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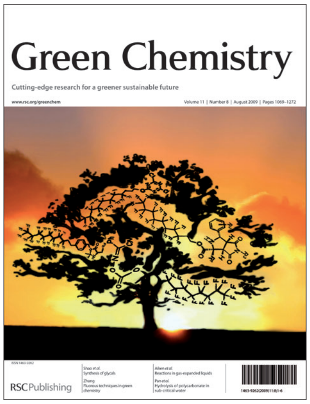
ISSN 1463-9262 CODEN GRCHFJ 11(8) 1069–1272 (2009)



Cover
See Zhang, pp. 911–920.
Fluorous chemistry provides a new green tool for small-scale organic synthesis to address issues in chemical reactions, sample analyses, and product separations.

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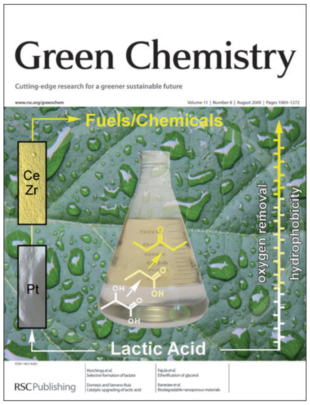

Inside cover
See Dumesic *et al.*, pp. 1101–1104.
A two-bed catalytic process is described to convert aqueous solutions of lactic acid into a spontaneously-separating organic phase that can serve as a source of chemicals and high energy-density fuels.

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HIGHLIGHTS IN CHEMICAL TECHNOLOGY

T57

Highlights in Chemical Technology provides a ‘snapshot’ of the latest applications and technological aspects of research across the chemical sciences from all RSC publications, showcasing newsworthy articles and significant scientific advances.

Highlights in Chemical Technology

August 2009/Volume 6/Issue 8

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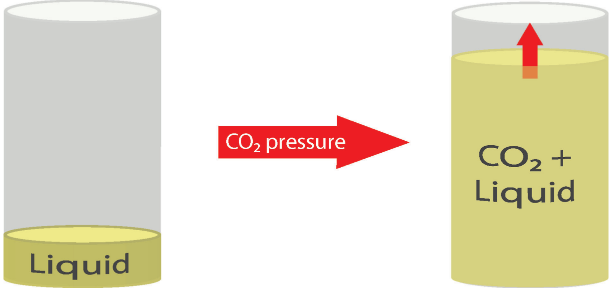
CRITICAL REVIEW

1083

A critical look at reactions in class I and II gas-expanded liquids using CO_2 and other gases

Geoffrey R. Akien* and Martyn Poliakoff*

This short review gives a summary of the publications on reactions in class I and II gas-expanded liquids (GXLs), and draws some conclusions from the trends in the published literature.



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Green Chemistry (print: ISSN 1463-9262; electronic: ISSN 1463-9270) is published 12 times a year by the Royal Society of Chemistry, Thomas Graham House, Science Park, Milton Road, Cambridge, UK CB4 0WF.

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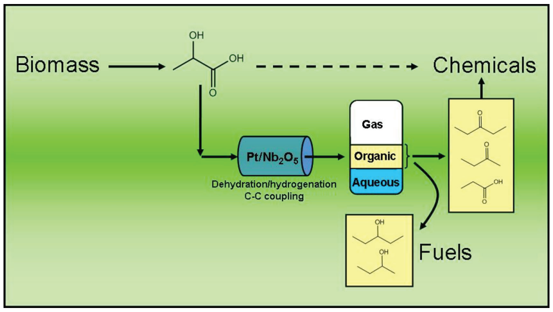
1101

Catalytic upgrading of lactic acid to fuels and chemicals by dehydration/hydrogenation and C–C coupling reactions

Juan Carlos Serrano-Ruiz and James A. Dumesic*

A single-reactor catalytic process is described to convert aqueous solutions of lactic acid into a spontaneously-separating organic phase that can serve as a source of valuable chemicals (propanoic acid and C_4–C_7 ketones) and can be used to produce high energy-density fuels.

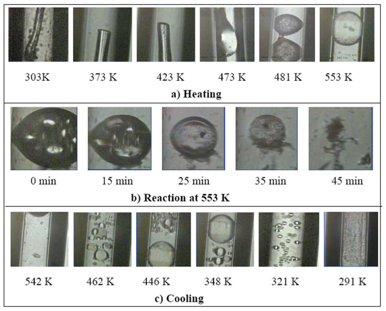


1105

Hydrolysis of polycarbonate in sub-critical water in fused silica capillary reactor with *in situ* Raman spectroscopy

Zhiyan Pan,* I-Ming Chou and Robert C. Burruss

Hydrolysis of bis-phenol A poly(carbonate) (PC) in sub-critical water was studied in fused silica capillary reactors. The phase behaviors were observed under a microscope and the reactants and products were characterized by *in situ* Raman spectroscopy.

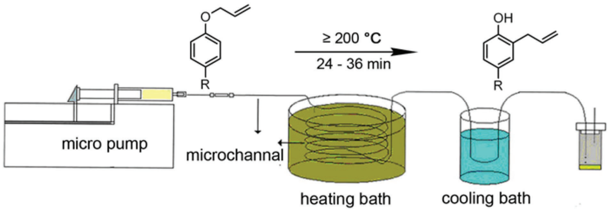


1108

Efficient Claisen rearrangement of allyl *para*-substituted phenyl ethers using microreactors

Lingjie Kong, Qi Lin, Xiaoming Lv, Yongtai Yang, Yu Jia* and Yaming Zhou*

A green way to synthesize allyl phenols has been developed. Quantitative yield of 2-allyl-4-methoxyphenol was obtained *via* a fast Claisen rearrangement in a microreactor system without solvent and work-up.

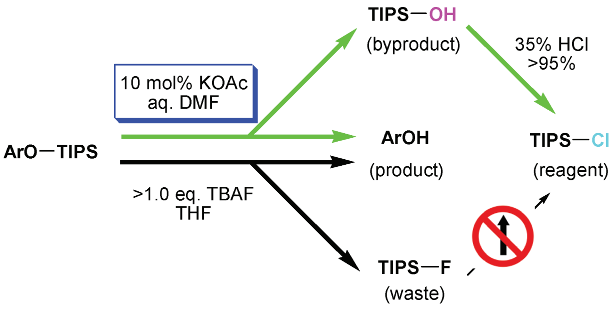


1112

Practical, environment-benign and atom economic KOAc-catalysed deprotection of aryl TIPS ethers under mild fluoride-free conditions

Bing Wang,* Hui-Xia Sun, Bo Chen and Zhi-Hua Sun*

A KOAc-catalysed, fluoride-free protocol achieved efficient and chemoselective deprotection of aryl TIPS ethers as well as greatly improved atom economy and sustainability.



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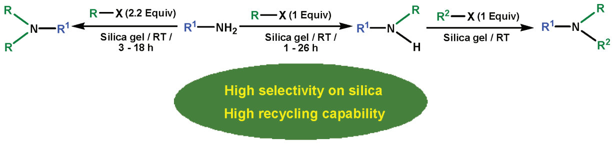
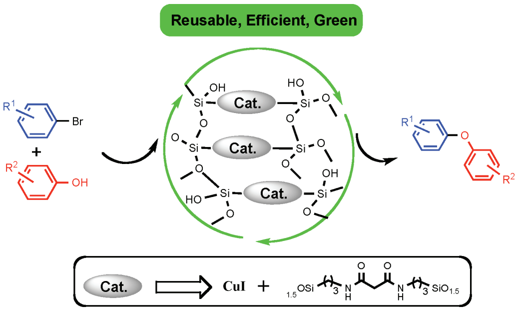


Highly selective *N*-Alkylation of amines promoted on silica: An efficient and recyclable surface

Basudeb Basu,* Susmita Paul and Ashis K. Nanda

A simple and efficient protocol for selective *N*-alkylation promoted on a silica surface is described. A variety of amines and alkyl halides have been tested to establish generalised conditions for high to excellent conversions of mono- or bis-*N*-alkylated products selectively.

