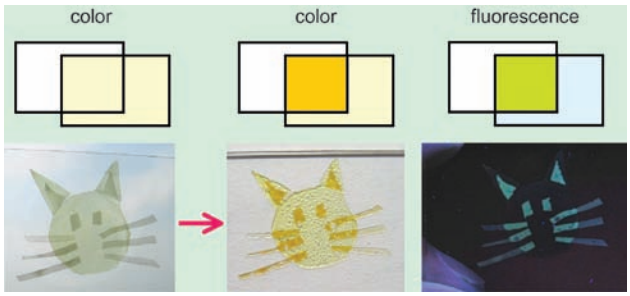
Dynamic polymers show their true colours

A team of French chemists have shown how two different polymers can be made to interact to produce a fluorescent hybrid.

Dynamic polymers are different from normal polymers in that the bonds that hold the monomers together can break and re-form. Jean-Marie Lehn and colleagues at the Université Louis Pasteur in Strasbourg, France, have now used this phenomenon to make a layered polymer hybrid that fluoresces when heated.

The principle consists of layering two different dynamic polymers, and then heating them so that bond exchange takes place. This changes the properties of the boundary region, in this case leading to fluorescence, which has potential for implementation in optical materials, said Lehn.

The key to developing these polymers was the nature of the monomers used to make them. The team first made a monomer consisting of a central unit flanked by two polyether chains, each linked to the central unit by a reversible N=C bond. They then made a similar monomer with slightly different central and flanking groups. These monomers were then converted to their respective polymers, both of which were nearly colourless. To show the fluorescence phenomenon in action, Lehn and colleagues overlapped a thin film of each polymer and heated them briefly to about 160°C. This caused some of the N=C bonds in the overlapped section to break and re-combine with the other polymer, producing a polymer hybrid at the interface.



The superimposed polymer films before heating (left), after heating (centre) and under UV light (right)

Under UV light, the hybrid produced a yellow–green fluorescence, caused by the different arrangement of double bonds. This feature, said Lehn, shows how polymers can be controlled by and respond to external stimuli. It also illustrates their potential in molecular sensing and photoactive devices, and gives, he said, 'a sort of Darwinian flavour to chemistry!'

David Barden

Reference
T Ono *et al.*, *Chem. Commun.*, 2007, 4360 (DOI: 10.1039/b712454f)

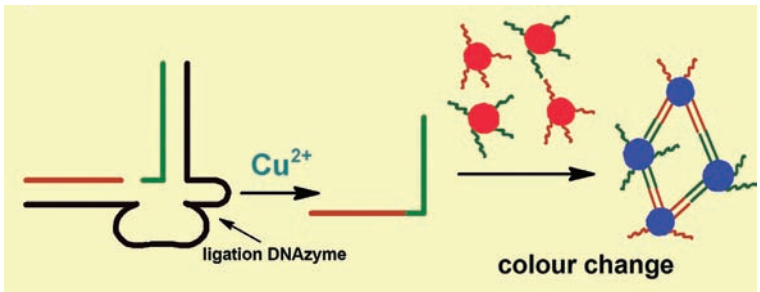
DNAzymes show promise as biosensors

The changing colour of gold

The copper ion Cu^{2+} is essential in biochemistry but can be toxic in high concentrations. Now, thanks to work by two chemists in the US, it can be detected with greater sensitivity.

Cu^{2+} has so far proved challenging to detect using conventional fluorescent sensors due to its quenching effect on fluorophores. To overcome this problem, Juewen Liu and Yi Lu at the University of Illinois at Urbana-Champaign used a colour change that takes place in a solution of gold nanoparticles as a selective and sensitive Cu^{2+} sensor.

The process is started by a DNA enzyme (DNAzyme), which is made up of an enzyme strand and two DNA strands. The presence of Cu^{2+} triggers a reaction that links the two strands of DNA together, known as a ligation reaction. The linked strands are then released from the DNAzyme and chemically modify the nanoparticles, causing them to aggregate and change colour in a process that can be monitored by the naked eye.



Two DNA strands (red and green) link up in the presence of copper ions, causing gold nanoparticles to clump together

Liu and Lu had previously developed a Cu^{2+} sensor that relied on selective DNA cleavage reactions by metal ions. According to Lu, the new method is more selective because there is far less chance of other species interfering with the ligation reaction than the cleavage reaction.

