

chemistry

June 2014

in Australia

Crumb, crust and chemistry

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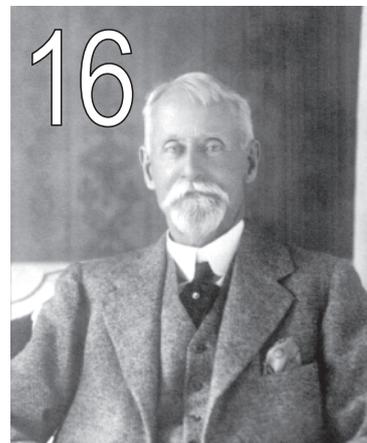
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June 2014



cover story

Using your loaf: history and chemistry of bread

It's been a staple food for many thousands of years, but the humble loaf isn't quite what it used to be.

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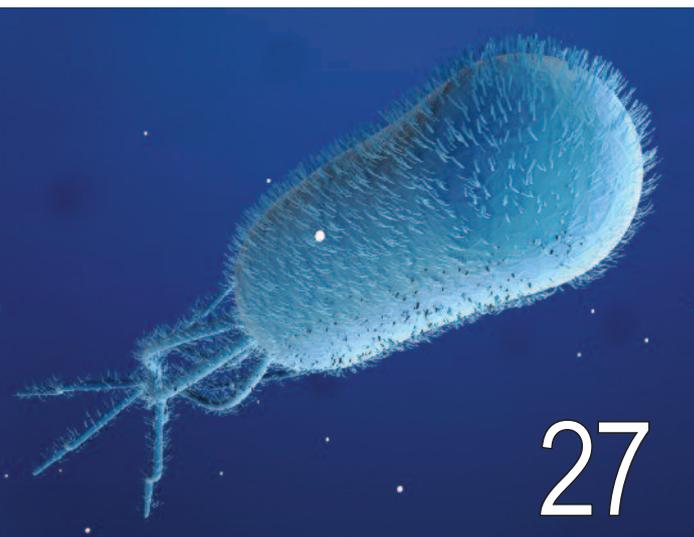
As Australia advanced from British colonies to nationhood, and towards war, a chemist established and developed its defence science.

24 The next great thing in AAS

Dave Sammut road tests a spectrometer that sports a single light source for all elements.

27 Q&A: Resistance to antibiotics

Many of us take antibiotics for granted, but rising bacterial resistance is having major health consequences.



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A virtual space for chemical heritage

Early in April, the School of Chemistry Virtual Museum (<http://museum.chemistry.unimelb.edu.au>) was launched at the Melbourne University Chemical Society's Valda McRae Lecture. McRae, a long-serving and valued part of the School, died in January (see p. 32). Initial funding for the museum came in 2009 from a Scholarly Information Innovation Grant to Associate Professor Michelle Gee, who has pursued her idea to fruition.

The museum features images of an array of fascinating objects from the university's Chemistry Cultural Collection, as well as profiles of prominent people throughout the School's history, a timeline and catalogue, and an interactive section (under construction, I think). Some of these people and items were part of the 'Our chemical cultural heritage' series, written by Petronella Nel and published in *Chemistry in Australia* in 2009. Nel, a lecturer, and researcher and objects conservator at the Centre for Cultural Materials Conservation at the university, says:

... the Chemistry Collection ... via the Virtual Museum ... brings to fruition the immense foresight of Joan Radford who not only documented the early history of the School of Chemistry but also rescued the associated heritage representing chemistry's development in Australia. The Virtual Museum initiative provides an appreciation of chemistry's historical roots in Australia to current generations and will inspire future generations of Australian scientists.

The objects (for example, the polarimeter pictured) have been nicely photographed, and some of them, such as the vacuum tube and the Davey lamp, would make handsome home décor and a fine conversation piece all rolled into one. Samples, lighting, spectroscopy and measurement are among the chemicalia illustrated, rounded out with explanations of their development and the people involved, such as Masson, Rivett and Hartung.

Among the samples are phosphonium and sulinium, for which covalency of phosphorus and the nature of bonding, respectively, were investigated by Masson and Kirkland. Another lamp, the Dobereiner hydrogen lamp, ignited when mixed with oxygen over spongy platinum, and the site informs us that 'this was the basis of a method of ignition for coal gas burners, with



Melbourne University Chemistry Cultural Collection

the hydrogen being generated by the action of sulphuric acid on zinc', something that lamplighters knew well. Two centuries ago, this was the latest technology, with the Gas Light and Coke Company supplying London with the first gas manufactured from coal for street lighting (May edition, p. 10).

The museum is an attractive and informative piece of history of the School's Cultural Collection and its people, and I'm glad to see chemical heritage coming to light, available to us all via the internet.



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'Kappa' Cornforth, a further tribute

I was exceptionally fortunate to work on the bench next to John Cornforth at the University of Sussex in 1986, and there be exposed to his massive intelligence. John (always known as 'Kappa' since his early days at Oxford with Robert Robinson, who had claimed that he could never remember the names of his students and therefore labelled them in order of appearance with consecutive Greek alphabetical characters), was somewhat hard to understand by the mid-1980s due to his lack of hearing of the spoken word, but the effort was well worth the trouble.

At that stage, Kappa was working on an artificial enzyme, looking for the protonation of a simple achiral olefin to provide a chiral hydrocarbon. This required that the starting material be held in a rigid template ('the enzyme') so that only one face of the olefin was available for protonation.

He kept a chessboard on his lab bench, and delighted in playing, from memory, the latest game in the world chess championship from the previous evening, chortling over any innovative move. All this was done at such amazing speed that I found it near impossible to keep up. Kappa was, of course, at one time the Number One board for the Sussex Correspondence Chess team.

He was a man full of invigorating ideas, and his theory that the exposure of spies and their secrets, so that ultimately all intelligence would be available to all people, resonates through until today.

My last physical contact with Kappa, in December 1986, involved us out-drinking all others at the Juggs Arms, and with just the two of us left, working our way through perhaps the fourth pint of 'Bishop's Tipple' (probably well over 6% EtOH at that time), he duly presented me with a University of Sussex pewter in memory of my time there. Kappa was then fortunate; his delightful wife Rita would pick him up by car as he was by that stage not driving, while I had to stagger home in the opposite direction by train and foot.

The last correspondence I had with Kappa was a somewhat plaintive request for me in Brisbane to confirm that he had succeeded in obtaining the X-ray structure of the lowest molecular weight organic compound yet to be determined!

Some of Kappa's publications in Australian sources still provide a great and stimulating read: The Ritchie Lecture (*Chem. Aust.* 1978, **43**, 249), The Robert Price Lecture (*Aust. J. Chem.* 1993, **46**, 157) and the RACI 75th Anniversary Lecture (*Aust. J. Chem.* 1993, **46**, 265).

He was a great man!

Ray Carman

Fact v furphie

What a great article on page 34 of the March 2014 issue. The amount of times I hear things like 'no nasty chemicals' or other such misleading statements, as on a recent ABC radio broadcast, a 'natural cleaning products' person claiming that some toilet cleaners produce 'mustard gas' if they react with other cleaning products. (They may produce chlorine, which is not mustard gas.)

The amount of 'greenwashing' by industry (in general) is amazing, and some of the claims made, for example that a baby's dummy (silicon teat) is BPA free, are irrelevant at best, given that BPA is chiefly used in the production of polycarbonates, not siloxane polymers.

I completely agree with the statement (despite perhaps same public opinion often being misinformed) that 'public opinion is a strong catalyst for regulatory initiatives in the political arena'. It is applicable beyond the chemical industry, for example in mining rehabilitation or processing of 'unpopular' minerals (such as uranium and lead), in 'fracking' of coal seam gas, and in relation to climate change.

I believe that a more informed public will be able to make better and more accurate decisions. The very people (scientists) who hold the answers to such problems as peak oil, renewable energy and climate change are the same people who are often tarred as being responsible for the woes of the world, such as pollution and chemical spills.

Chris Embery MRACI CChem

The Elements

Alan Jones' review (April 2014, p. 32) brought to mind my own joys in the learning of, using, and even memorising of, the periodic table.

The review, however, did not mention the wonderful app, also created by Theodore Gray and Nick Mann. Stephen Fry described the app as 'Alone worth the price of an iPad'. As well as all of the illustrations and information of the book, it includes animated views of the photos and the original version of Tom Lehrer's song.

Just to top it all off, there is a Japanese version of the Lehrer song, with lyrics by Thomas Howard Lichtenstein sung by his two young daughters, Angelina and Jennifer.

Stephen Fry is right!

Terry Corbett FRACI CChem

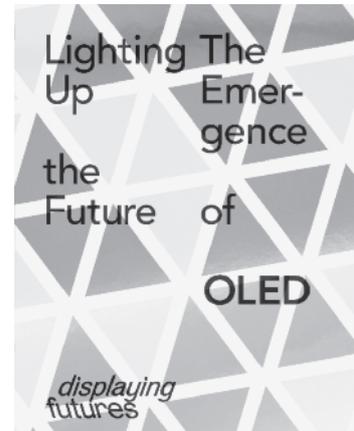
Lighting up the future – the emergence of OLED

The latest project by Merck within the scope of its Displaying Futures initiative showcases the possibilities of organic light-emitting diodes (OLEDs) in architecture, art and design, and looks at how innovative technological developments can positively affect people's lives.

Exceptionally thin, transparent, versatile, long-lasting and energy-efficient, OLEDs create possibilities that extend well beyond conventional lighting applications. *Lighting up the future*, which features 160 pages of text and fascinating pictures, presents concepts and theories being developed in avant-garde architecture, art and design.

For instance, Kjetil Trædal Thorsen of Norway, co-founder of the architectural firm Snøhetta, sees OLEDs as lighting materials for design and construction that give mankind new freedoms and serve as a major unifying element. With his concept of the accessible OLED room, the Darmstadt-based painter and video artist Willi Bucher exposes viewers to unusual realms of human experience. Sebastian Herkner developed the concept of 'OLED lighting curtains'. When switched on, the curtains float as a dynamic light surface in the room; when switched off, they are transparent.

Published by Trademark Publishing, *Lighting up the future – the emergence of*



OLED (ISBN 9783981586077) can be ordered for €28.00 from info@trademarkpublishing.de.



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Science vital to maintaining Australia's claim in Antarctica: Academy

The Australian Academy of Science has warned that a declining scientific effort is weakening Australia's claim to Antarctic territory and strategic position in the region.

In a submission to the Australian government's 20 Year Australian Antarctic Strategic Plan, the Academy states that 'inactivity or reduced activity within the Australian Antarctic Territory runs the risk of eroding Australia's long term goals, interests and our capacity to influence the long standing stability of the region'.

The submission says our Antarctic research is 'chronically underinvested' and Australia's current access arrangements to the territory and the sub-Antarctic islands are 'woefully inadequate'.

The number of science projects being supported by the Australian Antarctic Program has dropped from 142 in 1997 to just 62 this year.

Australia currently makes claim to 43% of the Antarctic continent based upon its geographic proximity and history of exploration, discovery and activity in Antarctica.

'As science is currency in Antarctica, [Australia's declining

research] impacts on the strength of Australia's claim over the Australian Antarctic Territory and its impact as an influential Consultative Party to the Antarctic Treaty,' the submission says.

'Australia is rapidly falling behind developing nations that are taking an increasingly high interest in the Australian Antarctic Territory, particularly China, Russia and India.'

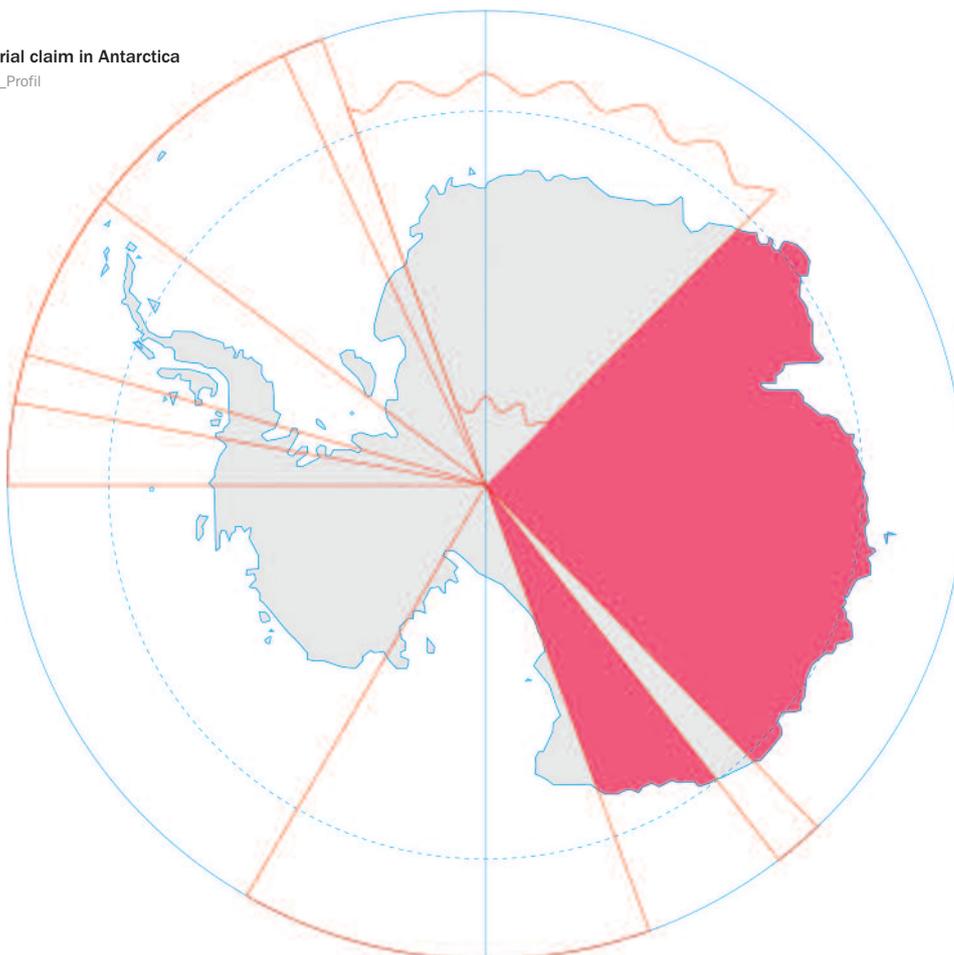
The submission outlines nine fundamental requirements essential to Australia maintaining its claims in Antarctica and a leading role in the Antarctic Treaty System, including adequate funding for research, reliable and increased access, and improved capabilities for data collection.

Antarctica is a unique research environment that cannot be replicated elsewhere and is particularly important for research in a diverse range of fields such as oceanography, atmospheric and earth sciences, fisheries, biodiversity and conservation, geology, medicine and astronomy.

The submission was prepared in consultation with the Academy's National Committees for Science. Read the full submission at www.science.org.au/reports.

AUSTRALIAN ACADEMY OF SCIENCE

Australia's territorial claim in Antarctica
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Is it *really* ok to pee in the pool?



iStockphoto/jamieklusacek

Sanitary-minded pool-goers who preach 'no peeing in the pool', despite ordinary and Olympic swimmers admitting to the practice, now have scientific evidence to back up their concern. Researchers are reporting that when mixed, urine and chlorine can form substances that can cause potential health problems. Their study appears in *Environmental Science & Technology* (doi: 10.1021/es405402r).

Jing Li, Ernest Blatchley, III, and colleagues note that adding chlorine to pool water is the most common way to kill disease-causing microbes and prevent swimmers from getting sick. But as people swim, splash, play – and pee – in the pool, chlorine mixes with sweat and urine and makes other substances. Two of these compounds, trichloramine (NCl_3) and cyanogen chloride (CNCl), are ubiquitous in swimming pools. The first is associated with lung problems, and the second can also affect the lungs, as well as the heart and central nervous system. But scientists have not yet identified all of the specific ingredients in sweat and urine that could cause these potentially harmful compounds to form. So Li's team looked at how chlorine interacts with uric acid, a component of sweat and urine.