1121

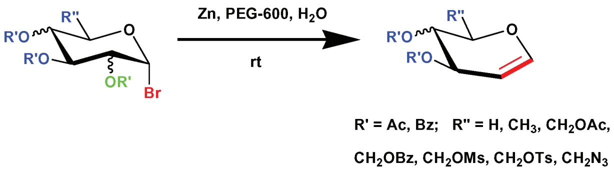


Sol–gel immobilized and reusable copper-catalyst for arylation of phenols from aryl bromides

Sofia Benyahya, Florian Monnier,* Michel Wong Chi Man,* Catherine Bied, Fouad Ouazzani and Marc Taillefer*

A green and sustainable route for diarylether synthesis *via* Cu-mediated Ullmann condensation has been developed based on hybrid sol–gel ligands.

1124



A mild and environmentally benign method for the synthesis of glycals in PEG-600/H_2O

Jinzhong Zhao, Shanqiao Wei, Xiaofeng Ma and Huawu Shao*

Glycals were synthesized *via* a simple, mild, convenient and environmentally benign procedure, in which protected glycosyl bromides undergo the reductive elimination in the presence of zinc in PEG-600/H_2O at room temperature.

PAPERS

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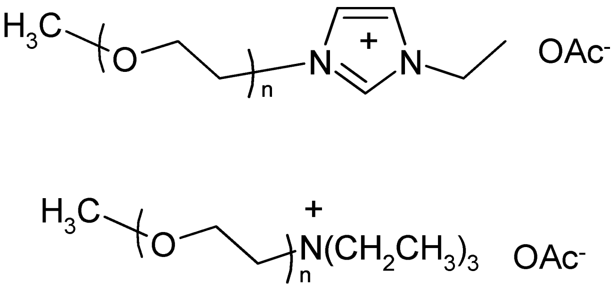


Lipase dissolution and stabilization in ether-functionalized ionic liquids

Hua Zhao,* Cecil L. Jones and Janet V. Cowins

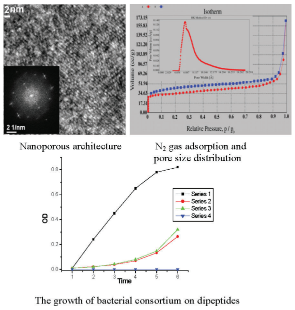
New ether-functionalized ionic liquids are capable of dissolving free lipase B from *Candida antarctica* (CALB), and stabilizing the enzyme at the same time. These new ionic solvents can also dissolve a variety of substrates including sugars, cellulose, L-ascorbic acid, betulinic acid and amino acids.

1139

Water soluble synthetic dieptide-based biodegradable nanoporous materials

Samit Guha, Tushar Chakraborty and Arindam Banerjee*

Two water-soluble dipeptides composed of a hybrid of α and β-amino acids form a new class of dipeptide-based biodegradable nanoporous materials which show excellent adsorption capacity for N_2 gas.



Nanoporous architecture

N_2 gas adsorption and pore size distribution

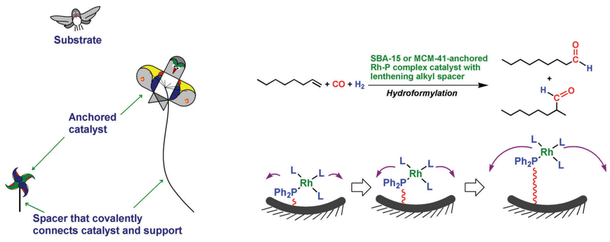
The growth of bacterial consortium on dipeptides

1146

A facile method for promoting activities of ordered mesoporous silica-anchored Rh–P complex catalysts in 1-octene hydroformylation

Wei Zhou and Dehua He*

A facile method for promoting mesoporous silica-anchored Rh–P complex activities in 1-octene hydroformylation was presented by simply lengthening the alkyl spacer that covalently connects the catalyst and the support.

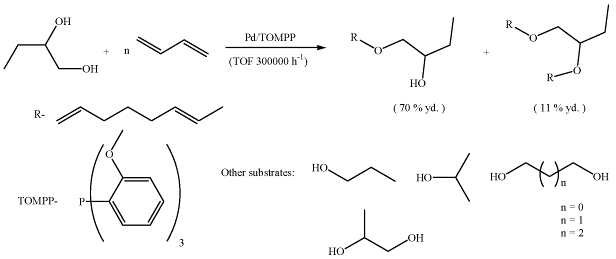


1155

Telomerization of 1,3-butadiene with various alcohols by Pd/TOMPP catalysts: new opportunities for catalytic biomass valorization

Regina Palkovits, Andrei N. Parvulescu, Peter J. C. Hausoul, Cornelis A. Kruithof, Robertus J. M. Klein Gebbink and Bert M. Weckhuysen*

Telomerization of 1,3-butadiene with various biomass-based alcohols was performed over Pd/TOMPP catalyst in a solventless system reaching TOFs up to 300 000 h^{-1} and TONs up to 10 000 in a single reaction run, with good and high selectivities (60–100%) for the mono-telomer.

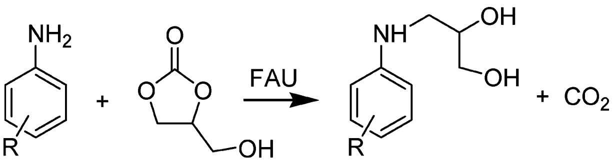


1161

The reaction of glycerol carbonate with primary aromatic amines in the presence of Y- and X-faujasites: the synthesis of *N*-(2,3-dihydroxy)propyl anilines and the reaction mechanism

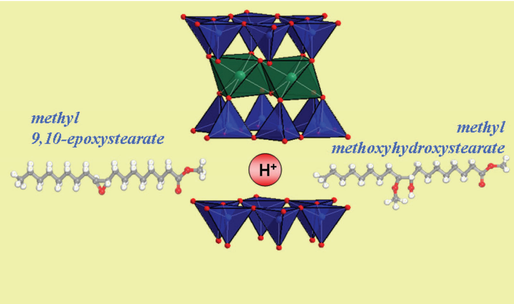
Maurizio Selva* and Massimo Fabris

At 140 °C, in the presence of alkali metal exchanged faujasites, preferably NaY, as catalysts, glycerine carbonate is an efficient and green alkylating agent of primary aromatic amines to produce *N*-(2,3-dihydroxy)propyl anilines (p-$XC_6H_4NHCH_2CH(OH)CH_2OH$).



R = H, OCH_3, Cl, OH
FAU = alkali metal exchanged faujasites

1173



An efficient ring opening reaction of methyl epoxystearate promoted by synthetic acid saponite clays

Matteo Guidotti,* Rinaldo Psaro, Nicoletta Ravasio, Maila Sgobba, Fabio Carniato, Chiara Bisio,* Giorgio Gatti and Leonardo Marchese

Rapid and efficient ring-opening of methyl 9,10-epoxystearate over acid saponite clays for the production of vicinal hydroxyethers and keto-derivatives from epoxidised fatty acid methyl esters.

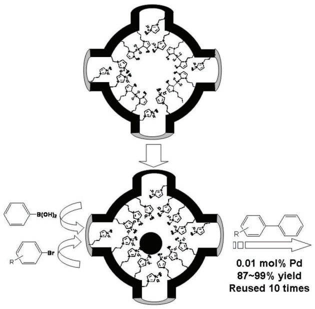
1179

Ionic liquid promoted atom economic glycosylation under Lewis acid catalysis

Jacques Augé* and Gwenaëlle Sizun

Straightforward glycosylation of alcohols gave good to excellent yields in [BMIM][OTf] under Sc(OTf)$_3$ catalysis. The ionic liquid was allowed to be recycled at least three times without loss of activity.

