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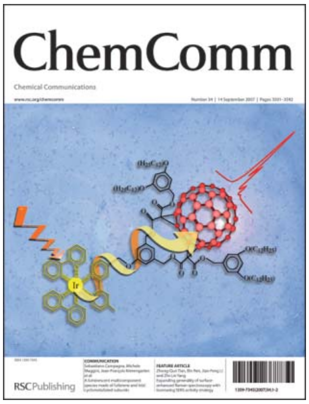

Cover
See Francesco Nastasi *et al.*, page 3556. Photoinduced energy transfer takes place in a new multicomponent Ir-fullerene species, resulting in fullerene phosphorescence in the near IR. Image reproduced by permission of Francesco Nastasi, Fausto Puntoriero, Sebastiano Campagna, Stefano Schergna, Michele Maggini, François Cardinali, Béatrice Delavaux-Nicot and Jean-François Nierengarten from *Chem. Commun.*, 2007, 3556.

CHEMICAL TECHNOLOGY

T65

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Chemical Technology

September 2007/Volume 4/Issue 9

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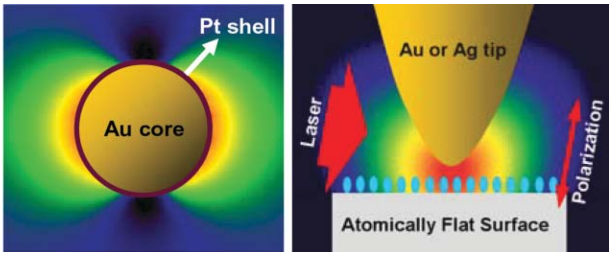
FEATURE ARTICLE

3514

Expanding generality of surface-enhanced Raman spectroscopy with borrowing SERS activity strategy

Zhong-Qun Tian,* Bin Ren,* Jian-Feng Li and Zhi-Lin Yang



By borrowing SERS activity of the Au core or Au tip, the surface Raman signals from species on transition-metal shells or single crystal surfaces have been obtained, giving enhancement of five to six orders of magnitude, which greatly expands the molecular, surface and substrate generalities of SERS.

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Fluoride-responsive organogelator based on oxalamide-derived anthraquinone

Zoran Džolić, Massimo Cametti,* Antonella Dalla Cort, Luigi Mandolini* and Mladen Žinić*

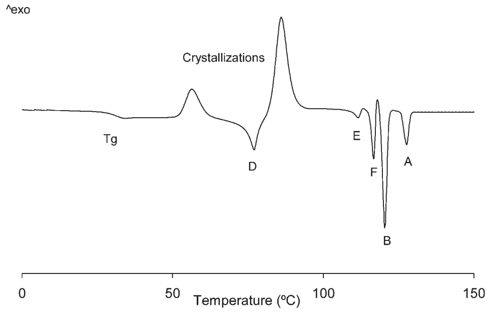
Anthraquinone derived oxalamide gelator **1** forms with aromatic solvents and alcohols very stable gels which selectively respond to the presence of fluoride anion by colour change and/or gel-to-sol transition.

3538

Polymorphism of (*S*)-triphenylglycol: kinetic dependent transformation of a new multipolymorphic system

Rafael Barbas, Marco Polito, Rafel Prohens* and Cristina Puigjaner*

A new example of a multipolymorphic system is reported consisting of six anhydrous forms, five of them observed simultaneously by DSC. A kinetic amplification process is suggested as a novel methodology for obtaining metastable forms.

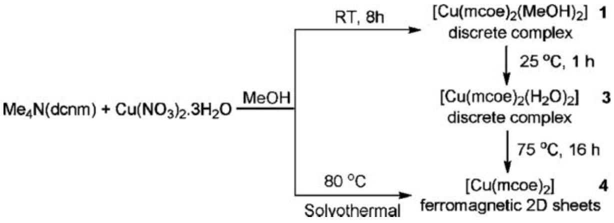


3541

Solvothermal *vs.* bench-top reactions: Control over the formation of discrete complexes and coordination polymers

Anthony S. R. Chesman, David R. Turner, David J. Price, Boujemaa Moubaraki, Keith S. Murray, Glen B. Deacon and Stuart R. Batten*

The formation of discrete complexes $[M(mcoe)_2S_2]$ (M = Cu, Ni; S = MeOH, H_2O) *vs.* a nitroso-bridged ferromagnetically-coupled Cu^{II} coordination polymer $[Cu(mcoe)_2]$ is influenced by the use of solvothermal reaction conditions.

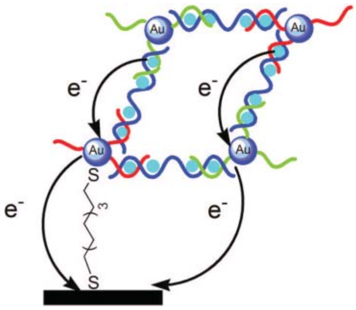


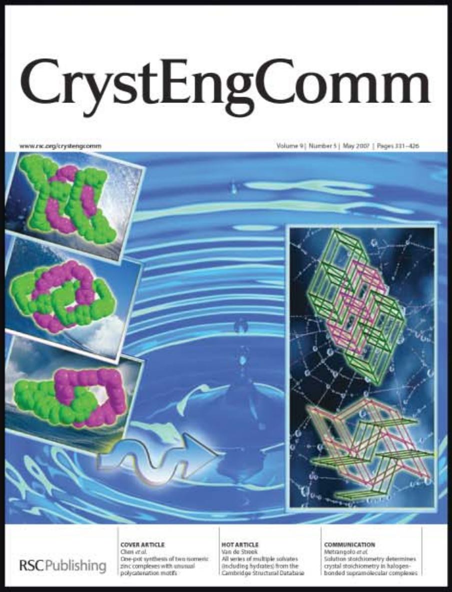
3544

Amplified electrochemical detection of DNA through the aggregation of Au nanoparticles on electrodes and the incorporation of methylene blue into the DNA-crosslinked structure

Di Li, Yiming Yan, Agnieszka Wieckowska and Itamar Willner*

The amplified electrochemical detection of DNA is accomplished by the analyte-induced aggregation of Au nanoparticles and the voltammetric analysis of methylene blue intercalated in the duplex units associated with the aggregates.



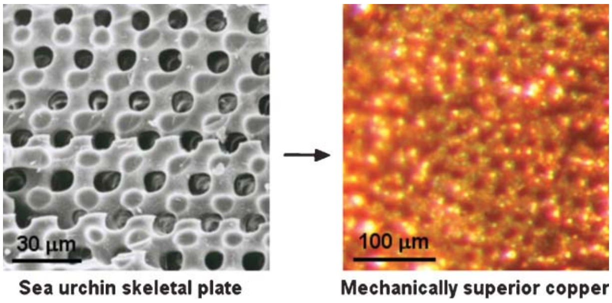


3547

Profiting from nature: macroporous copper with superior mechanical properties

Min Lai, Alex N. Kulak, Daniel Law, Zhibing Zhang, Fiona C. Meldrum and D. Jason Riley*

Macroporous copper with a complex hyperbolic morphology and superior mechanical properties was produced by replicating the remarkable form of a sea urchin skeletal plate using templated electrochemical deposition.



