



**NMR:** harder, better, faster, stronger  
Towards **better battery materials**

The fun of **chemistry outreach**  
**Lord Lewis:** fondly remembered

**I guess it all started with your PhD project. Tell me more.**

It's a fascinating story! I started my PhD with Chris Abell in 2009, working on microfluidic droplets. I passed my first-year viva, but the examiner suggested that I should find another angle as he thought what I'd been doing may not generate enough interesting results for a PhD thesis. I was a bit taken aback, but it turned out to be great advice as it got me thinking what else I could do with the droplets. It's a really controlled way of making water-in-oil emulsions, and the droplets are like tiny vessels. My husband, Roger Coulston, was a post-doc in Oren Scherman's group, working on supramolecular assembly of polymer and nanoparticles, and we thought it might be interesting to try and do his chemistry in my droplets and see what happened. The results were fascinating, as we created microcapsules in the droplets, with chemical material around the interface of the droplet that can be used to protect a valuable active cargo inside, and allow the cargoes targeted delivery and controlled release.

**So how did that lead to Aqdot?**

It took a while! Chris, with his experience of spin-out companies and commercialising technology, gave us some really good advice early on, which was to patent it before we published it. We still weren't sure whether it had real commercial potential, but we put in the patent application, and then published the work in *Science*. That got us a lot of press interest, which prodded us to explore it further.

By then, I was in the final year of my PhD, and Roger was awarded an ERC proof-of-concept grant to help with the early stage research to prove its commercial potential. This really helped us get enough results to convince three investors – Cambridge Enterprise Seed Fund, Imperial Innovations and Providence Investment Company – that we were worth funding. We raised £975,000 from them, which allowed us to set up the company.

**Did you immediately realise the work's commercial potential?**

Oh no – at first the pure aim was to generate enough data to finish my PhD! But that turned out to be good as it meant I had also generated the data we needed to start the company. In the beginning, we were focused on publishing the work in a good journal, but Chris had a hunch that it would be of commercial interest early on, even before the *Science* paper generated all that interest from industry.

**How difficult was it to get the patent?**

It was surprisingly straightforward to file the patent, actually. We had good

**When chemistry research has commercial applications, the best way to realise its potential can be via a spin-out company. Jing Zhang talks to Sarah Houlton about how her PhD research led to Aqdot**



help from Cambridge Enterprise, who brought technology transfer experts in to guide us through the process, and commissioned a patent lawyer with experience in writing patents in this area of chemistry. In fact he's a Cambridge chemist – Jonathan Wills, who did a PhD with Shankar Balasubramanian – and he's still working with us now. As I'd been writing everything up as I went along, all he needed was the experimental section of the paper, plus a few more answers from me. The whole process started in July 2011, and it was done by the end of the year

**And how did the company formation go?**

The *Science* paper was published in early 2012, and Aqdot came into being in August 2012. Imperial Innovations had already introduced us to John Hamlin, who worked for BP Chemicals for more than 20 years, and since then had become actively involved with a number of start-ups. He's now our chief executive. His business experience really helped us move the technology from a piece of pure research to an appealing business case, which allowed us to complete the seed funding round. The near-million pounds we raised allowed us to hire a team of talented polymer and formulation chemists, further develop the technology and, most importantly, engage with our customers.

**What potential uses does the technology have?**

There are many different areas it could theoretically be used in, such as household and personal care products, flavours & fragrances, agrochemicals, oil and gas,

and even pharmaceuticals. Discussions with customers really helped shape our thinking, and we decided that our first area of focus should be laundry detergents, where encapsulation could improve and retain enzyme activity, giving a longer product shelf-life, and allowing it to be released more quickly in the wash, and at the ideal time. We've got a couple of other areas also in action; with a platform technology like this that has so many potential applications you really need to focus, but you also need to keep a back-up as scientific results are never 100% guaranteed!

**You're currently on maternity leave. What effect has that had?**

Our daughter, Alexandra, was born in January, and I'm now back working part-time, mostly at home but also spending some time in the office. I plan to go back full time once we've found good childcare for her. Of course with an early stage company, there are so many things I can do that don't involve sitting in the office 9–5, and I can also help with the all-important thinking. I still get to think when at home with a baby – and it certainly hasn't had a negative impact on my career at all.

**I gather you'd already been involved in the Cambridge University Entrepreneurs society, even before Aqdot...**

That's right. Roger and I had always wanted to do research with practical application, and a good way to do that is via starting a company to commercialise a technology. CU Entrepreneurs aims to encourage students to find out about entrepreneurship, and encourage them to start their own companies. We both joined the committee, organising events and getting seasoned entrepreneurs in to give talks, and trying to match people with ideas up with people who had the skills to realise them. This turned out to be really helpful to us when we found the droplets might have commercial potential.

**What advice would you give to someone thinking about forming a company?**

My best advice is to prepare yourself before the opportunity presents itself. Get to know the people who might be able to help you in the future – Cambridge has so many resources you can use, and so many people with all kinds of experience. If you solely immerse yourself in the world of research and never look outside the lab, it might limit your potential later on.

## Haydon recalled

Dear Editor

The Spring 2014 issue of Chem@Cam carried a photo from Sanjoy Biswas of members of the former Department of Colloid Science (1960), of which his late father was then a research student. I arrived at the department some six years later but can identify some of the faces.

Sanjoy may like to know that his father's supervisor (and, later, mine), Denis Haydon, is fourth from right in the front row and to his right are Professor F.J.W. Roughton and Paley Johnson. Haydon and Johnson led separate research groups located on the top and lowest floors of this small offshoot of the then Cavendish Laboratory in Free School Lane.

Three members of the technical support staff on this photo also feature in the later photo which

accompanied my short article in your Spring 2010 issue. Sadly, Haydon died at the early age of 58, when he had become an honorary professor at the department of physiology.

Brendan Carroll  
(Trinity Hall 1963-69)

## Taxi for Norrish?

Dear Editor

Can anyone substantiate the delightful story I was told in the late 1960s, namely that Professor Norrish and a colleague had once so successfully celebrated a particular research breakthrough at the Spread Eagle that they had to summon a taxi to get back to the department?

Tom Banfield  
(Phys Chem 1965-68)

## eChem@Cam

Chem@Cam is now being sent out by email to those who have asked for a pdf version rather than a hard copy in the mail.

If you would like to swap your paper magazine for an e-version, send an email with the subject line 'eChem@Cam' to [jsh49@cam.ac.uk](mailto:jsh49@cam.ac.uk), and we'll send it to you electronically from the next issue.

Don't forget to tell us your postal address so we can check that the correct person is removed from the mailing list for the paper magazine.

You can check out e-back issues at [www.ch.cam.ac.uk](http://www.ch.cam.ac.uk)

# Chem@Cam: 50 not out!

It hardly seems possible, but this is the 50th issue of Chem@Cam. So we figured we ought to do something special to celebrate.

The department's photographers, Caroline Hancox and Nathan Pitt, came up with a great idea – enlist the help of technician Chris Brackstone to set up fiery 'birthday candles'. Chris soaked

mineral wool-covered wire frames in methanolic solutions of potassium nitrate, giving a purply hue to C@C, and sodium chlorate, making a golden 50 when they were set alight.

To complete the picture, Nathan took photos of Caroline taking photos while Chris created the burning letters. We're all rather pleased with the result!



Photography in action: Chris sets up the numbers, and Caroline lines up the shot



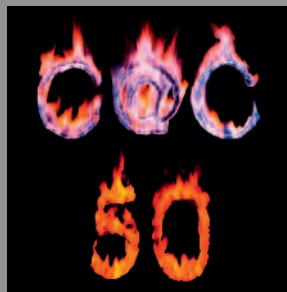
chem@cam

Chemistry at Cambridge Newsletter

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## Cover



Happy birthday to us!

**Photograph:**  
Caroline Hancox

**Technical wizardry:**  
Chris Brackstone

This newsletter is published three times a year by the University of Cambridge Chemistry Department. Opinions are not necessarily those of the editor, the department, or the university.

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Photo: Caroline Hancox

Yusuf Hamied poses with Daan Frenkel ahead of the screening

## An honoured honorary doctor

Dr Yusuf K Hamied has been awarded an honorary Doctor of Science degree by the university.