1184

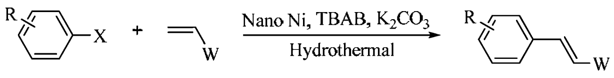


N-Heterocyclic carbene palladium complex supported on ionic liquid-modified SBA-16: an efficient and highly recyclable catalyst for the Suzuki and Heck reactions

Hengquan Yang,* Xiaojing Han, Guang Li and Yunwei Wang

A highly active solid catalyst for the Suzuki and Heck reactions was prepared by grafting the *N*-heterocyclic carbene palladium complex and ionic liquid on the internal surface of mesoporous cage-like material SBA-16.

1194



R = -H, -OCH$_3$, -CH$_3$, -OH, -COOH, -Cl, -NO$_2$.

X = I, Br, Cl.

W = -CO$_2$Me, -CO$_2$Et, -CO$_2$^{n}Bu, -Ph.

Hydrothermal Heck reaction catalyzed by Ni nanoparticles

Wu Zhang,* Hongling Qi, Liusan Li, Xiang Wang, Jie Chen, Kaishan Peng and Zhenghua Wang*

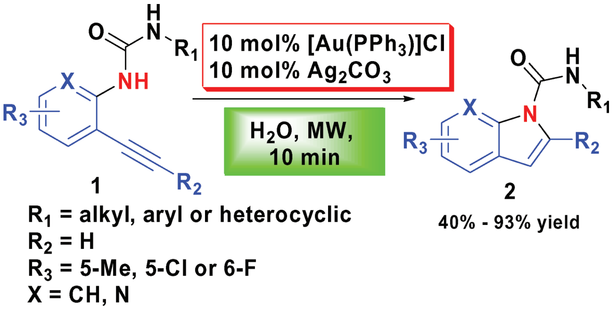
A novel environmentally benign Heck reaction using Ni nanoparticles as catalysts under hydrothermal conditions has been developed. The cheap catalysts retain good to moderate activity for at least six successive runs without any additional activation treatment.

1201

Gold-catalyzed intramolecular hydroamination of terminal alkynes in aqueous media: efficient and regioselective synthesis of indole-1-carboxamides

Deju Ye, Jinfang Wang, Xu Zhang, Yu Zhou, Xiao Ding, Enguang Feng, Haifeng Sun, Guannan Liu, Hualiang Jiang and Hong Liu*

A fast and green route to prepare indole-1-carboxamides from *N′*-substituted *N*-(2-alkynylphenyl)ureas *via* an [Au(PPh$_3$)]Cl/Ag$_2$CO$_3$-catalyzed 5-*endo-dig* cyclization in water under microwave irradiation is described

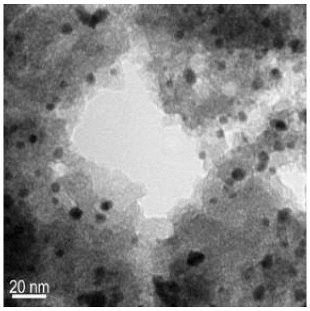


1209

Selective formation of lactate by oxidation of 1,2-propanediol using gold palladium alloy supported nanocrystals

Nikolaos Dimitratos, Jose Antonio Lopez-Sanchez, Sankar Meenakshisundaram, Jinto Manjaly Anthonykutty, Gemma Brett, Albert F. Carley, Stuart H. Taylor, David W. Knight and Graham J. Hutchings*

Au-Pd nanoparticles prepared by sol-immobilisation produce very active and selective catalysts for the oxidation of 1,2-propanediol to lactate.

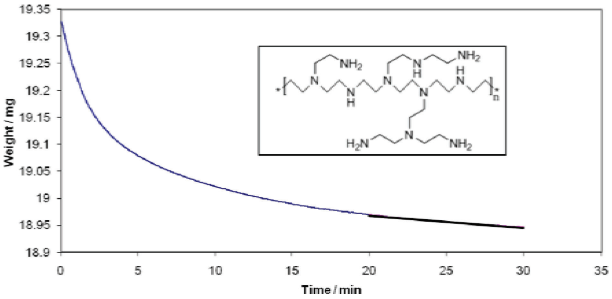


1217

Measurement of vapour pressures of ionic liquids and other low vapour pressure solvents

Ortrud Aschenbrenner, Somsak Supasitmongkol, Marie Taylor and Peter Styring*

The vapour pressures of a number of potential green solvents, including ionic liquids, poly(ether)s and poly(amine)s have been determined using a rapid screening method based on thermogravimetric analysis at elevated temperatures.

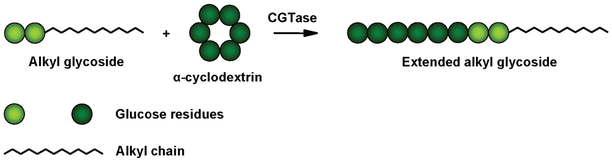


1222

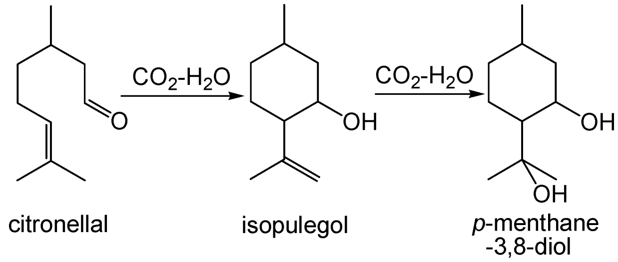
Enzymatic route to alkyl glycosides having oligomeric head groups

David Svensson, Stefan Ulvenlund and Patrick Adlercreutz*

Alkyl glycosides with long carbohydrate groups are synthesized without protection/deprotection reactions using cyclodextrin glycosyl transferase (CGTase) as catalyst in water.



1227

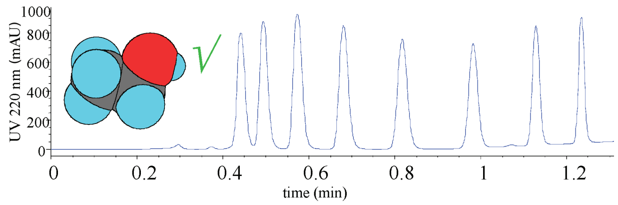


Cyclization of citronellal to *p*-menthane-3,8-diols in water and carbon dioxide

Haiyang Cheng, Xiangchun Meng, Ruixia Liu, Yufen Hao, Yanchun Yu, Shuxia Cai and Fengyu Zhao*

A clean process has been developed for the synthesis of *p*-menthane-3,8-diols from cyclization of citronellal, the cyclization was performed successfully in CO$_2$–H$_2$O medium without any additives.

1232

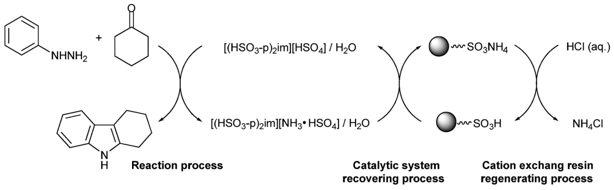


Performance to burn? Re-evaluating the choice of acetonitrile as the platform solvent for analytical HPLC

Christopher J. Welch,* Tanja Brkovic,* Wes Schafer and Xiaoyi Gong

This article re-examines the choice of acetonitrile as the platform organic solvent for HPLC, by addressing the question of whether greener solvents such as ethanol could potentially replace acetonitrile in some instances.

1239

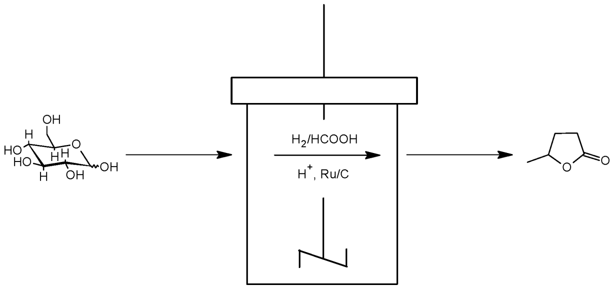


Fischer indole synthesis catalyzed by novel SO$_3$H-functionalized ionic liquids in water

Dan-Qian Xu, Jian Wu, Shu-Ping Luo, Ji-Xu Zhang, Jia-Yi Wu, Xiao-Hua Du and Zhen-Yuan Xu*

Novel SO$_3$H-functionalized ionic liquids were designed and successfully applied as catalysts for the one-pot Fischer indole synthesis in water medium without using any organic solvents.