Sea urchin skeletal plate

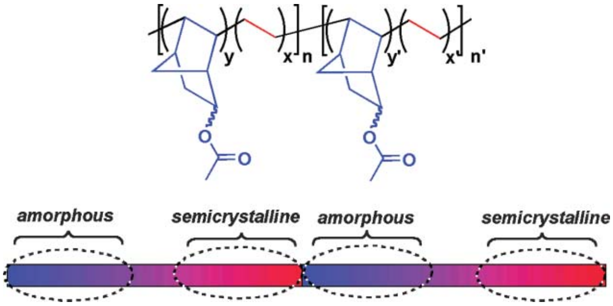
Mechanically superior copper

3550

Pseudo-tetrablock copolymers with ethylene and a functionalized comonomer

Robert C. Coffin, Steve J. Diamanti, Atsushi Hotta, Vikram Khanna, Edward J. Kramer, Glenn H. Fredrickson and Guillermo C. Bazan*

A simple two-step procedure allows for the synthesis of polymers containing ethylene and a functionalized norbornene co-monomer that have structures and elastomeric properties analogous to tetrablock copolymers.

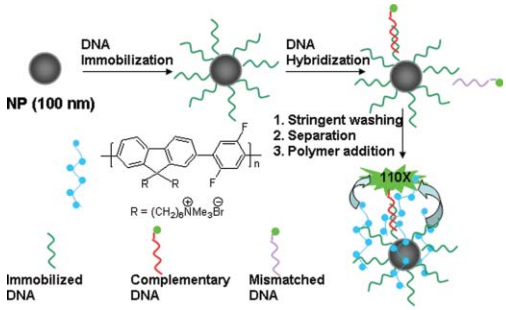


3553

Silica nanoparticle assisted DNA assays for optical signal amplification of conjugated polymer based fluorescent sensors

Yusong Wang and Bin Liu*

Silica nanoparticle-assisted DNA assays could provide the optical signal amplification for conjugated polymer based fluorescent sensors.

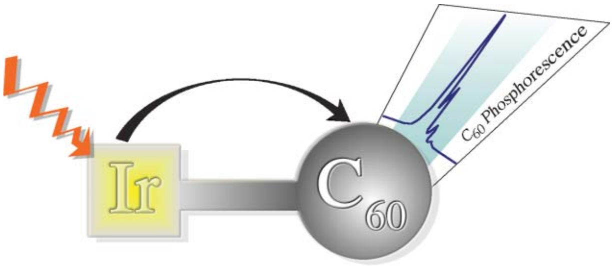


3556

A luminescent multicomponent species made of fullerene and Ir(III) cyclometallated subunits

Francesco Nastasi, Fausto Puntoriero, Sebastiano Campagna,* Stefano Schergna, Michele Maggini,* François Cardinali, Béatrice Delavaux-Nicot and Jean-François Nierengarten*

Photoinduced triplet–triplet energy transfer from the Ir-based MLCT state to the C_{60} triplet state occurs, leading to phosphorescence of the derivatized-C_{60} at 77 K, in a new multicomponent species.

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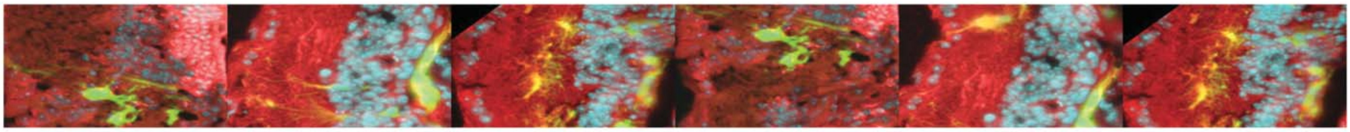
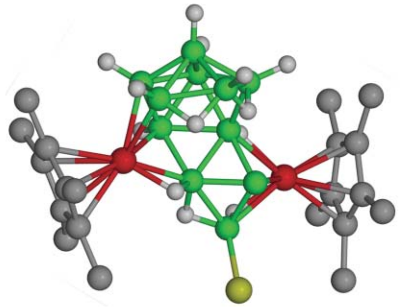


3559

Macropolyhedral boron-containing cluster chemistry. The unique *nido*-five-vertex-⟨B_2⟩-*nido*-ten-vertex *conjuncto* structure of [(η^5-C_5Me_5)$_2$$Rh_2B_{11}H_{15}$] *via* an unexpected cluster-dismantling

Michael J. Carr, Sarath D. Perera, Tomáš Jelínek, Bohumil Štíbr, William Clegg, Colin A. Kilner and John D. Kennedy*

$B_{16}H_{20}$ and [$RhCl_2$(η^5-C_5Me_5)]$_2$ with tmnd give [(η^5-C_5Me_5)$_2$$Rh_2B_{11}H_{15}$] with an unprecedented 13-vertex {(*nido*-RhB_9) + B_2, (*nido*-RhB_4)} cluster core.



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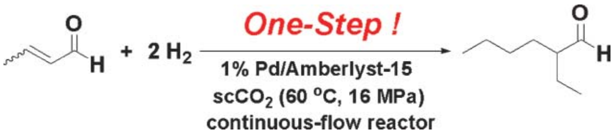
Continuous catalytic "one-pot" multi-step synthesis of 2-ethylhexanal from crotonaldehyde

Tsunetake Seki, Jan-Dierk Grunwaldt and Alfons Baiker*

The continuous 1% Pd/Amberlyst-15–$scCO_2$ hydrogenation catalytic system efficiently affords 2-ethylhexanal from crotonaldehyde in a "one-pot" process.



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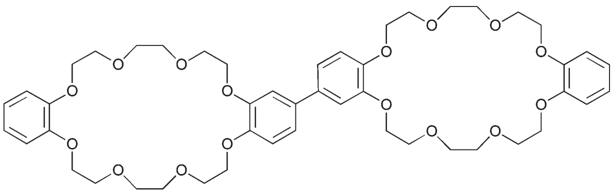
A biaryl cross-coupling strategy for functionalisation of benzocrown ethers

Sally Dixon, Richard C. D. Brown* and Philip A. Gale*

Convenient formation of a benzo-crown substituted organomagnesium reagent from halogen–magnesium exchange at 0 °C is reported. High yielding palladium catalyzed cross coupling of benzo-crown substituted aryl-zinc and -boron reagents is described for the convenient synthesis of novel functionalized benzo-crown ether systems.