They mixed uric acid and chlorine, and within an hour, both NCl_3 and CNCl formed. Although some uric acid comes from sweat, the scientists calculated that more than 90% of the compound in pools comes from urine. They conclude that swimmers can improve pool conditions by simply urinating where they're supposed to – in the toilets.

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June 2014

NTU's new perovskite solar cell, found to have light-emitting properties, as seen in the lab

NTU

Solar cell by day, light panel by night

In future, when your mobile phone or tablet runs out of battery, you could just recharge it by putting it out in the sun.

Nanyang Technological University (NTU) scientists have developed a next-generation solar cell material that can also emit light, in addition to converting light to electricity.

This solar cell is developed from perovskite, a promising material that could hold the key to creating high-efficiency, inexpensive solar cells (see March 2014 issue, p. 36). The new cells not only glow when electricity passes through them, but they can also be customised to emit different colours. Imagine a shopping mall facade that could store solar energy in the day and transform it into a light display for advertisements that glow at night.

This discovery, published in *Nature Materials* (doi: 10.1038/nmat3911) was made almost by chance when NTU physicist Assistant Professor Sum Tze Chien asked his postdoctoral researcher Xing Guichuan to shine a laser on the new hybrid perovskite solar cell material they are developing.

Sum said to the team's surprise, the new perovskite solar cell glowed brightly when a laser beam was shone on it. This is a significant finding as most solar cell materials are good at absorbing light but are generally not expected to generate light. In fact, this highly luminescent new perovskite material is also very suitable for the making of lasers.

'What we have discovered is that because it is a high-quality material, and very durable under light exposure, it can capture light particles and convert them to electricity, or vice versa,' said Sum, a Singaporean scientist at NTU's School of Physical and Mathematical Sciences.

'By tuning the composition of the material, we can make it emit a wide range of colours, which also makes it suitable as a

light emitting device, such as flat screen displays.'

His research partner, Assistant Professor Nripan Mathews from the School of Materials Science and Engineering (MSE) and the Energy Research Institute @ NTU (ERI@N), said this newly discovered property is expected to enable the industry to feasibly adopt the material for use into existing technology.

'What we have now is a solar cell material that can be made semitranslucent. It can be used as tinted glass to replace current windows, yet it is able to generate electricity from sunlight.

'The fact that it can also emit light makes it useful as light decorations or displays for the facades of shopping malls and offices,' said Mathews, who is also the Singapore R&D Director of the Singapore-Berkeley Research Initiative for Sustainable Energy (SinBeRISE) NRF CREATE program.

'Such a versatile yet low-cost material would be a boon for green buildings. Since we are already working on the scaling up of these materials for large-scale solar cells, it is pretty straightforward to modify the procedures to fabricate light-emitting devices as well. More significantly, the ability of this material to lase, has implications for on-chip electronic devices that source, detect and control light,' he added.

The inner workings of the new NTU solar cell material were published in *Science* in October last year.

The advanced material, which is currently patent pending, is five times cheaper than current silicon-based solar cells. This is due to its easy solution-based manufacturing process, which works by combining two or more chemicals at room temperature.

NANYANG TECHNOLOGICAL UNIVERSITY

High cost of poor hydrocarbon process safety



The combined financial loss from the 100 largest accidents in the hydrocarbon industry between 1974 and 2013 has been estimated at over US\$34 billion by insurance provider Marsh, whose energy loss database holds almost 10 000 records of losses spanning a period of more than 40 years.

The data was published by Marsh in the 23rd edition of *The 100 largest losses 1974–2013: large property damage losses in the hydrocarbon industry*.

The losses are dominated by the upstream (34%) and refining sectors

(29%), with the petrochemical sector accounting for nearly a quarter of losses (23%). Gas processing (9%) and distribution sectors (5%) accounted for more than a sixth of losses.

Marsh reported that eight new losses have entered the 100 largest losses list since 2011, including the Sendai refinery in Japan; Geismar petrochemical facility, Louisiana, US; and La Plata refinery, Ensenada in Argentina.

The Piper Alpha Disaster in the North Sea, UK, tops the list with estimated losses of US\$1.8 billion, followed by the

Pasadena petrochemical plant explosion, Texas, US, which incurred losses of US\$1.4 billion.

The hydrocarbon industry played a leading role at IChemE's Hazards 24 conference held in May, a process safety event for the chemical and process industries.

Andrew Furlong, IChemE's director of policy and communication, said: 'Marsh's latest report is another stark reminder of the sheer scale of financial loss resulting from process safety incidents. In reality, the financial loss is even greater with 10 000 incidents recorded by Marsh over the past 40 years.

'In 2014 there are sobering anniversaries of major disasters from recent decades including Flixborough, Bhopal and Exxon Valdez.

'However, it is the elimination of loss of life and serious injury that should be the priority of everyone in the chemical and process industries. With over 100 recorded accidents so far in 2014 resulting in over 400 deaths and injuries, we all need to do more to improve safety for everyone involved in these hazardous but vital industries.'

ICHEME

Australian chemistry industry welcomes deregulation agenda

The Plastics and Chemicals Industries Association (PACIA) has welcomed the federal government's deregulation agenda.

'Reducing the burden on Australia's manufacturing businesses is critical to ensuring the Australian chemistry industry can grow and take advantage of our proximity to emerging markets in Asia,' PACIA Chief Executive Ms Samantha Read said.

The aim of the Omnibus Repeal Day (Autumn 2014) Bill 2014 is to enable amendment or repeal of legislation across 10 portfolios. According to the Parliament of Australia, 'The Bill brings forward measures to reduce regulatory burden for business, individuals and the community sector that are not the subject of individual stand-alone bills.'

'This will enable the Australian chemicals and plastics industry to invest, innovate and bring the latest chemistry technologies to Australia. For example, under current regulation a product deemed safe in equivalent markets such as Europe, US

or New Zealand may need to be re-certified afresh in Australia, which can add millions of dollars to business costs through unnecessary duplication. If Australia is to take maximum advantage of 21st century opportunities, we need to continue to release the handbrake that inefficient and inconsistent regulation presents for the Australian chemistry industry,' said Read.

'While this Omnibus Repeal Day (Autumn 2014) Bill represents an essential first step, these deregulation efforts need to continue. In 2008, the Productivity Commission recommended a complete suite of measures to reform the framework of chemical regulation in Australia. While some individual measures have been progressed, the broader framework should now be re-examined within the current deregulation agenda,' said Read.

PACIA

Nature Publishing Index Asia–Pacific 2013

Japan remains the major scientific power in Asia–Pacific, despite China nipping at its heels, according to the Nature Publishing Index (NPI) 2013 Asia–Pacific published in March.

Japan, which is overcoming the impacts of the 2011 Tohoku earthquake and tsunami, with the help of a US\$1.8 billion science stimulus package, continues to lead the Asia–Pacific NPI in physics, life sciences and earth and environmental sciences.

Despite the University of Tokyo being knocked off the top of the Asia–Pacific NPI institution rankings for the first time by the Chinese Academy of Sciences, the institution is still the top contributor to *Nature*. Growth in China's output is outpacing Japanese science, and the former may overtake Japan in *Nature* publications within one or two years.

South Korea ranks fourth for scientific research output in the region. In 2013, the nation significantly increased its NPI output following a slight drop in 2012. Named a possible 'one to watch' by the supplement editors, with high levels of investment in science and technology announced by both government and private enterprise, its NPI output is growing faster than China's.

The Korea Advanced Institute of Science and Technology has risen two places to take top spot above Seoul National University, which has retained second place. Pohang University of Science and Technology has leapt from eighth to third, with a more-than-threelfold increase in corrected count, adjusted for the proportional contribution of collaborative institutions.

Last year's number one, Yonsei University, could not maintain its exceptional 2012 NPI output and has dropped to seventh spot. It is now just above a newcomer, the Institute for Basic Science, funded as part of the government's increased investment in basic

science. The Institute for Basic Science plans to open 50 research centres by 2017 and will no doubt provide increasing contributions in the next few years.

Singapore holds its own among its bigger Asia–Pacific neighbours, ranking fifth for scientific research output. The country's multibillion dollar research and development investment program has been steadily growing over the past decade and its NPI output almost doubled in 2013.

Singapore's three significant research institutions all rank in the Asia–Pacific top 20. The National University of Singapore, sixth in the Asia–Pacific, outperformed the top institutions from higher-ranked nations Australia and South Korea.

Nanyang Technological University recorded a 250% increase in corrected count to take second place in Singapore and 12th in the region. Third is national research body the Agency for Science, Technology and Research (at 19 in the region).

The National University of Singapore and Nanyang Technological University both rocketed up the global rankings in 2013, to 46 (from 74 in 2012) and 73 (from 217), respectively.

The Nature Publishing Index 2013 Asia–Pacific measures the output of research articles from nations and institutes published in the 18 *Nature*-branded primary research journals over the calendar year to provide a snapshot of research in the Asia–Pacific in 2013. To see the latest results for the region, and the Nature Publishing Index Global Top 100, visit the Index website at www.natureasia.com/en/publishing-index. The data posted on the website is updated every week with a moving window of 12 months of data.

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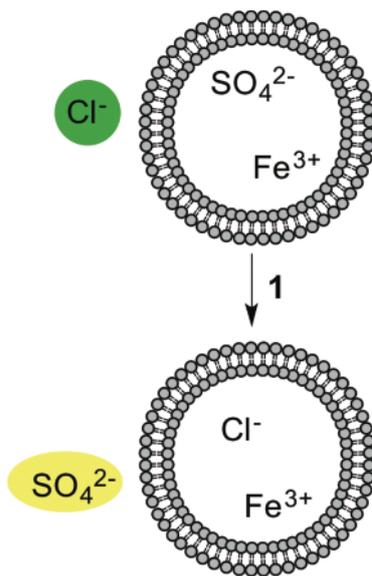
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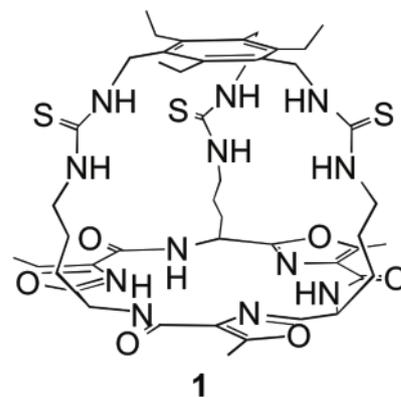


Smuggling sulfate across cell membranes

The transport of molecules and ions into and out of cells is key to the chemistry of life. Natural ‘transporter’ or channel-forming molecules facilitate this complex process, which is not yet well understood. Compounds that can replicate this activity have potential therapeutic use for treatment of diseases caused by disruption of transport (e.g. cystic fibrosis), but a better understanding of the chemistry involved is required first. A team of researchers led by Professors Kate Jolliffe (University of Sydney), Philip Gale (University of Southampton) and Janez Plavec (National Institute for Chemistry in Slovenia) has examined the transmembrane transport of the poorly studied sulfate anion, which is normally assumed to be too hydrophilic to be transported across membranes by small synthetic transporters (Busschaert N., Karagiannidis L.E., Wenzel M., Haynes C.J.E., Wells N.J., Young P.G., Makuc D.,



Plavec J., Jolliffe K.A., Gale P.A. *Chem. Sci.* 2014, **5**, 1118–27). To do this, they developed a new tool based upon sulfur NMR spectroscopy to directly monitor sulfate transport across membranes. Using this method, they established, for



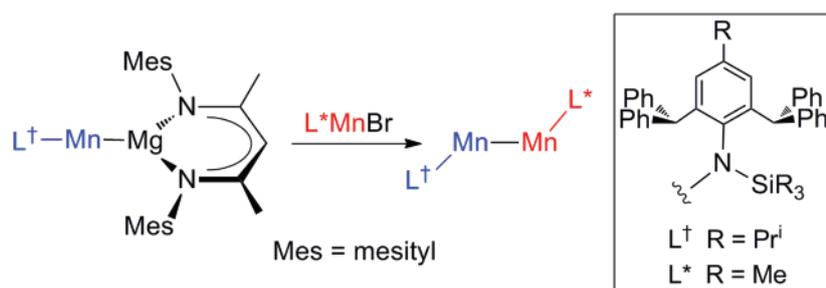
the first time, that transmembrane sulfate transport is mediated by a cyclic peptide-based sulfate receptor that wraps around the highly hydrophilic ion and screens it from the membrane environment.

An ‘inorganic Grignard reagent’ with a Mn–Mg bond

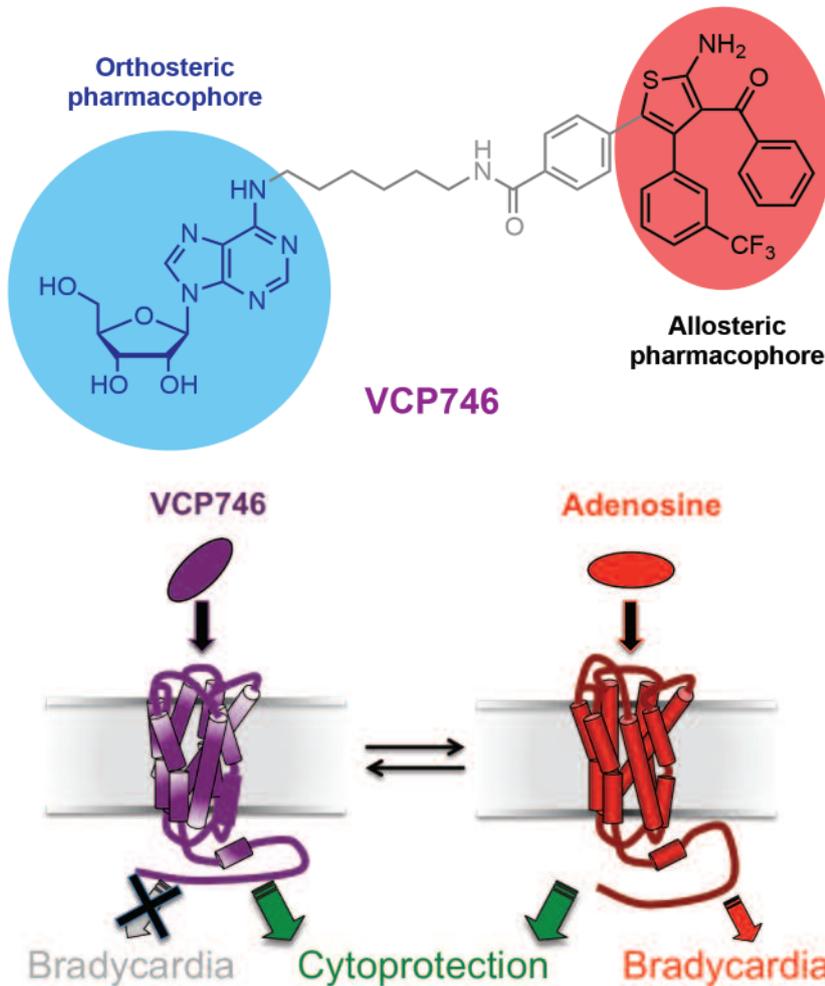
Metal–metal-bonded compounds have been intensively studied for many decades, and have found numerous applications in synthesis, catalysis, enzyme mimicry etc. Despite this, systems containing open-shell, low-coordinate first-row transition metals remain extremely rare, and are normally of low stability. The team of Professor Cameron Jones (Monash University) has begun to rectify this situation with their recent report on an unprecedented high-

spin, two-coordinate manganese(0) compound that bears an unsupported Mn–Mg covalent bond (Hicks J., Hoyer C.E., Moubaraki B., Manni G.L., Carter E., Murphy D.M., Murray K.S., Gagliardi L., Jones C. *J. Am. Chem. Soc.* 2014, **136**, 5283–6). The Mn⁰ centre of the compound is kinetically stabilised by a very bulky amide ligand, developed in Jones’ group, and was shown by SQUID, EPR and computational analyses to have an $S = 5/2$ ground state. Moreover, the

highly reactive compound acts as an ‘inorganic Grignard reagent’ in the facile formation of several previously inaccessible homo- and hetero-bimetallic compound types. These include the first examples of two-coordinate, high-spin transition metal(I) dimers (e.g. see picture), the preparation of which highlights the potential transition metal–magnesium bonded complexes have as reagents in synthesis. The realisation of this potential is currently being explored at Monash.