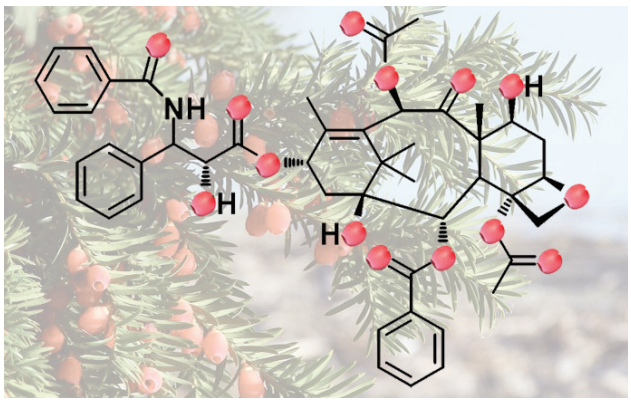
Other researchers in the field have welcomed the results. Chengde Mao, associate professor of analytical chemistry at Purdue University, Indiana, US, said the most attractive feature of the new technique is its convenience, adding that it could be performed without the need for specialised instrumentation or technical training.

Yingfu Li from the Department of Biochemistry and Biomedical Sciences at McMaster University, Ontario, Canada, considers the work ground-breaking. '[It] will certainly get [scientists] even more interested in creating more and better DNAzymes for real-world applications,' he said.

David Parker

Reference
J Liu and Y Lu, *Chem. Commun.*, 2007, DOI: 10.1039/b712421j

Solid state NMR technique takes on Taxol



US scientists have developed a new technique for investigating the biologically active forms of the anticancer drug Taxol.

David Grant at the University of Utah, Salt Lake City, and co-workers have used solid state NMR to establish the structure of a unique conformation of paclitaxel – more commonly known as Taxol.

Although it has been nearly 40 years since paclitaxel was discovered, little is known about the conformation of the bioactive form. 'Taxol has proven nearly impossible to structurally characterise due to its large size and flexibility,' said Grant.

Taxol's active conformation has proved a puzzle

Structural diversity in crystals is known as polymorphism, and is a common problem for drug molecules. Grant's technique offers new opportunities for determining polymorph structures from crystals too small to be of use for conventional x-ray techniques.

The scientists studied microcrystals of paclitaxel, giving a list of experimental chemical shift tensors – values that relate NMR chemical shifts to the molecular orientation. The team then compared the tensors with computationally predicted chemical shifts for all of the possible shapes of the drug molecule to establish paclitaxel's structure.

'The development of new solid state NMR and computational methods have allowed access to a previously intractable problem,' said Grant.

Jon Silversides

Reference
E M Heider, J K Harper and D M Grant, *Phys. Chem. Chem. Phys.*, 2007, **9**, 6083 (DOI: 10.1039/b711027h)

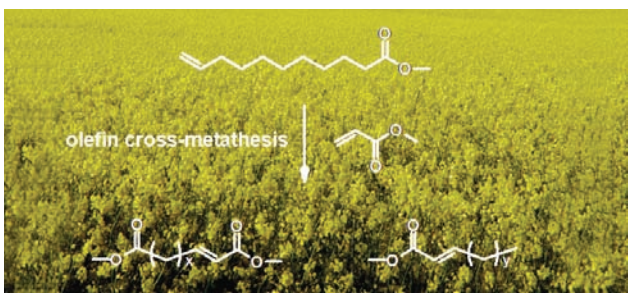
From plant oils to polymers

An efficient catalytic approach turns plant oils into precursors for polymers and detergents with very little waste, say chemists.

Michael Meier and Anastasiya Rybak at the University of Applied Sciences Oldenburg/Ostfriesland/Wilhelms in Emden, Germany, used fatty acid derivatives, which can be obtained from natural feedstocks such as castor oil, to make diesters that are useful monomers for making polyesters and polyamides.

The researchers used a simple cross-metathesis reaction between the fatty acid derivatives and the widely available compound methyl acrylate. The reaction was initiated by commercially available catalysts. Meier and Rybak's method avoids the need for high catalyst loading and cuts down on the long reaction times needed for previous acrylate cross-metathesis reactions.

'This approach can be considered as sustainable since it efficiently uses the synthetic potential of nature and hardly produces any waste,' said Meier. 'The reaction is solvent free, selective for the cross-metathesis product and the by-product is a starting material for detergents,' he added.



Metathesis reactions provide a way of breaking and remaking carbon–carbon double bonds

Jim Patel, a researcher with the Commonwealth Scientific and Industrial Research Organisation, Australia, said the research was a significant contribution. But Patel also pointed out that the catalysts used are expensive and that significant advances would be needed before the method becomes economically viable.