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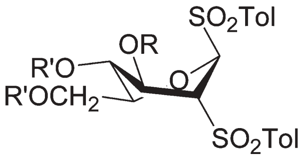
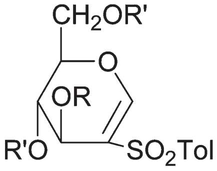
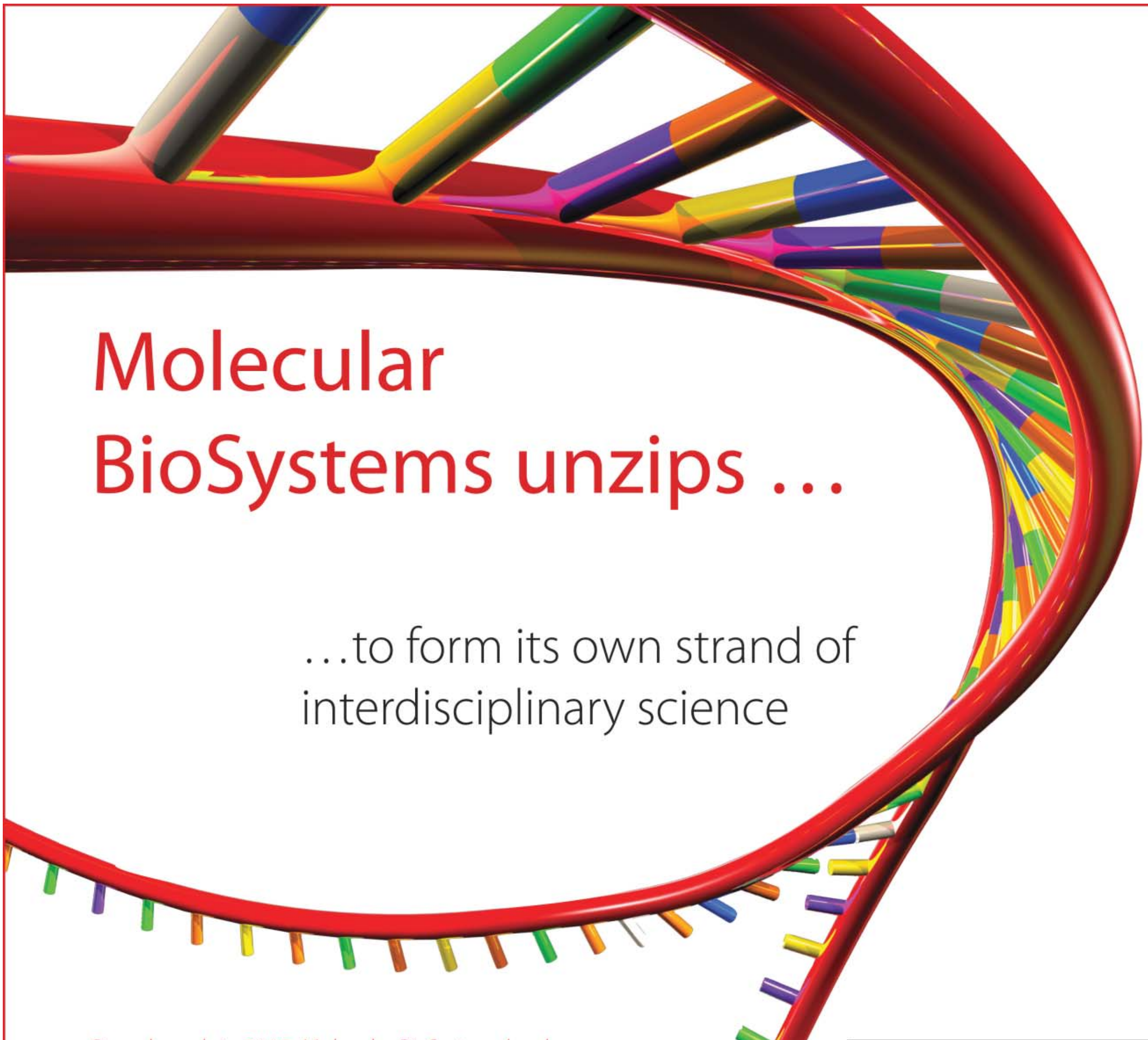
Preparation of 2-deoxy-2-*C*-*p*-tolylsulfonyl-β-D-glucopyranosyl *p*-tolyl sulfones having non-chair conformation and their elimination reactions

Tohru Sakakibara,* Tomomi Suganuma and Yasuhiro Kajihara

When the title sulfones are stirred with silica gel, elimination of the sulfonyl group at C-1 occurs if the hydroxyl group at C-6 is protected, whereas the elimination does not occur if the hydroxy group is free.





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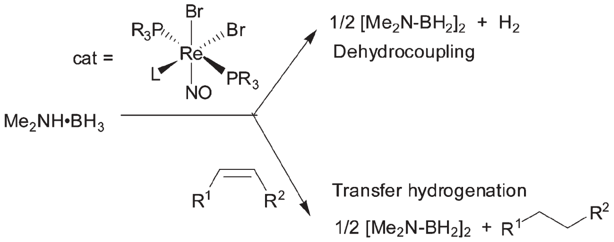
Dehydrocoupling of dimethylamine-borane catalysed by rhenium complexes and its application in olefin transfer-hydrogenations

Yanfeng Jiang and Heinz Berke*

New rhenium based catalyses with the precursor species bearing a labile ligand, $L = H_2$, MeCN and C_2H_4, were developed for the dehydrocoupling of dimethylamine-borane and its transfer hydrogenation of olefins.



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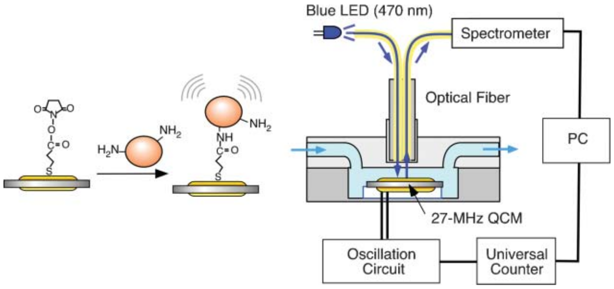
Simultaneous anomalous reflection and quartz-crystal microbalance measurements of protein bindings on a gold surface

Yuichi Manaka, Yukihiko Kudo, Hiroshi Yoshimine, Takayoshi Kawasaki, Kotaro Kajikawa and Yoshio Okahata*

Protein bindings onto a gold surface were detected simultaneously by QCM (ΔF_{water}) and anomalous reflection (ΔR) of gold on the same surface in aqueous solutions.