Yusuf was a PhD student in Lord Todd's group in the late 1950s. After leaving Cambridge, he joined Cipla, the Indian generics pharmaceutical company founded by his father, and he has been its chairman for the past 25 years. He has also been an extremely generous donor to both the department and his old college, Christ's.

While he was in Cambridge for the degree ceremony in June, he visited us here in chemistry to host a screening of

the documentary 'Fire in the blood', which describes how a number of people, including Yusuf, campaigned to make anti-HIV medicines available in cheaper generic form to people with HIV and Aids in poor countries.

This was followed by a Q&A session and wine reception in the department's lobby. Ian Fleming, one of Yusuf's contemporaries at Cambridge, also presented him with a copy of a photo of the department as it was in 1960 while they were both working there. Yusuf pointed out that, by coincidence, his car was one of those parked outside!

## Come and visit us!

As part of the university's alumni festival, on Friday 26 September the department is presenting a chemistry student showcase, and offering lab tours that will give visiting alumni an insight into some of the exciting science that's happening in the department today.

All former undergrads, PhD students and postdocs – and current department members! – are encouraged to come and learn about cutting-edge research going on here in chemistry. Several of our talented young researchers will give brief presentations on their projects, followed by lab tours.

The event will be hosted by Alan Battersby, and starts in the Todd Hamied room at 4pm. It will also give alumni the opportunity to find out what's changed since their time in the department – and what's still the same!

You can sign up for Alumni Festival updates by emailing [events@alumni.cam.ac.uk](mailto:events@alumni.cam.ac.uk). If you signed up before the 2013 Festival, you'll automatically get the updates about Alumni Festival 2014 too.



Photo: Nathan Pitt

This year's Lewis lecturer was Kazunari Domen of the University of Tokyo. He was in the department in April to give the two Lewis lectures on his research in the field of the production of solar fuel from water using photocatalysts

## Paterson 60/80

Ian Paterson has just celebrated his 60th birthday and 80th PhD student, so what better excuse for a symposium? The Paterson 60/80 symposium in May welcomed many group members back to the department, from as far afield as the US, Canada, Japan and Australia.

The weekend's festivities kicked off with a speakers' dinner in Trinity, and then after the Saturday symposium there was a dinner in Jesus. Finally, Clare hosted a celebratory lunch for Ian's birthday on the Sunday, followed by an enjoyable afternoon punting along the Backs. The symposium itself featured 14 lectures given by Paterson group members.

'I'd like to express my warm appreciation for all those who attended, particularly the excellent speakers, and the organisers and sponsors, which contributed to a marvellous weekend of fantastic science, good food and great fun,' Ian says.

'This was the best possible way of having a suitably memorable 60th birthday bash, and we really lucked out with glorious weather.'

Ian is pictured below with the four speakers from the first session: Simon Blakey (Emory University, US), Ed Anderson (Oxford), Roger Norcross (Roche, Switzerland) and Rob Britton (Simon Fraser University, Canada). The photo in the background is of the Paterson 50/50 symposium – how time flies!

## Support from Schlumberger

Schlumberger has announced its support for two new programmes in the department: the Schlumberger Lecture and the Schlumberger visiting professor programme.

The lecture will form part of an event organised by postgraduate students in the department. Schlumberger scientists will be invited to attend, and the lecturer will be a leading scientist chosen by an advisory committee of PhD students, postdocs, academics and representatives from Schlumberger.

A second distinguished academic scientist will be identified as the Schlumberger visiting professor, and will stay in the chemistry department for up to three months, to present lectures, discuss research, and collaborate with department research groups and Schlumberger Gould Research.

With initial funding for one year, the lecture and visiting professor programme will start in the coming academic year, with the first Schlumberger Lecture likely to take place in 2015.

## A BI good Fellow

Patrick Flagmeier, a PhD student in Chris Dobson's group, has received a prestigious Boehringer Ingelheim Fonds PhD fellowship. Patrick, who joined the department after a master's degree in Munich, is looking at the mechanism of  $\alpha$ -synuclein aggregation in Parkinson's disease, with a focus on nucleation. His aim is to characterise the different

microscopic steps of aggregation.

The fellowships are very competitive, with typically about 750 applications being made for the 45 annual awards, and the successful candidates whittled down via a rigorous selection process. As well as PhD funding, he'll get support to attend conferences, guidance and advice, and a range of seminars specific to holders of these fellowships that allow them to discuss their projects.



## A brace of honours

The Queen's birthday honours list brought double joy for Cambridge Chemistry this year, in the shape of a CBE for Jeremy Sanders, and an MBE for Peter Wothers.

Jeremy has been honoured for services for to scientific research. A fellow of the Royal Society and still active in chemistry research, he is currently the university's pro-vice-chancellor for institutional affairs.

'It is a huge pleasure that my small contribution, most of which should be credited to my research group and administrative colleagues, has been recognised in this way,' Jeremy says.

The citation for teaching fellow Peter, meanwhile, says he received the honour for services to chemistry. As well as his chemistry teaching duties in the department and St Catharine's, he's widely involved in outreach activities that promote chemistry to schoolkids and the general public, such as his chemistry open day lectures, and the Royal Society Christmas lectures he gave in 2012.

'It was lovely to be recognised in this way for the work I do with projects like the International Chemistry Olympiad and the promotion of chemistry to the public through the demonstration lectures,' Peter says. 'However, I've found it can be a bit hard trying to explain exactly what an OBE is when I'm overseas...'

### Promotions

Three members of the academic staff are being promoted in this year's round of senior academic promotions.

Jonathan Goodman and Jonathan Nitschke will become professors in October, and Stephen Jenkins a reader. John Skidmore is also being promoted, to principal research associate

## Gordon poster prize

Enass Abo-Hamed, a fourth year PhD student in Oren Scherman's group, recently attended the Gordon research conference on noble metal nanoparticles in the US, and came back with the best poster prize award.

Her poster was about thermoresponsive sponge-like materials for hydrogen production, storage and on-demand release. 'There were more than 50 poster presenters from all over the world,' Enass says. 'The whole experience was invaluable, as I was able to meet with leading researchers in the field, plus many outstanding students and postdocs.'

## It's award season!

A number of the department's academic staff have received prestigious prizes in the past few months, including Clare Grey, who was awarded the Davy Medal by the Royal Society. The prize, given every year for an important recent discovery in any branch of chemistry, was awarded to Clare for her pioneering applications of solid state NMR to materials with relevance to energy and the environment.

Tuomas Knowles has received two prizes: the British Biophysical Society's young investigator medal and award, and the International Union of Pure and Applied Physics' young scientist prize for biological physics. The former is given every other year for an outstanding contribution in biophysics to someone within a decade of finishing their PhD, and the latter in recog-

nition of exceptional achievements in biophysics. Both of these prizes include giving a lecture at a society conference.

Two more prizes have also headed Chris Dobson's way. He's been given the biennial Heineken Prize for biochemistry and biophysics by the Netherlands Academy of Sciences, and also the Feltrinelli International Prize by the Accademia Nazionale dei Lincei. This Italian organisation is the oldest existing academy of sciences, and while the prize is awarded every year, it rotates around five subjects – medicine, science, fine arts, literature and history.

Steve Ley has received the IUPAC ThalesNano prize in flow chemistry, recognising his outstanding contribution and creative work in methodologies for organic synthesis, especially in multistep synthesis in continuous flow chemistry reactor systems.

## Core capabilities launch

Cambridge MP – and former Cambridge chemist – Julian Huppert visited the department in July to help celebrate the recent £2 million upgrade of our core analytical facilities. It was part of a nationwide series of events on 21 July at UK chemistry departments who have received EPSRC funding in the past year to buy or upgrade NMR, mass spectrometry, atomic level microscopy and X-ray diffraction facilities as part of the Core Capabilities funding call.

Cambridge was one of 15 departments who received a share of the £15 million total. Applicants had to demonstrate the increase in research capabilities that would be possible by expanding, updating or upgrading their equipment.

Our share of £1 million was matched by the university. This allowed us to invest in state-of-the-art X-ray diffraction technology, upgrade several NMR machines, add a new high-end atomic force microscopy set-up, and buy a high-resolution proton-transfer mass spectrometer.