1247



Combined dehydration/(transfer)-hydrogenation of C6-sugars (D-glucose and D-fructose) to γ-valerolactone using ruthenium catalysts

Hans Heeres, Ratna Handana, Dai Chunai, Carolus Borromeus Rasrendra, Buana Girisuta and Hero Jan Heeres*

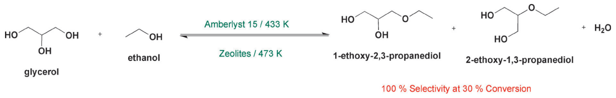
This paper describes the one-pot catalytic synthesis of γ-valerolactone from C6-sugars (D-glucose and D-fructose).

PAPERS

1256

Etherification of glycerol with ethanol over solid acid catalysts

Stephane Pariente, Nathalie Tanchoux and François Fajula*

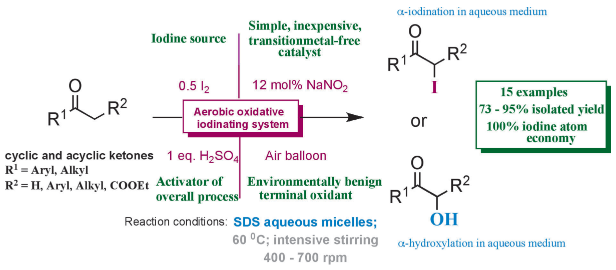


Different types of acidic heterogeneous catalysts, including sulfonic resins, zeolites and grafted silica, are used for the synthesis of mono-ethers of glycerol using ethanol as the alcohol. The study shows that the performances of the catalysts are governed by both the acidity and the polarity of their surface.

1262

Aerobic oxidative iodination of ketones catalysed by sodium nitrite "on water" or in a micelle-based aqueous system

Gaj Stavber, Jernej Iskra, Marko Zupan and Stojan Stavber*



The first example of non-enzymatic aerobic oxidative halogenation of organic compounds in aqueous media was developed using an I_2/air/$NaNO_2$(cat.)/H^+ iodinating system and 0.1 M sodium dodecyl sulfate (SDS) water solution as the reaction media.

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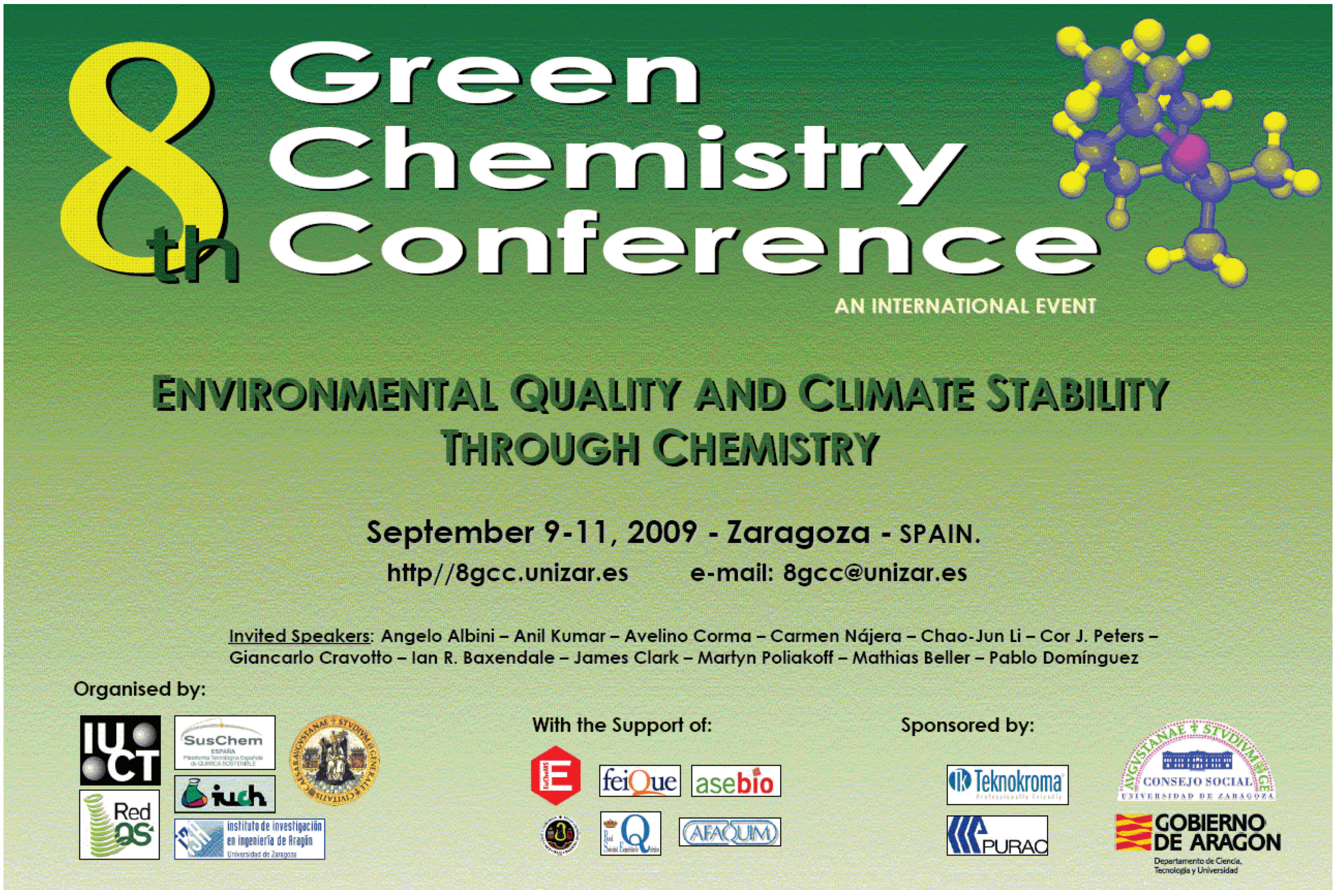

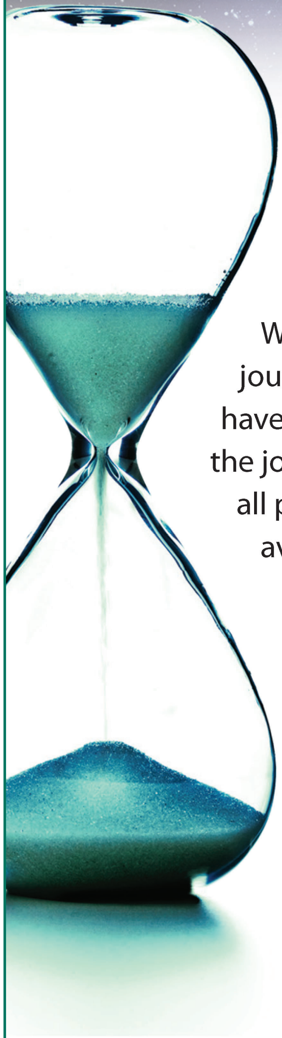

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Salamanca (Spain)

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2. Catalysis for Chemicals and Fine Chemicals
3. Selective Catalytic Oxidation using Environmentally Friendly Oxidants
4. Upgrading Oils and Improving Fuel Quality
5. Purification and Elimination of Pollutants: Chemical and Photochemical Catalysis Processes
6. Chemicals and Fuels from Biomass
7. Coal and Gas to Liquids
8. Hydrogen Production, Purification and Storage
9. Electrocatalysis and Fuel Cells
10. Synthesis of Nanostructured Catalysts
11. Catalysts at Work
12. Single and Multisite Catalysis: Homogeneous, Enzimatic and Cascade Reactions
13. Catalytic Processes, Catalyst Decay and Regeneration
14. High-Throughput Technologies

Plenary Lecturers invited:

- M. S. Rigutto, Shell Research and Technology Centre Amsterdam, The Netherlands (Topic: Present and future challenges in refining and petrochemistry)
- P. T. Anastas, Yale University, USA (Topic: Green chemistry)
- E. Iglesia, University of California at Berkeley, USA (Topic: Kinetics, reaction mechanisms and active sites)
- J. Lercher, Technical University of Munich, Germany (Topic: Activation of alkanes)
- P. Gallezot, IRCELYON, France (Topic: Biomass to chemicals)
- A. Corma Canós, Instituto de Tecnología Química, UPV-CSIC, Spain (Boudart Award Lecture)

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Highlights in Chemical Technology

Broken TVs turned into biocompatible materials

Expanding waste to reduce waste

ERICG1970 / DREAMSTIME.COM

Plastic from LCD screens can be recycled

Polymer waste from discarded TV and computer screens can be transformed into a high value material that could be used in biomedicine, say UK scientists.