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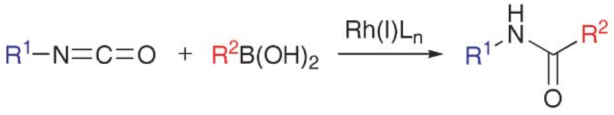
Rhodium-catalysed addition reaction of aryl- and alkenylboronic acids to isocyanates

Tomoya Miura, Yusuke Takahashi and Masahiro Murakami*

Isocyanates react with aryl- and alkenylboronic acids in the presence of a rhodium(I) catalyst to give secondary amides under mild conditions.



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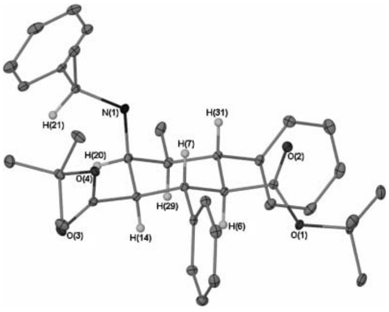
A new diastereoselective aza-allyl conjugate addition–Michael addition–ring closure reaction sequence and its application in the construction of six contiguous stereogenic centres

Magdaline Koutsaplis, Philip C. Andrews,* Steven D. Bull, Peter J. Duggan, Benjamin H. Fraser and Paul Jensen

A remarkable tandem aza-allyl conjugate addition–Michael addition–ring closure reaction sequence, initiated by the addition of a sodiated 1-aza-allyl anion to two equivalents of *tert*-butyl cinnamate, results in a chiral aminocyclohexane containing six new vicinal stereogenic centres with excellent stereocontrol.



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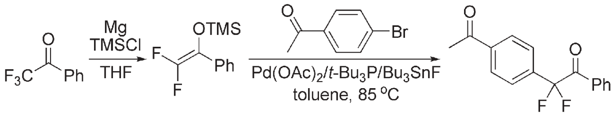
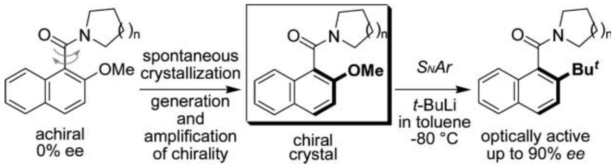


Effect of fluorine on palladium-catalyzed cross-coupling reactions of aryl bromides with trifluoromethyl aryl ketones *via* difluoroenol silyl or monofluoroenol silyl ethers

Yong Guo and Jean'ne M. Shreeve*

Palladium-catalyzed cross-coupling reactions of α-aryl-β,β-difluoroenol silyl and α-aryl-β-fluoroenol silyl ethers with aryl bromides proceed smoothly with good functional compatibility.

3586



An asymmetric S_NAr reaction using the molecular chirality in a crystal

Masami Sakamoto,* Atsushi Unosawa, Shuichiro Kobaru, Kazuyuki Fujita, Takashi Mino and Tsutomu Fujita

An asymmetric S_NAr reaction was performed by using molecular chirality generated and amplified by the spontaneous crystallization of achiral naphthamides.

September 2007 / Volume 4 / Issue 9 / ISSN 1744-1560 / CTHEC2 / www.rsc.org/chemicaltechnology

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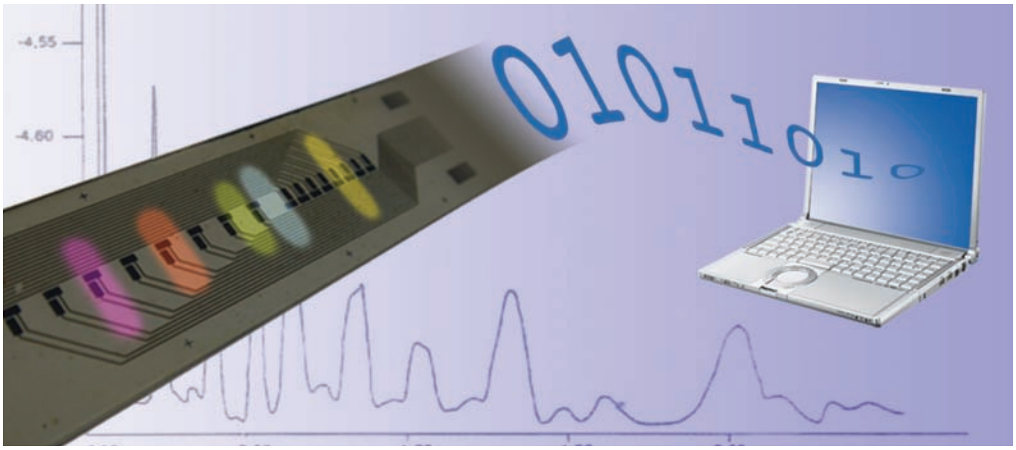
Photosensor array allows quality and quantity of mixture to be measured

Smart TLC



Italian researchers have developed a thin layer chromatography (TLC) plate that allows them to identify not only the presence of different components in a mixture, but also how much of each component is present.

Chromatography is a versatile and powerful technique that separates mixtures into individual components according to their different binding affinities to a mobile and a stationary phase. Augusto Nascetti and colleagues at the University of Rome put the stationary phase of a TLC plate and amorphous silicon photodiodes on the same glass substrate to make the plate 'active' and allow real-time monitoring of the separation process.

In their technique, the team irradiate the plate with ultraviolet radiation while the separation is taking place. This excites the fluorescence of the different components of the mixture being analysed. The intensity of the fluorescence signal is proportional to the peak height detected and this can be used to determine the quantity of each component in the mixture.

According to Nascetti the preliminary results 'suggest that the proposed system can effectively add value to conventional TLC technology'. The technique operates on a small scale and requires only small amounts of eluents, which reduces both the cost and any risks associated with the use of harmful solvents. Advantageously, the plate can also be easily incorporated into a portable field device. Potential applications include uses in food quality control such as early detection of toxins in wine.

Kathryn Lees

The intensity of the fluorescent signal is used to calculate the quantities present

Reference

D Caputo *et al*, *Lab Chip*, 2007, **7**, 978 (DOI: 10.1039/b709145a)

In this issue

China's pollution headache
Coal is the culprit in a year-long study of Chinese cities

Mars rocks
Laser-induced breakdown spectroscopy improved for mission

Instant insight: The shape of things to come
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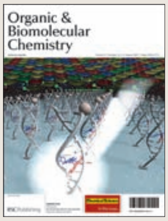
Jim Heath talks about the discovery of C_{60} and his more recent adventures



The latest applications and technological aspects of research across the chemical sciences

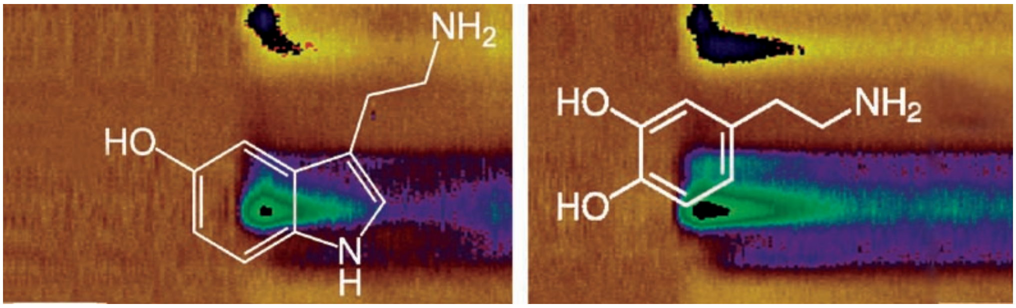
Application highlights

Important neurotransmitters can be studied simultaneously

Dual detection

Scientists in the US have developed a sensor that can detect dopamine and serotonin simultaneously *in vivo* for the first time.