'This important investment is a fundamental part of the government's ongoing effort to ensure the UK maintains its place as a global leader in

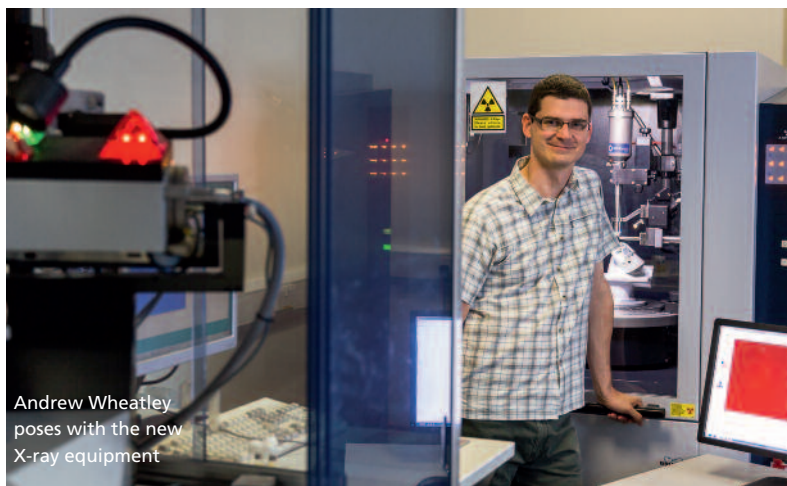


Cambridge MP Julian Huppert

Photo: Nathan Pitt

research in the chemical sciences,' said head of department Daan Frenkel. 'Techniques such as X-ray crystallography, NMR spectroscopy, mass spectrometry and atomic force microscopy are crucial to solving some of the most challenging problems we face in basic and applied research.'

For more about what the investments are allowing us to achieve in NMR, turn to page 8.



Andrew Wheatley poses with the new X-ray equipment

Photo: Nathan Pitt

Four of our academics have received Royal Society of Chemistry prizes. Ian Paterson was given the Natural Products Award for exceptional originality and creativity in natural product synthesis. Erwin Reisner received the Harrison-Meldola memorial prize for his work in combining molecular synthesis, chemical biology and materials chemistry to develop artificial photosynthesis. Oren Scherman was given the Cram Lehn Pedersen Prize in Supramolecular Chemistry in recognition of significant original and independent work in supramolecular chemistry. And David Spring received the Corday Morgan Chemistry Award for his contributions to chemistry-driven drug discovery through his work in diversity-oriented synthesis and chemical biology.

Finally, Shankar Balasubramanian has been awarded an honorary doctorate by the University of Liverpool. Congratulations all!

## Lensfield Road hosts RSC meeting

Front row (L-R): speakers Robert Phipps, Christina White, Silvia Diez-Gonzalez, María Paz Muñoz  
Back row: Session chairs Deborah Longbottom from Cambridge and Imperial's Sue Gibson, plus Anne Horan from the RSC



The Royal Society of Chemistry's half-day organic division SE regional meeting was held in the department in April, and organised by Jonathan Goodman.

Speakers included Silvia Diez-Gonzalez from Imperial College, who spoke about copper(I) catalysts for click cycloaddition reactions, UEA's María Paz Muñoz, whose talk featured metal–allene chemistry, and

our own Robert Phipps, who told how chiral anions can be used as phase-transfer catalysts in asymmetric fluorination.

The afternoon concluded with Christina White from the University of Illinois in the US being presented with the RSC Merck Award, and speaking about her work in the area of site-selective C–H oxidations.

Recent visitors to the department include this year's Melville lecturer David Weitz from Harvard (right), who spoke about microfluidics. We also hosted Jadranka Travašević from the University of Auckland (below left) and the RSC's Organometallic prize winner, Texas A&M's John Gladysz (below right)



Photos: Nathan Pitt

## Pesticide task force

Chiara Giorio, a postdoc in Markus Kalberer's group, is part of a global task force providing an independent scientific input to concerns about the impact of systemic pesticides on biodiversity and ecosystems. The hope is that this will allow more rapid, and better, decision-making.

The Task Force on Systemic Pesticides ([www.tfsp.info](http://www.tfsp.info)) is made up of about 30 scientists whose research is independent of industry funding. They give unbiased assessments on the environmental effects of these insecticides on different kinds of animals and insects.

Systemic pesticides don't just sit on the leaves of plants – they are transported through the plants to all tissues. Increasingly, they are used

prophylactically to prevent pest infestations. Notable examples include the neonicotinoids and fipronil, which can form even more toxic metabolites, and which can accumulate and persist in the soil for months, or even years.

Before she moved to Cambridge 18 months ago, Chiara worked at the University of Padova in Italy, assessing the acute exposure of honeybees to insecticide during sowing. 'The seeds are treated with insecticide, and the seed drilling machines create a lot of dust that contains the insecticide. If the honeybees fly over the cornfields during sowing, they can be contaminated with this dust, and the acute exposure causes them to die within hours.' And the long-term impact of exposure to lower doses could be even more damaging.

The task force has just published a huge

meta-analysis of 800 peer-reviewed papers, 'Worldwide integrated assessment of the impact of systemic pesticides on biodiversity and ecosystems', that concludes there is sufficient evidence of harm from these pesticides to warrant regulatory action. While in the short-term they might help protect the plants, the longer-term impact on plant-friendly insects such as those all important pollinators poses a real risk to the ecosystem, they concluded.

'Although I'm now doing rather different science at Cambridge, looking at model systems for chemical reactions that occur in the atmosphere, I have continued as part of the task force, assessing reports and papers in my spare time,' Chiara says. 'It's interesting work – but also incredibly important.'

## Proving protein structures with mass spectrometry

The importance of collaboration with experts is highlighted by a recent paper in *Nature* from a team led by Luca Pellegrini in biochemistry, which wouldn't have been possible without the expertise of one of our mass spectrometry team, senior technical officer Dijana Matak-Vinkovic.

Pellegrini is studying replication in eukaryotes – cells, like human cells, that contain a nucleus – by looking at a protein from a yeast called Ctf4. This protein links DNA helicase with DNA polymerase alpha, a process that is essential in DNA synthesis and normal cell progression.

They solved the structure of the crystallised protein, which showed it has two domains, and they also believed that it to be trimeric. But how to prove it, and prove that the structure is the same in a physiologically relevant environment as it is in a crystal?

This is where Dijana came in. 'I ran mass spec studies of the protein sprayed into vacuum from solution, which con-

firmed what they had found in the crystal structure – it is a trimer in solution, too,' she says. 'This is very important, because a protein in solution doesn't have to have the same structure as it has in a crystal lattice.'

They also studied the molecular mechanism by which the protein links the two enzymes together, identifying the binding regions on the polymerase and the helicase. 'We proved that both of these interact in a similar way with the Ctf4 protein, and both have the same binding motifs,' she says.

'We predicted that Ctf4 can support simultaneous interactions of varying stoichiometry with multiple partners, and via mass spec showed that complexes with stoichiometries of 1:1, 1:2 and 1:3 all existed. This is important because it provides a new model for lagging strands synthesis in eukaryotes.

Mass spec is the perfect technique to do this, she says, as it enables the stoichiometry

of proteins in solution to be defined. She used a technique called native mass spectrometry, a name that reflects its ability to investigate native-like quaternary structures. 'It's quite an advanced technique, and not many people can do it yet with protein complexes,' she says.

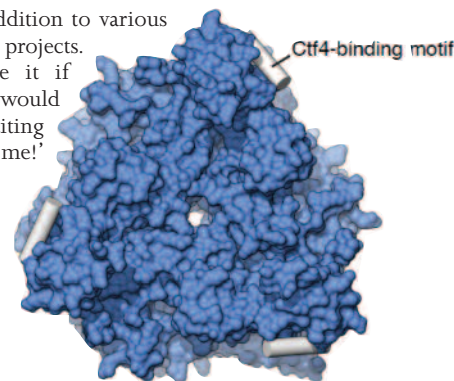
As well as working on projects with chemistry department colleagues, Dijana has also been collaborating with scientists in biochemistry for several years now. She also works with Andrew Munro's group at Manchester.

This is in addition to various

other one-off projects.

'I would love it if more people would bring their exciting problems to me!' she says.