A pathway-selective adenosine A₁ receptor ligand



The adenosine A₁ receptor (A₁AR) is an important target for cardioprotection, but current A₁AR drugs are limited for this indication because of the occurrence of bradycardia as a major adverse effect mediated by the same receptor. To address this problem, researchers at Monash University designed a ligand that simultaneously bridges two different sites on the A₁AR, based on the hypothesis that this bitopic mode would result in unique receptor conformations that could signal to desirable pathways

while avoiding pathways mediating undesirable effects (Valant C., May L.T., Aurelio L., Chuo C., White P.J., Baltos J., Sexton P.M., Scammells P.J., Christopoulos A. *Proc. Natl Acad. Sci. USA* 2014, **111**, 4614–19). This mechanism was validated in native rodent cells and isolated rat atria, providing proof of concept that the design of bitopic ligands may be a path forward to separating beneficial from harmful effects mediated by the same drug target.

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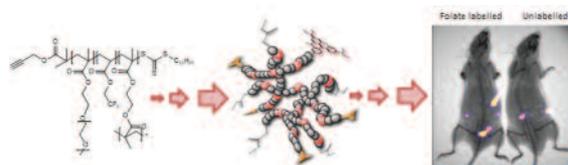
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Multimodal imaging in nanomedicine

In vivo molecular imaging has the potential to revolutionise modern medical diagnostics. Sensitive molecular probes with high signal-to-noise ratios that are capable of highly selective in vivo targeting are needed to probe biological processes, whether these are innate physiological processes or those resulting from a treatment or therapy. Dr Kristofer Thurecht and colleagues from the University of Queensland's Centre for Advanced Imaging, and Australian Institute for Bioengineering and Nanotechnology, along with collaborators from QIMR Berghofer Medical Research Institute and the University of Nottingham, have developed novel polymeric materials for imaging melanoma cells in vivo (Rolfe B., Blakey I., Squires O., Peng H., Boase R.B.B., Alexander C., Parsons P.G., Boyle G.M., Whittaker A.K., Thurecht K.J. *J. Am. Chem. Soc.* 2014, **136**,



2413–19). The polymeric nanoparticles can be tailored to a specific size, while the synthetic strategy facilitates incorporation of various functional groups, allowing optical and ^{19}F magnetic resonance imaging, as well as ligands for direct tumour targeting. These materials promise enhanced insight into the behaviour of nanomedicines in live animals by exploiting the advantages of the two complementary imaging techniques.

Compiled by **Matthew Piggott** MRACI CChem (piggott@cyllene.uwa.edu.au). This section showcases the very best research carried out primarily in Australia. RACI members whose recent work has been published in high impact journals (e.g. *Nature*, *J. Am. Chem. Soc.*, *Angew. Chem. Int. Ed.*) are encouraged to contribute general summaries, of no more than 200 words, and an image to Matthew.

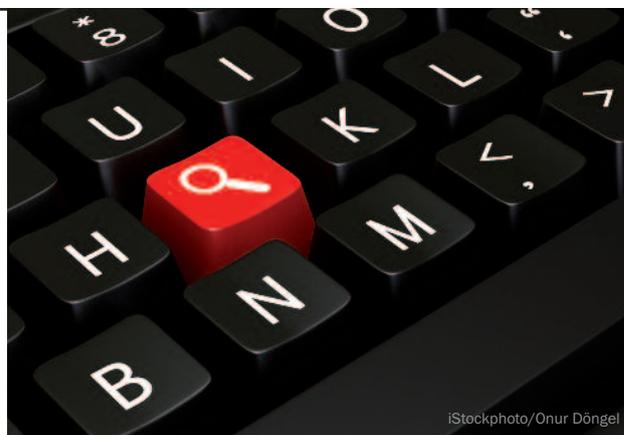
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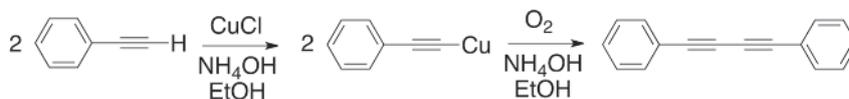
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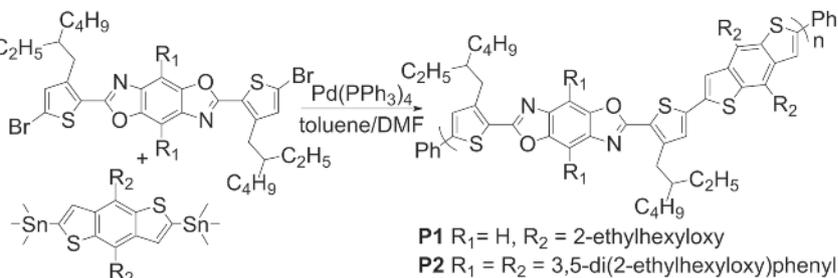
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Aust J Chem

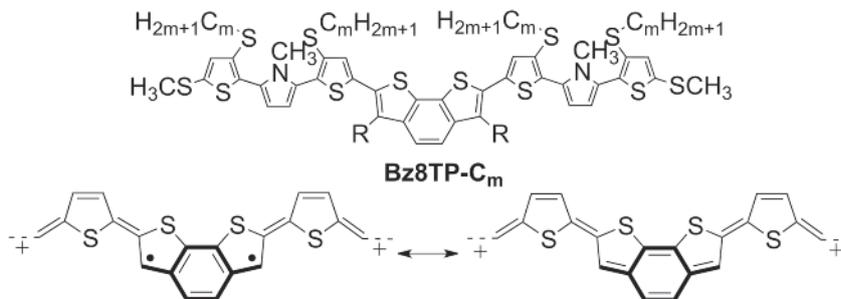
The Glaser coupling reaction of terminal alkynes is widely used in the synthesis of 1,3-diynes, often by using Cu salts. O'Hair and coworkers (University of Melbourne) describe a decarboxylative Glaser-type C-C coupling of carboxylates $R-C\equiv C-COO^-$ investigated by multistage mass spectrometry.



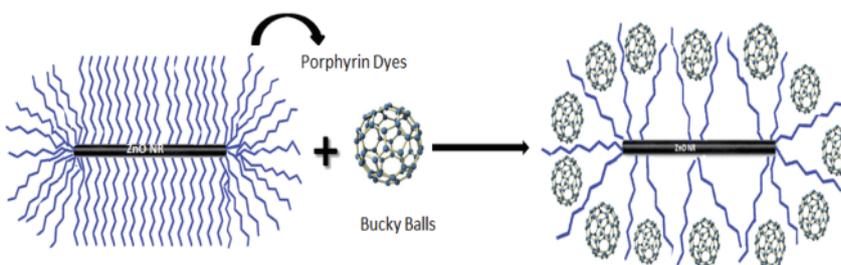
Jeffries-EL et al. (Iowa State University) describe the synthesis and optical properties of extensively conjugated two-dimensional polymers P1 and P2, which absorb in the visible spectrum in the 400–600 nm range in thin films.



Nishinaga and co-workers (Tokyo Metropolitan University) report benzo- and naphtho-annulated thiophene-pyrrole mixed octamers, such as Bz8TP- C_m . The dications of these compounds have significant diradical character as expressed in the resonance structures. The interest in such properties lies in applications of reversible bond formation and dissociation of radicaloid species (π -dimers) to control the motion of molecules.



Porphyry dyes are inherently prone to aggregation, which leads to self-quenching, thus hindering electron transfer to the conduction band of semiconductors in dye-sensitized solar cells. Porphyrins aggregate extensively on the surface of ZnO nanorods, but fullerenes break these aggregates, thereby allowing for more efficient solar cells as described by Shah and co-workers (Quaid-i-Azam University).



Curt Wentrup FAA, FRACI CChem (wentrup@uq.edu.au)
<http://researchers.uq.edu.au/researcher/3606>

Cecil Napier Hake

Australia's first defence scientist

BY **DAVID KILMARTIN**

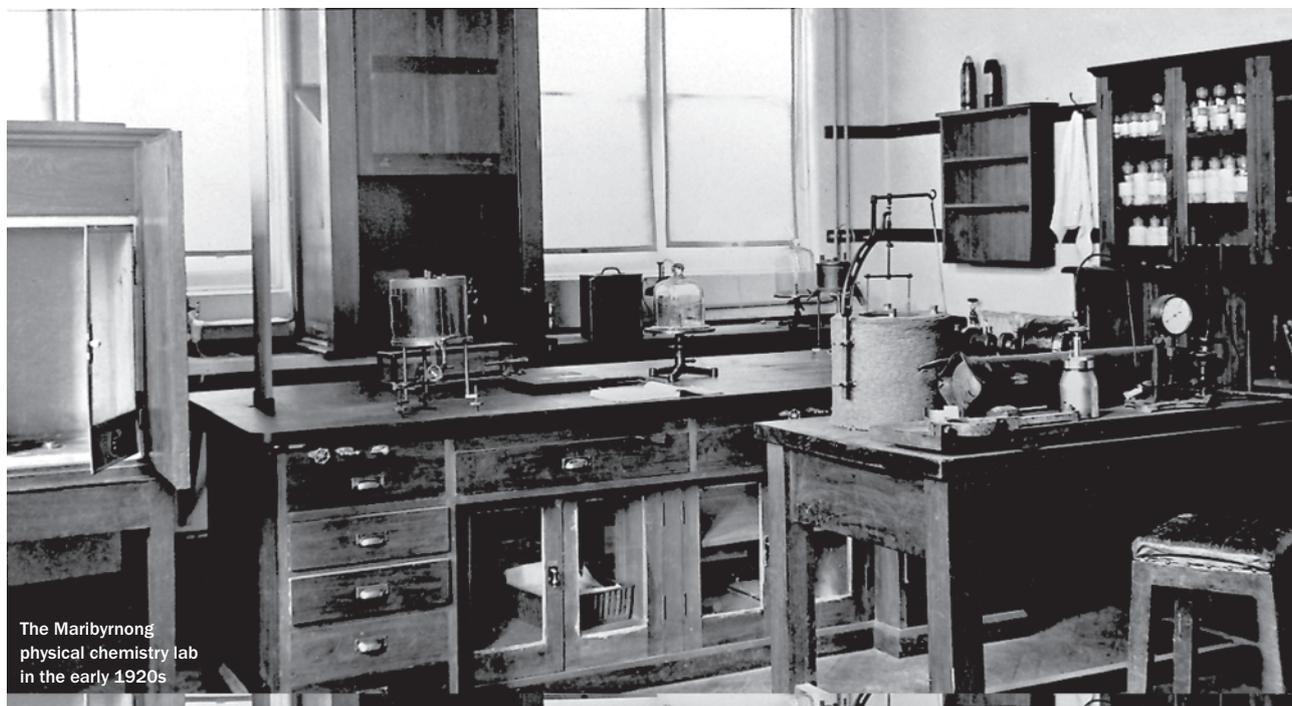
As Australia advanced from British colonies to nationhood, and towards war, a chemist established and developed its defence science.

Australia's first defence scientist was a chemist. Cecil Napier Hake's training in chemistry, experience managing chemical factories and explosives, and family connections in the English military hierarchy made him a natural choice as our first defence scientist. His expertise was key to a young Australia establishing the ability to defend itself post-Federation.

First-class connections in explosives

Hake initially came to Australia as the Inspector of Explosives for the colony of Victoria. Melbourne's *Argus* newspaper announced on 4 December 1889 the imminent arrival of Mr C. Napier Hake, who was to have left England at about the end of October, 'and should therefore arrive in the colony very shortly'. How Hake ended up being offered that position is an interesting prologue to his later more significant role in Australia.

Hake was born in England on 15 May 1848. He was educated at King's College in London and later



The Maribyrnong physical chemistry lab in the early 1920s

studied at the Royal College of Chemistry under the German chemist August Wilhelm von Hofmann. He worked as an assistant to August Dupré at the Westminster Hospital Medical School in London, where Dupré was lecturing in chemistry and toxicology. Dupré had studied in Germany under chemistry luminaries Justus von Liebig at the University of Giessen and Robert von Bunsen at Heidelberg University.

Hake left Westminster in 1866, aged just 18, to become a chemist for Leister and Townsend of Stassfurt, a company managed by Dupré's brother Fritz. The Dupré and Hake families grew closer when Fritz married Hake's sister Lucy. Some years later, August published a chemistry manual with Cecil's younger brother Henry Wilson Hake (himself also a chemistry professor). Clearly the Hakes had a love of chemistry.

Cecil had 20 years industrial experience under his belt when he returned to consult with Dupré at Westminster in the emerging field of explosives. In 1887, Alfred Nobel had patented a smokeless replacement for gunpowder called ballistite, and in

1889 the English government developed cordite, a similar propellant based on nitroglycerine, guncotton and petroleum jelly. In the thick of things, in November 1888 Hake filed US Patent US400207A for 'new and useful improvements in the manufacture of Nitrate of Ammonia'. To this day, ammonium nitrate is the main component of the majority of explosives used in the mining industry. Ammonium nitrate is not used in conventional military explosives because its velocity of detonation is too low for military purposes. In the mining industry, the low velocity of detonation is a benefit as it helps to heave solid material out of the ground without unduly shattering it. Ammonium nitrate is of course an important fertiliser, and it is also used illegally to make homemade explosives.

Colonial call for assistance

At about this time, Victoria's Agent-General Sir Graham Berry sought the assistance of the director of the English Home Office Explosives Department, Major Majendie, to find a suitable person to act as Victoria's Inspector of

Explosives. Majendie, who had consulted with August Dupré about the explosives trade in preparing England's Explosives Act of 1875, strongly recommended Dupré's assistant (and brother-in-law) Hake for the position.

Perhaps with some input from Dupré, Majendie testified to Hake's 'thorough acquaintance with explosives, and also his mastery of chemical analysis'. The glowing reference noted that Hake had been 'for some years assistant to Professor Dupré of the Westminster School,

besides having spent some years in practical chemical work' and was a nephew of General Gordon (an English military hero).

Hake accepted the office, and a salary of £800 per annum, and prepared to migrate to Australia.

Hake gets down to business

In 1890, Hake took up the position of Inspector of Explosives with enthusiasm and diligence. He immediately set about modernising his Explosives Branch and introduced protocols to improve the safety of explosives manufacture and handling.

Just a year into his tenure, in June 1891, *The Argus* reported that Hake was flexing his muscles by taking the manager of the Colonial Ammunition Factory, Captain Asa Whitney, to court for manufacturing explosives without a licence. The Crown 'did not press for any thing more than a nominal penalty, it being largely a test case to settle a question of official control. The point was whether the special privileges given to the company by an act of Parliament were intended to override the general law.' Hake, familiar with England's Explosives Act, was concerned that 'if allowed to carry on as they claimed they had a right to do, the company's operations would be practically free from control by the inspectors.' The interesting case was reported on in great detail, and added to Hake's growing profile in the colony as a highly regarded expert in the weapons industry.

The newspapers continued to be peppered with mentions of Hake's work as crime scene investigator and expert witness in explosive-related cases. Following the fatal explosion at the Australian Explosives and Chemical Company Ltd in 1892, 'witnesses saw the accident, and having telegraphed to Mr. Hake, left everything about the place as it was, pending Mr. Hake's visit.' Hake concluded that 'the accident had been caused most likely by a fracture in the machine producing friction between the working parts and





This round was used by the Royal Navy as a line throwing blank. It is loaded with a cordite charge (44 grains) with a 1-grain tuft of gun cotton at the top and bottom of the charge. The case is closed with an inverted cardboard cup sealed with shellac.

contact with the dynamite.'