Dopamine and serotonin are important neurotransmitters. Serotonin is known to regulate sleep and is a common target for depression medication. Dopamine has been linked to locomotion, reward and motivation, and is a common target for illicit drugs. The death of dopamine receptors is the cause of Parkinson's disease. However, the two are inherently linked; cocaine is known to act on both dopamine and serotonin transporters, for example. Consequently, the simultaneous, rapid, *in vivo* detection of these compounds is a requirement if their interactions in the brain are to be understood.



Serotonin (left) and dopamine (right) give different electochemical signals at carbon nanotube electrodes

However, using electrochemistry to detect both compounds simultaneously has proven difficult. due to the compounds' similar oxidation potentials. Detecting dopamine causes fouling by serotonin, while methods to avoid serotonin fouling prevent dopamine detection.

Now, Jill Venton and Kumara Swamy at the University of Virginia have developed carbon nanotube modified microelectrodes that can detect serotonin and dopamine at the same time.

'We showed that carbon nanotube sensors have increased sensitivity for dopamine and serotonin and are more resistant to fouling by oxidative products of serotonin,' explained Venton.

Mark Wightman, an expert in neurochemistry and electrochemistry at the University of North Carolina, Chapel Hill, US, appreciated the significance of their new technique. '*In vivo* voltammetry at carbon-fibre microelectrodes provides the only way to follow the release and uptake of neurotransmitters in the brain as they control rapid behaviours on a second-to-second time scale.' he said. 'This new approach by Venton ... has several advantages.'

Although it is still unclear how the carbon nanotubes increase resistance to fouling Venton hopes the microelectrodes will allow further studies of dopamine and serotonin in the brain.

'The next challenge,' she said, 'is to create even smaller, nanotube-based electrodes to more closely approach the small size of synapses.'

Edward Morgan

Reference

B E K Swamy and B J Venton, *Analyst*, 2007, DOI: 10.1039/b705552h

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Polymer replaces oxide material in display cathode

Flexible electrodes

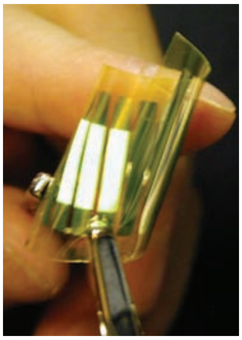
New bendy LEDs don't crack under the strain.

Electrodes made from conducting polymers make LEDs more flexible, according to a team from Imperial College London, UK.

Polymer LEDs consist of layers of light-emitting polymer sandwiched between two electrodes. Although various studies have tried to build polymer LEDs on flexible substrates, the electrode materials cannot always cope with being bent. One of the most commonly used cathode materials, indium tin oxide (ITO), is quite brittle, and tends to crack when the LED is flexed. ITO films are usually made by evaporation at high temperatures, but when working with plastic substrates the temperature has to be kept much lower to avoid melting the plastic, and ITO films made at these lower temperatures tend to be of low quality.

The Imperial team replaced the ITO cathode with a conducting polymer layer, made from poly(3,4-ethylenedioxythiophene) and polystyrenesulfonate. They built their LEDs on overhead projector transparencies, and succeeded in making bright yellow LEDs which work even when tightly rolled up into a tube.

'The main challenge now is to drive up the conductivity of the polymer anode to the point where it actually starts to compete with ITO. This won't be easy but we have a few ideas up our sleeves,' said John deMello, who led the research.



Bendy LEDS have a future in biomedial devices

'The other issue is LED lifetime. The organic layers are extremely air-sensitive so finding an effective way of protecting the devices inside flexible, transparent packaging is going to be absolutely crucial.'

Commercial applications are already on their way for these LEDs, added deMello. 'The technology has recently been licensed to a start-up company called Molecular Vision, who are using it to develop a new line of disposable diagnostic devices for health care testing. They're combining the LEDs with flexible photo-detectors (also developed at Imperial) to create ultra-miniaturised low cost sensors for the analysis of blood and urine.'

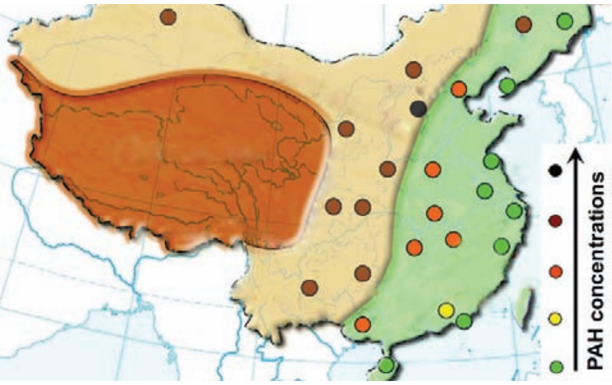
Clare Boothby

Reference

J Huang *et al*, *J. Mater. Chem.*, 2007, DOI: 10.1039/b705918n

A year-long study of pollution in cities finds coal is the culprit

China's pollution headache



Pollution levels were greatest in areas with colder winters

Chinese scientists have found concentrations of polycyclic aromatic hydrocarbons (PAHs) in some Chinese cities to be among the highest in the world, exceeding proposed EU air-quality standards in many cases.

PAHs are formed from the incomplete burning of fossil fuels and the International Agency for Research in Cancer has classified some of them as probable human carcinogens.

As China is the world's most populated country and largest consumer of coal, and its number of vehicles is growing along with its economy, Gan Zhang and co-workers set out to conduct a large-scale study of PAH levels across the whole of China, comparing 36 cities (and three rural locations) across all four seasons of 2005. The team, based mainly at Guangzhou Institute of Geochemistry, found that levels were greatest in cities on higher ground (in north and north-west China), which had colder winters and burnt more coal.

Kevin Jones, of Lancaster University, UK, worked on the study and described this negative correlation between the average annual PAH concentrations and annual average temperature as 'significant' and explained that, although several factors acting in combination influenced air concentrations, 'winter time PAH concentrations correlated with estimated coal consumption'.