A.C. Simon et al. *Nature* 2014, 510, 293



## Better battery materials

For electric cars to become a practical widespread alternative to those powered by petrol or diesel, more effective batteries will be required. Lithium-ion batteries, as found in laptops and mobile phones, meet many of the requirements, and are used in the current generation of electric cars. But to improve their performance – whether by making them lighter or quicker to recharge, for example – new materials must be designed, and to do this it's important to understand their properties.

One such material,  $\text{LiFePO}_4$ , was first used as a battery material in the late 1990s. Upon charging and discharging the battery, Li ions are removed and inserted, respectively, into the structure, while the  $\text{FePO}_4$  framework remains intact. Initially, it was thought this material does not have a high electrical capacity at high cycle rates, but when smaller nano-sized particles were used instead of the previously studied micron-sized particles, it turned out that its capacity retention at high cycling rates was extremely high.

But why is this? The material undergoes a phase transformation that involves significant structural rearrangement when charging, which ought to preclude rapid cycling. Recent research in Clare Grey's group has found the answer to this question, which should be important in the future design of battery materials.

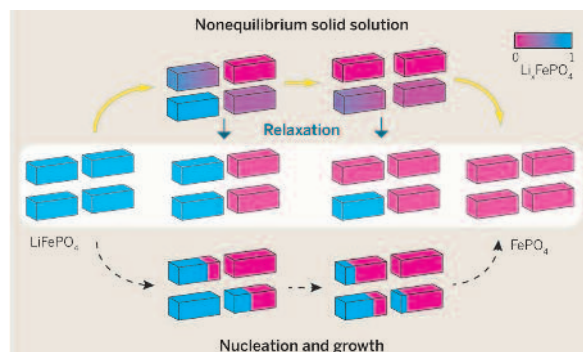
In the large, micron-sized particle, the delithiation reaction involves a nucleation process, where one phase is formed and grows within the parent phase. But it turned out that's not the case in the high-rate nano-sized particles – in fact, instead of this gradual nucleation process, the material switches from lithiated to non-lithiated forms via a series of intermediate metastable structures, without forming a high energy interface.

This material is already used by Tesla in their electric cars, explains PhD student Fiona Strobbridge. 'Originally it was thought the delithiation reaction involved a nucleation process, where the  $\text{LiFePO}_4$  phase transforms to a  $\text{FePO}_4$  phase,' she says. 'But this would require the interface between the two phases to propagate along the crystals as it changes from one to the other.'

However, it turns out that's not what is happening, as they found via synchrotron X-ray diffraction experiments. 'Instead of this moving interface, the whole thing switches from one phase to the delithiated phase instantaneously,' says her colleague, PhD student Hao Liu. 'This is important. If you build up an interface each time you charge and discharge the battery, the reaction only occurs at the interface. If the whole particle reacts at the same time, the reaction takes place everywhere in the particle.'

This explains why the material has the unexpectedly high rate capability. 'There are implications for other electrode materials,' Fiona says. 'If we can understand how and why materials behave as they do, it will help greatly in the design of better ones in the future.'

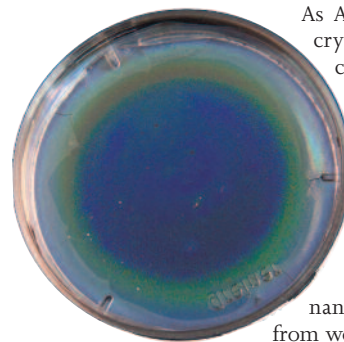
H. Liu et al. *Science*, 2014, 344, 1480



Delithiation via the formation of a nonequilibrium solid solution phase (yellow arrows), compared to nucleation (dashed arrows)

## Changing colours

Silvia Vignolini and postdoc Ahu Gümrah Dumanli, along with collaborators in the Cavendish Lab, created iridescent colour films that contain no pigments – just carefully organised cellulose nanocrystals. They've now worked out how they form.



As Ahu explains, the liquid crystal and nanoparticle communities are familiar with self-assembly creating colourful films. Now, they have created multi-coloured domains. 'We identified green, orange and blue colours,' she says.

Rod-shaped cellulose nanocrystals are extracted from wood pulp, and when suspended in water, spontaneously assemble to form nanostructured layers that reflect coloured light that remained intact when the water evaporated. By altering the environmental conditions during evaporation, they could change and control the colour, as humidity has an impact on the final nanostructure.

They used optical spectroscopy to identify three stages of film formation. First, the nanocrystals are isotropically suspended, allowing the interface between air and the cellulose suspension to be imaged directly; they also found no other interfaces within the sample other than the interface with the petri dish at the bottom. This means the crystals remain in suspension as they form larger scale assemblies.

Once some of the water has evaporated, a more viscous gel phase forms. Areas with a stacked structure can be identified, randomly oriented through the gel. Finally, colour appears, but only in the left circular polarised channel, and not the right. 'Interparticle forces are more dominant in the self-assembly than capillary forces during this final stage,' Ahu says. The stacked structures align perpendicular to the surface of the dish, driven by the presence of the meniscus, but at the edges, where the hydrophobicity of the glass creates a curved meniscus, the stacks are not aligned in this way. This creates what they describe as a 'coffee ring' effect – the colours look like a coffee mug stain, as in the image above.

'It's fascinating that we can start with a colourless solution of polydisperse particles and get them to segregate and form domains of specific colours,' Silvia says. 'These are always the same, and depend on the evaporation conditions. We are now starting to understand from the optical spectra and images how the films form, and how the colours are created.'

A.G. Dumanli et al. *Adv. Opt. Mat.* 2014, 2, 646 and *ACS Appl. Mat. Interfaces* doi: 10.1021/am501995e

## Alternative amines

A new way to functionalise aliphatic amines has been developed by Matt Gaunt's group. They use a palladium catalyst to activate otherwise inert carbon-hydrogen bonds, allowing novel molecules to be created. 'This is important because many pharmaceutical agents contain aliphatic amines,' Matt says. It also allows access to a previously unexplored class of aliphatic amines. 'There are no examples in the biological literature because no-one's made them before!' he claims.

The new mode for C-H activation invented by Matt, along with postdoc Andrew McNally, plus PhD students Benjamin Haffmeyer and Beatrice Collins, enables the nitrogen atom of the amine group to direct the activation via a novel four-membered ring intermediate that contains palladium. This unusual ring system is very strained.

'In the new reaction, we take a simple secondary amine flanked by a methyl group and form a cyclopalladium intermediate,' he says. 'This can then be turned into either a four-membered ring beta-lactam, a familiar motif in antibiotics, or a three-membered-ring aziridine,' he says. 'This happens in a single transformation. Both of these molecules are very versatile intermediates that can be used to make complex new secondary amines.'

These initial examples of the reaction started with very hindered amines, as these were required by their mechanistic hypothesis. 'While they are structurally novel, they could be argued as being a little esoteric!' Matt explains.

'We've already managed to get the reaction to work with a handful of much less hindered amines, and now we want to expand it to all secondary amines, which are much more prevalent in the chemical and pharmaceutical literature.'

A. McNally et al. *Nature* 2014, 510, 128

# NMR upgrades and new experiments

Recent investments in our core analytical equipment have had a huge impact on the speed and capabilities of our NMR machines



Photo: Nathan Pitt

Walk in to the basement room that's home to our trio of NMR experts – Peter Grice, Duncan Howe and Andrew Mason – and it's hard to ignore the constant 'chirp chirp chirp' of the cooling systems on the spectrometers they share their space with. They don't notice it any more – 'What chirping noise?!' says Peter – but as Duncan says, if they walk into the office first thing in the morning and it's quiet, that's the time to start worrying.

The two service machines in the office are just the tip of the iceberg. The current tally is 11 solution state machines, ranging from the teaching 200MHz machine to a 700MHz instrument, plus two solid state machines. There are four more (and another on the way) in Clare Grey's lab.

## COMPLEX EXPERIMENTS

Two are open-access; the two in the office are used by Peter, Duncan and Andrew to run more complex experiments; and the remainder are all operated by trained students and postdocs. 'In principle, we can run NMR spectra of pretty much any nucleus that has the right magnetic properties, as long as there's enough sample,' Peter says.

The NMR team is responsible for keeping all the machines up and running, which includes regularly refilling the magnets with liquid helium and liquid nitrogen to keep the coil inside the magnet cold. Liquid helium is used to cool the coil to about 4K, with the liquid nitrogen as a sacrificial barrier to

minimise the evaporation of the much more expensive (and scarce) helium.