Hake's position in society can also be evinced from the detailed social pages of the day. On a Saturday in May 1893, for example, he is listed, alongside Captain Grenville Forbes (attendant to the Governor of Victoria) and Captain Richard White (Royal Navy, Commandant of the Naval Forces of Victoria), as having attended an 'at home' soiree at Myoora, the residence of prominent barrister and MP Robert Harper. Later in the year at a benefit night in Melbourne Town Hall for Madame Lucy Chambers, Hake's name is listed alongside lords, ladies and reverends. In 1894, he married Elizabeth Carstairs Simson, with Captain White as his best man.

In 1893, Hake had given the Presidential Address for Chemistry on Recent Developments in Modern Explosives at the fifth meeting of the Australasian Association for the Advancement of Science. Then two years later, with concerns over the future of explosive supplies in Victoria, he was tasked with investigating the advantages of cordite manufacture over traditional gunpowder. He inspected cordite production in England and concluded that Australia too should convert to cordite manufacture, which it eventually did.

And so, at the time of Federation,

Victoria had the most comprehensive defence establishment in the country, including, thanks largely to Hake, a top-class munitions factory.

Federation, and a question of defence preparedness

In the years following Federation, Hake continued to work for the government of Victoria, consolidating that state's position as the centre of munitions manufacture in Australia. His expertise also led the new Commonwealth Department of Defence to seek his advice. In 1905, he was asked by then Minister of Defence Thomas Playford to investigate the problem of the army's exploding rifles. Hake demonstrated that ammunition was becoming 'double bulleted' because of faulty equipment. Hake devised a weighing system to check whether two bullets were in a single cartridge, and the Minister issued a recall of the suspect ammunition.

Fundamental to Australia's history post-Federation was the push for greater self-sufficiency in munitions and ordnance; the question of Australia's preparedness to defend itself continued to exercise the new Defence Department. Key to this push for greater independence in defence materiel was the need for the recruitment of scientists and the

development of defence science to establish and maintain standards. War materials had to be manufactured within strict tolerances and in conformity with similar articles made throughout the Empire. Consequently, there was a need for strict attention to dimensional standards and an understanding of instruments and practices for checking gauges and tools in order to meet these standards. The first tentative step in the Commonwealth government's commitment to defence science was the instruction to Hake on 15 April 1907 to proceed to England to gather information and make recommendations concerning the establishment of a cordite factory in Australia.

Hake's report of 18 October 1907 recommended a factory with an annual output of 150 tonnes of cordite. He also recommended the appointment of an Inspector of Cordite in accordance with his instruction to research the storage of cordite.

Following illness, Hake resigned from Victoria's service to take the position as Chemical Adviser on the permanent staff of the Department of Defence on 16 September 1909. In his own words, Australia's inimitable first defence scientist undertook works of 'a varied character, such as examination of Service explosives, investigations of many complex problems connected with ammunition, &c., inquiries into accidents with explosives, and much consultative work of a confidential nature connected with proposals for the establishment of a Cordite factory locally, and other matters.'

Defence science's first major achievements

In accordance with Hake's recommendation, plans were implemented for the establishment of the government's cordite factory, with 103 hectares of land for the purpose being appropriated by an Act of Parliament on 4 July 1908 on the site of

Australian defence science post-World War II

At the height of the World War II conflict in the Pacific, over 6000 people were employed at the Maribyrnong factory. The factory was closed in 1994 and defence science ceased at the site in 2007.

In 2007, a redeveloped Fishermans Bend defence science complex was opened, including a new three-storey building housing some of the research areas transferred from Maribyrnong. It is named the Cecil Napier Hake Building, after Australia's first defence scientist. A descendant of Hake unveiled a plaque on the building during the opening event.

The RACI's most distinguished medal, the Leighton Memorial Medal, commemorates the distinguished career of chemical engineer A.E. Leighton, who also played a significant role in Australia's defence science. It is awarded in recognition of eminent services to chemistry in Australia.

A free comprehensive history of Australian defence science, produced by DSTO, is available at www.dsto.defence.gov.au/publications/5470/DSTO_100yr_book.pdf.

Many see Hake's contribution as a critical foundation of the munitions structures that supported our World War II campaigns.

the disused Maribyrnong racecourse about 11 kilometres from the Melbourne General Post Office. The site (recommended by Hake) was admirable, being bounded on three sides by the Maribyrnong River, and on the fourth side by the site that would later become the Government Ordnance Factory.

While researching cordite in England, Hake had encountered chemical engineer Arthur Edgar Leighton. Leighton had for several years been helping construct the Indian government's new explosives factory. Hake recommended that Leighton be appointed to design and manage Australia's future cordite factory, and Leighton was duly appointed manager in 1909.

Tenders for construction of the cordite factory were let on 9 March 1910 and Leighton had the first sample of cordite pressed on 7 June 1912. Six months after opening, the factory was producing on average 5.5 tonnes of cordite each month.

Meanwhile, the Chemical Adviser's Laboratory was established in a bluestone guardhouse at Victoria Barracks in Melbourne and opened in September 1910, in accordance with Hake's recommendation for an Inspector of Cordite independent of the cordite factory. The purpose of this, Australia's first defence science

laboratory, was to test stocks of explosives and determine their state of preservation.

An honourable exit

Hake resigned his position as Chemical Adviser to the Department of Defence from 1 April 1911, while the cordite factory was still under construction. John Jensen, Head of the Commonwealth Munitions Branch, suggests Hake resigned with defence's best interests at heart:

Without intending in any way to minimise the great services rendered over the years by Mr Hake, the facts are that whereas Mr Leighton was an experienced Chemical Engineer and Factory Manager, Mr Hake, although a notable figure in the Chemistry profession, did not have Mr Leighton's practical experience, and once the latter had returned from England, there was no field for two 'Captains' to be in charge of the construction of the factory. Mr Hake therefore gracefully relinquished his responsibilities in connection with the factory and left the field solely to Mr Leighton.

Before relinquishing his position, Hake presented his Minister with a report of his team's achievements from 1907 to 1911, the major work being the establishment of the Australian cordite factory. The report also contained his last words of advice. On

the early deterioration of cordite, Hake advised storage in more temperate locations. On the general difficulty of transporting the cordite, Hake wrote 'the proper solution to this difficulty is, in my opinion, to utilise the torpedo boat destroyers of the Australian navy, pending the acquirement of a small Defence transport.'

Hake and his wife returned to England and in September 1913 newspapers reported that 'Mr. and Mrs. Cecil Hake have decided not to return to Melbourne for some time at least. Their friends will be sorry to hear the news, as both Mr. Hake and his wife are a decidedly popular pair.' They never returned.

Hake continued to work as an analytical and consulting chemist in London for a time before retiring to the Mediterranean. On 20 October 1924 a cable from London announced his death.

Hake's legacy is a significant one, with his initiative being carried forward by those whose appointments he had recommended, particularly that of Arthur Leighton. Many see Hake's contribution as a critical foundation of the munitions structures that supported our World War II campaigns.

David Kilmartin is editor of *DSTO Connections*, Defence Science Communications, Defence Science and Technology Organisation.



iStockphoto/GlenJ

Using your loaf

History and chemistry of bread

The history of bread goes back at least to the ancient Egyptians. Whether you like bagels or baguettes, farls or focaccia, pita or paratha, there are only two main ingredients: flour and water (plus yeast for leavened breads). The virtually unlimited combinations of different flour types, together with varying proportions of additional ingredients, has resulted in the huge assortment of bread types, shapes, sizes and textures available around the world today – everything from Aish Merahrah to Zwieback.

There is increasing concern that today's bread might be less nutritious than it was in the past. Research being carried out jointly by analytical chemists and food scientists at RMIT University in Melbourne aims to find out why by applying modern chemical techniques to one of our oldest technologies.

The best place to start investigating is in the field. Bread is made from the flour of one or more grains; wheat is the most popular, but rye, oat, corn, amaranth and many others are also often used. Wherever it comes from, the basic nutrient content of the flour

depends on the parent plant; this in turn is reliant on the soil in which the plant was grown. Soil degradation, either through over-use or erosion, can result in land that supplies nutrients to crops in insufficient amounts for adequate human nutrition. There are also some indications that modern varieties of wheat (bred for increased growth and disease resistance) may absorb fewer minerals and vitamins than older varieties. Both options lead to flours and breads with similarly depleted nutrient profiles.

Even where nutrient-rich or fortified flour is available, modern industrial baking techniques can leave said nutrients unabsorbable by the human gut. A particular problem in this regard is inositol hexakisphosphate (IP6), also known as phytic acid, or phytate when present as a salt. IP6 is a saturated cyclic acid and the main phosphorus storage compound in many plants. It chelates several important micro minerals (e.g. zinc and iron) and some macro minerals (e.g. calcium and magnesium). Bound up in this way, the nutrients are less able to be absorbed during digestion.

Interestingly, wholemeal bread is

BY **OLIVER JONES**

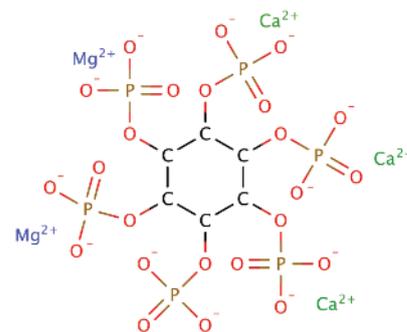
It's been a staple food for many thousands of years, but the humble loaf isn't quite what it used to be.

worse than white bread in regard to nutrient availability because it contains more phytate. Traditional baking methods overcome the phytate problem during the process of bulk or slow fermentation. It sounds ominous but all it means is that you mix all the ingredients together, knead the dough and then allow it to 'rest' for a set period (the exact time depends on the type of loaf). This step usually appears in home bake recipes as 'allow dough to rise'. During this time (up to several hours), the dough has time to leaven (rise), and naturally occurring microorganisms start breaking down some of the flour components, including phytate. The process also degrades some of the protein in the dough. This is why you need to use 'strong' flour (with a high protein content) in home baking: enough protein is left after fermentation to ensure the structural integrity of the final loaf.

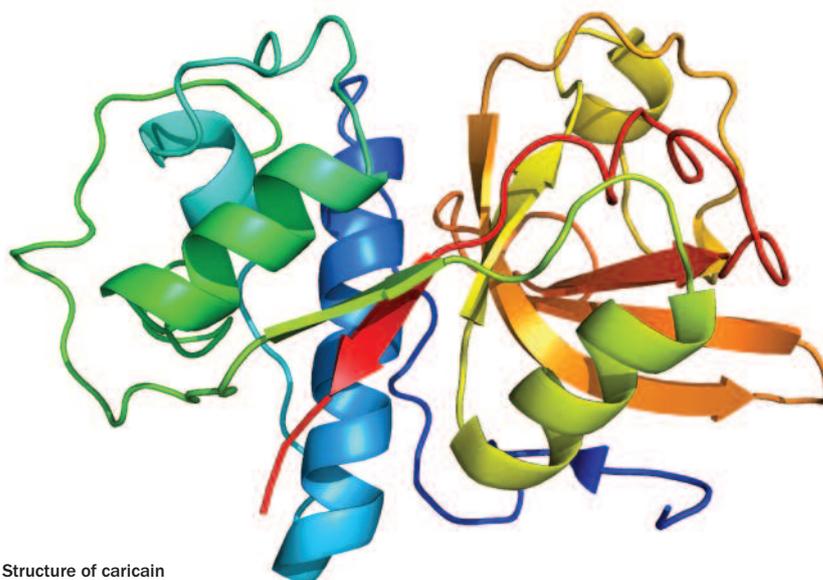
Slow fermentation, after inoculation of the dough with a starter culture of yeasts and lactobacilli bacteria, is used for sourdough breads. This may take several hours, often overnight. Sourdough breads have a characteristic mildly sour or bitter taste as a result of the lactic acid produced by the bacteria. Sourdough fermentation is most often used to make the dark rye breads common to central and eastern Europe. Rye flours contain large amounts of heat-stable enzymes, which would normally degrade all the starch and proteins in the dough during fermentations, making bread baking impossible. However, the low pH caused by the lactic acid inactivates rye enzymes and this means the dough retains enough protein and starch to rise properly. Sourdough fermentation was the usual form of leavening until the Middle Ages until it was replaced by 'barm', the foam formed on the top of fermented alcoholic beverages during brewing (the term 'barm cakes', is still used for bread rolls in the north-west of the UK where I grew up) and, later,

by the purposefully cultured yeast commonly used today.

This all sounds good, but a stop of even one or two hours, let alone eight or nine, is a significant hold-up if you are baking bread commercially, so an engineering process that allows large amounts of bread to be baked very quickly is very advantageous. This is just what was invented in the small village of Chorleywood (just outside London) in 1961. Pressure, along with high-speed, intense mechanical



2D model of inositol hexakisphosphate binding calcium and magnesium ions



Structure of caricain

working and mixing, is used, and yeast, ascorbic acid (vitamin C), fats and other bread improvers are added. Flour and water become a sliced and packaged loaf in just a few hours. Being fast, the process involves little enzyme action, so a wider variety of (low protein) flours can be used, but this further reduces the nutritional content.

Today the Chorleywood process is responsible for about 80% of the loaves sold in Britain, and it and similar methods produce the majority of loaves that you see in supermarkets around the world. Depending on who you talk to, the Chorleywood process

There are some indications that modern varieties of wheat (bred for increased growth and disease resistance) may absorb fewer minerals and vitamins than older varieties.



Comparison of enzyme treated (left-hand panel) and standard (right-hand panel) breads showing crumb and crust characteristics. The images are not to the same scale.

is either, quite literally, the best thing since sliced bread (invented in 1928 by Otto Rohwedder in the US) or the worst thing to ever happen to baking because it not only produces a product that is inferior to the traditional loaf (speed of production excepted), it may also be responsible for the increasing incidence of coeliac disease in developed countries because more proteins and peptides (which can initiate an immunological response) remain in the final product.

Coeliac disease is another reason that one might not be able to absorb nutrients. The condition is caused by intolerance to the gliadin class of proteins found primarily in wheat and to some extent in barley, rye and other cereals. Together with glutenins, gliadins are the main components of the gluten fraction of wheat, but the two are quite different in form. Gliadins occur as monomeric proteins that can be separated into four types (α , β , γ and ω). Glutenins are multimeric complexes consisting of high- and low-molecular-weight subunits held together by disulfide bonds.

Coeliac disease is a serious health condition that affects around one in 100 to one in 300 of the Australian population and can result in life-

threatening immune reactions. Aside from this is the risk of long-term damage to the small intestine, which can result in a range of other symptoms from minor gastrointestinal complaints to severe malabsorption of nutrients caused by a reduction in the absorptive surface of the duodenum. If left untreated, serious consequences of nutrient deficiency, such as osteoporosis and anaemia, may result.

The main treatment for the condition is dietary avoidance of these gluten-containing cereals, but avoiding a dietary staple is difficult, particularly for children. Clear information and advice about gluten on individual food product labels is sometimes lacking, and prepared food is often supplied by people without a detailed knowledge of the ingredients or what constitutes 'gluten-free'.

Some manufacturers have responded to this challenge by baking gluten-free breads using rice or chick pea flour blends. As well as being expensive, differing properties of the non-wheat flours makes these products heavy, dense and lacking in taste. Recent work conducted at RMIT University by one of my PhD students is looking for a way to reduce the part of gluten that stimulates the immune

response, while leaving the binding properties of the dough intact. He has shown that treating the dough with the enzyme caricain reduces the gliadin content of grain-based products to almost undetectable levels.

