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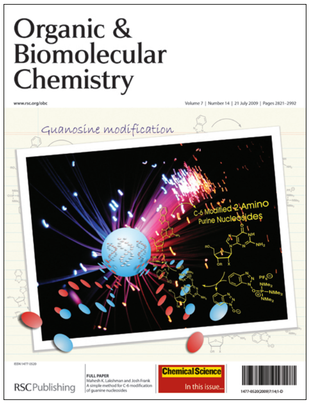
IN THIS ISSUE

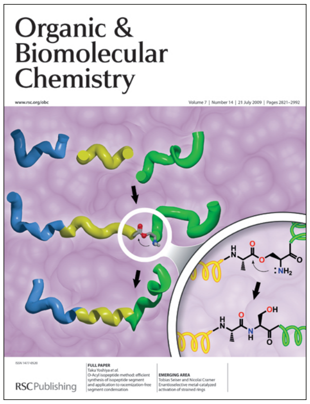
ISSN 1477-0520 CODEN OBCRAK 7(14) 2821–2992 (2009)



Cover

See Mahesh K. Lakshman and Josh Frank, pp. 2933–2940. Nucleoside analogues are highly important in biochemistry, biology and medicine. Modified guanosine nucleosides are now easily accessible via novel O^6-(benzotriazol-1-yl) derivatives. The authors thank Satish Lakshman for designing the cover art.

Image reproduced by permission of Mahesh K. Lakshman from *Organic & Biomolecular Chemistry*, 2009, **7**, 2933.



Inside cover

See Taku Yoshiya *et al.*, pp. 2894–2904. Orexin-B, a 28-residue neuropeptide associated with food craving and wakefulness, was efficiently synthesized by solution phase racemization-free O-acyl isopeptide segment condensation.

Image reproduced by permission of Yoshiaki Kiso from *Organic & Biomolecular Chemistry*, 2009, **7**, 2894.

CHEMICAL SCIENCE

C49

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

Chemical Science

July 2009/Volume 6/Issue 7

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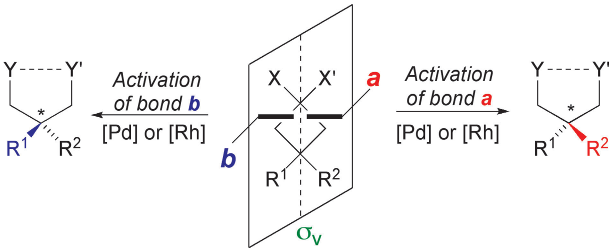
EMERGING AREA

2835

Enantioselective metal-catalyzed activation of strained rings

Tobias Seiser and Nicolai Cramer*

Activation of otherwise inert bonds has significant potential in the design of efficient and synthetically useful transformations. This article describes recent developments in the field of enantioselective activations of strained rings.



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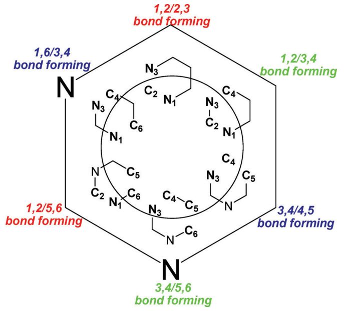
PERSPECTIVE

2841

Recent highlights in the synthesis of highly functionalized pyrimidines

Marco Radi, Silvia Schenone and Maurizio Botta*

The pyrimidine scaffold represents an important pharmacophore and is present in many pharmacologically active compounds. This perspective article will briefly outline the most interesting approaches recently reported for the synthesis of highly functionalized pyrimidines.



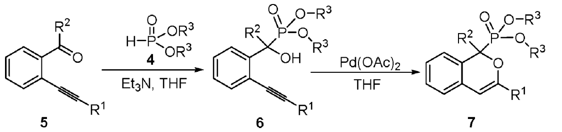
COMMUNICATIONS

2848

Efficient syntheses of phosphonylated isochromenes by regioselective 6-*endo-dig* addition to carbon-carbon triple bond catalyzed by Pd(OAc)$_2$

Fei Wang, Zhiwei Miao* and Ruyu Chen*

Palladium(II)-catalyzed cycloisomerization of [(2-alkynylphenyl)hydroxymethyl]phosphonates **6** provides an efficient route to phosphonylated isochromenes **7** in THF at room temperature and the reaction proceeded in a regioselective manner leading to the 6-*endo-dig* products **7** in moderate to excellent yields.



R^1 = butyl, Ph, p-MeC$_6$H$_4$, p-FC$_6$H$_4$ R^2 = H
R^3 = CH$_3$, C$_2$H$_5$, n-C$_3$H$_7$, i-C$_3$H$_7$, n-C$_4$H$_9$

2851

Size-dependent cation transport by cyclic α-peptoid ion carriers

Chiara De Cola, Sabina Licen, Daniela Comegna, Emiddio Cafaro, Giuseppe Bifulco, Irene Izzo,* Paolo Tecilla* and Francesco De Riccardis*

The synthesis, conformational features, binding to alkali metal ions and membrane transport of new lipophilic cyclic *N*-benzyloxyethyl α-peptoids are disclosed.

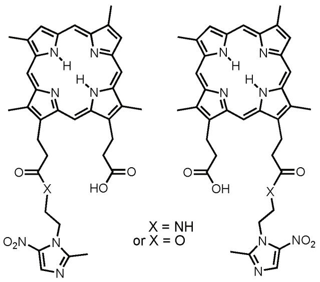
PAPERS

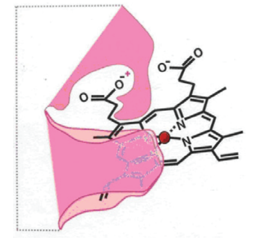
2855

Porphyrin-linked nitroimidazole antibiotics targeting *Porphyromonas gingivalis*

Benjamin C.-M. Yap, Grace L. Simpkins, Charles A. Collyer, Neil Hunter and Maxwell J. Crossley*

Rational design based on active site for porphyrin recognition and synthesis of porphyrin-linked nitroimidazole antibiotics as alternatives to currently used broad-spectrum nitroimidazole antibiotics. These exhibit superior potency and selectivity towards a key pathogen of periodontal disease.





Active site model for porphyrin recognition by *P. gingivalis*

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September 6-11 2009, Haifa, Israel

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Christian Amatore
David Avnir
Christopher W. Bielawski
Aaron Ciechanover
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Josef Michl
Eiichi Nakamura
David N. Reinhoudt
Jeremy Sanders
Dieter Schlüter
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See you in Haifa!