Ian Gray

Reference
A Rybak and M A R Meier, *Green Chem.*, 2007, **9**, 1356 (DOI: 10.1039/b712293d)

Big science for small sensors

Why do some ion sensors perform worse the longer they spend in solution? The answer, say researchers in Australia and Switzerland, is in the water.

Polymeric ion-selective electrodes distinguish between ions by having a polymeric membrane that only allows the intended ion to pass through to the electrode. These electrodes can be made small enough to use in lab-on-a-chip methods. The trouble with these coated-wire electrodes is that their performance deteriorates significantly the longer they spend in solution.

Roland De Marco at the Curtin University of Technology, Perth, Australia and colleagues, believe that the deterioration is caused by a layer of water that forms between the membrane and the electrode. This water layer acts as a reservoir for ions that have already passed through the membrane, and these ions interfere with the normal operation of the sensor.

'Many researchers have speculated about the existence of a detrimental water layer, but no single research group has provided direct structural evidence,' said De Marco. The team used neutron and x-ray reflectometry to demonstrate the existence of this layer.

De Marco also has some ideas about how to prevent the formation of the water layer. 'We have a new approach employing a water-repellent ion sensing polymer film,' he said.

In terms of characterising ion sensors, De Marco warns that the 'big science' techniques using neutron and x-ray sources are 'inaccessible by industry' and an industrially practical method is needed. 'In this context, we have developed a conventional electrochemical technique, that is, electrochemical impedance spectroscopy, for the characterization of new solid-state polymeric ion sensors.'

Colin Batchelor

Reference
R De Marco *et al*, *Phys. Chem. Chem. Phys.*, 2008, DOI:10.1039/b714248j

Interview

Relatively challenging

Pekka Pyykkö talks to Caroline Moore about relativistic effects and the thrill of theoretical chemistry

Pekka Pyykkö

Pekka Pyykkö is professor of chemistry at the University of Helsinki where he studies relativistic effects in heavy elements and simple chemical species using theoretical methods. He is an editorial board member of *Physical Chemistry Chemical Physics*.

Why did you become a scientist?
I think I became attracted to science on my own. I kept a diary when I was a child and around the age of eight, I started making observations on nature and reading popular science books. I was interested in all sorts of science – chemistry, things like electric motors, electronics, and rockets. The last entry in my diary was at the age of thirteen: 'finally one of the electric motors worked and one of the rockets flew.'

What made you specialise in theoretical chemistry?
I did my PhD degree in physics but it was a very chemical kind of physics – I participated in building an NMR machine. My PhD thesis was about two thirds experimental NMR on solids and one third quantum chemistry, much of which I learned in Uppsala, Sweden. There was no official quantum chemistry in Finland, before I founded it myself. I sometimes joke that I went from being a Finnish speaking experimental physicist to being a Swedish speaking theoretical chemist!

You've done a lot of work on new gold species and relativistic effects. Why do you find these so interesting?
While I was working on the theory of NMR properties, I realised that there were very significant relativistic effects influencing the heavy elements' spin-spin coupling constants, which no one had told me about. I started to try to calculate them and had a few early papers on the relativistic theory of NMR parameters. After we had started to do relativistic molecular calculations, I was comparing certain properties for silver and gold compounds and I realised that the entire difference between them comes from relativity, which was a revelation.

I realised from the beginning that this was going to be something very important. The fact it explains something so simply that it can go to a textbook is what I would consider my largest achievement.

Do you think theoretical chemistry has a lot to teach experimental chemists?
Yes, I think so. One joke which I often quote comes from the famous Russian crystallographer, Alexander Kitaigorodsky who said: 'You have three levels of theory: third rate, second rate and first rate. First rate theories predict, second rate theories forbid and third rate theories explain.' It can be valuable to explain something like the difference between silver and gold but the best kind of theory is to predict. We have probably predicted a few hundred compounds, of which about forty have now been made. We have had a fairly good rate of success which I find most interesting. I think the theoretician is really leading the way. Half of chemistry is still undiscovered. We don't know what it looks like and that's the challenge.

How important is international collaboration between chemists?
Crucial. I would talk about complementary competencies. From the beginning, I was always the idea man but I was not necessarily the best person to do the actual work. Getting the work done, especially if it is technically difficult, always means finding the best expert to work with.

Another area you're interested in is the history of science. How did you become involved in that?
I grew up in Turku, which is the former centre of Finland and the site of our first university in 1640. Chemistry was studied there from 1761. For many years, just per chance, I lived at the exact address where Johan Gadolin, the famous Finnish chemist, lived and, since 1984, I have been in the younger branch of his Chair at Helsinki. I find it simply fascinating.