Caricain, derived from papaya, is a peptidase and was specifically chosen for its ability to break down particular bonds in gliadin, generating the required effects on gluten and dough. Most significantly, these results were achieved without undue effects on the crumb and crust characteristics of the bread. This means that you can use modern biochemistry to bake a light and tasty loaf with almost no detectable gluten. This latter fact was confirmed by both in-house and commercial testing.

So, not only is chemistry a vital part of bread, it can be used to make gluten-free breads more palatable. Some clever technology has boosted bread production, but traditional breadmaking techniques, although largely superseded, still have a nutritional edge.

Oliver Jones MRACI CChem is a lecturer in analytical chemistry and helps analyse bread at RMIT University; occasionally he bakes it (badly) at home.

RACI National Awards

The National Awards recognise and promote the contributions and achievements of our members.

The awards cover a broad range of areas and are open to all members of the RACI. Some can be applied for by the candidate; others have to be nominated by third parties.

- Leighton Memorial Award
- H.G. Smith Memorial Award
- Rennie Memorial Award
- Cornforth Award
- Masson Memorial Award
- C.S. Piper Award
- Applied Research Award
- Distinguished Contribution to Economic Advancement (Weickhardt) Award
- Fensham Award for Outstanding Contribution to Chemical Education
- Pearson Education/RACI Chemistry Educator of the Year Award
- Centenary of Federation – Primary and Secondary Teaching Award
- Citations – Contributions to Chemistry & Chemical Profession
- Distinguished Fellowship Award

Full details of the awards and the eligibility criteria can be found at www.raci.org.au.

Membership renewals 2014–15

Membership renewal time is with us again. The Board had the difficult decision of how to address the financial requirements of the Institute while maintaining membership value.

Two fundamental changes are being made to cater for newly qualified postgraduate student members and primary and secondary school teachers.

- School teachers will revert to concessional rates as was the case up to 4 years ago.
- Newly qualified postgraduate student full membership fees will be phased in over a 3-year period: 65% of full MRACI fees in year 1, 75% in year 2 and 90% in year 3.

On the income side of the equation, the institute is facing the 'baby boomer' syndrome as many members move into the concessional category as they retire. This lowers the membership income but not the operating costs. After great deliberation, the Board decided to increase membership fees by around 4% to help to balance the books.

The 2014 Membership fees will be:

FRACI/MRACI CChem	\$270	Concessional/Postgraduate/Schoolteacher	\$120
MRACI	\$235	Associate	\$95
Newly qualified PhD	\$175	Undergraduate student	\$25

To renew your 2014–15 membership, go to www.raci.org.au and log in with your membership number and password. Click on 'View My Account' under your login, click on 'My Memberships' and follow the prompts.

Board elections

Do you want to get involved in the future direction of the RACI?
Do you believe the RACI can be improved for the membership?
Do you want to have your say?



You can have that opportunity by nominating for the Board positions due for re-election this year. The positions are:

President Elect: a 4-year commitment with the individual taking over the presidency of the RACI in year 3

National Representative: a 2-year commitment, which is open to all full members nationally

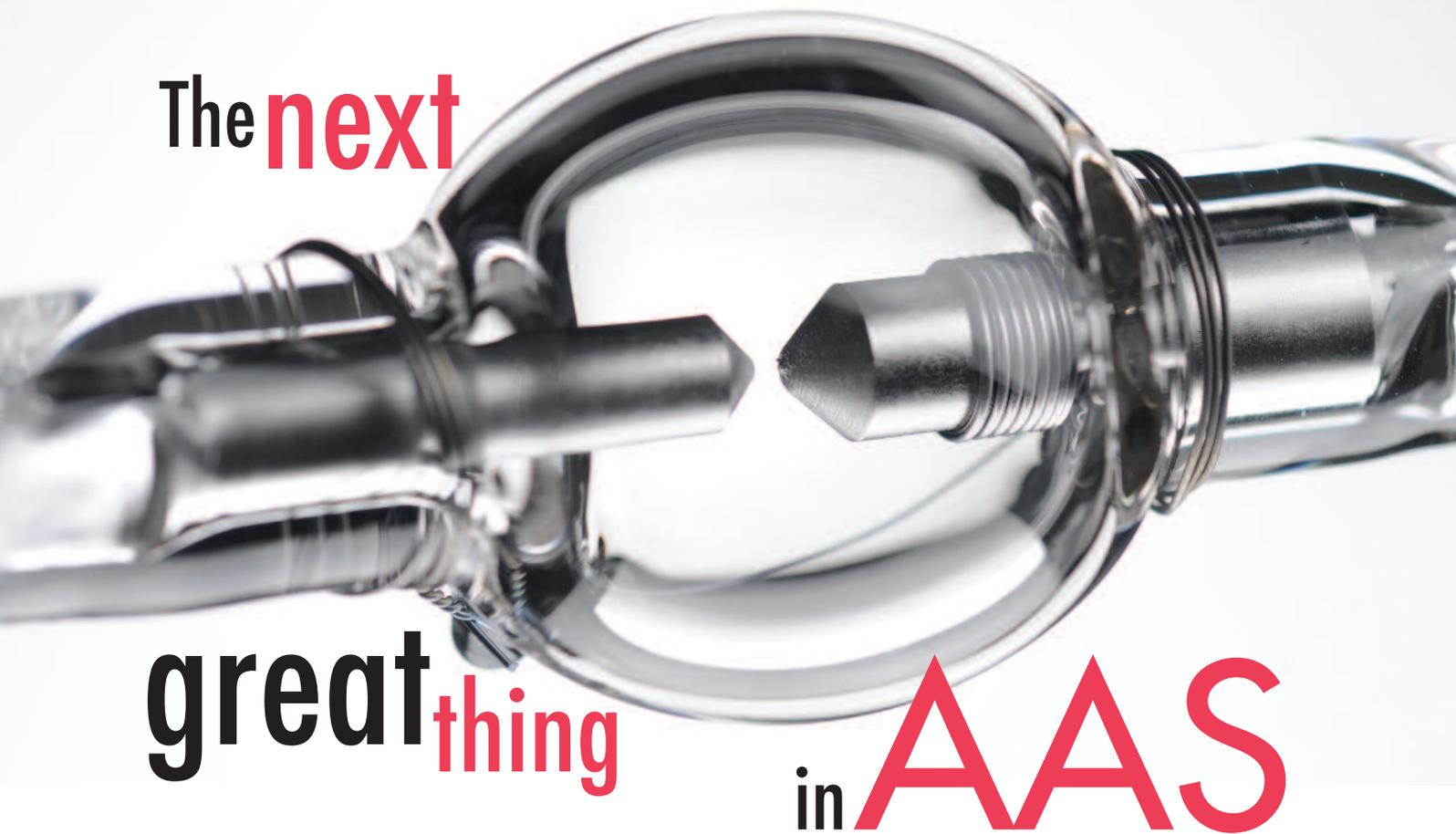
Western Representative: a 2-year commitment, which is open to all full members in WA, SA and NT

Nominations close 30 June 2014 and elections will be held in September.

Nomination forms and instructions can be found at www.raci.org.au/document/item/1068.

Completed nomination forms can be emailed to robyn.taylor@raci.org.au or posted to the National Office.

The newly elected officials will take up office at the 2014 AGM in Adelaide during the RACI National Congress.



The **next**

great thing

in **AAS**

DAVE SAMMUT
road tests a
spectrometer that
sports a single
light source for
all elements.

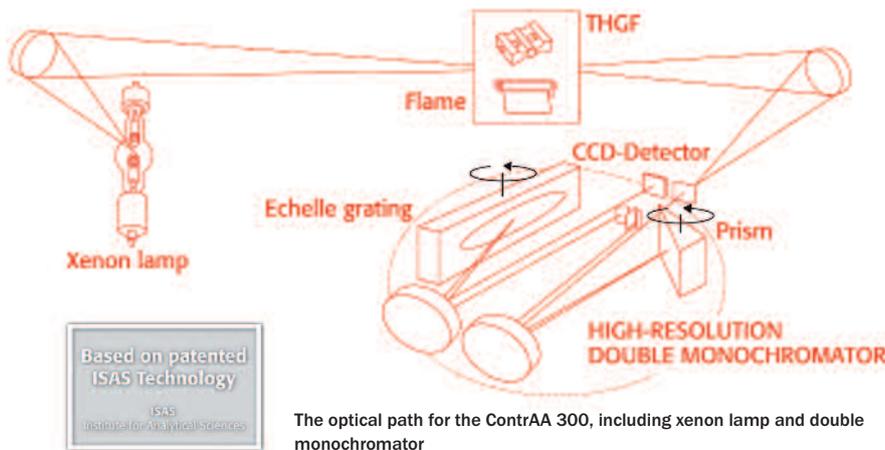
Flame atomic absorption spectroscopy (AAS) has been a mainstay of every one of my laboratories for the past 20 years. Across five different labs, I have run nine of these instruments. Over the years, these have grown in their complexity and capabilities: rotating turrets to hold multiple lamps, automatic burner rotation, deuterium background correction lamps, double-beam optics, automatic samplers, auto sampling and auto dilution. Generally, these capabilities delivered improved performance, either in convenience and/or in reduced operator effects.

However, the underlying technology across all of the instruments has remained essentially unchanged throughout the time I have been using AAS, or indeed for another 20 and more years before that.

I work in hydrometallurgy. My aqueous systems contain high concentrations of metals (up to 100 g/L) in extremely concentrated salt solutions (typically >6 M, or over 400 g/L total dissolved salts). These samples are not easy to analyse by any technique, and over the years I have tried a variety of alternatives to AAS without much success: ion chromatography, energy-dispersive XRF and others.

Inductively coupled plasma optical emission spectroscopy (ICP-OES) and/or mass spectroscopy (ICP-MS) are of course able to analyse my samples, but ICP comes with its own disadvantages, the primary among which are twofold: first, the equipment is far too pricey to operate for my comparatively small number of R&D samples, to yield quick turnarounds on

short sample runs; and second, everybody knows that ICP is closely related to witchcraft – to get really good analyses from ICP, one has to sacrifice a black rooster over the instrument on the full moon. Or putting that in more scientific terms, it is critical to set up the ICP methods



The optical path for the ContrAA 300, including xenon lamp and double monochromator

precisely and with careful attention to matrix matching for really good quality results.

So AAS has always been my 'go to' analytical method for these solutions. The results are somewhat quick and dirty, so to speak, but cheap enough and sufficiently accurate to provide guidance on my R&D.

Given the high metal concentrations in my solutions, AAS's limited sensitivity is seldom an issue for my purposes. Indeed, the multiple dilutions required to get the metals into a useful analytical range tend to introduce additional and cumulative sources of random error that further decrease sensitivity. But AAS can generally handle TDS concentrations up to about 5%, and if I initially dilute 1 millilitre of a 40% sample into 19 millilitres of 3% HCl (to maintain the stability of the metals in solution), the resulting sample contains just under 5%.

Provided that I planned ahead on my assay sequence, restricted the number of elements to a handful of key metals (typically copper, iron, silver, lead and zinc, in order of increasing difficulty), and made sure that my lamps were warmed in readiness for when I needed them, then AAS was generally good enough for my purposes.

But that's a pretty hefty list of caveats. I couldn't do simultaneous analysis, so longer runs of multiple elements become pretty tedious. With

signal instability at least partially due to the salts, I had to use long read times (typically three repeats at 10 seconds), which can consume sample quickly across those runs. And there is a wide range of elements that are well outside my purview. Ultimately, I still had to rely on external labs using ICP for a percentage of my analytical needs.

So I was pretty excited when I first read about continuum source AAS in an ad within the pages of this magazine. I immediately conjured visions of simultaneous analysis, which alone could reduce my operator time considerably.

However, I was also somewhat suspicious. We don't live in the world of Star Trek (yet). I can't wave a 'tricorder' over my sample for instantaneous and complete analysis. And if half a lifetime of science has taught me anything, it would be that there are no 'free rides'. In instrumental analyses, I only look for net gains – a positive balance of advantages over disadvantages. 'Where', I asked myself, 'is the rub?'

The short answer is that I haven't found one so far. By every appearance, continuum source AAS might be the first major advance in this field in the last 50 years. Stemming from the work of Becker-Ross and co-workers in the mid-1990s, German company Analytik Jena has commercialised continuum spectrum instruments for both flame and graphite furnace AAS, and the

resulting instruments appear to fully live up to the hype.

The breakthroughs from Becker-Ross and colleagues are two-fold. First, the xenon short-arc lamp gives a high-intensity emission down

to well below 250 nanometres, which was not possible with previous, weaker-emission xenon lamps. Operating at 10 000 K, the manufacturer claims that it can start quickly, without the long warm-up times associated with traditional hollow cathode lamps (HCLs). This has advantages for quick equipment availability, but the high intensity also significantly aids sensitivity. A paper by Welz from 2005 (*Anal. Bioanal. Chem.* vol. 381, pp. 69–71) suggests that detection limits could be improved by as much as a factor of five, and the manufacturer claims a full order of magnitude.

The other major development was a monochromator of sufficient resolution (>100 000) to provide a spectral bandwidth corresponding to the half-width of atomic absorption lines. The solution is an innovative double monochromator.

Much of the literature extolled the virtues of the high-resolution CCD line detector in the spectrophotometer. With 598 pixels, 200 pixels are dedicated to analysis, with the remainder available for background correction, source drift correction (aiding fast start-up) and other mathematical improvements to aid sensitivity and signal-to-noise ratio. For flame AAS, this is repeatedly referred to as giving fast sequential analysis – not true simultaneous analysis, but a good practical outcome to come closer to the ideal.



The high-intensity continuous spectrum light of the ContrAA's xenon short-arc lamp is visible in the window and along the length of the burner.

However, this may be my main criticism of the instrument so far. Given the massive leaps forward in CCD technology in the last 10 years emanating from the photography and mobile phone markets, surely the capabilities of the instrument could now also be massively upgraded, riding off the back of those advances.

As criticisms go, that's pretty minor. It boils down to 'It's good now, and it looks like it could get even better'.

With all of this in mind, I had the pleasure of visiting the University of Technology Sydney's lab at Ultimo, to view their ContrAA 300 flame CS-AAS. I brought along a few samples of my own, and Mr Harj Sandhu of MEP Instruments took a few hours to show me just what the instrument can do.

Starting with the basics, the lamp intensity is particularly noticeable. Capable of setting fire to a business card held at the focal point above the burner, it is really quite striking. The instrument has automatic burner adjustment, as well as an auto sampler and auto diluter. In general AAS, I more typically view these as being unnecessary – or even just another thing to potentially go wrong. But

operating the ContrAA 300 for multi-elemental analyses, it quickly became apparent how useful these could be for efficient operation.

One of the minor advantages of this operation is that it supports flow injection analysis, and even in standard 'mean mode', the continuous flow of either sample or 'wash' means that the burner maintains an even temperature.

After a relatively quick run of basic method development in single elements, the instrument was set to its first multi-element run. Quite simply, the efficiency gains using this mode were immediately and fully obvious for up to about 8–10 elements. After that, ICP would still have the advantage.

Although the basic mode certainly provides fast sequential elemental analysis, it is noteworthy that there are several transition metal combinations for which the close but separate spectral lines would support true simultaneous analysis. Critically, the resolution of the peaks within the spectra was spectacular.

Our method set-up work was somewhat hampered when the results clearly showed both lead and zinc contamination in the analytical water

supply. But the results we were able to show on the day left me with little doubt that the instrument could give me good results for all of my key elements in a single analytical sequence. MEP Instruments has kept my samples, and there may be a follow-up article to provide a case study on the outcomes.

I was also thrilled with the little 'aside' to our discussion, where Harj showed me how the instrument could be operated to run a semi-quantitative scan for other metals. This isn't a function I would run every day, but it could be incredibly useful at times, and my recommendation to Analytik Jenna is that the capability could be very easily enhanced via some simple software updates.

At a price comparable to conventional models on the market (rotating turret, double beam, and with accessories for a fair comparison), the ContrAA 300 is competitive at current exchange rates. And the cost of operation will be considerably less once labour is taken into account.

