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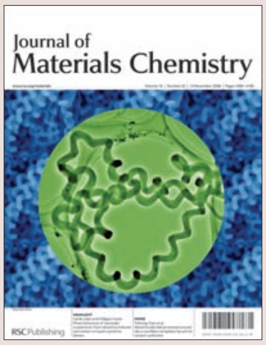
Chemical Technology

Separating radioactive materials

A Franco-American collaboration has used x-rays to study the chemistry behind separating radioactive ions from nuclear waste. They attribute the success of the extraction to the conformational flexibility given by two ligands.

B Gannaz *et al*
Dalton Trans., 2006, 4553

Metal cluster complexes add to CDs and DVDs



Supersized CDs and DVDs with extra storage space are a step closer, thanks to researchers in China. They made metal cluster complexes that simultaneously absorb two photons and can produce precise laser beams.

F Jian *et al*
J. Mater. Chem., 2006, **16**, 3746

Antibacterial wallpaper

Zinc oxide nanoparticles have been coated onto paper, giving it an antibacterial surface suitable for use as wallpaper in hospitals. Using ultrasound to coat the paper is simpler, cheaper and greener than existing methods.

K Ghule *et al*
Green Chem., 2006, DOI: 10.1039/b605623g

Controlling the flow

A new way of directing the flow of water could revolutionise microfluidics, say researchers from Sweden. They directed water down certain channels with an electric potential.

L Robinson *et al*
Lab Chip, 2006, **6**, 1277

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Application highlights

Iridium catalyst provides clue to hydrogenation mechanism

From greenhouse gas to feedstock

Turning carbon dioxide into a useful feedstock chemical could help to reduce levels of this greenhouse gas in the atmosphere, as well as providing a cheap source of carbon.

Now Japanese researchers have isolated the active form of a catalyst that turns CO_2 into formic acid using water as a green solvent, a crucial step in developing this technology on an industrial scale.

Seiji Ogo from Kyushu University and co-workers had previously found that water-soluble ruthenium aqua complexes could catalyse the hydrogenation of CO_2 without using large amounts of base, which are usually required for the reaction. Base stabilises the formic acid product against decomposition by forming unreactive sodium formate. 'If CO_2 hydrogenation could only be achieved in the presence of bases that would be a dead end,' explained Ferenc Joo, Chair of the Institute of Physical Chemistry at the University of Debrecen, Hungary.

However, Ogo's team could not isolate the active form of the ruthenium catalyst, thought to be a hydride complex. Using ruthenium, the slowest step of the reaction involves formation of the hydride complex, which is then rapidly used up to make formic acid.

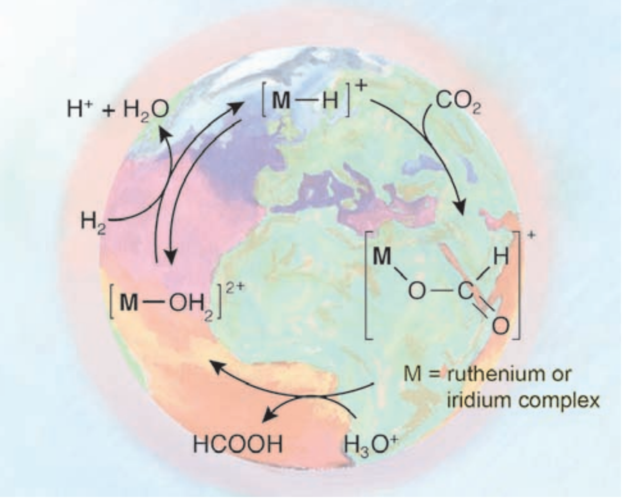
So they switched to a water-soluble iridium complex, making the reaction of hydride with CO_2 the rate-determining step. This means that the active hydride catalyst survives for much longer, allowing them to pin down the active catalyst at the heart of the reaction.

Ogo believes that 'this work provides a valuable strategy to develop new catalytic systems for the hydrogenation of CO_2.'

The next major hurdle is that in most cases, the same metal complex that catalyses the formation of formic acid is also a catalyst for its rapid decomposition, explained Joo. Ideally, the product should be used as it is generated, in reactions such as turning alkenes into carboxylic acids.

'But the results of Ogo and co-workers demonstrate that with suitable catalysts, formic acid can be produced in substantial quantities, opening the way to further synthetic applications,' added Joo.

Joanna Stevens



Carbon dioxide can be transformed into formic acid

Reference
S Ogo *et al*, *Dalton Trans.*, 2006, 4657

Porous catalyst operates at high temperatures without coking

Microreactors for hydrogen fuel cells

Ceramic microreactors show promise as portable electrical power sources, say US scientists.

For the first time, alumina microreactors containing porous silicon carbide 'monoliths' have been studied for on-site hydrogen production from readily available hydrocarbons.

Paul Kenis and colleagues at the University of Illinois at Urbana–Champaign have shown that silicon carbide monoliths with a coating of ruthenium act as catalysts for high temperature 'steam reforming' reactions when integrated in high-density alumina housings. The monoliths are difficult to make, but, unlike typical oxide catalysts, their structure doesn't collapse at high temperatures – which is key to the catalysts' success, said Kenis.