James Clark and colleagues at the University of York expanded the structure of waste polyvinyl alcohol (PVA) from liquid crystal display (LCD) screens to form a mesoporous material with a high surface area. Because PVA is biocompatible, Clark claims the expanded PVA could be used for enzyme immobilisation, tissue scaffolds or drug delivery, all of which require high surface area substrates.

The team heated the PVA in water in a microwave, refrigerated it for 12 hours then washed it with ethanol to give the expanded product. They found that iodine, which is present in waste PVA, is essential for the expansion process.

LCD waste from electrical and electronic equipment is the fastest growing waste stream in the European Union. Although PVA is not a major environmental hazard, wasting it consumes a non-renewable resource, explains Clark. 'Reuse in new LCDs is unlikely, so we need to find new applications for this plastic and thus avoid turning a useful material into a burden on the environment,' he says.

Martin Goosey, an expert in electronics at Loughborough University, UK, celebrates the research. 'There are increasing numbers of LCDs being discarded and this technique provides an exciting new method for recovering materials that would otherwise go to waste,' he comments.

Clark's team is currently looking at other waste streams to identify more potentially useful components.

Amaya Camara-Campos

Reference

A J Hunt *et al*, *Green Chem.*, 2009, DOI:10.1039/b906607a

In this issue

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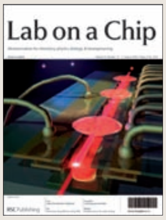
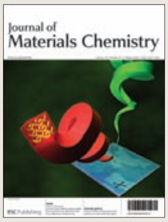




The latest applications and technological aspects of research across the chemical sciences

Application highlights

Hydrogen production turned on and off with the flick of a light switch

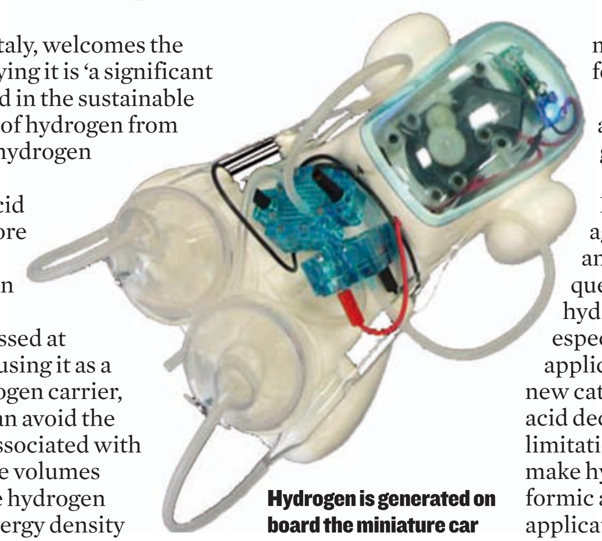
Phototriggered fuel production

Light significantly accelerates hydrogen generation from formic acid, according to a report by German scientists. Combining the process with a small fuel cell could create a power source suitable for replacing batteries in laptops and other mobile devices, they claim.

Matthias Beller and colleagues at the University of Rostock used a ruthenium catalyst to break down formic acid into hydrogen, which can be used to power a fuel cell, and carbon dioxide. They found that shining a light on the reaction mixture increased the reaction rate, meaning they could turn hydrogen production on or off by controlling the light source. To demonstrate the potential of their system, the team created a miniature hydrogen-powered car.

Serafino Gladiali, an expert in catalysis at the University of Sassari, Italy, welcomes the research saying it is 'a significant step forward in the sustainable production of hydrogen from renewable hydrogen donors'.

Formic acid contains more hydrogen per litre than hydrogen gas compressed at 350 bar. By using it as a liquid hydrogen carrier, scientists can avoid the problems associated with storing large volumes of explosive hydrogen gas. 'The energy density of formic acid is five to 10 times higher then the current lithium ion batteries,' explains Beller. 'One molecule of catalyst can generate up to 300 000 molecules of hydrogen, which makes the catalyst attractive for small scale applications.'



Hydrogen is generated on board the miniature car

Reference

B Loges *et al*, *Chem. Commun.*, 2009, 4185 (DOI: 10.1039/b908121f)

Gabor Laurenczy, an expert in hydrogen generation at the Federal Polytechnic School of Lausanne, Switzerland, agrees. 'Hydrogen storage and delivery are the central questions for the future hydrogen-based economy especially for mobile and off-grid applications,' he comments. 'The new catalysts for selective formic acid decomposition overcome the limitations of previous systems and make hydrogen generation from formic acid viable for practical applications.'

Beller says the team are continuing to develop prototype power sources and he hopes the catalytic system will be used in mobile devices in the future. *Russell Johnson*

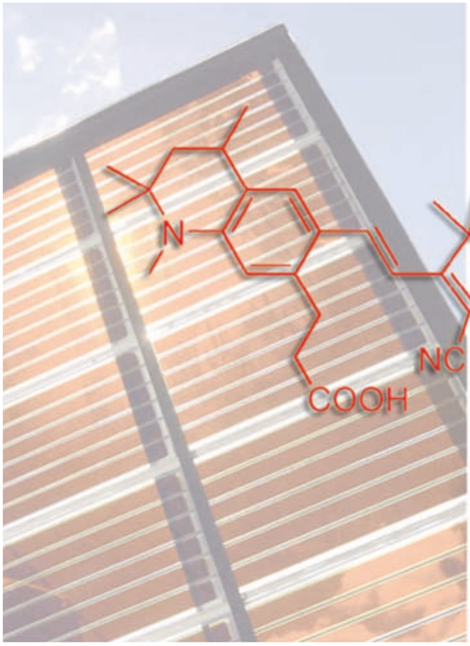
Redesign of dye structure enhances efficiency of energy conversion

Lateral thinking for solar cells

A new way of anchoring dyes in organic solar cells improves their performance, says an international team of scientists.

Dye-sensitised solar cells (DSCs) contain an organic dye that releases electrons when excited by sunlight. The electrons are transferred to a semiconductor to generate electricity. The dye consists of a donor unit and an acceptor unit separated by a spacer group. Most DSCs use cyanoacrylic acid coupled to the acceptor unit to anchor the dye to the semiconductor. However, this makes it difficult to modify the dye's structure to improve the cell's performance.

Xichuan Yang, at Dalian University of Technology, China, and colleagues changed the anchoring group to propanoic acid and attached it as a lateral chain to the donor unit. By separating the anchor from the acceptor, the team could easily modify the donor and acceptor units' structures to tune the dye's absorption spectra. Their new dyes were better at absorbing near infrared light than previously reported dyes of this type and so were more efficient at converting sunlight to electricity.



The anchor is separated from the acceptor so the donor and acceptor can be easily modified

'This strategic change opens up possibilities for the design and synthesis of a new generation of organic dyes with broad absorption spectra and high molar extinction coefficients,' comments Yang.