Invited Speakers

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Alessandro Bagno
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Matthias Bickelhaupt
R. Stan Brown
Guy Lloyd-Jones
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Einar Uggerud

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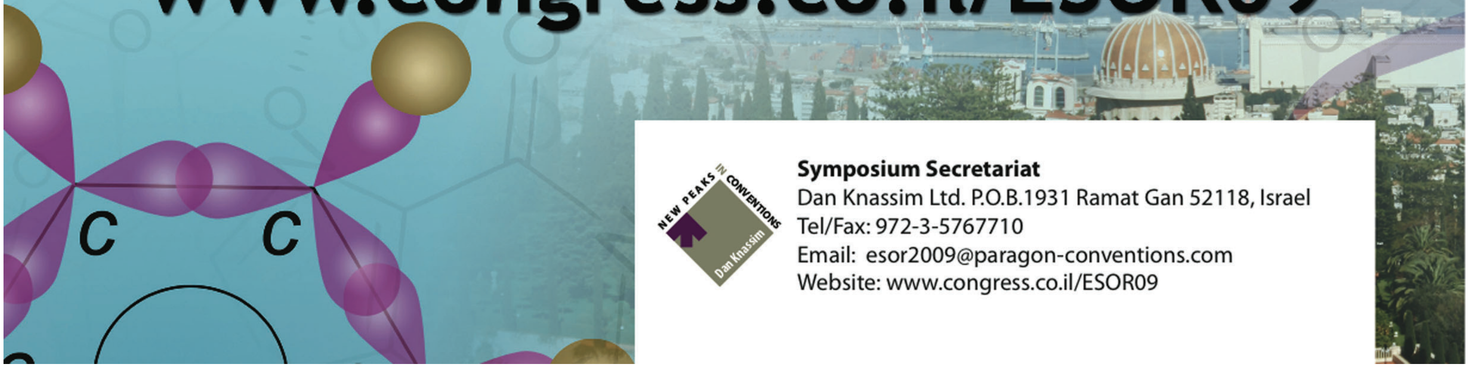

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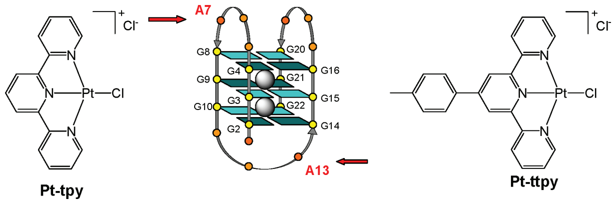
2864

Exclusive platination of loop adenines in the human telomeric G-quadruplex

Hélène Bertrand, Sophie Bombard,* David Monchaud,
Eric Talbot, Aurore Guédin, Jean-Louis Mergny,
Renate Grünert, Patrick J. Bednarski and
Marie-Paule Teulade-Fichou*

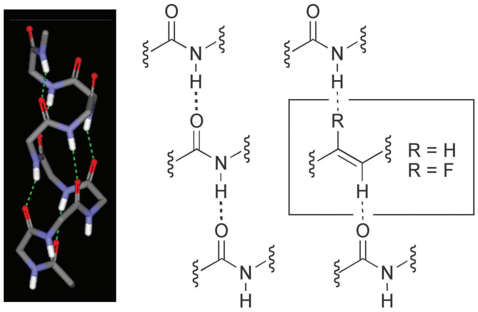


Exclusive platination of adenines located in the loops of the human telomeric G-quadruplex is observed using Pt(II)-terpyridine derivatives. This single-site platination evidences the involvement of the loop residues in small molecule accommodation by G-quadruplex DNA.

2872

Peptide bond mimicry by (*E*)-alkene and (*Z*)-fluoroalkene peptide isosteres: synthesis and bioevaluation of α-helical anti-HIV peptide analogues

Shinya Oishi,* Hirotaka Kamitani, Yasuyo Kodera,
Kentaro Watanabe, Kazuya Kobayashi, Tetsuo Narumi,
Kenji Tomita, Hiroaki Ohno, Takeshi Naito, Eiichi Kodama,
Masao Matsuoka and Nobutaka Fujii*

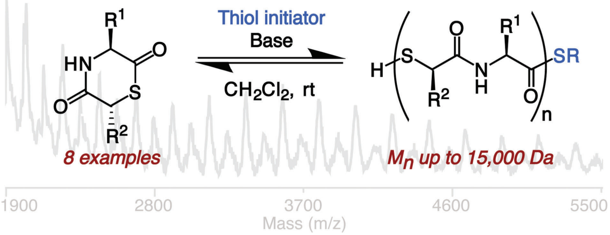


The effect of hydrogen bonds in anti-HIV peptides was evaluated using planar peptide bond surrogates.

2878

Dynamic polythioesters *via* ring-opening polymerization of 1,4-thiazine-2,5-diones

Yasuyuki Ura, Mohammad Al-Sayah, Javier Montenegro,
John M. Beierle, Luke J. Leman and M. Reza Ghadiri*

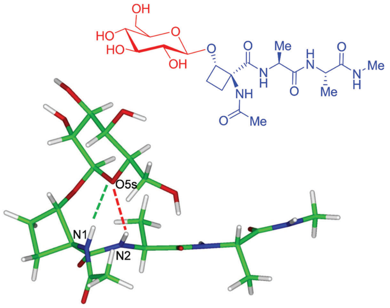


Novel thioester-based polymers that undergo dynamic constitutional exchange under mild conditions can be generated *via* reversible ring-opening transthioesterification of several 1,4-thiazine-2,5-dione monomers.