As is, the ContrAA 300 could be a considerable enhancement to the capabilities of any mining, wine, water or research lab, and quite a lot more besides. With enhancements to the CCD, to aspects such as sealing and positive-pressure air for industrial environments, and with upgraded software to take full advantage of the capabilities of the instrument, it could be truly phenomenal.

Overall, I'm sold. I believe that this truly is the first major breakthrough in flame AAS in the last 50 years. My birthday is coming soon ... anyone?

Dave Sammut MRACI CChem is principal of DCS Technical, a boutique scientific consultancy providing services to the Australian and international minerals, waste recycling and general scientific industries. DCS Technical has no association with any companies mentioned herein, and the article is not associated with any advertisement or promotion in *Chemistry in Australia*.

Q&A:

Resistance to antibiotics

BY ROY ROBINS BROWNE

Artist's impression of *E. coli*
iStockphoto/luismmolina

The World Health Organization has declared resistance to antibiotics to be one of the greatest threats to human health. This strong statement raises several questions.

- What is antibiotic resistance, and why is it a threat to health?
- Why does antibiotic resistance occur?
- What can we do about it?

Before considering these issues, we need to know what antibiotics are. Strictly speaking, antibiotics are naturally occurring chemical substances produced by microorganisms (most often fungi) that exert harmful effects on other organisms. The first antibiotic used to treat infections in humans was penicillin G, which was originally

Many of us take antibiotics for granted, but rising bacterial resistance is having major health consequences.

derived from a *Penicillium* mould.

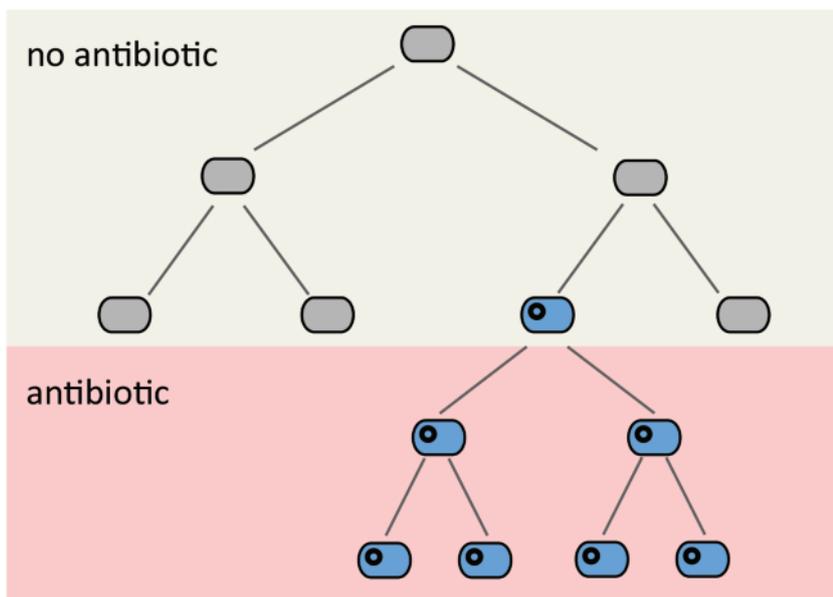
Today, many antibiotics are manufactured synthetically, so the strict definition no longer applies.

Nevertheless, all of the antimicrobial drugs used to treat infection work on the principle that they harm infectious agents while causing minimal damage to the host. This mostly works, because the antibiotics target a structure or biochemical pathway that is present in bacteria but missing from animal cells.

Although some antibiotics are active against fungi, their major use is to treat infections caused by bacteria.

What is antibiotic resistance and why is it a threat to health?

Over time, many leading causes of infections of humans, including bacteria such as *Staphylococcus aureus* (golden staph), *Escherichia coli* and *Mycobacterium tuberculosis* have become resistant to a wide variety of different antibiotics. This means that infections caused by these bacteria, often called 'superbugs', do not respond to treatment in the way they once did.



-  bacterium susceptible to antibiotic
-  bacterium resistant to antibiotic

The process of natural selection of antibiotic-resistant bacteria. Bacteria are shown replicating by binary fission. At some point during this replication, one bacterium becomes resistant to an antibiotic. In the presence of this antibiotic, only the resistant bacterium and its progeny survive.

The seriousness of this situation is compounded by the fact that we are starting to run out of antibiotics we can rely on to treat serious infections, and it is becoming increasingly common for doctors to see patients with life-threatening bacterial infections for which there are no useful antibiotics left. This is like going back in time more than 70 years to the period before antibiotics were discovered.

Why does antibiotic resistance occur?

The main reason for antibiotic resistance is the considerable evolutionary advantage bacteria have over humans and other mammals. The principal features of bacteria in this regard are their enormous numbers, their capacity to replicate extremely quickly, and their ability to modify their genetic make-up and to acquire new genes.

The Human Microbiome Project

(www.genome.gov/27549144) has revealed that each human being is home to about 10^{14} bacteria, approximately 70% of which reside in our intestines. These bacteria, known collectively as our normal microbiota, seldom cause us harm. In fact, many benefit us by promoting healthy development of the immune system.

Put another way, there are more bacterial cells in a teaspoon of intestinal contents than people who have ever lived. Also, although our bodies are the product of around 25 000 genes, we also carry within us more than one million unique bacterial genes.

The second reason why bacteria have an advantage over us is that a generation for an average bacterium is around 20–30 minutes, while for humans it is more like 20–30 years. In other words, bacteria replicate more than 500 000 times faster than ourselves. This means they can adapt and respond to or recover from a

threat to their survival far more rapidly than we can.

Also, because bacteria replicate by binary fission (one cell becomes two, two become four, four become eight, and so on) their numbers increase very quickly. For example, if we start with just one bacterium, after 12 hours (approximately 36 generations) we would have 2^{36} or around 70 billion bacteria, which is 10 times the number of people alive today.

The ability of bacteria to replicate quickly also means they have extraordinary recovery powers from events that in humans would be unimaginably catastrophic. Consider a situation where a population of one billion bacteria is exposed to a chemical that kills all but one of them because it is resistant to that chemical. Amazingly, an entirely new population of one billion resistant bacteria can emerge from that single cell within a few hours.

The third advantage bacteria have over us is their genetic malleability. Just like us, bacteria tend to breed true (i.e. their offspring carry the same genes as their parent), but if they are under stress the rate of random mutation in the DNA of their single chromosome can increase, making favourable (and unfavourable) mutations more likely. A beneficial mutation could take a long time to occur, even several years. But if it gives the mutant a survival advantage, this mutant will persist and may start to dominate the population of that particular bacterial species as a whole.

In addition, bacteria can acquire genes directly from other bacteria, including bacteria that are quite unrelated to them. One particularly insidious means of gene transfer between bacteria involves plasmids. These are small closed circles of double-stranded DNA that 'infect' bacteria, and then replicate independently using the host bacterium's replication machinery.

Plasmids have probably been

around for almost as long as bacteria – 3.5–4 billion years. During the past 70 years, however, since the beginning of the widespread use of antibiotics, many different plasmids have acquired genes that encode resistance to specific antibiotics. An example is a gene that encodes penicillinase, an enzyme that breaks down penicillin, rendering it completely useless.

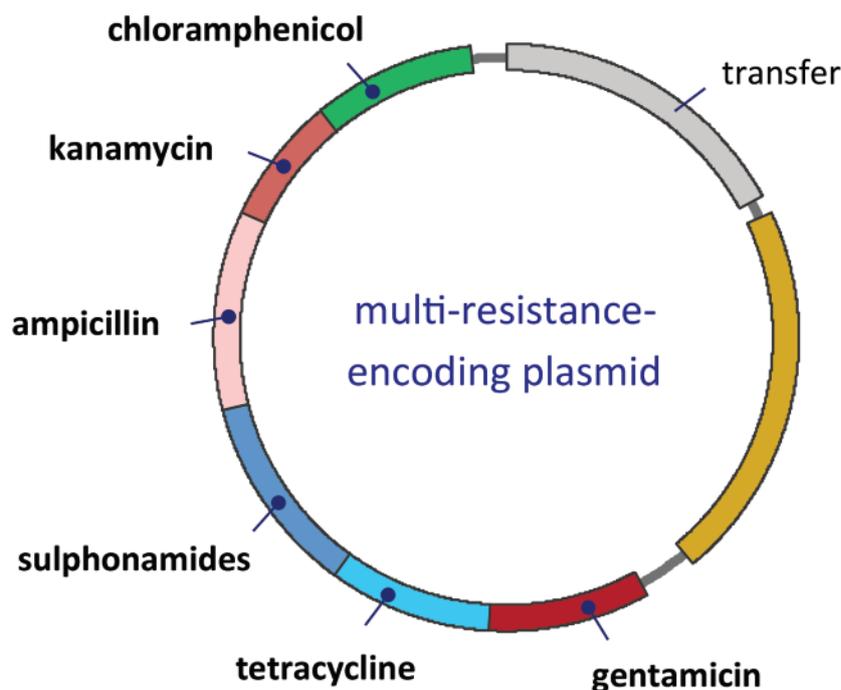
Today there are many examples of plasmids that encode resistance to several different types of antibiotic, such as penicillins, tetracyclines, erythromycin and many other clinically valuable drugs. A bacterium that acquires one of these plasmids will, in one genetic event, become resistant to all of these drugs at the same time.

By their very nature, antibiotics are extremely powerful agents of natural selection (survival of the fittest). This is because all of the antibacterial drugs in current use act by killing bacteria or markedly slowing their growth. Bacteria that are resistant to a particular drug will have an enormous evolutionary advantage in the presence of this drug and soon become the dominant population. Furthermore, if the resistance is encoded by a gene on a plasmid, all of the other resistance-encoding genes on this plasmid will also be selected because they are genetically linked to each other.

An important source of genes that encode resistance to antibiotics is the normal microbiota that live in our bodies and those of our domestic animals. Although these bacteria are mostly harmless or even beneficial, they and their ancestors have survived countless exposures to antibiotics that we and other people, as well as our companion and food animals, have consumed during the past 70 years.

What can we do about it?

When antibiotic resistance first emerged as a clinical problem, the response of pharmaceutical companies was to develop new drugs to replace those that were no longer



Representation of a plasmid that encodes resistance to several different antibiotics. This particular plasmid also encodes the ability to transfer itself between bacteria. If this plasmid is acquired by a bacterium, this bacterium would become resistant to all of these drugs simultaneously. Moreover, any one of the drugs shown could be used to select for the entire plasmid and thus for all of the resistance-encoding genes.

useful. However, as you will appreciate from the nature and origin of resistance, these new drugs also soon became ineffective. The extremely high cost of developing new drugs no longer warrants this investment by most pharmaceutical companies. For this reason, governments in Europe and North America are offering strong financial incentives for companies to develop new drugs, but the uptake has been slow.

Some researchers are investigating entirely new types of antibacterial agents. These drugs do not interfere with growth, but instead target the ability of pathogenic bacteria to cause disease. These drugs would have no effect on the normal microbiota because they act on specific targets that are present only in disease-causing bacteria. Such drugs are at an early stage of development and have not yet been trialled in humans.

In the meantime, all we can do is to use antibiotics more responsibly than

we have in the past. One of the reasons that resistance has emerged so rapidly and spread so widely has been the irresponsible use of the antibiotics we have. This includes adding them to animal feeds to encourage growth and using them in circumstances where they are known not to work, such as for colds and other infections caused by viruses.

So, when you next visit your local doctor with a cold and he or she tells you that you don't need an antibiotic, you should not try to force their hand but respect their advice and welcome the fact that they are playing an important role by preserving the usefulness of these remarkably beneficial drugs for as long as possible.

Roy Robins Browne is at the Department of Microbiology and Immunology, the University of Melbourne and the Murdoch Childrens Research Institute, Royal Children's Hospital, Melbourne.

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Australian science leaders elected to Academy Fellowship

The Australian Academy of Science announced in March the election of 21 leaders in Australian science to its Fellowship. The new Fellows, including three RACI members, have been elected for their outstanding contributions to and application of scientific research.

Academy President Suzanne Cory congratulated all of the new Fellows for their stellar achievements and contributions to advancing the sum of human knowledge.

'All of these scientists are doing amazing and significant work in their chosen fields – they are the Olympic athletes of science,' she said.

Every year the Academy honours the work of Australia's leading scientists with election to its Fellowship, which now numbers 481.

New Fellows were formally admitted to the Academy at its annual flagship event, Science at the Shine Dome, in Canberra this May, where they made short presentations about their work.

RACI members who have received Fellowships this year are:

- **Professor Rose Amal MRACI CChem, School of Chemical Engineering, University of New South Wales**, for her outstanding contributions to photocatalysis and leadership in harnessing solar energy to purify water and generate hydrogen-2
- **Professor Michelle Coote MRACI CChem, Research School of Chemistry, Australian National University**, for developing and applying accurate computational chemistry for modelling radical polymerisation processes
- **Professor Peter Gill FRACI CChem, Research School of Chemistry, Australian National University**, for his fundamental and applied research in quantum chemistry, the discipline in which the laws of quantum mechanics are applied to understand and predict molecular behaviour.

AUSTRALIAN ACADEMY OF SCIENCE

Women in leadership breakfast

Around 65 members of the chemistry community had the opportunity to network and quiz the expert panel at WINC's fourth flagship breakfast for 2014. Held on 26 February 2014, the event was hosted by CSIRO at Clayton, Victoria, and sponsored by Phillips Ormonde Fitzpatrick.

The theme for the breakfast was women in leadership and the challenges of transitioning to more senior roles. However, with plenty of participation from the audience, the discussions extended to strategies for maximising career opportunities, the benefits of formal mentorship, seeking out sponsors, self-promotion and managing career breaks in light of Australia's current government funding models.

The panel of experts consisted of Dr Alison Funston, ARC Future Fellow and lecturer in the School of Chemistry at Monash University; Professor Amanda Sinclair, consultant and professor at the Melbourne Business School; and Professor Bob Williamson, Honorary Professor of the Murdoch Institute, the University of Melbourne and Monash University.

The breadth of experience ensured our panel members did not always agree on all topics. However, they were united by the notion that organisations and research outcomes suffered

by not fully harnessing the talent women have to offer, particularly in senior management and decision making.

Dr Funston implored the audience to put themselves forward and not allow self doubt to deprive them of opportunity. Professor Williamson pointed out that a number of women return to part-time work after a career break yet still take on a full-time load. He encouraged women not to accept part-time pay for full-time work. Professor Sinclair discussed the need for sponsorship within organisations to ensure individuals are not overlooked for key promotions and to ultimately address the gender imbalance that exists in senior management across a number of sectors.

Over breakfast, students, academics and industrial chemists at all stages of their career were able to build new connections and share anecdotes from their chemistry careers. All in all, the 2014 Women in Chemistry breakfast offered excellent discussion, delicious food and the chance to engage with a broad cross-section of the chemistry community in Melbourne. We thank our guest panellists and sponsors for their support.

Amanda Lee Associate Member is a Trainee Attorney at Davies Collison Cave and secretary of WINC for 2014.

Alan R. Katritzky

Pre-eminent heterocyclic chemist



Heterocyclic chemists and the wider chemistry community were saddened to learn that Alan Katritzky passed away on 10 February 2014, in Gainesville, Florida, US, at age 85. Alan had suffered a stroke in January 2013, but continued his work at the University of Florida, where he was Kenan Professor of Chemistry and Director of the Centre for Heterocyclic Compounds.

In a chemical career spanning over 60 years, Alan Katritzky was the pre-eminent heterocyclic chemist, with a prodigious published output of over 2200 papers and 200 books, as author, co-author or editor.