Ian Colbeck, director of the Centre for Environment and Society at the University of Essex, UK, said Zhang's study was 'another example of the adverse impact on the environment as a result of China's drive to increase industrial output'.

'The health implications of the high concentrations of PAHs in the densely populated Chinese cities are very significant,' added Colbeck.
Ian Gray

Reference
X Liu *et al*, *J. Environ. Monit.*, 2007, DOI: 10.1039/b707977j

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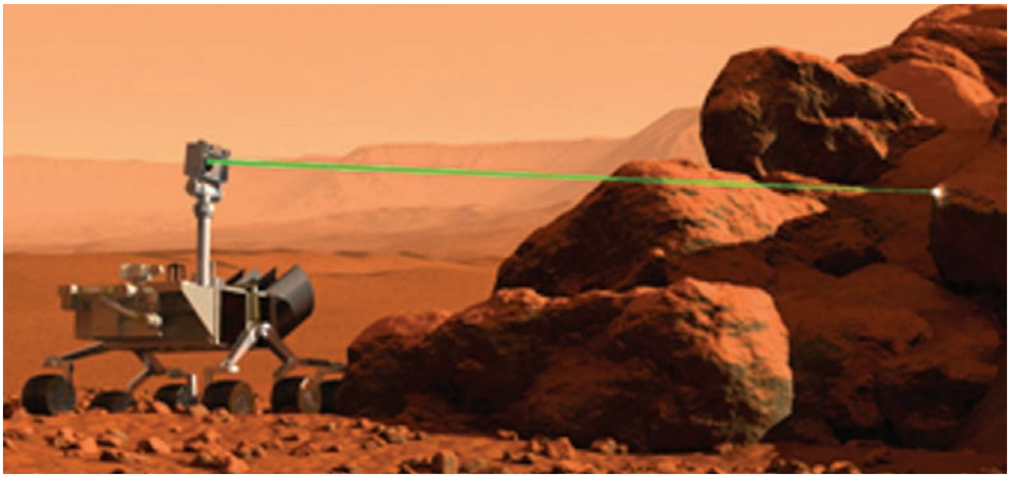
Laser-induced breakdown spectroscopy improved for mission

Mars rocks



The Mars Science Laboratory rover will use a laser to vaporise the outer layer of Martian rocks

The way in which the Mars Science Laboratory rover will identify Martian rocks has been tested by French scientists.

The Mars Science Laboratory rover is due to be launched in 2009. Its overall mission is to determine whether Mars is (or ever was) able to support microbial life. It will carry an instrument called ChemCam, which will use laser-induced breakdown spectroscopy (LIBS) to remotely identify Martian rocks.

Jean-Baptiste Sirven, of the CEA Saclay, and colleagues tested chemometric methods for analysing LIBS spectra. A laser is used to vaporise the dust-covered rock to get to the non-weathered layers below. The elements in the rock are excited by the laser and emit light at characteristic wavelengths. These spectra are then compared to spectra of known samples to classify the rock samples.

Sirven tried three different ways of statistically analysing the spectra. He found that a combination of methods would give the best results. At the start, a method that is able to differentiate between rocks of very similar composition would be used. Then, as the number of Martian spectra collected increases, a laboratory-calibrated model would become more accurate, as it became more representative of the planet geology. According to Sirven, the combined method correctly identifies over 99 per cent of samples.
Susan Batten

Reference
J-B Sirven *et al*, *J. Anal. Atomic Spectrosc.*, 2007, DOI: 10.1039/b704868h

Cancer markers monitored in real-time with a biocompatible device

The only way is in

An implantable cancer sensor that uses a membrane to isolate cancer-detecting nanoparticles should help speed up diagnoses, according to researchers from the US.

Early diagnosis and choosing the right treatment are two of the most important factors in the fight against cancer. One of the best ways to monitor cancer is to look for so-called cancer markers – compounds which are produced by cancerous cells, but until now this has been done by performing blood tests or biopsies.

Michael Cima and colleagues from MIT and Harvard have come up with a way of testing for cancer markers in real-time which could make initial diagnosis quicker, and potentially give an indication of whether a particular treatment is effective.

Nanoparticles whose magnetic properties change in the presence of certain analytes (in this case the cancer markers) have been reported previously, but they have not been used in the body because of their stability and toxicity.

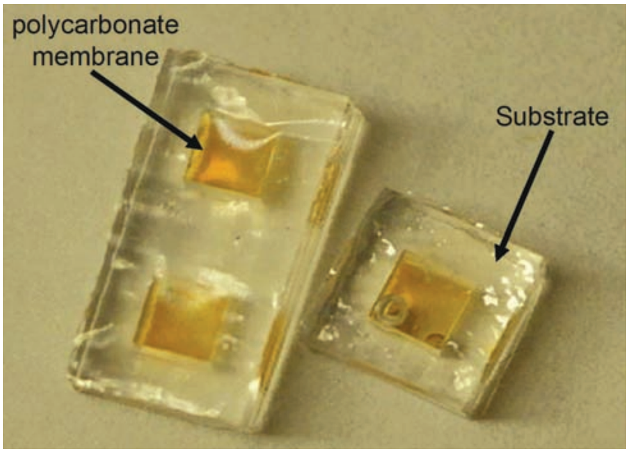
Cima's team solved this by encasing them in a polymer reservoir and semi-isolating them from the environment by using a membrane which only allows small molecules to pass. This allows the cancer markers in (and out) but the nanoparticles remain within the device and are stable. 'We would hope to implant a device at the same time as performing a needle biopsy,' said Cima

Hsian-Rong Tseng from the University of California, Los Angeles, US, said 'The components of the device are already known to be biocompatible, so this can easily be utilised as an implantable sensor. The multiple wells mean that the measurements can easily be repeated improving the quality of the data obtained.'

Martin Leach from the Institute of Cancer Research, London, UK, said 'This is indeed an interesting advance, at present the diffusion across the membrane is slow, but if this can be improved, one could envisage truly real-time experiments where it will be possible to observe where and how chemotherapeutics work.'

Cima and his team continue to work closely with clinicians in developing this technology.

Stephen Davey



Only the cancer markers can pass through the membrane – not the toxic nanoparticles

Reference
K D Daniel *et al*, *Lab Chip*, 2007, DOI: 10.1039/b705143c

Single nucleotide polymorphs found quickly and easily

DNA chips detect disease

A DNA chip that can identify genetic mutations has been synthesised by Japanese scientists.

The most common form of genetic variation between individuals is caused by single-nucleotide differences in our DNA code. These are called single nucleotide polymorphisms (SNPs). SNPs can be used to identify disease genes and can highlight when a person is likely to develop a disease.

Kenzo Fujimoto and colleagues at the Japan Advanced Institute of Science and Technology have developed a simple and rapid method for identifying SNPs. They hope it could be the basis for automated diagnosis.