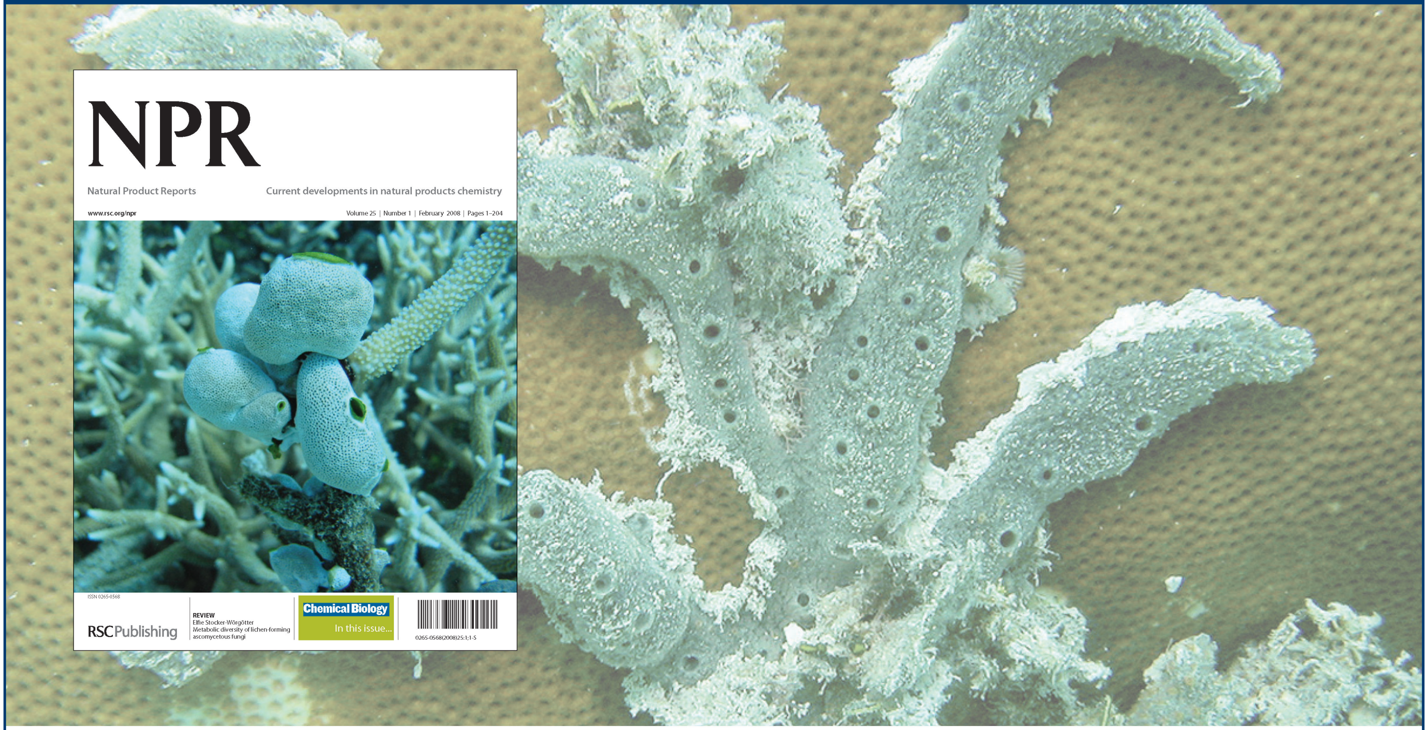
2885

Stabilizing unusual conformations in small peptides and glucopeptides using a hydroxylated cyclobutane amino acid

Alberto Fernández-Tejada, Francisco Corzana,*
Jesús H. Busto, Alberto Avenoza and Jesús M. Peregrina*



The first example of a glycopeptide containing a carbohydrate moiety linked to an underlying non-natural amino acid residue is reported. In contrast to natural derivatives, the carbohydrate moiety appears to stabilize extended conformations of the peptide due to the existence of inter-residue hydrogen bonds.

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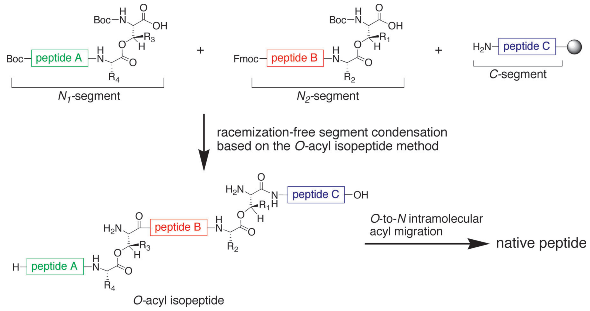
2894

O-Acyl isopeptide method: efficient synthesis of isopeptide segment and application to racemization-free segment condensation

Taku Yoshiya, Hiroyuki Kawashima, Youhei Sohma, Tooru Kimura and Yoshiaki Kiso*

We report an *O*-acyl isopeptide method-based racemization-free segment condensation reaction. The sequential condensation reactions using isopeptide segments containing C-terminal Ser/Thr residues were successfully completed without epimerization.

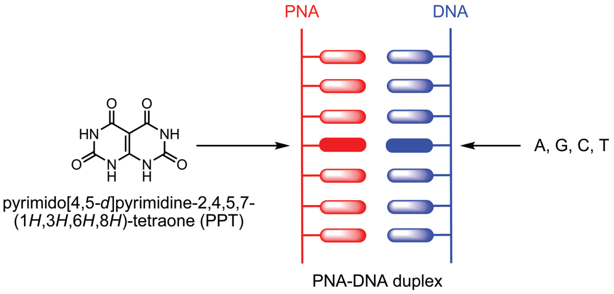


2905

Peptide-nucleic acids (PNAs) with pyrimido[4,5-*d*]pyrimidine-2,4,5,7-(1*H*,3*H*,6*H*,8*H*)-tetraone (PPT) as a universal base: their synthesis and binding affinity for oligodeoxyribonucleotides

Taisuke Hirano, Kenji Kuroda, Masanori Kataoka and Yoshihiro Hayakawa*

Peptide-nucleic acids including PPT as a nucleobase were synthesized, and their binding affinity for the complementary oligodeoxyribonucleotides was investigated.

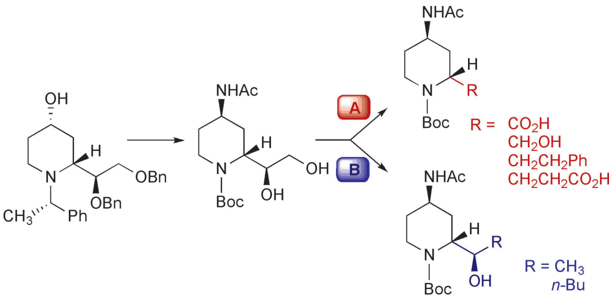


2912

Stereocontrolled synthesis of orthogonally protected 2-substituted 4-aminopiperidines

Ramón Badorrey, Elsa Portaña, María D. Díaz-de-Villegas* and José A. Gálvez*

A rapid entry to 2-substituted 4-aminopiperidines starting from the carbohydrate chiral pool is reported. In the described protocol the stereoselectivity of the procedure is fully guaranteed and controlled.

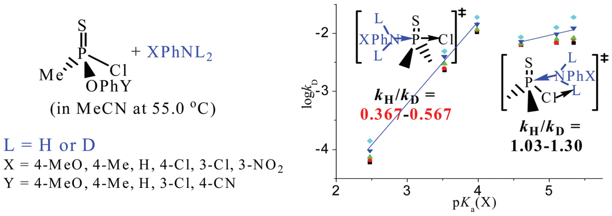


2919

Concurrent primary and secondary deuterium kinetic isotope effects in anilinolysis of *O*-aryl methyl phosphonochloridothioates

Md. Ehtesham Ul Hoque, Arun Kanti Guha, Chan Kyung Kim, Bon-Su Lee* and Hai Whang Lee*

The title reactions, in MeCN at 55.0 °C, exhibit discrete non-linear free energy correlations. Deuterium kinetic isotope effects involving deuterated anilines ($XC_6H_4ND_2$) are primary ($k_H/k_D = 1.03–1.30$) for stronger nucleophiles whereas they are extremely large secondary inverse ($k_H/k_D = 0.367–0.567$) for weaker nucleophiles.