Alan Roy Katritzky was born in London on 18 August 1928, the third of Emily and Charles Katritzky's four children. It is said that Alan prepared his first heterocyclic compound, the barbiturate Veronal on his 15th birthday. Alan went up to Oxford in 1948, where he obtained in quick succession, the degrees of BA (First Class Honours) BSc and MA. In 1952, Alan applied for a job with The Shell Petroleum Company Limited, but was rejected, on the grounds that the company 'could find no opening in our organisation, either in this country or overseas, which we can offer you.' A shock to Alan, I am sure, a misfortune for Shell, but a very good outcome for heterocyclic chemistry.

Alan married Linde Kilian in 1952 and they had four children. Later, having achieved that criterion, Alan used to joke with his graduate students that a couple was not 'properly' married until they had four children!

Alan published his first paper on heterocyclic chemistry (benzotriazoles) in 1953 with S.F.G. Plant, in the *Journal of the Chemical Society*. Alan received the DPhil in 1954 after working two years with Sir Robert Robinson, OM FRS. This was followed by teaching appointments at Oxford. Alan moved to Cambridge in 1957, where he completed the PhD and ScD degrees, and came under the influence of Sir Alexander, later Lord Todd OM FRS and Sir John Cockroft, OM FRS, becoming a Founder Fellow of Churchill College in 1959, of which Sir John was Founder Master. Alan openly acknowledged that 'political manoeuvring' at Oxbridge was 'an excellent training' for his later academic appointments.

It was while he was at Cambridge that Alan and Jeanne Lagowski wrote the book *Heterocyclic chemistry*, which rationalised the subject in terms of electronic theory. The book changed forever the way heterocyclic chemistry was taught and learned.

Alan was appointed founding Professor of Chemistry at the new University of East Anglia, in Norwich in 1963 at age 35. The university began in temporary quarters in what was known as the University Village. As Dean of the School of Chemical Sciences 1963–70 and again 1976–80, Alan played a major role in recruiting staff, shaping the teaching program, establishing research and designing the permanent School of Chemical

In a chemical career spanning over 60 years, Alan Katritzky was the pre-eminent heterocyclic chemist, with a prodigious published output of over 2200 papers and 200 books, as author, co-author or editor.

Sciences building, across Earham Road, on the University Plain, where the university, designed by eminent British Architect Denys Lasdun was under construction.

Alan and Linde purchased a family house at 396 Unthank Road, Norwich, and Alan would often be seen riding his bike to and from the university. It also became the centre of their social life, entertaining visitors to the school from the UK and abroad and a steady stream of academic staff, postdocs, graduate students and, once a year, undergraduates.

By 1980, the School of Chemical Sciences was flourishing. Alan had achieved his objectives in establishing the School and a vigorous research program, when he accepted an invitation to become Kenan Professor of Chemistry at the University of Florida, in Gainesville. In the same year, Alan was elected a Fellow of the Royal Society (FRS).

The *Katritzky Newsletter*, sent annually to all former and current Katritzky research group members, announced the move to Florida, in issue number 8 (May 1980) with mixed emotions.

Alan quickly settled in at Florida but continued his extensive travelling, usually accompanied by Linde, to lecture and consult in the US and Europe, but also further afield, including the Middle East, Japan and China. Alan visited Australia three times, in 1971, 1973 and 1982, and in 1983 he was elected a Foreign Fellow of RACI.

While at the University of East Anglia, Alan cultivated strong ties with the chemical industry and encouraged his academic staff to undertake consulting work. Senior industry people were appointed visiting professors and spent a few weeks each year, teaching undergraduates new skills and mixing with academic staff, graduate students and researchers. Beginning in 1970, Alan introduced (short and long) refresher courses in organic chemistry for graduates who had been working for some years. The concept transferred with Alan to Florida, becoming the Florida Heterocyclic and Synthetic Conference (FloHet). The 15th FloHet held 2–5 March 2014, was a great success, but sadly the founder and main organiser was not present.

Throughout his career, Alan was the recipient of over 30 prestigious honours and awards, among them Cavaliere Ufficiale of the Order Al Merito Della Repubblica Italiana, the Tilden Medal of the Chemical Society, London, and the Gold Medal of the Scientific Partnership Foundation, Moscow. He was awarded 14 doctorates (honoris causa). Alan will also be remembered for his service to scientific societies, as a member of the editorial advisory boards of no less than 27 scientific journals and as a visiting professor, examiner, referee and consultant. ARKAT-USA, the Alan and Linde Katritzky Foundation, supports research and education, and manages ARKIVOC, a free electronic chemistry journal, and the annual FloHet Conference. Alan also established named prizes for undergraduate achievement at St Catherine's College, Oxford, Churchill College, Cambridge, and the University of East Anglia. A Katritzky family bequest to the University of Florida in May 2013 will establish the Katritzky Chair of Heterocyclic Chemistry.

Alan Katritzky was a remarkable man who touched and influenced the lives of thousands of people during his life. Alan is survived by his wife of over 61 years, Linde, their four children, a son-in-law, three grandchildren and a sister. Linde's absolute devotion, encouragement and support, contributed immeasurably to Alan's lifetime achievements.

Peter G. Lehman FRACI CChem

Alan Katritzky's CV can be viewed at www.ark.chem.ufl.edu/Index.asp?Views=Aims_achievements/ARKCV/ARKCV.asp, while a list of all his publications can be found in the Published Papers section. Alan Katritzky was the author's 'Doktor Vater' at the University of East Anglia.

Obituary guidelines

Obituaries for publication in *Chemistry in Australia* should have an approximate length of 450 or 800 words or less and can be submitted with an image to the Editor at wools@westnet.com.au.

Valda McRae

University of Melbourne chemistry historian

Valda May McRae was born on 22 April 1935 and died on 3 January 2014.

After completing a DipEd in 1956, Valda taught at McLeod and Numurkah High Schools before returning to the School of Chemistry, University of Melbourne, in 1960 to complete her PhD as a part-time student while working as a demonstrator and later senior demonstrator.

Valda spent from 1966 to 1968 at the University of Leicester as a postdoctoral fellow. Leicester was one of the few universities where it was possible to continue the study of fluorine chemistry, and interesting novel compounds of fluorine with the rare gases were prepared.

On returning to Australia with her husband Jack in 1968, Valda worked in the Science Faculty Office, as Assistant to the Sub-Dean and then Sub-Dean; and then worked in Chemistry as principal tutor, lecturer and senior lecturer (1988). Her research interests, after returning to the School in 1974, were in analytical and radiochemistry. From 1995 to 2000, Valda was the Executive Manager of the School of Chemistry. Her main responsibilities were in the academic administration of the School with a heavy emphasis on the planning and organisation of timetables, tutorials and practical classes. Once retired, Valda spent much of her time working on the School archives and history, and in 2003 edited the Lady Masson Lectures. In 2008, Valda published *Chemistry @ Melbourne 1960–2000*, a history of four decades in the School, and in 2013, *From chalk and talk to Powerpoint*, an account of the first 1000 meetings of the Melbourne University Chemical Society.

Possessing sharp intellect and strong views, Valda did not suffer fools gladly. Upon her retirement, however, she appeared to mellow somewhat. Relaxing with her many friends, she was lively and engaging company. Although having no children of her own, she clearly took great joy in interacting with them, and they reciprocated with great affection.

During her later years, Valda underwent successive mastectomies in an effort to defeat breast cancer. In 2013, the disease surfaced again and, after complications, she died in Caritas Christie Hospice, Kew.

Valda was forthright but kind, a supportive friend and mentor, and a brilliant human being. We deeply regret her passing, and will miss her greatly.

Frances Separovic FRACI CChem and **Jenny Bennett** MRACI CChem



Norman Stewart Ham

Leader in spectroscopy

On 5 February 2014, Australia lost one of its leaders in the application of spectroscopy to structural chemistry.

Norman Stewart Ham MRACI CChem was born on 29 August 1928 in Kew, Victoria, and worked for most of his career in the CSIRO Division of Chemical Physics, first at Fishermans Bend and later at Clayton, Victoria.

He was educated at Box Hill High School and later Melbourne High School, after which he studied science at the University of Melbourne and completed his BSc degree in 1949 with first class honours in both chemistry and theoretical physics. He obtained first class honours in his MSc research, conducted under Mr (later Professor) A.N. Hambly of the Chemistry Department, on the Raman spectra of some aromatic sulfonyl halides, and for this he needed access to the complementary technique of infrared spectroscopy. I first met Norman when he came to us at the CSIRO Division of Industrial Chemistry in 1950 to learn about this technique, which I had been engaged in using since 1948. In 1951, he was appointed as a research scientist in the Chemical Physics Section of the Division, and in the next two years Norman and I took part in the development of Alan Walsh's 'multiple monochromator'. He also worked with Dr Lloyd Rees on the effects of solvents on the ultraviolet spectrum of iodine.

From 1952 to 1955, Norman worked at the University of Chicago with Professor Robert Mulliken NL, a world leader in quantum mechanics and spectroscopy. He gained his PhD for work on electronic interaction of the free-electron network for conjugated systems and the application of his theory to the ultraviolet spectra of a range of aromatic hydrocarbons. On returning to Australia, he became involved in working with the new technique of nuclear magnetic resonance (NMR) spectroscopy and in using early computers to handle the necessary calculations. He spent most of 1963 at MIT in Boston with J.S. Waugh, a pioneer in this field.

Much of Norman's NMR work was done to assist other laboratories, particularly the CSIRO Division of Organic (later Applied) Chemistry. One important project was carried out in conjunction of with Dr C.C. Culvenor, of the Division of Animal Health, on the proton magnetic resonance spectra and conformation of acetylcholine and acetylthiocholine in solution. In 1967, he collaborated with S.N. Stuart and others in two

proton studies of intermolecular exchange of methyl groups in solution. He was on the organising committee of the 1st International Symposium on Magnetic Resonance, held in Melbourne in 1969.

Norman continued to make contributions to other fields of spectroscopy, including the development, with Alan Walsh, of microwave-powered lamps for the excitation of Raman spectra, though these were soon superseded by far more powerful laser-powered sources. He also collaborated with other members of the Chemical Physics Spectroscopy Section in work on the lifetimes of excited atoms in flames and in my own studies of atomisation problems in atomic absorption spectrometry.

On 1 January 1987, the Division of Chemical Physics became part of the Division of Materials Science and Technology and shortly afterwards Norman was appointed Assistant Chief of the combined Division. He retired in 1989, but continued for some years as a post-retirement fellow in the Division of Chemicals and Polymers.

Norman had a wide range of non-scientific interests. He was a talented musician, having learned the piano and the organ in his youth, winning an early radio talent quest. While in Chicago he became deeply involved in choral singing, and he continued after his return to Australia as a member of the Oriana Madrigal Choir, which pioneered the performance of early choral music in Melbourne. He was a skilful furniture restorer, upholsterer and French polisher, and an accomplished cook.

Before returning in 1955 from his stay in the US, Norman married Kathryn Keller, a medical graduate of the University of Chicago. She joined the Pathology Department of the University of Melbourne, where for many years she carried out research on kidney tissue and function, receiving a PhD in 1971. She died in 2012. Their son Andrew was born in 1964, and two years later they adopted a daughter, Katia, who died in 2009.

Norman was a very modest person. His son recalls that it wasn't until he (Andrew), in his final years of high school happened to visit Melbourne High School to play in a concert, that he learned from the honour boards that his father had been dux of the school in 1945 and had won prizes in chemistry, physics and mathematics.

Norman Ham was a valued colleague for 35 years and also a personal friend, so I feel honoured to be able to pay him this final tribute.

I should like to thank Andrew and Brenda Ham, Susan Smith, Tom Spurling, Stephen Stuart and Ian Willing for their help in writing this obituary.

J.B. Willis FRACI CChem

Linking in: using industry partnerships to enrich career development

Engaging with industry can take you a long way if there's some good business sense behind your ideas.

Last October, the Australian Early/Mid Career Researcher Forum organised a conference that aimed to link researchers with industry connections. Science Pathways: Engaging with Industry and Innovation was attended by delegates from government, academic and industry research institutions. From early- and mid-career researchers (EMCRs), concerns about cross-training and developing 'soft skills' needed for liaising with business were common, as were concerns about not knowing where to find the right industry partner. Industry experts emphasised the need for innovation and the reliance a small business community like Australia has on academic research to provide solutions and technical expertise. The Forum will continue to try to provide EMCRs with links and access to industry.

Why engage?

Engaging with industry has benefits for the researcher as well as for the industry partner's bottom line. This is particularly true for EMCRs, where industry partnership can be a lucrative source of ideas for funding applications. Academic environments are often not the most efficient space for commercialisation; in Europe, for example, 10% of universities account for 85% of the invention-generated income (www.oecd.org/sti/sci-tech/commercialising-public-research.htm).

Knowledge transfer should be a key component of academic work, and many academics have an imperative from their employers to disclose, protect and use their intellectual property. The debate over academic patenting has been well-characterised elsewhere, and it can be an important part of knowledge transfer and adding value to a research portfolio. Additionally, the licensing and subsequent distribution of the intellectual property doesn't always need to come at an astronomical cost, and the benefits for the researcher, and the community, are well established (www.wipo.int/sme/en/documents/academic_patenting.html).

Experience with the patenting process and managing intellectual property can be an invaluable asset for EMCRs, and can give an added advantage when searching for employment in industry.

Partnering with industry

When planning a project with potential industry interest it is important to specify what you bring to the table, and what you hope to achieve. Having a mix of 'blue sky' and short-term goals can help frame the project, and a rough idea of a budget for

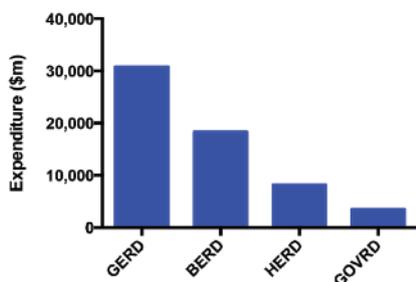
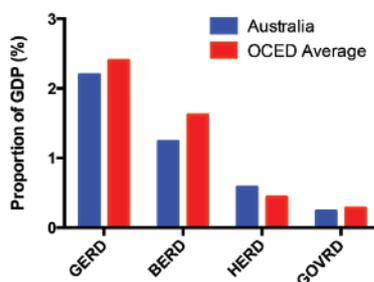
both can help move initial conversations forward. If you have a particular partner in mind, then consider their resources and expertise, and aim to finish the project with more techniques, valuable data, and a wider professional network. Publication in high-profile journals is good for the researcher and the business partner, and outlining a publication scheme ahead of time (considering intellectual property constraints and authorship) can help avoid conflict when the project has started. Be sure to involve your business development manager (or equivalent) in conversations and ensure you have a non-confidential discussion, or that you have the appropriate confidential disclosure agreement in place ahead of time.

Professional societies, national conferences, and social media are a good place to start when trying to understand the landscape for a particular industry. If you have an idea that you think is ripe for collaboration with industry, or are interested in learning more about how your research can help businesses innovate, your first port of call should be the business development manager (or equivalent) for your organisational unit. Business development managers are trained to recognise opportunities for collaboration and probably know the players in your field for investment. Your grants manager or research unit may also be able to show you previous grants with industry partners that were successful, including Australian Research Council Linkage Project grants, that may help you craft your pitch.