'We've always had a large number of NMR spectrometers in the department, but they don't last forever,' Duncan says. 'However up-to-date they are when installed, it doesn't take long before they become behind state-of-the-art. The manufacturers say the console, essentially the electronics that control the experiment, becomes obsolete in 10 years or so. Some of the kit we had was nearly 20 years old, so the recent investment was very much needed.'

Top of the list of machine upgrades are the two open-access machines, one provided by GlaxoSmithKline in 1998, and the other even older. Both are 400MHz machines that used robotic arms for changing samples; now they're equipped with the latest generation of sample changer. They've also had their probes upgraded, increasing their sensitivity. Both of these upgrades speed up spectrum acquisition. 'We renewed everything except the magnet!' Peter says.

Importantly, the new probes can now switch nucleus automatically, from proton to carbon, phosphorus, nitrogen or even one of the more exotic nuclei such as boron or lithium. Previously, this process would have involved much more hands-on intervention, and potentially even changing the probe. With students and postdocs now having easy access to these capabilities, running spectra is now routine. And, for the first time, fluorine spectra can be run on an open-access machine.

Andrew, Duncan and Peter hard at work in their basement office

With the busy-ness of the NMR machines, replacing the two open-access machines required a lot of planning – between them, in a busy month, they run about 3000 spectra of one form or another. 'We took one out of service, moving all the load to the second machine, where the sample queue rose from up to 20 minutes to a three to four hour wait,' Peter says. 'We could then install the upgrades to the first machine, run tests, and rejig our software interface to make it work on the new instrument.'

All this time, the second machine was carrying the whole load, so there was a real need to complete the upgrade quickly. 'It was completed in about 10 days,' Andrew says. Then it was time to repeat the process with the second machine. To add to the complication, this was all around the time that Duncan's daughter was born in November, and he had to get all the software debugged and working.

Three other machines have recently had complete system upgrades, too. The console from one of the old 500MHz machines has been transformed into a 600MHz one, and teamed up with the Ley Group 600MHz magnet. 'This was one of the oldest consoles we had, but by changing the lock boards and getting a few bits and pieces from Bruker's factory, we could make it work at the higher frequency,' Peter says. 'We also replaced the 15-year-old probe for one with automatic tuning and matching between different solvents and samples.'

## EXPANDED CAPABILITIES

Of course, upgrading the equipment allowed new capabilities to be added, facilitating new experiments. 'It also allows us to increase our routine capabilities, and put them into users' hands, rather than us having to do them as a service,' Peter says. 'NMR machines have got much easier to use over the years, and there is now a lot of automated functionality that takes over many things that previously would have to have been done by hand, including looking up numbers and calibration. Now, you can simply press a button and, say, suppress three solvent peaks. It will do it for you – and get it right.'

This leaves the NMR team free to work on more complex problems, and learn about new things they might be doing. 'We now stand more chance of being able to read a paper in a journal that details a new experiment, trying it, and getting it to work,' Duncan says.

One type of experiment the team have been working on quite a bit recently is diffusion-oriented NMR. 'It's



a lovely piece of maths!' Andrew says. Essentially, these experiments enable diffusion constants to be measured.

Large, flexible molecules such as proteins will diffuse through a solution rather more slowly than more compact small molecules. 'Jonathan Nitschke's group do these types of experiment quite a lot, as they have molecules that assemble into clusters, trapping other molecules inside,' Peter says. 'If we can determine the diffusion constants of both trapped and untrapped molecules, it shows the trapped ones diffuse much more slowly, proving they are indeed trapped.'

While these experiments could be carried out before, they can now be done much more precisely, and Duncan has had the time to spend thinking about the myriad ways these experiments can go wrong. 'Sometimes, you can get the wrong answer without realising it,' he says. 'You get a perfectly plausible-looking number, and the statistics software will tell you there's an error of  $10^{-12}$ , which encourages you to believe it's correct. But it may not be!'

The most likely cause of these errors is diffusion involving transport within the sample. NMR tubes tend to be kept at a constant temperature within the spectrometer via heating or cooling at the bottom of the tube, creating a temperature gradient through the sample. 'Convection currents can develop, which is not very helpful if you're trying to measure diffusion!' Peter explains. 'Side-to-side convection currents can also form. There are ways of getting around these issues, but unless you look at your data correctly, you could find that you get the wrong answer.' Understanding what is going on in the sample and how to correct for the convection currents saves a lot of time, as multiple experiments can be avoided.

### BUSY, BUSY, BUSY

The introduction of cryoprobes has greatly increased the speed at which spectra can be run. These cool the transmit and receive coils down to 20K, and the preamp down to 70K or so. This reduces the background noise that the electronics would otherwise produce, thus giving a better signal-to-noise ratio.

A carbon spectrum on a natural product or steroid, for example, can be run in just 10 minutes if there's 1mg of material in the sample. A cryoprobe machine can run in a day what it would take a non-cryoprobe machine system a month to complete. 'It's frighteningly fast,' Andrew says.

Much of the service work the team carries out involves running a whole suite of 1D and 2D spectra on a sample as supporting data for publication. Another common request is to run spectra on tiny amounts of material that are too dilute for a machine without a

cryoprobe. 'If you want a carbon spectrum quickly, you'll need to put 20 or 30mg of material in the tube,' Peter says. 'If you only have 1–2mg, it would take too long, but it could be done in a reasonable time in one of the cryoprobe machines. With 100 $\mu$ g, we could still do it, but it will take all weekend!'

The most common request that makes their hearts sink is for nitrogen spectra on unlabelled material. 'The natural abundance of  $^{15}\text{N}$  is pitiful, so the sensitivity is also pitiful,' Peter says. 'Realistically, the only way you can do it is by labelling the nitrogen, as is routinely done for protein NMR, or making the sample strength in the one-molar range! We discourage it otherwise; we tell the student it would take more than two days to get a result on the 10mg of sample they can get to dissolve, even with the cryoprobe. Then they realise it is not going to happen.'

Another recent addition to the department's NMR capability is a new probe for the 700MHz machine that can run protein experiments with carbon acquisition or, in principle, nitrogen acquisition of labelled samples. It's quite complicated, as Peter explains, but it can be a useful technique when running NMRs on proteins, and looking at the relationship between the different peaks. 'In a typical protein experiment, we start with the amine proton, then move on to the nitrogen, then the alpha-carbon, and then the carbonyl carbon atom, encoding information on the way,' he says. 'Then you bounce the magnetisation from the carbonyl back through the other atoms to the proton. That's a lot of steps – and you will have losses of information at each step.'

Another problem is that you're working in water, so the big solvent peak hiding the information you're looking for needs to be suppressed. 'There are ways around this, but as the information we're looking for is encoded once we get to the carbon atom, why don't we just look at that? There is now no water in the way, and although using data acquired at carbon as an indirect dimension means you need to generate a lot of data points, it does mean you can run 3D protein experiments in this way, and get better resolution,' Peter says. 'We're one of only a couple of UK chemistry departments who can do these experiments at the moment.'

It's not just biologics such as proteins that can benefit from a very high field machine. If you're unlucky and two peaks overlap, while changing solvent can sometimes resolve them, the answer can lie in running the spectrum on the 700MHz machine. The additional resolution can be sufficient to split up the peaks.

A further novelty is a three-channel instrument. Two-dimensional spectra that look at the relationship between carbon and hydrogen have been com-

mon for many years, but now we can do experiments involving three nuclei. 'It requires a special probe and the right kind of amplifiers and transmitters within the spectrometer, and the upgrade cost was too high to justify adding it before,' Duncan says. 'But when we were upgrading the whole system, the marginal cost of adding the third channel was much lower.'

### THREE CHANNELS

Two of the channels are fixed – one looks at H and the other P, which is useful for studying at chiral catalysts, where the ligands are frequently phosphorus-based. The third channel can be pretty much anything else, whether C, F, B or Li, or even something more unusual. 'It allows you to join the dots,' Peter explains. 'If you have several Li and P atoms, it is going to be a great help to know which are associated, and which are remote from each other.'

So how many spectra are run in the department every year? It's difficult to tell, but the answer is certainly a pretty large number. 'The last time I tried to count, about five years ago, we were running about 100,000 a year,' Duncan says. 'It must be more like 150,000 now.' The breakdown varies from machine to machine; at least 70% of the time, the 700MHz machine will be running biological spectra that take much longer to acquire.