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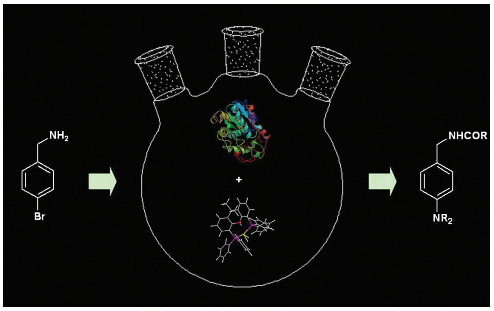
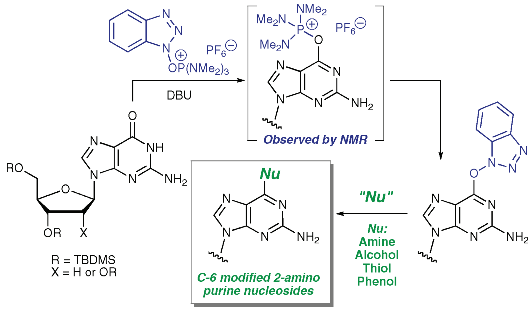


Synergy between chemo- and bio-catalysts in multi-step transformations

Aldo Caiazzo, Paula M. L. Garcia, Ron Wever,
Jan C. M. van Hest,* Alan E. Rowan* and Joost N. H. Reek*

The successful combination of a lipase catalyzed amidation with palladium catalyzed coupling reactions was achieved on the same substrate. An unexpected synergistic effect between the chemo- and bio-catalysts was observed.

2933

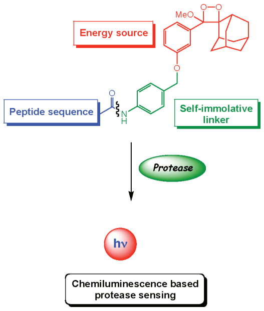


A simple method for C-6 modification of guanine nucleosides

Mahesh K. Lakshman* and Josh Frank

Chemical modification at the C-6 position of guanine nucleosides can be readily accomplished through SNAr reactions of the easily synthesized O^6-(benzotriazol-1-yl) nucleoside derivatives with amine, alcohol, thiol and phenol nucleophiles.

2941

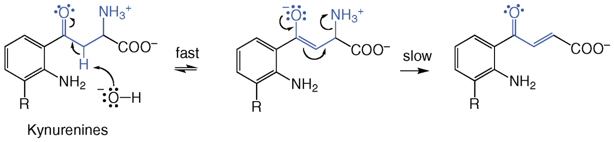


Self-cleavable chemiluminescent probes suitable for protease sensing

Jean-Alexandre Richard, Ludovic Jean, Caroline Schenkels,
Marc Massonneau, Anthony Romieu* and
Pierre-Yves Renard*

Reactive chemical adaptors were used to design the first chemiluminescent probes suitable for detecting protease activities. The PABA traceless linker proved to efficiently release the light-emitting phenolic 1,2-dioxetane moiety under physiological conditions through an enzyme-initiated domino reaction.

2958



Kinetics and mechanism of thermal decomposition of kynurenines and biomolecular conjugates: Ramifications for the modification of mammalian eye lens proteins

Lyudmila V. Kopylova, Olga A. Snytnikova,
Elena I. Chernyak, Sergey V. Morozov,
Malcolm D. E. Forbes* and Yuri P. Tsentalovich*

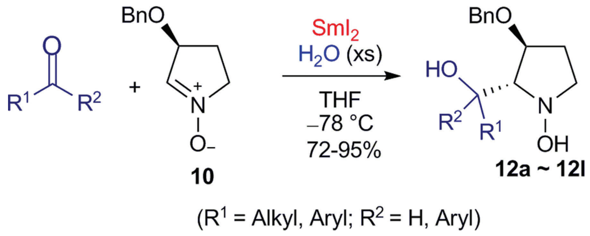
Kynurenines are UV-filter compounds found in mammalian eye lenses, whose degradation leads to age-related cataract disease. The mechanism of one such pathway, deamination, proceeds by generalized base catalysis.

2967

A new approach to 3-hydroxyprolinol derivatives by samarium diiodide-mediated reductive coupling of chiral nitrone with carbonyl compounds

Shao-Feng Wu, Xiao Zheng,* Yuan-Ping Ruan and Pei-Qiang Huang*

A new approach to *trans*-(3*S*)-hydroxyprolinol derivatives was developed based on the SmI_2-mediated reductive coupling of the (*S*)-malic acid derived chiral nitrone **10** with carbonyl compounds.

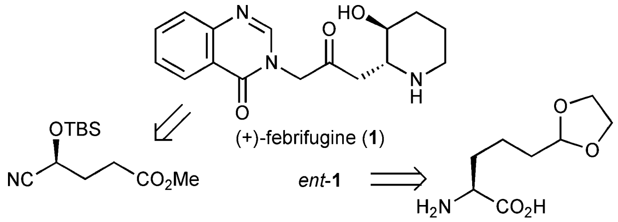


2976

Complementary chemoenzymatic routes to both enantiomers of febrifugine

Marloes A. Wijdeven, Rutger J. F. van den Berg, Roel Wijtmans, Peter N. M. Botman, Richard H. Blaauw, Hans E. Schoemaker, Floris L. van Delft and Floris P. J. T. Rutjes*

Two different complementary chemoenzymatic strategies to both enantiomers of febrifugine have been developed.

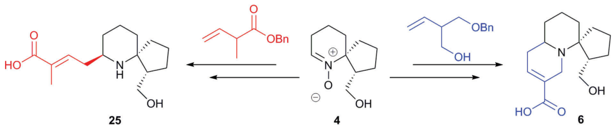


2981

A concise approach to the core structures of pinnaic acid and halichlorine

Sung-Hyun Yang, G. R. Clark and Vittorio Caprio*

A highly concise synthesis of the azaspiro[4.5]decane core structures of the marine anti-inflammatory alkaloids pinnaic acid **25** and halichlorine **6** is described from key spirocyclic nitrone **4**. This synthesis is highly amenable to scale up and to the preparation of an array of structural analogues.