'The microreactors can produce hydrogen from readily available hydrocarbon fuels such as propane without degradation of performance over time,' Kenis explained. 'To our knowledge, our microreactors produce the highest rate of hydrogen per volume compared to any work.'

Hydrogen fuel cells are highly efficient but there are safety issues related to distributing and storing compressed hydrogen. This makes on-site generation of hydrogen a preferred solution, the team say.

The challenge, according to Kenis, has been finding ways to do this which avoid deactivating the catalyst by 'coking' (soot deposition). Kenis' microreactors can avoid this by operating at temperatures above 800°C, which is achievable because of the silicon carbide materials used.

The next challenge for scientists is to integrate the microreactors into a complete fuel processing system, said Kenis.

Caroline Moore

The silicon carbide monoliths have a coating of ruthenium

References
Christian, M Mitchell and P J A Kenis, *Lab Chip*, 2006, **6**, 1328

Airborne bacteria can be collected on filters and cultured

Building a bioaerosol barometer

Air handling units could be used to study airborne microorganisms such as anthrax, according to engineers in the US.

Air handling units (AHUs) are already installed in most modern buildings, and their filters routinely collect viruses and bacteria from the air (bioaerosols). James Farnsworth of TSI Incorporated, working with scientists from the University of Minnesota argues that these filters could be removed and the amount of each species measured. The filters trap a relatively small amount of potential pathogens, and collecting the samples would cause no inconvenience to the buildings' occupants.

The team believe that although this type of sampling could not provide early warning of a biological attack, it could determine the background level of pathogens and bacteria similar to them. This would reduce the chance of false positive results in biosensors. Rather than studying pathogens such as anthrax and smallpox, the team used safer surrogate bacteria and viruses.

To prove their method, the team successfully cultured bacteria collected on typical AHU filters. However, they found that the viruses died within a few hours of settling on the filters, but suggest that they could be identified by the polymerase chain reaction, a method that involves replicating small amounts of DNA that can then be used to identify the microorganisms.

Clive Beggs of the University of Bradford, UK, was positive about the technique, saying that it was 'applicable for bacterial and fungal species'. Bioaerosol expert W. David Griffiths of Airborne Matters, UK, reflected 'It may be more efficient and less costly to use bioaerosol samplers in the room.'

Farnsworth is undeterred and said 'High volume sampling using AHUs could be a wonderful tool. The data generated from this research will be useful to the developers of biodetectors.'

Wendy Crocker

Most modern buildings already contain AHUs

Reference
J E Farnsworth *et al, J. Environ. Monit.*, 2006, DOI: 10.1039/b606132j

Embryos' health checked by monitoring oxygen use

Measuring the earliest of breaths

Chemists in Ireland have developed a device that can measure the breath of tiny embryos.

Dmitri Papkovsky and colleagues at University College Cork built a microchip that monitors the oxygen used by mouse embryos at the very earliest stages of their development, when they are only a few cells in size.

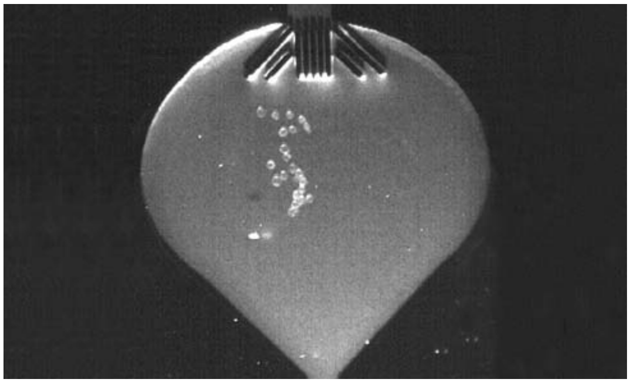
The team hope the chip will prove useful for monitoring the health of embryos created by in vitro fertilisation (IVF), a process whereby eggs are extracted and fertilised outside the body and the successfully fertilised eggs are implanted into the womb later. IVF is used to help infertile couples conceive, as well as being a useful tool in animal breeding programmes.

'Multiple births and unsuccessful attempts are commonplace in the field of IVF,' said Papkovsky. He ascribes this to a lack of understanding of the factors that make a healthy embryo. The rate at which embryos consume oxygen is a good indicator of their health, but because very early embryos use such tiny amounts of oxygen, this can be hard to measure. Papkovsky's chip uses a molecule that fluoresces when oxygen is removed in order to provide a sensitive measurement of how quickly the oxygen is used up.

'This work shows the importance of taking an integrated view of sensing devices to combine advances in both chemistry and engineering to meet real needs,' said Tony Turner, professor of biotechnology at Cranfield University, UK. 'Developments in biochips are now reaching the stage where they have exited the research lab and are finding real utility in clinically relevant situations,' he added

Although the chip can only currently measure embryos in batches of ten, Papkovsky sees monitoring of individual embryos as an achievable goal. 'We see moving towards use in routine analysis in IVF clinics as the way forward for this work,' he said.

Clare Boothby



The biochip works in conjunction with an oxygen sensitive probe

Reference
C O'Donovan *et al, Lab Chip*, 2006, DOI: 10.1039/b607622j

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