Do you think it's important that younger chemists should be made more aware of the history of science? It's often a subject that's taught as part of history, rather than part of science.
I think the history of science has a very invigorating effect on students. If you want to have success in science, my advice is simple: aim right, hit hard. In order to aim right, you have to develop an intellectual taste. To do this, history of science is crucial because it shows you what ideas turned out to be important in the long-run. Another thing which is also fun is to see that these scientists were also human, as human as you and me.

If you weren't a scientist, what would you be?
Perhaps I could have had success in languages because I speak a number of them. Or I could have been a plumber. In our house, we recently had a very demanding plumbing problem. Its immediate importance for people who are freezing in the Finnish winter is far higher. Maybe I could have a second career!

Excellence in the UK
1967-2007

Bruker BioSpin

BRUKER

Would anyone really put a Formula One engine in a family saloon?

In the NMR world however, it makes perfect sense…

Our new generation of 5mm ^{13}C-optimised CryoProbe is available at 400MHz and above!

This makes your 400MHz spectrometer as sensitive as an 800.
Just think what this could mean to you...

- 16-fold productivity improvement
- Run a ^{13}C spectrum in minutes, not hours
- Why not a ^{13}C on every sample?
- And DEPT-135 and ^{13}C HSQC spectrum as well?

At last, CryoProbe™ sensitivity for the organic chemist

Contact us for more details: +44 (0)24 7685 5200 sales@bruker.co.uk www.bruker-biospin.com

think forward

NMR Solutions

Instant insight

Mutants make more

Andreas Kirschning from Leibniz University Hannover, Germany, explains how genetically modified microbes offer a short-cut to valuable derivatives of natural products

Nature's reservoir of diverse natural products seems to be endless. Increasing numbers of new and highly complex metabolites – the chemical by-products that result from metabolism – are being discovered all the time and evaluated for their use in medicine as antiinfectives, immunosuppressants and in cancer therapy.

Many natural products are produced by microbes in the form of secondary metabolites. Although these compounds might have properties that are potentially useful to humans, they are not designed by intention to meet these demands. As a consequence, even though the main structure of a natural product might harbour highly potent biological activity, other characteristics, such as its low solubility in water, could render it useless for any biomedical application.

While this might suggest that researchers should be strengthening their efforts to invest in huge screening programs to access what kind of diversity nature still has to offer, a different path, one that is deeply ingrained in human nature, can be chosen: to learn, to change and to improve.

The increasingly sophisticated toolbox of organic chemistry offers the means for the latter option. Keeping what is needed for a natural product's biological activity while changing things that might improve its unwanted characteristics, such as insolubility, is usually achieved in two different ways.

Firstly, even highly complex natural products can be completely artificially prepared by chemical total synthesis, starting with simple building blocks. While in the process of constructing a whole metabolite from scratch, modifications can be incorporated that can successfully alter unwanted characteristics. Alternatively, the native natural product can be prepared or isolated and then chemically modified to meet target demands. Termed semisynthesis, this approach allows access to small compound libraries, but it is limited to certain types of modifications by the respective natural product's stability and reactivity profile. In contrast, total synthesis can lead to any modification one can think of but it is often impractical or too cumbersome for screening programs.

Fermentation flasks are used to cultivate the mutant microbes

Reference
A Kirschning, F Taft and T Knobloch, *Org. Biomol. Chem.*, 2007, **5**, 3245 (DOI: 10.1039/b709549j)

However, a third way of obtaining modified natural products has arisen in recent years with the development of sophisticated methods of metabolic engineering. This strategy combines chemical synthesis with genetic engineering. Refined insights into the intricate ways in which living organisms make natural products – termed biosynthesis – have made it possible to genetically engineer microbial mutants, which are unable to generate the essential building blocks required for assembly of a particular natural product. Disrupting the biosynthesis of the natural product in this way can open doors to the biosynthesis of other 'unnatural' products.

While the biosynthesis of natural products is known to be a highly selective and efficient process, it has been shown that certain degrees of flexibility do exist in these finely tuned assembly line systems. This flexibility can be exploited by feeding chemically prepared modified natural building blocks to the mutant microbes, leading to novel natural product derivatives. These compounds might already have the desired characteristics, or may be more suitable for further modifications than the natural product itself. This concept is known as mutational biosynthesis, or mutasynthesis.

It has to be noted that the intricacies of biosynthetic pathways are not fully understood yet and in the past many mutasynthetic approaches were far from being practical in terms of productivity. That said, mutasynthesis has huge potential to provide short-cut access to natural products and derivatives of choice.