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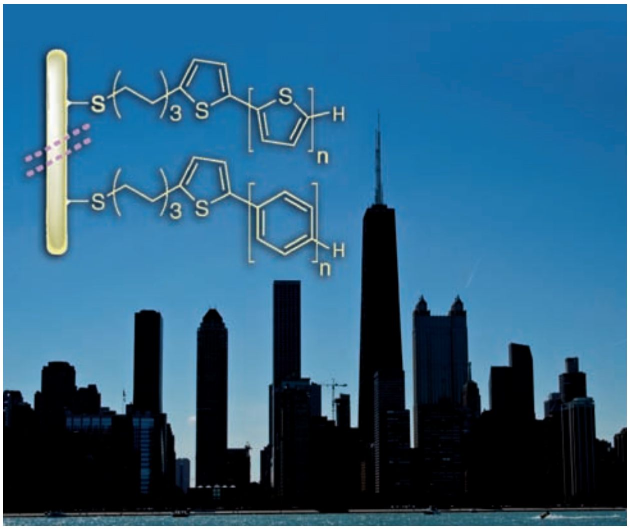
July 2009 / Volume 6 / Issue 7 / ISSN 1478-6524 / CSHCBM / www.rsc.org/chemicalscience

Chemical Science

Scientists brush up on biofuel cells for powering medical implants

Skyscraper approach to nanoelectronics

Scientists based at the University of Georgia, US, have grown conjugated polymer brushes directly onto monolayers, producing films with thicknesses less than 42 nanometres. This is a significant breakthrough for nanotechnology as existing techniques for creating electronics on the nanoscale are reaching their limits.



Polymer brushes were grown on gold monolayers in a skyscraper approach

Previous attempts to grow conjugated polymers on monolayers have had limited success. Using a modified Kumada-type catalyst-transfer polycondensation, Jason Locklin and his team grew polyphenylene and polythiophene brushes, from aryl Grignard monomers, on gold monolayers. They analysed the polymer brushes using cyclic voltammetry, polarisation modulation-infrared reflection-adsorption spectroscopy and atomic force microscopy. ‘This surface-initiated polymerisation technique allows one to create conjugated polymer films in a controlled fashion,’ Locklin comments. The technique ‘allows for a high density of functional groups to be obtained in a limited area. This has been called the skyscraper approach.’

‘Locklin’s work represents another important addition to the synthetic toolbox for generating functional polymer brushes,’ says Wilhelm Huck, an expert in macromolecular chemistry at the University of Cambridge, UK. ‘I am confident that we will see a lot more work on conjugated polymer brushes and with improvements in synthesis, hopefully, improvements in device performance will follow.’

With potential applications in electroluminescent and photoelectric devices, batteries and organic electronics, it may be difficult to know which to study further. Locklin sees his polymer brushes being used for the construction of enzymatic biofuel cells for powering cochlear implants and pacemakers, and biochemical sensors. ‘Individual polymer chains serve as molecular wires, facilitating efficient charge transport between a fuel cell catalyst and the electrode to which it is attached,’ he says. He is, however, realistic: ‘There are many issues that must be overcome before this technique can be applied to real-world devices.’

Ian Coates

Reference

S K Sontag, N Marshall and J Locklin, *Chem. Commun.*, 2009, 3354 (DOI: 10.1039/b907264k)

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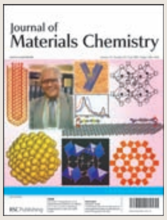
Hisashi Yamamoto is inspired by chess, Buddhism and food. Find out more in this month’s interview



A snapshot of the latest developments from across the chemical sciences

Scientists find a new use for the food thickening agent

101 uses for guar gum

LUCID COLLOIDS

Guar gum comes from the shrub *Cyamopsis tetragonoloba*

Scientists from Japan and India have produced a temperature-sensitive film from guar gum.

Guar gum, a polysaccharide, is a cheap and environmentally friendly material produced naturally by a leguminous shrub. A range of industries use the gum but its inability to form gels and high-quality films has limited its use.

Now, Jun-ichi Kadokawa from Kagoshima University and colleagues have discovered a way to produce a thin film from the gum. They did this by treating the gum with an ionic liquid, 1-butyl-3-methyl-imidazolium chloride, and heating the mixture until the gum had dissolved. They then cooled the mixture and treated it with organic liquids. The team compressed the resulting gel to form a stable film.

The film has a high tensile strength and Kadokawa says it can conduct electricity as efficiently as semi-conductors. Uniquely, the film hardens upon heating but becomes soft again as it cools. These properties mean that it could be used to produce temperature sensors.

The method could also be extended to produce films from other polysaccharides and solvents, but first Kadokawa and his team want to understand the gel's structure and properties.

Yoshiaki Yuguchi, an expert in polysaccharide gels at the Osaka Electro-Communication University in Japan, says: 'This research has the potential of producing an advanced novel material. Polysaccharides are usually used in the food industry, but this technology is developing a new field.'

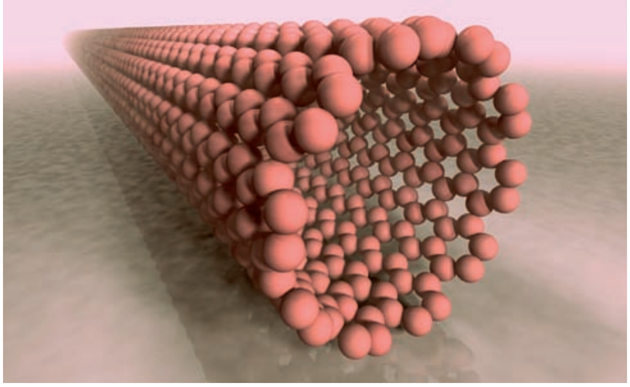
Harriet Brewerton

Reference

K Prasad *et al*, *J. Mater. Chem.*, 2009, **19**, 4088 (DOI: 10.1039/b903332g)

Mixtures of useful nanotubes can be separated without destroying either type

Sorting out carbon nanotubes



Chinese scientists have developed a method to separate mixtures of metallic and semiconducting single-walled carbon nanotubes (SWCNTs) by a two-step dispersion–centrifugation process.

Hao-Li Zhang's team at Lanzhou University revealed that the key to their separation strategy is in the strong interactions between SWCNTs and aromatic molecules. The team found that by carefully choosing the aromatic molecule, this caused the two types of nanotube to disperse differently in an organic solvent. They then centrifuged the mixture, firstly extracting the metallic SWCNTs and then the semiconducting ones. They discovered that linear anthracene and pentacene derivatives were more efficient at extracting the metallic SWCNTs and the best results were obtained using solvents in which the nanotubes are moderately soluble, such as *N*-methylpyrrolidone or dimethylformamide.

Current procedures for making carbon nanotubes result in the formation of both metallic and semiconducting types. These exhibit different properties: metallic nanotubes can be used to make electrical wires and semiconducting nanotubes have shown promise in nanoscale electronic devices.

It's important to separate metallic and semiconducting nanotubes as the mixtures can't be used directly in many applications

'Because the metallic and semiconducting SWCNTs have different properties, the mixture cannot be used directly in many applications, such as electronic and photovoltaic devices. Therefore, it is very important to separate them,' explains Zhang. Previously reported methods for separating the nanotubes involved either the destruction of one type or complicated, low-yielding processes.

Shanju Zhang, an expert in carbon nanotube-based nanocomposites at the Georgia Institute of Technology, Atlanta, US, comments that this is 'a simple method that provides a promising route to a way of separating SWCNTs. This method would be very useful for future nano-electronic applications.'