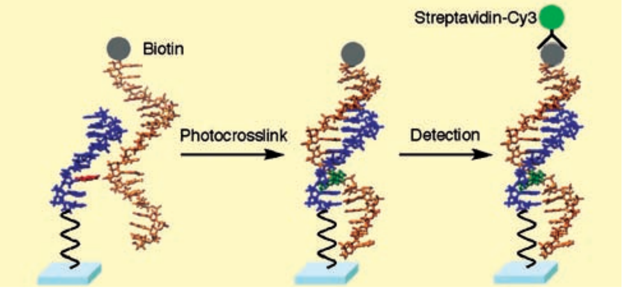
The method uses a short strand of DNA, known as an oligodeoxynucleotide probe, attached to a glass chip. The probe contains DNA bases complementary to those in the DNA strand containing the SNP of interest, except that one base is replaced by a vinyl-containing nucleoside known as cvP. When Fujimoto placed the target DNA onto the chip and shone ultraviolet light on it, the cvP reacted with an adenine base on the target DNA, in a reaction known as photocrosslinking. Fujimoto detected the photocrosslinked product using fluorescence imaging.

Photocrosslinking only occurs when all the bases on the probe are complementary to those on the target DNA, so if there is a mismatch in the strands the chip does not fluoresce.

'This method is an efficient reaction and proceeds with high sequence specificity,' said Fujimoto. 'Photochemical DNA manipulation is a highly original research theme.'

Hans-Achim Wagenknecht, of the University of Regensburg, Germany, said the work is a significant improvement for SNP detection. 'Such cheap, sensitive and reliable screening tools are needed to clinically diagnose genetic variations, infectious diseases and pharmacology,' he said.

Joanne Thomson



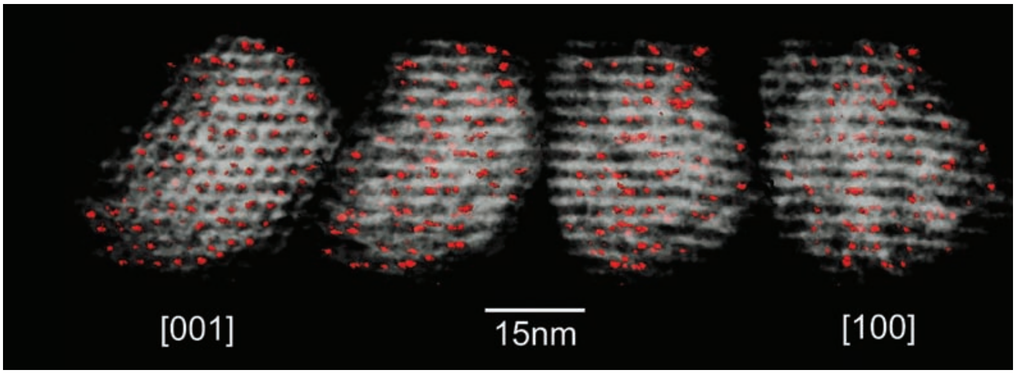
The blue DNA probe is crosslinked to the orange target strand

Reference
T Ami *et al*, *Org. Biomol. Chem.*, 2007, DOI: 10.1039/b708264a

Instant insight

The shape of things to come

Paul Midgley, Edmund Ward, Ana Hungria and John Meurig Thomas discuss using nanotomography to take a 3D glimpse at the nanoworld



A montage of projections of a scanning transmission electron tomogram. It shows a selective hydrogenation $Ru_{10}Pt_2$ nano-catalyst in which the distribution of nanoparticles (red) is revealed within a mesoporous silica support (white). A mean particle size of 100 atoms indicates the zeptogram (10^{-21} g) sensitivity of this 3D imaging technique

There is little doubt that medicine has benefited greatly from the ability to visualise the internal organs of the human body using a variety of radiation including X-rays, positrons, ultrasound and nuclear magnetic resonance. The invention of the 'cat-scan', or CT-scan, in the 1960s enabled such views to be further improved by allowing a full three-dimensional reconstruction of the internal architecture of the body. The basis behind the reconstruction is the technique of tomography, from the Greek word 'tomos' meaning 'slice' or 'section', in which a series of images, or projections, is used to create a three-dimensional view by back-projecting these images into a 3D space in a computer.

In the chemical sciences, relatively little advantage has been taken of tomographic techniques even though it has long been clear that the spatial resolution ultimately attainable by the use of X-rays and electron beams far exceed those associated with CT scans and NMR imaging of the human body.

Just as the morphology and size of organs is of key importance in the human anatomy, in nanoscience and nanotechnology the size and shape of an object may play a key role in determining its electronic and chemical behaviour. There are many examples where the physical and chemical properties of nanocrystals and clusters deviate significantly from their bulk crytsalline phase. Gold in its bulk state displays no catalytic activity and yet in nanoparticle form it is an extremely good catalyst for selective oxidation of hydrocarbons and the complete combustion of carbon monoxide in air. The shape or crystal morphology can be equally important, such as in ceria nanoparticles for automotive catalysis.

The shape, size and distribution of nanoparticles and nano-structures are all key to their function and the need for tomographic methods applicable to chemical systems (ranging from the physical to the biological) is therefore pressing, just as it is in the engineering and earth sciences.

In our Critical Review[1] we investigate nanotomographic methods that are open to the materials-oriented chemist and present a range of illustrative examples taken from nanoscale chemistry, along with contiguous sub-disciplines encompassing parts of biology and medicine.

We focus mainly on electron tomography (of which there are several variants), and its life sciences application, such as the study of cellular organelles, magnetotactic bacteria and the nuclear pore complex, and in the physical sciences, including supported catalysts, nanoalloys and binary II–VI compounds and polymers. Three-dimensional spatial resolution of 1 nm^3 is now possible and efforts are afoot worldwide to reach atomic resolution in three dimensions using electron tomography. In anticipation of future developments, we also outline the rudiments of tomography via transmission X-ray microscopy, a technique that will undoubtedly be of tremendous importance, especially with greater access to next-generation synchrotron X-ray sources, such as the new Diamond Light Source in the UK. Other nanotomographic techniques highlighted in the review include atom probe field-ion microscopy (APFIM), a destructive technique applicable to conducting and semi-conducting samples. It uses time-of-flight mass spectrometry to identify single ions combined with position sensitive detection to produce a sensor capable of determining three-dimensional information with excellent resolution in both location and chemical identity. Serial sectioning, in which a three-dimensional model may be constructed from a series of slices, is possible with techniques such as atomic force microscopy and scanning electron microscopy (SEM), coupled with a focussed ion beam (FIB) workstation.