This is all possible because of advances in technology and automation speeding up the acquisition process. It's a far cry from the completely manual process in the early days of NMR, or even 20 years ago when you'd be lucky to get two or three spectra run in a half-hour slot on a machine. 'For a normal proton spectrum, about four minutes elapse from the moment that the sample drops into the magnet until the user receives an email with their spectrum,' Andrew says. 'And the actual acquisition time is a very small percentage of that.'

The new breed of sample changer has greatly increased the machines' throughput



Photo: Caroline Hancock

# Hands-on chemistry entertainment

Once again, the department was filled with excited schoolchildren on our open day, as they found out how much fun chemistry can be. Nathan Pitt and Gaby Bochetti provide the photographic evidence!

Our annual open day in March was its customary success, with a couple of thousand visitors, young and old, flocking to the department to discover just how exciting and important chemistry is. And once again the buzz around the department was infectious.

The aim of the fun-packed day, part of the university's science week, is to get children aged six-plus involved in a variety of experiments. Student and staff volunteers stewarded the event and manned the experiments and exhibits. These ranged from extracting DNA and making nylon to cornflour slime, lava lamps and rainbow water, biodiesel, ferrofluids, and even the rather messy-sounding blue goo.

The demonstration lectures were also a huge hit, as always. This year, they were given by Microsoft's Chris Bishop. If you missed his 'It's rocket science'

talk, you can watch on the internet at [richannel.org/its-rocket-science](http://richannel.org/its-rocket-science).

Head of department Daan Frenkel is keen to stress that there is nothing automatic about the popularity of our open days – the success relies on the commitment and hard work of a large number of people, and the exceptional dedication of a small group of people.

'I wish to thank all those who contributed to the success of this year's open day,' he says. 'It is difficult to overstate the importance of this activity – not just for the department, but for society: demonstrating the excitement and relevance of science in general, and chemistry in particular, to young people is of crucial importance for the future.'

Our thanks also go, once again, to the Walters-Kundert Trust for its generous support of our open day activities, without which it wouldn't be possible.





## Summer science at the RS – with added chemistry



The Royal Society has held a Summer Science Exhibition at its London headquarters every year for more than a decade, and this year one of the 22 exhibits featured Cambridge atmospheric chemists, along with collaborators from various other institutions.

The team's exhibit was entitled 'Flying around storms in the tropics', and gave an insight into the recent field campaign to make measurements in storms in the western Pacific ocean.

It was such a success they're now talking to the Science Museum, the National Railway Museum in York, and Manchester's Museum of Science and Industry about the possibility of putting on events there, too.

The stand included a mock-up of the UK BAe 146 research aircraft that visi-

tors could sit in, alongside hands-on features so they could get more involved. 'At the weekend, parents brought younger kids along, and the audio on the stand of recordings from one of the flights proved a real hit,' explains Neil Harris, who organised the exhibit. 'Some of them sat there listening through the headphones for ages.'

The exhibition attracted record numbers of visitors this year, with about 15,000 over seven days. Many of these were school parties, from older primary groups to sixth formers, particularly over the first five days, with members of the public making up the bulk of the rest of the visitors.

On the final day, the Sunday, everyone had to pack up their exhibits sharp-ish, as the Royal Society had rented its build-

Michelle Cain (left) explains how the aircraft works

ing out to the Tour de France organisation, as the Cambridge-to-London third stage was finishing on the Mall just behind it on the Monday.

There were about 10 people manning the stand each day, from a rota of about 30 people, and Neil was there every day. 'The buzz was amazing,' Neil says. 'I'd been worrying about it for weeks, but the moment it started, it became clear that it was great fun.'

'Everyone who came to help on the stand – even those whose arms I'd twisted, ended up thanking me for inviting them! I expected it would just be a lot of hard work, but it was incredibly rewarding.'

As well as being open to the public during the day, there were also soirees for fellows of the society. 'That was a very different dynamic, with some of the older fellows sitting drinking champagne in the aircraft seats!' Neil says.

Neil Harris (below) gets visitors to blow through a funnel into an instrument that measures CO<sub>2</sub>, CH<sub>4</sub> and CO so they could see how much of each of these gases is in their breath



# Lord Jack Lewis, 1928–2014

Lord Jack Lewis, who has died aged 86, was the 1970 inorganic professor in this department from 1970 to 1995. Highly energetic and extremely talented, he was among a small band of pioneers who revolutionised inorganic chemistry, and must be regarded as one of the true founding fathers of modern inorganic chemistry. His time in the department was highly successful, and inorganic chemistry thrived under his leadership. His research remained active well beyond retirement.

He strongly believed in the value of international relationships, encouraging young members of his group from a wide variety of foreign backgrounds. His interaction with the support staff was superb and he never failed to recognise the enormous contribution they made to the excellence of the department. He also played a significant role in university affairs and was the first Warden of Robinson College, a position he valued greatly.

Jack obtained his PhD at Nottingham under the guidance of Professor C.C. Addison (at that time deemed a physical chemist!) and worked on non-aqueous solvents, which in the 1950s was a dominant theme in chemistry. His work included studies of dinitrogen tetroxide and liquid sodium, both important inorganic liquids, the former as a component of rocket fuel and the latter as a coolant for reactors.

On completion of his PhD, he took up a lectureship at Sheffield where he developed a deep interest in the magneto-chemistry of transition metal compounds and complexes, recognising that such measurements gave an important guide to the stereochemistry of transition metal ions and the nature of inorganic structures. In those days, equipment for such measurements was not available and, in typical fashion, Jack wound his own magnets. It was during this time that Jack realised the value of physicochemical techniques as structural probes, and later was among the first to realise the value of mass spectrometry and multinuclear NMR spectroscopy as probes to the nature of inorganic and organometallic compounds.

After a short time at Sheffield, he moved to Imperial College and then on to University College, where he developed a deep and lasting collaboration with the late Sir Ronald Nyholm. They made a perfect team. Among many avenues of interest, they were aware that, apart from few isolated compounds such as mercurous compounds with a Hg–Hg bond, there were no examples of direct transition metal–transition metal bonds. Together, they established routes to a



Lord Jack Lewis: a founding father of modern inorganic chemistry

number of these systems, and nowadays such bonds are commonplace.

Jack received the call to the inorganic chair at Manchester in 1961, and played a significant role in the construction of the new chemistry building. He retained his interest in inorganic magneto-chemistry and the synthesis of metal–metal bonds, but also became interested in the factors which stabilised the transition metal–carbon sigma bond, in those days a rarity. At the same time, with Arthur Birch, he developed an interest in the reactivity of co-ordinated ligands. He and Birch discovered that the iron(tricarbonyl) unit stabilised the keto form of phenol. It was this observation that led Jack to consider the effect of other organometallic substrates such as ruthenium(tricarbonyl) on a variety of organic systems.

## TRANSITION METAL CLUSTERS

The problem was finding a route to this ruthenium fragment. Eventually, tri-rutheniumdodecacarbonyl was synthesised, and shown to be an ideal precursor. However, most importantly, the synthesis of this trinuclear compound was to lead him into an entirely new area of chemistry – transition metal clusters. This area, possibly more than any other, is the one that is most closely associated with Jack. At its conception, few examples of these compounds had been established; this was to change entirely in subsequent years, and lead to many tangential studies of the metallic surface, catalysis, and so on.

Towards the latter part of his career, after he had moved to Cambridge, he turned his attention towards the chemistry and electronic properties of organometallic polymers, a highly successful venture in which he collaborated extensively with members of the physics department.

Jack was an exceptionally charismatic character. He instantly commanded respect, and his intrinsic goodness and

deep understanding of his subject led countless students and colleagues to choose to work alongside him, to enjoy being with him and to benefit from him. He was warm, avuncular and firm – you knew where you stood with Jack. He also possessed an almost unbelievable self-discipline. His arrival at Cambridge coincided with the earliest reports of the dangers of smoking. This persuaded him to give up smoking instantly, and overnight he went from 50 cigarettes a day to none. At one stage, he also developed a minor back problem. He was advised to lose a stone or two which he did immediately.