Elizabeth Davies

Reference

C-H Liu *et al*, *Phys. Chem. Chem. Phys.*, 2009, DOI: 10.1039/b901517e

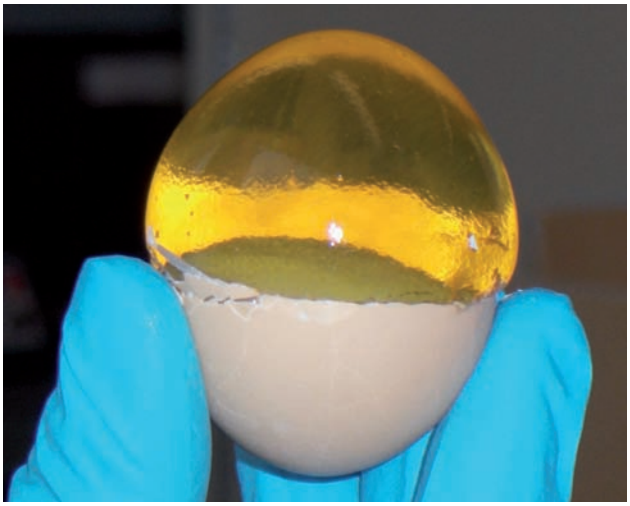
Scientists unravel the mysteries of protein folding with a cookery experiment

A good egg

UK and Dutch scientists have mimicked an ancient Chinese culinary technique of preserving eggs to study how proteins cause disease.

Erika Eiser from the University of Cambridge and colleagues looked at how proteins in egg whites altered during this preservation process. The Chinese method involves wrapping raw eggs in an alkaline paste of lime, clay, salt, ash and tea and storing these so-called century eggs for several months. Eiser modified the method by incubating a boiled egg in a strong alkaline sodium hydroxide–salt solution for up to 26 days.

After peeling back the shell, Eiser found that the egg white had transformed into a gel. This transformation is caused by changes in the way protein strands, called ovalbumin, in the white are held together. Boiling an egg causes bonds between the protein strands to break and the proteins to partially unfold. The proteins then come together, or aggregate, in a different way to form the opaque and brittle white. The transformation was thought to be irreversible, but the alkali causes the proteins in the white to aggregate into fine strands to form a transparent and elastic gel. Eiser found that the gel was more stable than the white, and could be heated without changing its structure.



Hard boiled egg whites become a transparent gel in an alkaline solution

Paul Bartlett, an expert in colloids and protein aggregation at the University of Bristol, UK, comments that Eiser's findings 'will be important for understanding protein gels and will inspire more work in colloidal materials.'

'Similar chemical transformations could be used to change the properties of protein aggregates not only in food but also in other biomaterials,' says Eiser, who plans to test the method on different proteins. 'If we understand the mechanism that drives aggregation then we could slow it down or reverse the aggregation into something else.' This could be important in preventing diseases caused by unnatural protein aggregation such as Alzheimer's.

Anna Roffey

Reference

E Eiser *et al*, *Soft Matter*, 2009, DOI: 10.1039/b902575h

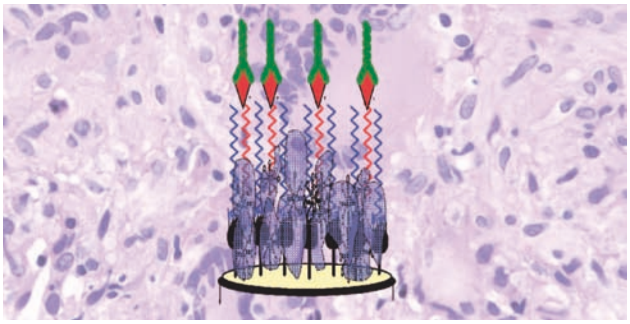
A quick and easy method to diagnose tuberculosis

A golden result for TB diagnosis

South African scientists have devised an electrochemical technique that could provide a quick and easy diagnosis of tuberculosis (TB).

TB is a highly contagious disease and is often a secondary infection that causes death in many HIV/AIDS infected patients, particularly in south-east Asia and sub-Saharan Africa. Current diagnostic techniques involve culture analysis of phlegm from patients and usually take 4–8 weeks. This leads to delayed diagnosis and hinders prompt patient care, explains Kenneth Ozoemena from the Council for Scientific and Industrial Research in Pretoria and the University of Pretoria, South Africa.

Ozoemena and colleagues have now developed an immunosensor that could allow easier TB detection. The team modified a gold electrode with mycolic acid, an antigen that forms the cell walls of the TB bacterium. This allows the electrode to recognise antibodies that are present in an infected patient's blood and results in a change in the electrode response.



A gold electrode is modified to recognise antibodies present in infected blood

By comparison with previous detection methods, the new immunosensors are 100 times more sensitive, says Ozoemena, who is enthusiastic about these results. 'Many people have used electrochemical impedance techniques to detect protein–DNA interactions, but no one has actually considered this technique for TB detection,' he says.

Craig Banks, an expert in electrochemical sensors at Manchester Metropolitan University, UK, points out that 'the sensor shows immense potential for a rapid point-of-care test for TB, but further work is required to fully understand the underlying electrochemical principle.' To this end, Ozoemena has already begun to investigate exactly how the antibodies interact with the electrode's surface. He says that he hopes this work will lead to 'the realisation of a clinical device for fast detection of TB that is cheap and easy to operate, even by non-specialists with minimal training.'

David Sharpe

Reference

N S Mathebula *et al*, *Chem. Commun.*, 2009, 3345 (DOI: 10.1039/b905192a)

Greening up HPLC doesn't necessarily mean diminished performance

The case for using green solvents in HPLC

Is it a good idea to replace HPLC solvents with greener alternatives with low performance capabilities? Christopher Welch and his colleagues at Merck Research Laboratories in Rahway, New Jersey, US, think so.

High performance liquid chromatography is the most widely-used analytical technique in the pharmaceutical industry and acetonitrile is by far the preferred HPLC solvent. 'A pharma company could have over a thousand instruments in operation,' explains Welch, who adds, 'While the amount of waste generated by an individual HPLC is small, the cumulative volume is substantial.'

Recent improvements in HPLC technology mean that greener, but less effective, solvents such as ethanol can be used without a significant loss in analytical capacity. Improved UV detector design has led to an enhanced signal-to-noise ratio and lower-volume mixing has improved the speed of experiments. 'More importantly, there has been a revolution in column packing materials that has led to dramatically improved peak sharpness. The smaller the particles packed into the chromatography column, the better the chromatographic efficiency,' says Welch.


WATERS

A high performance liquid chromatography instrument

Welch tested the solvents with a range of sample mixtures and conditions. He found that while acetonitrile undoubtedly delivers outstanding performance as a HPLC solvent, greener alternatives perform reasonably well, and may be suitable replacements.