The next challenge is to examine the mechanism of electron transfer, Yang adds. 'The excited electrons in these dyes are supposed to be injected into the semiconductor through the acceptor moiety rather than the lateral anchoring group. More experimental studies of the behaviour of these dyes on the surface and the electron injection pathways need to be conducted,' he says. *Edward Morgan*

Reference

L Sun *et al*, *Chem. Commun.*, 2009, 4031 (DOI: 10.1039/b908396k)

Molecularly imprinted polymer removes flavour-altering vitamin from drinks

The science of longer lasting lager

Chemists have designed a polymer that can improve the shelf life of drinks, including beer.

One of the long-standing problems in the drinks industry is how to prevent chemical processes in the drinks compromising their taste, quality and shelf life. In particular, riboflavin (vitamin B2) is responsible for driving photooxidation reactions that affect the flavour of many drinks and so they often have to be packaged in light-shielded containers.

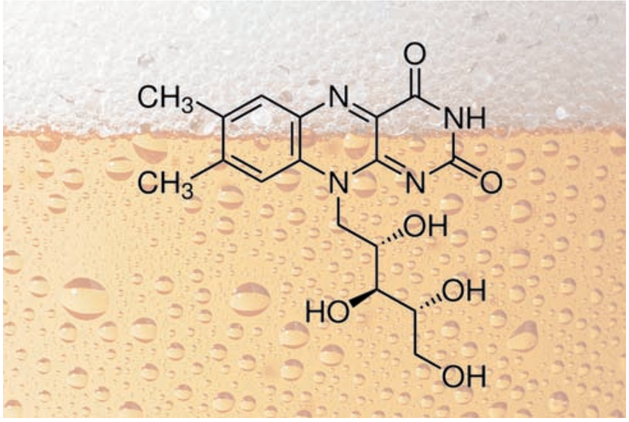
Now Börje Sellergren, at the Technical University of Dortmund, Germany, and colleagues have developed a way of removing riboflavin. They imprinted riboflavin-shaped pockets into a polymer by synthesising it in the presence of riboflavin tetra-acetate template molecules. Removing the templates left empty receptor pockets, which the team showed could capture and remove riboflavin from milk, beer and multivitamin mixtures.

According to Sellergren, his molecularly imprinted polymer is unlike many others designed to capture or detect small molecule targets because it performs well in aqueous systems. It can extract up to 86 per cent of the riboflavin compared to 47 per cent for the corresponding non-imprinted control polymer, he explains. 'Food analysis and processing is a field that would profit from such receptors,' he says. 'Generic techniques to prepare fully water-compatible molecularly imprinted polymers will become important for unlocking such applications.'

Nicholas Snow, a separation science specialist at Seton Hall University, South Orange, US, says the work represents 'an important transition [for molecularly imprinted polymers] from being artificial receptors used in laboratory applications to being scrubbers capable of selectively removing unwanted, toxic or irritating compounds from many types of consumer products'.

A significant proportion of the riboflavin is still removed by non-specific hydrophobic binding interactions, says Sellergren. The next step is to refine further the polymer preparation process to reduce the non-specific binding, while retaining the integrity and activity of the specific binding pockets.

David Parker



Riboflavin degrades in light, affecting the taste of drinks

Reference
P Manesiotis *et al*, *J. Mater. Chem.*, 2009, DOI: 10.1039/b906117g

Multiple reactions performed simultaneously could accelerate drug discovery

Click chemistry on a chip

US scientists have used a microfluidic device to perform over 1000 click chemistry reactions at once. The device could speed up the discovery of new enzyme inhibitors for treating diseases such as cancer.

Hsian-Rong Tseng, at the University of California, Los Angeles, and colleagues purified all 1024 reactions using solid phase extraction and analysed them using mass spectrometry.

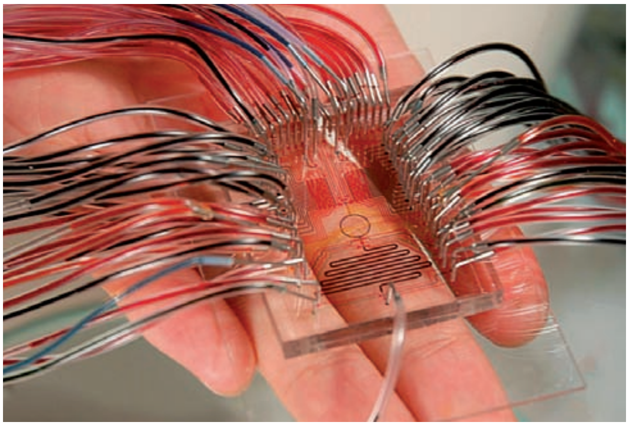
In situ click chemistry uses azide and alkyne building blocks that react (click) to form triazoles inside the binding pocket of an enzyme, which acts as a template and guides product formation. Because the resulting triazoles fit well into the binding pocket, they are potential inhibitors of the enzyme.

Tseng explains that the traditional way of screening libraries of in situ click reactions is time-consuming and uses a lot of reagents. 'Our system enables large-scale screening with minimum sample consumption,' he says – the device mixes tiny amounts of reactants with great precision and without cross contamination. Many more reactions can be performed at once, he adds.

'This is a great example of how miniaturisation can transform the process of library screening,' says Andrew deMello, a microfluidics expert at Imperial College London, UK. 'What's especially clever is how they have integrated their microfluidic platform with both sample clean up and mass spectrometry analysis. This drastically reduces both analysis times and sample requirements.'

'We hope to explore the use of our microchip for other screening reactions where reagents and samples are in limited supply,' comments Tseng. This includes a class of enzymes called kinases, which play critical roles in the malignant transformation of cancer, he says.

Fay Nolan-Neylan



1000 reactions in a hand

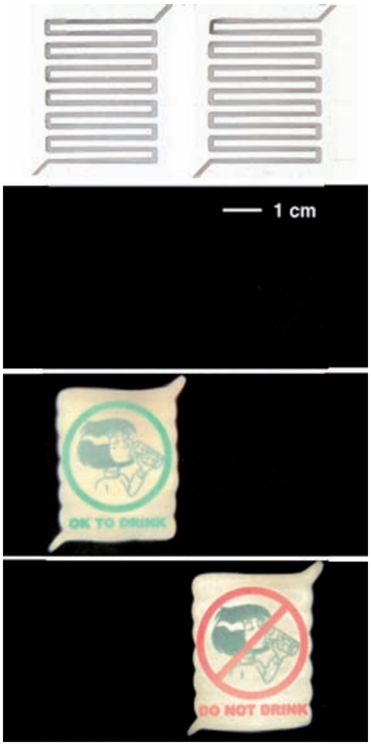
Reference
Yanju Wang *et al*, *Lab Chip*, 2009, DOI: 10.1039/b907430a

Cheap electronic display for point-of-care diagnostics

Paper displays hidden messages

US scientists have turned a sheet of paper into a cheap, lightweight and foldable electronic display.

George Whitesides and colleagues at Harvard University, Cambridge, printed a message on one side of the paper and patterned the other side with conductive wires. They then sprayed a thermochromic (changes colour with temperature) dye over the message. When they passed an electrical current through the wires, the heat generated changed the dye from coloured to transparent, revealing the message underneath. The colour change is reversible, says Whitesides, and after cooling, the device can be used more than 100 times again.



Picture messages allow complex instructions to be communicated to populations with high illiteracy or where multiple languages are used

Point-of-care diagnostics is an important field, especially for developing countries, where access to medical and analytical resources is limited. Adam Siegel, who worked on the project, says the team wanted to avoid expensive, complex equipment. 'The goal was to make a simple display that will give very clear information in the language of the person using the device, or even in picture form,' he comments. The display is easier to make and cheaper than current electronic display technologies – it costs less than six pence per square metre – which makes it accessible and practical for single-use applications, such as medical tests. And because it is made from non-toxic components, it can be easily disposed of.