The need for three-dimensional visualisation and analysis at high spatial resolution is likely to increase as nanoscience and nanotechnology become increasingly important – nanotomography will play a key role in understanding structure, composition and physico-chemical properties at the nanoscale.

Reference

1 P A Midgley *et al*, *Chem. Soc. Rev.*, 2007, **36**, 1477 (DOI: 10.1039/b701569k)

Read the full Critical Review 'Nanotomography in the chemical, biological and materials sciences' in issue 9 of Chemical Society Reviews.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Technology in a bottle

Jim Heath talks to Alison Stoddart about the discovery of C_{60} and his more recent adventures

Jim Heath

Jim Heath is Elizabeth W Gilloon professor of chemistry at California Institute of Technology, US, and director of the NanoSystems Biology Cancer Center. His current research spans many areas including nanotechnology, molecular electronics and cancer diagnosis. During his graduate studies with Richard Smalley, Jim was the principal student involved in the discovery of C_{60}.

What prompted you to study nanotechnology?
When I started it wasn't a field. As a graduate student, I was the guy who discovered C_{60}. That became one of the poster children of nanotechnology. Then, almost by accident I moved into the area. I worked at IBM for a while – synthesising silicon nanoparticles. I guess I fell in love with nanotechnology.

Can you describe the experiment where you saw C_{60} for the first time?
We were trying to emulate the surface of a carbon star. This was Harry Kroto's idea. We vaporised carbon with a laser in an environment that contained some of the small molecules that surround a carbon star, and then expelled it into a vacuum so we froze the chemistry very quickly. The first time I put carbon in the machine, I saw C_{60}. We had seen interesting clusters of systems before, but this looked unusual. So, even though we were focusing on small clusters, we decided to always monitor C_{60}. As Harry and I worked on the machine, we realised that C_{60} was a special molecule. I came to the conclusion that it was a closed ball. We had a long debate one day about its structure, we checked out books by Buckminster Fuller and Richard Smalley came up with the structure that night.

It took a while for the scientific community to accept the structure of C_{60}, why was this?
Our experiment was exotic but I thought we had an airtight case. It explained beautifully C_{60}, C_{70}, why we only saw even numbered carbon clusters and why the clusters weren't stable below a certain size. But chemists like to see X-ray crystal structures and NMR spectra and we didn't have these. We only had about 1000 molecules at any given time. But science works by people doubting what you do and pushing you forward.

Were you surprised that C_{60} became so popular?
C_{60} was a curiosity until 1991. Then Huffman and Krätschmer made solid-state C_{60} in gram-sized amounts. In fact, the surprise with C_{60} was how easy it was to make. Suddenly hundreds of groups worldwide were involved with C_{60}. This explosion was the power of having something interesting plus having something in a bottle. This made me realise that I didn't want to do gas phase chemical physics but I wanted to do something in a bottle.

What are your current research interests?
We work in the area of molecular electronics – making perfect electronic circuits that are macromolecular in dimension. In addition, we can make superconductors and thermoelectrics. A thermoelectric converts a temperature difference into a voltage – like an engine with no moving parts or it does the reverse and acts as a coolant. It turns out that solid-state thermoelectrics have limited uses because they aren't very efficient. If you could make them efficient then the rewards are amazing. We have made materials from oxygen and silicon that are close to the world record for thermoelectrics. These could be used in energy recovery systems in computer chips so wasted energy could be recycled.

I also work with cancer. Our goal is to translate molecular network models of cancer that describe how the disease evolves into tools that can be used in the clinic. We want to be able to do 1000 measurements from a finger prick of blood and at a fraction of a penny per measurement. We have made devices that are used by clinicians but it will be a similar advance as for computer chips. Right now, we can take a finger prick of blood and in a few minutes we do about 20 measurements and we ought to be able to do 40 next year. Our devices have no moving parts, they are made of just glass and plastic, because we want them to be practically free.

These two projects aim to tackle at least pieces of major global problems – energy and world healthcare.

What is your ultimate goal in the cancer project?
Take diabetes – it's a disease which has been transformed by technology over the last few years because you can monitor your glucose levels and take control of the disease. I would be interested to know if you could do this for cancer. It may be possible to detect cancer early on, before clinical signs, and you can always cure it at that point.

What is the secret of being a successful scientist?
It is important to be a good experimentalist, pick the right problems, look across different fields and collaborate with other scientists. When picking a problem, the pathway must be richer than the problem itself – so you have a chance of discovering something interesting along the way. It also helps to recognise when you are lucky.

Essential elements

Five fast and first-rate years

As celebrations for the fifth year of publishing for *Organic & Biomolecular Chemistry* (*OBC*) continue, RSC Publishing staff have been reflecting on the activities and successes.

Launched in 2003, *OBC* was built on the foundations laid by its predecessors *Perkin Transactions 1* and *2*. The intention was to ensure a strong international presence in the organic community – which has already been fulfilled. Not only does *OBC* have a competitive impact factor of 2.874, it also boasts quicker publication times than any of its competitors.

'The achievements over the first five years have been tremendous,' commented *OBC* editor Vikki Allen, 'and with the continued help of our authors, referees and readers we anticipate a first-rate future.'

As part of the celebrations for five successful years of publishing, the journal has featured a series of 'Top 5 articles' from a variety of geographic areas, plus members of the Editorial Board have selected their favourite five articles published in the journal since launch.

Benjamin List, the winner of the 2007 *OBC* Lecture Award, spoke about the challenges for chemists during his lecture on organocatalysis at the 20th International Symposium: Synthesis in Organic Chemistry in July. Whatever the future challenges across the broad organic spectrum of synthetic, physical and biomolecular chemistry, articles published in *OBC* are sure to be at the forefront.

Read more at www.rsc.org/obc

Packed with energy

One of the major challenges for the twenty-first century is the development of cleaner, sustainable sources of energy. The chemical sciences will play a critical role in successfully overcoming such issues, and the RSC is devoted to addressing them and working toward a better, cleaner future.

For more news on energy related research from RSC Publishing, please visit www.rsc.org/energy

Issue 30 of *Journal of Materials Chemistry* hosts a theme issue dedicated to New Energy Materials. Guest edited by M. Saiful Islam (University of Bath, UK) and including contributions from a range of internationally acclaimed authors, the issue highlights some of the latest developments in energy conversion and storage technologies making it a must-have for all scientists interested in energy research.

With the fastest publication rates in the industry and a soaring impact factor of 4.287 (a staggering increase of 58% over the past 2 years), *Journal of Materials Chemistry* has a well deserved reputation for excellence in the field.

Materials chemistry will play a critical role in developing energy-related applications and therefore it is particularly timely to publish a focused set of articles covering this. The issue contains more than 20 articles on a range of topics, including: fuel cells, lithium-ion batteries, solar cells and hydrogen storage, and additionally hosts several feature, application and highlight articles.

Further information can be found at www.rsc.org/materials

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