He strongly believed that research was only of value when correctly recorded and published, and his amazing publication record is witness to that. Most publications appeared in the various journals of the Royal Society of Chemistry, but there were also 19 papers in *Nature*. Jack received many diverse honours and awards. He was elected a Fellow of the Royal Society in 1973, and was awarded the Davy Medal in 1985, and its Royal Medal in 2004.

## HONOURS AND RECOGNITION

Chemists throughout the world held Jack in high regard and, among many such honours, he was elected a member of the American Academy of Arts and Science in 1983, and the American Philosophical Society in 1994. From 1986–88 he was president of the Royal Society of Chemistry. He was knighted in 1982, and inducted into the House of Lords in 1989 as Baron Lewis of Newnham. He was an active member of the House, serving on many committees, primarily concerned with environmental issues.

Jack and I worked closely together for 31 years. For me, it was a truly wonderful and beneficial experience. I remember with great affection the very many times we covered the blackboard in his office with scribbled ideas, solutions and, sometimes, rubbish. Many others will vouch for that! I also remember the happy times Christine and I spent with Jack, Freddie and their two children, Penny and Ian. He also loved rugby, having played as a young man, and he and I spent many hours at Grange Road, and in front of the TV watching the Varsity Match. Conferences were always invigorating with Jack around, and we spent many exhilarating times at meetings through the world.

Jack Lewis was a remarkably brilliant chemist, and a thoroughly decent man in every respect. He will always be held in the highest regard by those who had the good fortune to work with him or alongside him. His published work is a testament to his remarkable abilities as a chemist, and Robinson College to his other contributions to Cambridge life and the university.

Brian Johnson

## Cycling to time trial glory



The department now has a national cycling champion among its ranks, in the shape of PhD student Hayley Simmonds. Hayley, who's working on aluminium catalysts in hydrogen storage with Dominic Wright, won the British 50 mile time trial in Poole at the beginning of June – a race which was her first ever time trial over that distance.

She only discovered cycling relatively recently, having rowed as an undergraduate, making it to the women's reserve boat Blondie in 2009, before giving up to focus on her Part III studies. Her boyfriend had been cycling since he was 14, and persuaded her to get on a bike as her next competitive challenge – and she was hooked.

Hayley on her way to time trial victory, and atop the winners' podium (right)

'I took up competitive cycling in 2011, initially in inter-university races, and then in 2012 entered national competitions for the first time, coming eighth in one and ninth in another,' she says. 'Last year, I did three, coming fourth in two and second in the third. My aim this year was to win one – and I did!'

As well as time trials, she also enters a lot of road races, and recently took part in a five-day stage race in France, the Tour de Bretagne Fémenin. This involved two short time trials and three 80-plus-mile road race stages. 'It was the most racing I've ever done over five days,' Hayley says. Although she normally rides for the Velosport Pasta Montegrappa team, for this race she was a guest in Dame Sarah Storey's team, Pearl Izumi Sports Tours International Boot Out Breast Cancer. She did pretty well – finishing 49th out of 109 starters, and second in the team behind Storey. Not bad in a race that was packed with pro riders!

Her most recent exploits were in the national 25 mile time trial in early August, finishing second – behind Sarah Storey. 'It was a difficult day on the bike with very changeable weather conditions and a torrential storm 10 miles in which nearly caused me to stop riding due to concerns over visibility – or lack thereof!' she says.

The season isn't over yet, with the national 10 mile time trial at the end of August, and then she plans to compete in a couple of races in France in the autumn. Her aim now is to make it as a pro rider, once she finishes her PhD in 2016. 'If I don't have a big team to pay me by then, I plan to spend a year as a full-time athlete, funded from my savings,' she says.

When Hayley was in France with Sarah Storey's team, all she had to focus on was eating, sleeping and riding her bike. 'There were mechanics to look after the bike, and everything was done for us. Being able to ride my bike and then rest up for the next day made all the difference. At the moment, I'll get up at 6am, train for an hour and then go in to the lab, and train again in the evening. By the end of the week I'm exhausted – and I still have to race at the weekend. Come Monday, I feel like I've had no rest at all! Being full-time would give me the best chance of succeeding as a cyclist.'



## A chemical wedding – Indian style

Rucha Chiddarwar, a PhD student in Andreas Bender's group, sends along this picture of what she describes as her 'Big Fat Indian Wedding' to Sriram Aravamudhan, who's a biology PhD student in Germany. The pair met in Edinburgh, when they were both masters' students.

Rucha is from Mumbai in the north of India and Sriram from Chennai in the south, and, she says, their parents decided to incorporate both cultures into the wedding. 'Indian weddings are always extravagant affairs, where festivities last up to a week, with enormous supplies of food and beverages!' she says.

Several of their friends from the UK and Germany attended the week of festivities in Nagpur, with the main events taking place over three days in June. On the first day, Haldi involves a paste of turmeric and water being applied to the bride's face by friends and family to make her skin sparkle, and in the evening the bride and all the ladies applied henna 'tattoos', along with folk dancing and music. This signifies the departure of the bride from her home to her husband's.

On the second day was the Baraat, a large gathering of family and friends, and the arrival of the groom. 'This is traditionally on a decorated horse, but Sriram arrived in much more extravagant style – in an Audi!' she says. This was followed by the ring ceremony, where a huge rotating lotus-shaped stage opened slowly to reveal the bride and groom inside, under a shower of flower petals. In the evening was Sangeet, a music and dance evening the day before the wedding itself, typical of north Indian weddings.

Rucha and Sriram in two of the many traditional costumes they wore during the festivities



The big day itself was the third, with six rituals performed according to south Indian traditions, as Rucha explains. 'First was Kashiyaatre, where the groom takes off on a mock pilgrimage, but the bride's father persuades him to change his mind and marry his daughter. Usually, after a lot of persuasion, he agrees – but in our case, Sriram quickly agreed!'

Next, in Sambanhmale, the couple exchange garlands, then Oonja is performed to ward off evil forces. Then Kanyadaan, where the bride's father gives her away to the groom. Mangalyadharanam is next, which Rucha describes as the highlight of the marriage. 'The groom ties the sacred taali on the bride as she is seated on the lap of her father,' she says. 'Finally, Sapthapadi is the ritual where the couple walk around the sacred fire. The groom walks with the bride to the right side of the sacred fire while holding her right hand. He stops, bends down and holds her right toe with his right hand and helps her take seven steps around the fire. At the beginning of each step, he recites a Vedic mantra seeking the blessings of Lord Maha Vishnu.'

And once all this was over, they were finally man and wife – and headed off to the Maldives on honeymoon.

## A graduation and a baby!



Matt Bushen, one of the department's electricians, has recently completed an Open University degree in arts and humanities. Over the past six years of part-time study, he investigated subjects as diverse as philosophy, psychology and history. There was even some science in there, including human genetics, and Darwin and evolution. He's pictured in his snazzy graduation robes with wife Amy.

Matt also sends along a baby photo – their second child, Jacob, was born in January. Big sister Isabelle is delighted!



Congratulations to our apprentice plumber Dan Ayling, who has been named apprentice of the year by Cambridge Regional College. Dan's now half way through his course, so that's another two years to go. Well done!

## It's a knockout...

Ten intrepid members of the Abell group, including Chris himself, took part in an 'It's a Knockout' competition and family fun day which took place in Willingham one Sunday in July. The event was held to raise funds for the much-needed refurbishment of the Willingham playground.

Chris' team was called Ready, Willing and Abell, and our spy Catherine Atkins (who also happens to be Chris's secretary) reports with some glee that they didn't beat her team of local playgroup mums, Bubbleicious, which was the only female team in the final.

'I must admit it was more down to

the tactical playing of our joker, rather than any real athletic prowess,' she says. And the fund-raising was a success too, with more than £7000 being added to the playground fund.



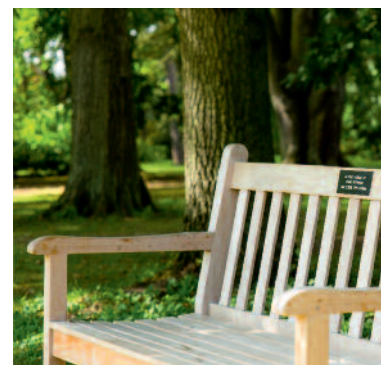
Pedro Oliveira and Chris Abell channelling their inner Tellytubbies... eh oh!