Shuichi Takayama, an expert in point-of-care diagnostics at the University of Michigan, Ann Arbor, US, thinks there is a lot of scope for this kind of technology. 'You can envision having a paper computer and a paper cell phone,' he says.

The team say they hope that this display will be used as part of larger, more complex systems. They envisage that a signal from an electrochemical sensor testing water purity, for example, could be converted into a current that causes the thermochromic display to reveal the purity result. *Anna Roffey*

Reference
A C Siegel *et al*, *Lab Chip*, 2009, DOI:10.1039/b905832j

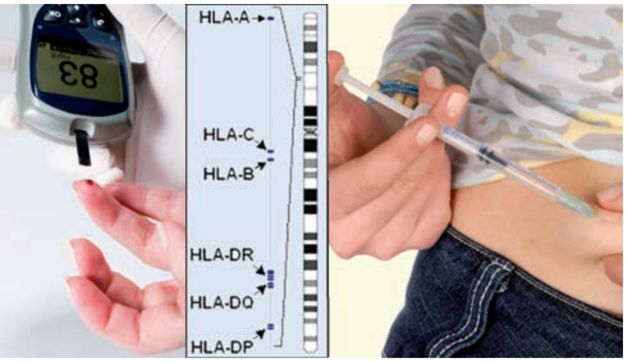
Probe nucleotides detect variations in gene sequences

Fluorescence brings genetic disease to light

Genetic disease markers could be distinguished using fluorescent probes, according to Italian scientists.

A large degree of genetic variance, known as polymorphism, exists between individuals. These genetic differences mostly involve only one nucleotide, but they can be linked to genetic disease.

Alessandra Andreoni at the University of Insubria, Como, and colleagues used fluorescent nucleotides to identify single nucleotide polymorphisms in a group of genes associated with the development of type 1 diabetes. The nucleotides had a fluorescent label at one end and a quencher at the other and contained either a complementary sequence of the gene region or polymorphic variations.



Detecting variations in genes could reveal a patient's susceptibility to diseases, such as diabetes

Polymorphic probes don't bind as well as the complementary probe to the gene sequence, explains Andreoni. The polymorphic probes bend, bringing the quencher closer to the fluorescent label and so decreasing the fluorescence decay time.

'More efficient quenching at reduced label–quencher distance reveals more errors in the probe-to-target sequence matching,' says Andreoni. This enabled the team to determine the degree of base mismatch quantitatively, an improvement over the 'yes or no' binding information provided by other methods. They also were able to identify the specific base change for each target.

'We could reliably type [identify] the targets by using a single probe and working with a few millilitres of low concentration targets,' states Andreoni. 'We are thus confident that our technique can be used to diagnose non-amplified genome samples. As sequence variants, though not necessarily directly pathogenic, are often linked to the occurrence of diseases, the possibility to perform wide range screening of the relevant genes would give a powerful tool in disease prediction.'
Michael Spencelayh

Reference
A Andreoni *et al*, *Photochem. Photobiol. Sci.*, 2009, DOI: 10.1039/b906043j

Interview

The beauty of molecules

Omar Yaghi is trying to solve the clean energy problem. Elizabeth Davies investigates

Omar Yaghi

Omar Yaghi is the Jean Stone Professor of Chemistry at the University of California, Los Angeles, US, and is ranked among the top 10 most highly cited chemists worldwide. He has received many awards for his work, including the 2009 American Chemical Society Chemistry of Materials Award and the International Izatt-Christensen Award in Macrocyclic Chemistry. He is the inventor of metal–organic frameworks (MOFs), zeolitic imidazolate frameworks (ZIFs) and covalent organic frameworks (COFs).

What inspired you to become a scientist?

I became interested in chemistry as a child after I saw stick and ball drawings of several molecules such as water and methane. It was attractive because the secret of a material was revealed by knowing the chemical structure. At that time, I felt like I was discovering something that was hidden about these materials. It was a lot of fun. I always wanted to dig deeper to find what was behind the phenomena and that was really my attraction to chemistry. That's not to say I was born to do chemistry or that I was set on chemistry from the outset. I think all that came later once I started doing chemistry.

You have been an instrumental player in the chemistry of MOFs, COFs and ZIFs. Of which achievement are you most proud and why?

We're very passionate about making sure that what we do is new and exciting and I don't really have any single event or result that I am most proud of. Although, in retrospect, the synthesis of MOF-5 was a turning point in MOF chemistry because, for the first time, we were able to take an inorganic unit and an organic unit and put them together into a pre-determined structure. The synthesis showed new ways of making materials and the properties broke the porosity record, so this was exciting.

The gas storage ability of MOFs has been the focus of much research recently. Where do you see the field in 10 years?

Already, we are very close to using some of these MOFs in automobile fuelling by natural gas. I think that materials of this kind (MOFs, COFs or ZIFs) are going to be the materials that allow room temperature hydrogen storage. They have already shown exceptional properties in the capture of carbon dioxide. We will also see them used in high value, high performance type applications, such as imaging or drug transport. In the long run, we will see MOFs that are capable of more complex functions. I think, ultimately, and this is something we are aiming for, you will be able to design MOFs that have been modified to produce low-coordinated metals which hopefully we can use to activate carbon dioxide. Instead of capturing carbon dioxide and pumping it underground, we want to be able to convert it into a fuel.

Lots of your work has an impact in the wider media. How important do you think it is to get chemistry this kind of exposure?

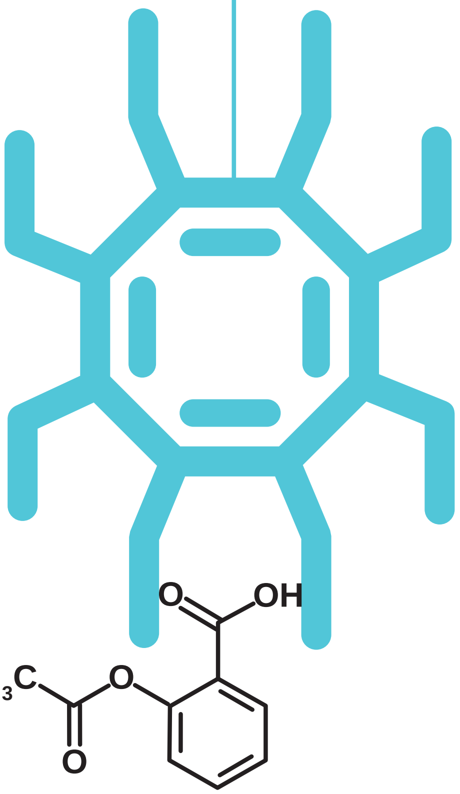
It's good and bad. It's good for society and younger people who aspire to do something useful in their life to see that chemistry is not some exclusive club. I think it is important for them to see that chemistry is a field that has important implications in our daily lives. So that's the positive side. The negative side is that sometimes the media simplifies things so much that the reader is given the wrong information or impression about various aspects of chemistry. I find the scientific media to be much more careful than the general media. In general, the media attention that some of our results has received has had a lot of positive impact.

What advice would you give to a young scientist who wants to pursue a career in materials chemistry?

My advice is do it because you love doing it. If I had set out to solve the hydrogen storage problem, I may have completely missed the discovery of MOFs, COFs and ZIFs. Part of discovery has to do with a guided plan or a plan that is grounded in sound science. But also another part of it, a good part, is keeping your eyes open to what nature might be telling you to do.

If you weren't a scientist what would you be?

By nature, I enjoy doing solitary things and I am very good at learning things very quickly. I think that I would have made a good pianist or a good gardener. In both, nature reveals itself to you in a very measurable way – in the beauty of music and in terms of product in the garden. You cultivate your tree and at the end of it you get a very nice orange. Now you can see why I enjoy being a synthetic chemist because at the end of the day, I have a product in my hand that has colour, smell, character and shape. So you feel you've done something productive.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Instant insight

Detecting danger

Can science end the threat of terrorism? Michael Knapp and Meaghan Germain at the University of Massachusetts, Amherst, US, explain chemistry's key role

MATTPHOTO / DREAMSTIME.COM

Explosive sensors can detect the tri- and di-nitrotoluene given off by landmines

In this modern age, marred by terrorism and deadly explosives, identifying and then neutralising hidden threats is crucial to restoring the personal safety of both civilian and military populations. Without such confidence, travel and economic development would suffer. Consider the civil disruption that results in war-torn countries when a trip to visit loved ones or purchase food at the market carries with it the danger of a hidden landmine or an improvised explosive device (IED).