'Many analysts are uncomfortable with the idea of giving up any performance, preferring to have as much firepower as possible available for handling whatever scenario may arise,' comments Welch. 'While justifiable in some settings, the fact remains that every bit of excess performance delivered by modern HPLC technology is probably not needed in most cases. As the cost of acetonitrile and the resulting cost in waste disposal continue to escalate, the ethanol alternative becomes increasingly compelling.'

Michael Spencelayh

Reference

C J Welch *et al*, *Green Chem.*, 2009, DOI: 10.1039/b906215g

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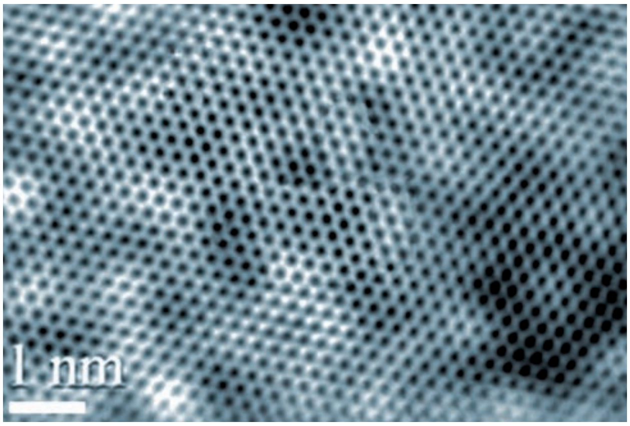
A new breed of flexible electronics, including smart clothing, is a step closer

The worm turns – into graphene

Chinese scientists have found a new route to high-quality graphene sheets for making flexible electronics.

Hongwei Zhu and co-workers from Tsinghua University in Beijing developed a three-step process to synthesise the one atom-thick carbon sheets from worm-like expanded graphite (WEG). WEG consists of a tall stack of graphene sheets, expanded, but not fully separated into individual layers. Graphene is expected to eventually replace silicon in a revolutionary new breed of flexible electronics for applications including smart clothing, for example, health-monitoring sensors embedded in fabric, and foldable displays.

To make the WEG precursor, Zhu mixed natural graphite with sulfuric acid. The acid forced the graphite's layers apart to create a structure with graphite layers held together by sulfuric acid molecules. Zhu heated the resulting compound to decompose the acid, which increased the distance between the graphite sheets even further. He then exfoliated, or repeatedly peeled, the WEG product by ultrasonication and centrifugation to produce the single graphene layers. The graphene was not damaged by these processes; in fact, the individual layers produced were shown by Raman spectroscopy to be almost unchanged from their state in the natural graphite precursor.



The graphene sheet, as seen through a high resolution transmission electron microscope

'Our exfoliation approach combined with advances in the large scale manufacturing of WEG could lead to the development of new and more effective graphene products, for instance, carbon-based flexible electronics,' Zhu says, adding that his method would be easier and cheaper to scale up than existing techniques.

Hannes Schniepp, head of the Nanomaterials and Imaging Lab at The College of William and Mary, Virginia, US, agrees: 'Zhu has optimised the process to yield single-layer graphene sheets of remarkable quality. Having a pathway to produce macroscopic amounts of high-quality graphene is crucial for many applications, making use of its exciting electronic and mechanical properties.'

James Hodge

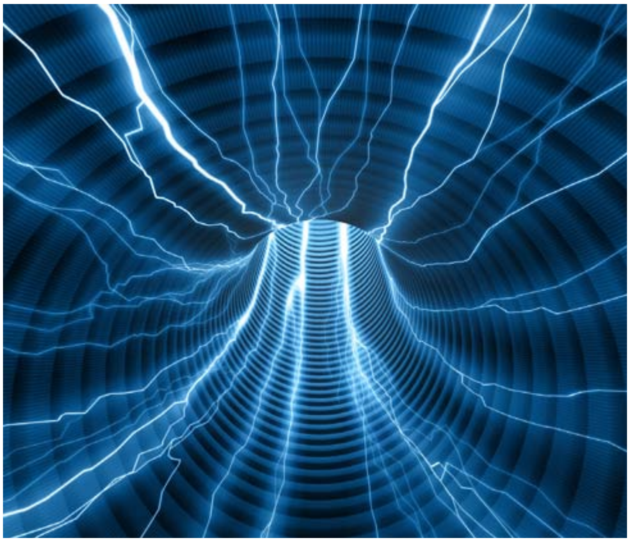
Reference

W Gu et al, *J. Mater. Chem.*, 2009, **19**, 3367 (DOI: 10.1039/b904093p)

Instant insight

Harnessing nano power

Andrei Fedorov from the Georgia Institute of Technology (US) and Mildred Dresselhaus from the Massachusetts Institute of Technology (US) and their colleagues explain how nanotechnology might solve our energy crisis



KTS / DREAMSTIME.COM

The global demand for energy is set to double, if not triple, by the end of the 21st century – harnessing that energy is one of the most pressing global challenges we face. More than 80 per cent of our energy comes from the carbon dioxide-emitting fossil fuel trio of coal, oil and natural gas. Only a small fraction is provided by renewable sources, such as geothermal, wind and solar power, and biofuels. But with the current explosion in economic development and population growth, particularly in China and India, to meet the rising energy demand we would need to increase fossil fuel use to levels that would pose a grave environmental threat. We acknowledge now that a major scientific and societal change is upon us, to convert from a fossil fuel-based energy economy to a sustainable one.

Creating a sustainable energy generation, storage and distribution infrastructure requires massive global investments in research and development. Putting in place a new energy generation, storage and distribution system quickly and on such a large scale will require major scientific discoveries and engineering developments in the next 10–20 years. This is shorter than customary for discovery to technology transitions. These new technologies must provide sufficient energy with minimal environmental impact, and little economic and societal disruption. Solar, thermal and electrochemical energy conversion, storage and conservation technologies are being investigated. At the heart of this revolution in energy technologies are nanoscale science and technology.

Nanoscale design is critical to the next generation of energy carriers

Several aspects of nanoscale design are critical to the development of the next generation of energy technologies. For example, studying the manipulation and control of the fundamental energy carriers – photons, excitons, electrons/holes, phonons and molecules/ions – emphasises the importance of these nanoscale interactions. These studies should enable us to make the greatest impact across the entire spectrum of nanotechnology-enabled energy conversion, storage and conservation technologies.

To see the bigger picture, we must put in place a strategy where mid-term and long-term goals can evolve but must be periodically revisited and re-calibrated based on near-term advances, successes and failures. In the near-term (2–5 years), energy conservation technologies will have a major impact. These include advanced thermal insulation materials for buildings and industrial processes, waste heat conversion into electrical power using thermoelectrics, and technologies such as solid-state lighting based on light-emitting diodes. In the mid-term (5–10 years), hydrogen fuel and devices such as fuel cells will reach the point of becoming competitive in the energy market, especially for transport. The long-term (>10 years) future will rely on solar fuels as truly sustainable energy carriers. These would, with solar energy, use only renewable feedstocks, such as water and carbon dioxide, to produce synthetic liquid fuels.