Read Andreas Kirschning's Perspective article on mutasynthesis in issue 20, 2007 of Organic & Biomolecular Chemistry.

Essential elements

New RSC Books website

The RSC Books website has recently undergone a substantial revamp, and we are pleased to present our new and improved site. New features include improved functionality that allows users to browse RSC books by series, subject area, publication copyright year and by A–Z title searching. Alternatively, keyword or author searches can now be carried out using the built-in Google search. Forty years of RSC books are included on the new website, from early titles in 1968 to the books RSC will be publishing next year in 2008.

The new RSC Books website site is closely linked to our online shop with direct links to the RSC eBook Collection. This enhanced visibility enables you to view the table of contents and first chapter of any book in the collection free of charge. The new RSC Books website provides all the browser requirements, such as a shopping cart facility with selected special discounts function, needed for simple website navigation and ease of use. All the latest information can be found in the new RSC Books website: how to publish your book with RSC Publishing, titles in our RSC eBook Collection and regular website updates on our new releases, most popular titles and books for students.

For more information visit www.rsc.org/books

Tokeshi wins Pioneers in Miniaturisation prize

Manabu Tokeshi has been named as the 2007 winner of the Pioneers in Miniaturisation prize.

The prize, first awarded in 2006, was established by two of the major players in the miniaturisation sector, *Lab on a Chip* and Corning Incorporated.

Joydeep Lahiri, research director at Corning Inc., commented 'Tokeshi's multi-disciplinary research exemplifies the essential outreach that is necessary – particularly to the molecular biology or medical areas – in order to find "the next big thing" that will succeed, for example, Corning's µPlate technology.'

The prize aims to promote miniaturisation through micro and nanotechnologies to the wider scientific community and encourage both young and new scientists into the field.

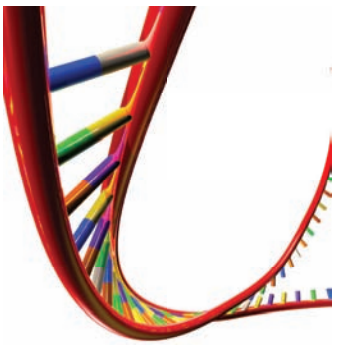
From left: Harp Minhas, editor, *Lab on a Chip*; Manabu Tokeshi (2007 Award Winner); Joydeep Lahiri, research director, Corning Inc.; and Andreas Manz, chair of the *Lab on a Chip* editorial board.

Yoshinobu Baba of the Plasma Nanotechnology Research Center Nagoya University, Japan, said 'Tokeshi has been the powerhouse behind many interdisciplinary publications as his record shows.'

The presentation of this prestigious award was made at the µTAS 2007 conference held in Paris, France, in October.

For more information see www.rsc.org/loc

And finally...



***Molecular BioSystems* unzips ...**

From January 2008 *Molecular BioSystems* will form its very own strand of science as a stand alone monthly journal, becoming solely available to readers and subscribers independently of its host journal. Read more on how the journal is serving the community and why it is ready to unzip at *www.molecularbiosystems.org*

Speaking volumes...

Times flies when you're publishing high impact science. In 2008, four RSC journals celebrate their tenth year of publication: *Physical Chemistry Chemical Physics*, *CrystEngComm*, *Green Chemistry* and the *Journal of Environmental Monitoring*. These diverse journals are all now firmly established as market leaders in their subject areas, with each continuing to go from strength to strength. Watch out for special 10th anniversary events and celebrations throughout 2008!

Chemical Science (ISSN: 1478-6524) is published monthly by the Royal Society of Chemistry, Thomas Graham House, Science Park, Milton Road, Cambridge UK CB4 0WF. It is distributed free with *Chemical Communications*, *Dalton Transactions*, *Organic & Biomolecular Chemistry*, *Journal of Materials Chemistry*, *Physical Chemistry Chemical Physics*, *Chemical Society Reviews*, *New Journal of Chemistry*, and *Journal of Analytical Atomic Spectrometry*. *Chemical Science* can also be purchased separately. 2007 annual subscription rate: £199; US $376.

All orders accompanied by payment should be sent to Sales and Customer Services, RSC (address above). Tel +44 (0) 1223 432360, Fax +44 (0) 1223 426017. Email: sales@rsc.org

Editor: Nicola Nugent

Associate editors: Neil Withers, Celia Clarke

Interviews editor: Joanne Thomson

Essential elements: Daniel Bradnam, Rebecca Jeeves and Kathryn Lees

Publishing assistant: Ruth Bircham

Publisher: Janet Dean

RSC Publishing