In the distant past, landmines and related devices had metal casings and could be identified with metal detectors. Modern explosives, however, rely increasingly on plastic components. Asymmetric warfare has increased our awareness of the danger of IEDs manufactured by terrorists in clandestine labs. Consequently, intelligence and military agencies need to identify threats by detecting the chemical components used in explosives manufacturing.

Chemists play a key role in this search for new explosives sensors. Chemical explosives encompass a variety of compounds, including nitro-organics, nitramines and peroxides, making universal explosives detection challenging. Each class of chemical explosives presents its own hurdles to detection, such as nitramine and peroxide's low vapour pressures, but clever chemistry and engineering can overcome such challenges. Because explosives combine strong oxidants with fuel, detection is possible through a combination of chemical reactivity and molecular recognition. For example, trinitrotoluene (TNT) and its degradation product, dinitrotoluene (DNT), are unique chemical signatures of many landmines, making them a common target for explosives detection.

Detection requires that a chemical response, such as the binding of TNT, leads to a sensor output, such as a change in a spectroscopic signal or a unique molecular decomposition pattern. Each detection approach must balance various factors, such as the analyte's physical properties, the potential for false positives or negatives and the instrument's portability. A single sensor is seldom universally applicable.

Some of the most exciting advances have been made in optical sensors. They show great promise for minimising the cost and operator training needed for threat detection while maximising portability and sensitivity.

Optical detection techniques have focused on either fluorescence quenching, which relies on molecular recognition and the electron-accepting nature of explosives, or colorimetric assays, which rely on a chemical reaction of explosives to produce a new colour. Each of these approaches can be implemented as hand-held kits or sensors that are both cheap and easy to use.

Because current fluorescence-quenching sensors rely on molecular recognition, they are typically specific for only one class of explosives (nitroaromatics but not nitramines, for example). Developing fluorescence sensors responsive to a broad range of explosives would represent a significant advance for this field, as it would enable a richer identification of threats. Further utility could come from discriminating between related compounds, such as different nitroaromatics (for example DNT versus TNT) through a sensor array, which could reduce the instances of false positives and negatives.

Fluorescence turn-on sensing, in which explosives chemically react to create a new fluorophore, is one approach that is growing in importance. It combines the advantage of sensing by chemical specificity with an increased signal intensity to indicate the presence of explosives.

Chemists have much to contribute to maintaining our confidence in personal security. Through continued improvements in explosives sensors, we may one day eliminate the threat posed to civilians by minefields or the threat to our military posed by IEDs.

Read more in "Optical Explosives Detection: from Color Changes to Fluorescence Turn-On" in issue 9 of Chemical Society Reviews

Reference

M E Germain and M J Knapp, *Chem. Soc. Rev.*, 2009, DOI:10.1039/b809631g

Essential elements

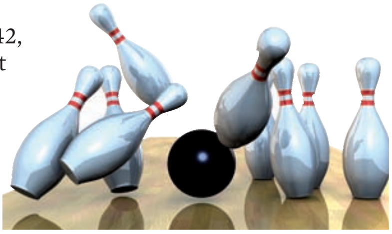
Record impact factors

RSC Publishing celebrates the 2008 impact factor results calculated by ISI® as the highest ever achieved for the majority of RSC journals. The average impact factor for the RSC portfolio now stands at 4.7, equal to the ACS collection. That's a rise of 8.2 per cent in the average impact factor for RSC since last year's results were released.

Nearly all the RSC journals increased in impact factor, immediacy index and article influence, with 3 journals noticeably standing out. *Chem Soc Rev* increased by 33 per cent to an incredible 17.42, confirming its position as a first class international chemistry journal.

Lab on a Chip celebrates a 28 per cent rise taking its impact factor to 6.48, placing it within the top ten journals in the multidisciplinary chemistry category. *PCCP* also faired well, with an impressive 20 per cent increase to its highest ever impact factor of 4.06. Its new immediacy index (0.81) also remains the highest value for any journal publishing general primary research in the fields of physical chemistry and chemical physics.

In addition, RSC journals feature in the top 10 rankings (by impact factor and immediacy index) in 6 of the 7 core chemistry categories* as listed on ISI, and, of the top 100 chemistry journals, ranked by impact factor, 15 are from RSC Publishing.



James Milne, editorial director for RSC Publishing comments: 'RSC journals have attracted a significant increase in submissions, with nearly 60 per cent more material published (over the past 5 years).' He continues: 'To provide more articles and also higher quality articles is a clear reflection of the dedicated support the journals receive from authors, editors and referees throughout the world; for this contribution, I would like to sincerely thank all the scientists involved.'

Visit www.rsc.org/publishing to read more about the journals' impact factor results.

* The 7 chemistry journal subject-categories as listed by ISI: Chemistry, Analytical; Chemistry, Applied; Chemistry, Inorganic & Nuclear; Chemistry, Medicinal; Chemistry, Multidisciplinary; Chemistry, Organic; Chemistry, Physical.

e-Platform

In 2010 RSC Publishing will launch a powerful new content delivery platform that supports multiple content types. The new website will deliver world-class RSC-hosted journal, book and database content in a single platform. The new platform will span more than 165 years of premium content, including 20 000 book chapters; 300 000 journal articles; and 450 000 database records.

RSC has worked with experts in software engineering to develop the platform functionality and has consulted a leading web design agency on building the user interface. Designed around our readers' preferences (identified from a detailed user-interview process), our user-friendly platform will offer faster browsing, intelligent searching, consistent user experience irrespective of content type sought, and simpler more intuitive navigation.

Graham McCann, publisher, is spearheading the project and his enthusiasm for the platform makes it clear something exciting is happening. 'The next stage is beta-testing; we can't wait to show some of our users the innovative platform we're working on,' he says. 'Our aim is to combine rich functionality and powerful searching with some additional features that will deliver an exceptional online experience. True to RSC reputation as an innovator in chemical science publishing, we're going to deliver something unique and different.'

For the rest of 2009, the platform will undergo extensive user testing. To be among the first to hear the latest news about the new Platform follow ChemPub on Twitter (www.twitter.com/ChemPub).

Metallomics

Since its launch in January this year, new journal *Metallomics: Integrated Biometal Science* has attracted articles from some of the leading names in the field. This timely new journal is expected to be the core publication for the emerging metallomics community as they strive to fully understand the role of metals in biological, environmental and clinical systems.

Metallomics celebrated its 2009 launch at the Second International Symposium on Metallomics (ISM'09), held in Cincinnati, Ohio, US, from 7–10 June. The journal was proud to sponsor this high profile meeting, which attracted many leading researchers, and saw sessions covering human metallomics, microbial metallomics, metallomics technology, phytometallomics and environmental metallomics. *Metallomics* is the recommended avenue of publication for ISM'09: watch out for a themed issue early in 2010 featuring work presented at the conference.

The current issue of *Metallomics* is free to all readers online throughout 2009 and 2010, and free institutional online access to all 2009 and 2010 content is available following a simple registration process.

Find out more at www.rsc.org/metallomics

Highlights in Chemical Technology (ISSN: 2041-5826) 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, Journal of Materials Chemistry, Analyst, Lab on a Chip, Journal of Atomic Absorption Spectrometry, Green Chemistry, CrystEngComm, Physical Chemistry Chemical Physics, Energy & Environmental Science* and *Analytical Abstracts. Highlights in Chemical Technology* can also be purchased separately. 2009 annual subscription rate: £199; US $396. 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

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