Nanotechnology research will play a critical part in these developments and will make the systems more efficient and cost effective. The strategic recommendations as discussed above should provide a focus for future research activities. What is also clear, though, is that in addition to these breakthroughs, science and engineering research communities, working with industry and policy makers, will have to educate the next generation's workforce and the general public to preserve our planet's environment for future generations.

Read more in 'Nanoscale design to enable the revolution in renewable energy' in issue 6, 2009, of Energy & Environmental Science.

Reference

J Baxter *et al*, *Energy Environ. Sci.*, 2009, **2**, 559 (DOI: 10.1039/b821698c)


They said it couldn‘t be done...
1 GHz

Tactical thinking

Hisashi Yamamoto is inspired by chess, Buddhism and food. Joanne Thomson finds out more

Hisashi Yamamoto

Hisashi Yamamoto is a professor of chemistry at the University of Chicago, US, where his research group develops more versatile, selective and reactive catalysts for organic synthesis. He has received many awards in recognition of his work, including the Japan Academy Award in 2007 and the American Chemical Society Creativity Award in 2009.

Who or what inspired you to become a chemist?
There was a professional chess player, Kozo Masuda, I liked in Japan. He was very famous but died young. He always said: 'My life is to develop new tactics and strategies.' He invented something new in every game. He is my hero and so, like him, I try to do everything new and original.

When I started my degree I was lucky – I had the chance to work with extremely good chemists. I got my Batchelors degree with Professors Nozaki and Nyori. They were both my mentors. I then moved to the US and worked for Professor Corey. He was very helpful and influenced me a lot. Then I returned to Japan and worked with Professor Jiro Tsuji, a famous palladium chemist. I thank all these people.

Your work focuses on acid catalysis in organic synthesis. What drew you to this area of chemistry?
My target is to find chemical reactions that make molecules efficiently and selectively. I am also interested in asymmetric synthesis using acid catalysis. I initiated chiral Lewis acids over 25 years ago. I then shifted my interests to Brønsted acids as well. The number of people in this area is increasing – sometimes I feel it is a little too crowded.

What are you working on at the moment?
I have nine graduate students and four post docs. Each one is doing something different. I am particularly interested in cascade reactions – everything should go into one pot or into a tube reactor. I believe this is the future of organic chemistry. The big question is how to make molecules in very few steps. If a molecule used to be made in 20 steps but you can now make it in three then that changes the world.

Is the economic crisis making it more difficult for you to obtain funding?
At the beginning of my career it was very difficult to get funding but now it is easier. The economic crisis hasn't hit us too hard at least at the moment. Thanks Mr Obama!

In Japan, the older I get, the easier it is to get funding. In the US, it is much more difficult. You have to write down a lot to justify the funding. I find this quite useful though because I have the chance to think about my projects very seriously – not that I didn't before!

You studied in Japan but now live in the US. How do science and attitudes to science differ between the two countries?
It may sound very diplomatic but both are great. I have been lucky enough to spend time working with young people in both countries. They all have had nice energies and a positive way of thinking.

You travel the world attending conferences. Do you have a favourite destination?
I like Belgium, France, Italy, Japan – anywhere there is good food!

What do you do in your spare time?
I sometimes play golf but most of the time I am thinking about where I can eat nice food!

I am also interested in Zen Buddhism – I like the way of thinking it promotes. I have Chinese brush writing representing the word 'now' in my office. It is a very important word. It means 'no past, no future, no regret or worry – just enjoy the moment'.

What would you be if you weren't a chemist?
I never thought about it. In junior high school I had already started studying organic chemistry by myself. When I finished high school I had finished some university textbooks. I wasn't interested in other fields. Organic chemistry is my life.

Essential elements

New journal: *Polymer Chemistry*

On 1 June, RSC Publishing announced that *Polymer Chemistry* – a new journal encompassing all aspects of synthetic and biological macromolecules, and related emerging areas – will be the latest title to join its journal portfolio.

Launching early in 2010, the journal will provide a showcase for the ongoing efforts driving polymer chemistry, highlighting the creativity of the field and previously inaccessible applications. Monthly issues will contain a full mix of research articles including communications, reviews and full papers. The journal will have a broad scope, covering areas of polymer chemistry of interest to materials scientists and bioscientists, as well as all traditional areas of the field.

Editor-in-chief of *Polymer Chemistry* is David Haddleton of the University of Warwick, UK. In outlining his vision for *Polymer Chemistry,* he describes how the new journal 'will report on the best polymer chemistry from around the globe and will become a high impact factor journal that all polymer chemists will be proud to have on their CV.'

Polymer Chemistry joins an exclusive group of journals launched by RSC Publishing in the past 12 months. *Metallomics* and *Integrative Biology* both published their first issues in January 2009, with new journals *Nanoscale* and *Analytical Methods* due to follow later this year.

The current issue of *Polymer Chemistry* will be freely available to everyone on the website from launch until the end of 2011. Free online institutional access to previous issue content during 2010 and 2011 is also available following a simple registration process.

Visit www.rsc.org/polymers to find out more.

Community embraces RSC–ChemSpider

Hailed by some as 'a scientific "marriage" made in heaven,' news about RSC's recent acquisition of ChemSpider spread fast through the blogosphere and other channels.

ChemSpider, a free online service providing access to almost 21.5 million unique chemical entities sourced from over 200 different data sources and integration to a multitude of other online services, is the richest single source of structure-based chemistry information. Its acquisition reflects RSC's commitment to providing access to premium resources of chemistry data and information. This complements RSC's existing leading role in online chemistry, including award-winning semantic mark-up technology and the release of the InChI resolver, recently launched in partnership with ChemSpider.

Antony Williams, the original host of ChemSpider, is excited by the new possibilities. 'What originally started as a hobby project to give back something to the chemistry community has become one of the primary internet resources for chemistry. And this from home built computers in a basement, with no funding and a team of volunteers,' he says. 'With the resources, reputation and vision of the RSC to support ChemSpider, our long term goal is to deliver the primary online platform where chemists will resource information and collaborate with a worldwide community of scientists.'

The ChemSpider website will be re-launched later in the year. *Visit www.chemspider.com*

Free advertising

Finding the right candidate for your vacancy can be a time-consuming, not to mention costly, process. The good news is that *Chemistry World Jobs*, the website for vacancies in chemistry and the chemical sciences, can make this experience easier for you.

Registration is free, and from 1 July to 30 September advertising your vacancy is also free! Simply register your details to create an account, and then upload your job vacancy or training course. What could be easier?

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Contact recruitment@rsc.org or set up your account today at www.chemistryworldjobs.org

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