## Remembering Angie in the garden

Nine years ago, Emma Graham did a parachute jump to raise funds to place a memorial bench in the Botanical Gardens for friend and colleague Angie Dickinson, who loved the place. Angie was Brian Johnson's secretary, and died of motor neurone disease in 2004.

With the additional help of members of the department, enough money was raised, and the bench has recently been placed. 'At the time, the Gardens advised that there was a very long waiting list, but I didn't realise how long that wait would be!' Emma says. 'But finally we reached the top of the waiting list, and there is now a bench in her memory in the gardens.'

The tree is in a beautiful spot under a tree, directly opposite the Cory Lodge, in the grassed area opposite the café.



'I'm sure Angie would have approved of such a lovely setting.'

Reception have tickets for weekday entry, and a map locating the bench, if anyone would like to visit the gardens and remember Angie.

## Melvyn retires – with antipodean input



Melvyn receives his leaving presents from Chris Abell (left), and talks to Tim Layt in New Zealand via computer (right)

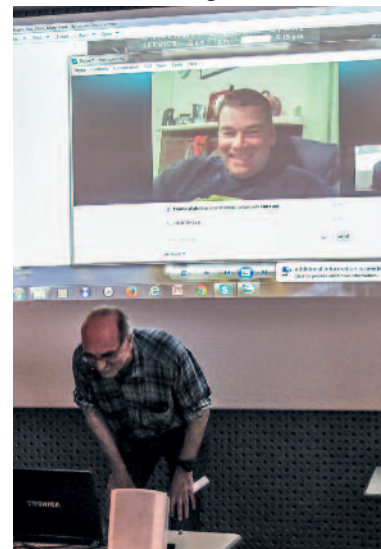
Melvyn Orriss retired at the end of March, after almost 45 years in the department. He'd started work in the department of organic and inorganic chemistry in September 1969 as a laboratory technician. When he retired, he was a principal laboratory technician, primarily working with research groups on the first and second floors, giving wise advice and dealing with the day-to-day running of the labs.

He was presented with a pile of Amazon vouchers, and a painting of a pike – an ideal gift for such a keen fisherman! 'I did not initially want a leaving party, but I'm so glad I did, as I had a lovely time,' Melvyn said. 'I am very grateful to everyone!'

The Todd Hamied room was packed out with friends past and present in the department wanting to wish him well. Also present, via the miracles of modern technology, a Skype connection and a projector, was former technician Tim Layt, who emigrated to New Zealand with his Kiwi wife Kirsten (herself a former receptionist here in Lensfield Road) in 2011. He was so keen to pass on his appreciation and regards to Melvyn that he got up in the middle of the night in Auckland to do it.

'I certainly had my fingers crossed that as such an old man (sorry, Melvyn!), he wouldn't make it to late afternoon and his retirement party would be at lunchtime – selfishly work-

ing out the time difference – but no, not to be.' Tim says. 'Still, it was a pleasure to wake up at something like 3:30am, get dressed (mostly) and break out the single malt to raise a glass to the Boss. The man is a legend.'



## Last issue's solutions

Either last issue's puzzles proved even harder than usual or the email snails and postal mice have been nibbling away at the entries and ate them before they arrived. However, we did have some submissions...

### Double killer ChemDoku

David Thompson's magnificent take on the killer ChemDoku, where solvers had to recreate the grid as well as fill in the gaps, proved a challenge. But one that several readers rose to! Alison Griffin's comment is typical. Despite rather too many times nearly being convinced that there must have been some typographical error, dogged determination not to be beaten was eventually successful and I deduced the

unique solution,' she says. 'Phew!! Congratulations to David on his masterful puzzle.'

Other correct solutions came from Mike Barlow (who says it was easy if you started from the bottom right), Richard Moss, David Wilson, Godfrey Chinchin, John Billingsley, Tim O'Donoghue (who said the puzzle was tough) and Ian Fletcher. Ginola Puscat von Moglitude was pressed into winner selection once more, and she made a beeline for Tim O'Donoghue's catbiscuit. So the prize is heading his way.

### Pascal's Triangle

Despite setter David Wilson's expectation that this puzzle would prove pretty simple, in reality, it defeated most readers. In fact, we only had one semi-answer, from Richard Moss. He man-

aged to solve the easy triangle, but not the hard one, claiming the maths was OK but the chemistry defeated him. But we're going to send him the prize anyway. Congratulations!

The solution to the easy triangle is H - O - Ni - Ba - Yb - Ba - Ni - O - H.

For the hard triangle the rule, David says, is that any main group element is replaced by its corresponding 'mirror image' in the same period of the periodic table e.g. Li (group I, third line) is replaced by F (group VII). The rule can be deduced because 'a' before transformation is Li ( $H + H = 1 + 1 = 2$ ) and after transformation is F ( $Ne - H = 10 - 1 = 9$ ); and the rule can be checked by following through to 'd' which is half of Cf = 98, i.e. In = 49 not Sb = 51.

So a = F (Li) 9; b = Cl (Na) 17; c = Se (Ca) 34; d = In (Sb) 49; e = Br (K) 35; x = Ho 67.

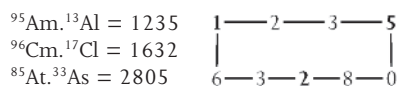
## This issue's puzzles

### Triads for the 21st century

In something approximating to trepidation, here's another puzzle from David Wilson, which he thinks is pretty straightforward, and devised while on holiday in Greece in an attempt to ward off the attractions of simply lotus-eating for a couple of weeks. Here's hoping readers agree about its straightforwardness, and we get plenty of solutions!

David says... does it ever strike you as strange how symbols for elements cluster together? Nine C-s but only two K-s, for instance. This thought prompted the following problem. Work out the products of the atomic numbers of elements whose symbols are alphabetically immediately adjacent (thus Q/Qa and Qa/Qb would qualify, but not Q/Qb or Qa/Qc). Some of these products can be grouped into triads, as in this example, with the

last digit of one number being the first of the next member of the triad. Note that numbers are to be entered left to right.



The least such triad can be completed using atomic numbers less than 72; the next with atomic numbers less than 82; and a third with atomic numbers less than 92. Individual elements may be used more than once, in different pairings, but the same pair may only be used once. Only four-digit numbers, and no leading zeroes, please.

Which elements make up each triad?

### ChemDoku

And finally, a return to a regular ChemDoku, with a precious metal (and a few other things you might find in jewellery) theme for our 50th birthday.

Ti			Pd			C		Ag
Pd	Au					Rh		
			Ag			W		
		Rh				Ir		
	C		Au		Pt			
Ag				W				
Au			C					
Rh					Ti	Pd		
Ir		W			Au			C

Email your puzzle entries to [jsh49@cam.ac.uk](mailto:jsh49@cam.ac.uk), or you can send them by snail mail to Chem@Cam at the address on p3

## The art of science book publishing

A tome of memoirs reaches us from reader Michael Rodgers. Although he's not a Cambridge chemistry alum, he's been an avid reader of Chem@Cam ever since the first issue. He thought other readers might be interested in his book, in which he recalls the highlights of his career as a commissioning editor for science books at Oxford University Press. He was the first to commission books from such famous names as Richard Dawkins and Peter Atkins.

In 'Publishing and the advancement of science - from selfish genes to Galileo's finger', he describes the process of commissioning books - particularly popular science books and textbooks for students. It's not as simple as merely deciding a book is a good idea and it magically appearing in print a couple of months later - much collaboration takes place between authors and editors, and books can take years to be completed.

One textbook Michael commissioned, and one which many Chem@Cam readers will be extremely familiar with, even inspired one of the

chapter titles - 'The best textbook of organic chemistry I ever hold in my hands' - a quote from a thank you letter from a very enthusiastic German chemistry lecturer.

That book is, of course, 'Organic Chemistry' by Jonathan Clayden, Nick Greeves, Stuart Warren and Peter Wothers, the first two authors being former PhD students of Stuart's, and Peter is a teaching fellow in the department. Michael tells the tale of how the book came into being, and the process by which it developed into the must-read textbook for students of organic chemistry.

From first idea to first edition took about 15 years, and the first edition remained in print for 11 years before the second was published in 2012. 'My personal guess is that with regular new editions it will still be selling in 25 years' time,' Michael says.

'Publishing and the advancement of science' is published by Imperial College Press, ISBN 978-1-78326-371-4