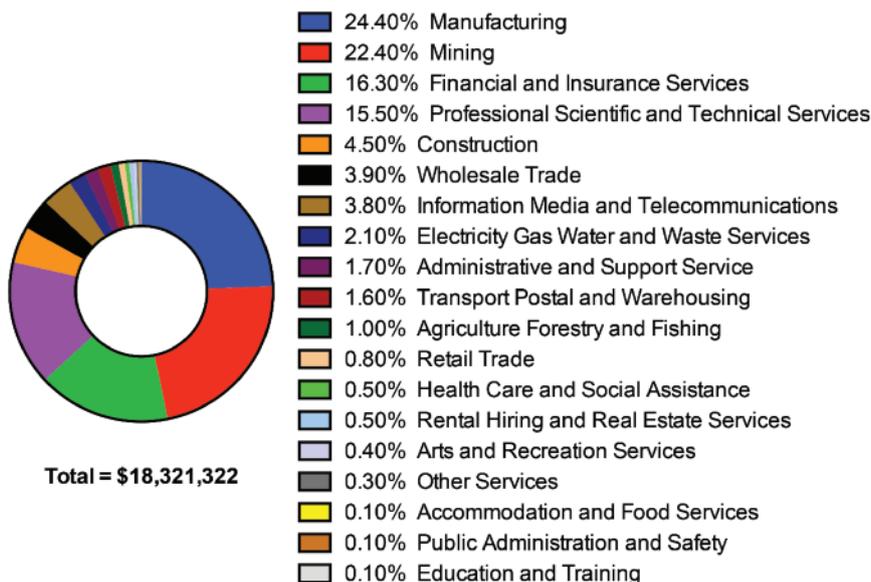
Queensland has launched several funding schemes (the Accelerate Partnerships) that specifically target its pillar sectors: resources, construction, tourism and agriculture; early-career researchers are invited to apply. As a result of priorities set by the Queensland Government, academic, government and industry researchers are searching for ways to minimise the impact of climate extremes on human health, agricultural production, and biodiversity.

Funding your partnership

The importance of research and development (R&D) for innovative practices is clear. On the whole, businesses invest more in R&D than do higher education and government agencies (graph A). Despite this practice, on average, OECD countries have a higher gross and business expenditure than does Australia (graph B). Australian businesses spend over \$18 million on R&D; almost 50% of these expenditures are from the manufacturing and mining sectors. In order to remain

A**B**

Research and development indicators give an idea of how much money is being spent on innovation in Australia. The dollar amount of spending in Australia (panel A) is shown to compare with spending as a proportion of GDP (panel B) in Australia and OECD countries. GERD = gross expenditure on research and development; BERD = business expenditure on research and development; HERD = higher education expenditure on research and development; GOVRD = government expenditure on research and development. Data from 2010–2012; excerpted from the 2014 Australian Government Department of Industry *Australian Key Innovation Indicators Data Card* (www.innovation.gov.au).



Business expenditure on research and development by industry sector (2011–2012). Data from 2010–2012; excerpted from the 2014 Australian Government Department of Industry *Australian Key Innovation Indicators Data Card* (www.innovation.gov.au).

competitive in a global market, businesses are keen to find innovative partners to enhance their R&D programs.

Many government agencies and funding schemes that encourage innovation for Australian businesses; many of these have schemes specifically earmarked for EMCRs. For more field-specific inquiries, try contacting the business development manager for your organisational unit. A non-exhaustive list is shown here (purple box on the right) (also available at <http://bit.ly/PfSQ9n>).

Maggie Hardy is a postdoctoral research fellow at The University of Queensland's Institute for Molecular Bioscience, and an affiliated academic at the Queensland Alliance for Agriculture and Food Innovation. Her research program is focused on the rational discovery of novel therapeutics from animal venoms and poisons. Maggie is interested in science communication and science policy, and is a member of the Australian Early-Mid Career Researcher Forum. You can follow her on Twitter @DrMaggieHardy.

Agencies and schemes that encourage innovation

Australia wide

ARC Linkage Projects
 Australian Innovation Research Centre
Business.gov.au
 Australian Government Rural Industries Research and Development Corporation
 AusIndustry
 Australian Government Department of Industry
 Innovation and Business Skills Australia

State specific

ACT: Innovation ACT
 New South Wales: Innovate NSW
 Northern Territory: Department of Business
 Queensland Government: Science and Innovation Grants
 South Australia: Innovation in South Australia
 Tasmanian Innovation and Investment Fund
 Victorian Government: Department of State Development, Business and Innovation
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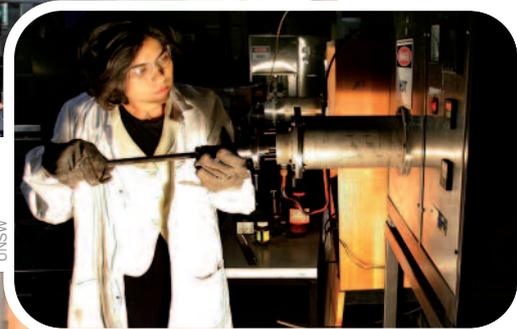
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Learning from the MOOCs model

Massive Open Online Courses (MOOCs) are a form of distance education, with internet-based learning courses intended for large-scale participation. The key word is 'massive'. The business model is that thousands of participants give large economies of scale, with low marginal costs: hence, it is possible to have large-volume, low-cost offerings. Many MOOCs provide free access to learning materials, and charge for assessment and certification; some MOOCs also charge for access to the materials. Web 2.0 technologies enable both live chats or synchronous discussion, and asynchronous discussion forums. The business model assumes that the participants or learners will become a de facto self-help community, so a relatively small number of instructors can serve a large number of learners.

... we should engage students in learning and recognise that students are not empty vessels into which knowledge can be poured.

High-profile institutions such as Yale and University of California Berkeley have used movies of traditional 50-minute lectures as their primary online learning materials in chemistry MOOCs. American chemistry degrees consist of theory-only courses (subjects or units), and laboratory-based courses; the MOOCs showcase some theory-only courses. The production values of these chemistry MOOC lectures are high. For example, the Yale and Berkeley lectures feature their best lecturers (professors); there are multiple cameras that are operated by live technicians, so that the cameras can pan, move and zoom. Each lecture is effectively an advertisement for the university and would have required a marketing-type budget.

However, the chemistry education community, both in Australia and overseas, have not embraced MOOCs because it is not possible to offer laboratory-based learning via the internet. Laboratories are still the signature pedagogy in chemistry education (see September 2013 issue, p. 35). The same is true of biology and other laboratory-based disciplines. In contrast, much of modern physics uses computer-controlled instrumentation for experimentation, so these can be converted into internet-accessible form. The Australian FarLabs (Freely Accessible Remote Laboratories) program is an example of such physics experiments, even at high-school level.

A second reason why the Australian chemistry education community has not embraced MOOCs is that MOOCs are incompatible with the mission of most Australian universities, which seek to serve the Australian community. Currently, 32% of

Australians aged 25–34 have bachelor degrees; it is intended to raise this higher education attainment to 40% by 2025. The 2008 Bradley Review recommended that government and universities encourage and cater for groups of students who are currently under-represented in higher education: by 2020, 20% of undergraduate enrolments in higher education should be students from low socio-economic backgrounds. Students from a variety of backgrounds, and with a variety of learning needs, require a range of supports in their learning. One size does not fit all. The institutions in the MOOC space aim to attract elite students, who can excel with relatively less academic support, in universities where graduate-student teaching assistants do much of the teaching.

Australian universities do more than impart discipline-based knowledge; they also offer help with study skills. For example, in an average Australian university, many science students have weak mathematics skills. Professor Roy Tasker, the recipient of the 2011 Prime Minister's Award for Australian University Teacher of the Year, often says that the best learning is a collective and social endeavour. Student–student interactions as well as interactions between staff and students are crucial.

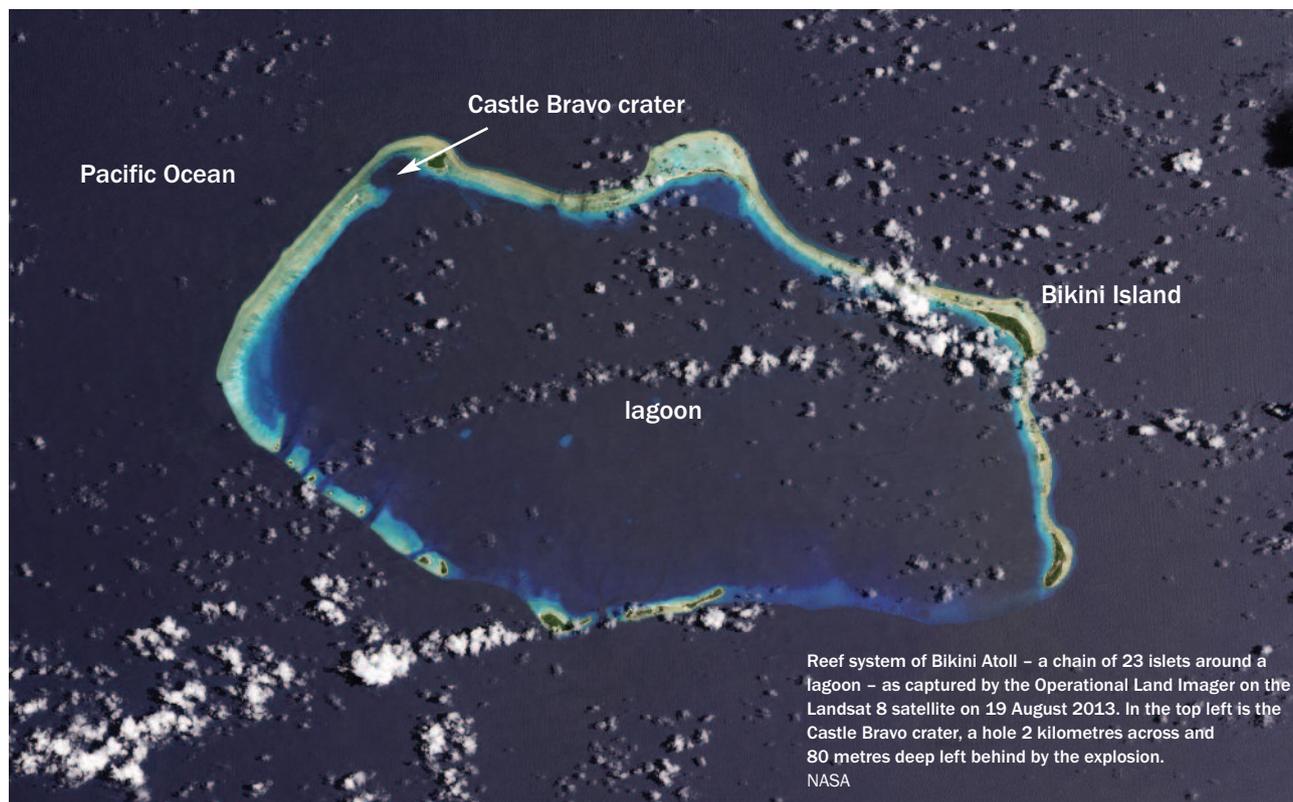
MOOCs have student-to-instructor ratios of thousands-to-one; the much smaller student-to-instructor ratios in Australian universities are not perfect but they do permit explanations and learning activities to be adjusted to cater for students from a variety of backgrounds, especially those from non-traditional educational backgrounds and those who are weaker in the discipline and related areas.

MOOCs do have important lessons for us. Yes, electronic learning resources and learning objects should be used where appropriate. Yes, the stand-and-deliver passive-learning lecture has long been inappropriate for most students. Successful MOOCs break up the content delivery into small packages, typically of 5–10 minutes duration, interspersed by other learning activities. The successful MOOC model of learning is similar to active learning programs such as POGIL (Process-Orientated Guided-Inquiry Learning) and ALIUS (Active Learning in University Science), which have been used successfully in chemistry education (see December 2008 issue, p. 22). The lesson is not that internet-based delivery will be the salvation of our universities; the lesson is not that we must teach online 24/7; the lesson is not that we should embrace MOOCs because they are the newest and biggest fad. The lesson is that we should engage students in learning and recognise that students are not empty vessels into which knowledge can be poured. The lesson is that teachers need to interact with students in this collective and social endeavour called education.



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The hydrogen bomb and TNT equivalences



This year, 1 March marked the 60th anniversary of the hydrogen bomb at Bikini Atoll in the Pacific. This bomb had a TNT equivalence of 15 megatonnes in contrast to the bomb used in World War II on Hiroshima in 1945, which had a TNT equivalence of 15 kilotonnes. The fission bomb used at Hiroshima contained 64 kilograms of uranium and was only 2.5 times heavier than the fusion bomb of 1954 – the huge difference in blast is a result of the lighter element hydrogen in the fusion process.

The hazards of the nuclear process can be seen by comparing the energy released from the nuclear fission reaction of uranium with that from the chemical explosion of methane:



The seven orders of magnitude difference between the nuclear fission process and the chemical one can be offset when large amounts of a chemical fuel explode, so if an oil tanker containing a million barrels of crude oil exploded, the blast would exceed that due to the bomb at Hiroshima.

According to NASA (http://imagine.gsfc.nasa.gov/docs/teachers/hera/spectroscopy/snr/fusion_calculation.html), the energy of the hydrogen fusion reaction of the Bikini Atoll bomb is:



Although this is an order of magnitude lower than the energy released from the fission reaction, the widely different atomic

masses of hydrogen and uranium mean that the fusion reaction has a much higher energy release.

From the three orders of magnitude excess of the Bikini Atoll TNT equivalence over the Hiroshima bomb, one might reasonably argue that the offsetting of heat releases by quantities, valid for fission processes, becomes difficult to validate for fusion.

Another type of explosion includes those due to mechanical effects in the absence of any nuclear or chemical process. The most obvious example of this is the blowing up of an autoclave containing steam and water in phase equilibrium. A simple calculation will show that were an autoclave containing 5 kilograms of steam at a pressure of 3 bar absolute (2 bar gauge) to explode, the TNT equivalence would be 0.35 kilograms, more conventionally expressed as 0.35 millitonnes.

So TNT equivalences can span the range of millitonnes (autoclave) to of the order of 10 megatonnes (hydrogen bomb) – a range of ten orders of magnitude. Perhaps one strength of the TNT index in evaluating explosions is its wide numerical basis. More details on the calculations can be had from the author.



Clifford Jones FRACI CChem (j.c.jones@abdn.ac.uk), who worked in Australia over the period 1978–95, is now a reader in the School of Engineering at the University of Aberdeen.

Flexcubes as oak barrel alternatives

When I first became active in oenology research in the early 1980s, the idea of using plastic vessels for wine production was regarded as totally inappropriate, although they were in use in smaller wineries. The plastic vessels at that time were made from thermosetting polymer resin mixed with fibreglass for reinforcement. If the solvents and initiators used in the thermosetting process were extracted into wine, they could lead to a distinct taint, robbing the wine of its quality.

In 2001, Tony Flecknoe-Brown opened up a new approach to the use of plastic vessels for wine production. Tony's background was in food engineering and he set his mind to using food-grade thermoplastic polymers such as polyethylene. Thermoplastics do not contain free solvents or other reagents that can migrate into wine, thus eliminating the taint issue with thermoset resins. Tony's research trials led to the commercial development of Flextank (now Flexcube, www.flexcubegroup.com) vessels that were first used in the Australian wine industry in the 2003–2004 vintage.

Polymer inertness is the key to the success of Flexcube. The production of polyethylene (PE) polymers using metallocene catalyst technology had given rise to a material that is suitable for use in wine because in addition to being taint-free, it has better mouldability, with less processing degradation. Importantly, the PE materials have very a low level of volatile sorption ('scalping'), leading to essentially no change in the aroma status of the wine during storage. In addition, the well-defined linear molecular structure of the PE polymers gives consistent gas permeability, a significant advantage for wine maturation.

Oxygen is required for the maturation of red wine as oxidative reactions lead to stabilisation of colour and a change in palate structure, especially astringency. Oxygen can be pumped into wine in a tank as in micro-oxygenation (MOX; see our 2011 review in *Critical Reviews of Food Science and Nutrition*, vol. 51, pp. 115–31). Alternatively, when wine is stored in oak barrels, slow air ingress can occur between the staves (see April 2014 issue, p. 39). MOX considerably reduces the time for maturation in comparison to the longer maturation times in barrels.

Flexcubes are reported to have controlled oxygen permeation rates, allowing a defined amount of oxygen to permeate into the wine over a given period. This, it is argued, is a consequence of the highly reproducible conditions used in the PE polymer production process. The construction of oak barrels from staves is far from reproducible and thus barrels have variable permeation rates. Each time a barrel is used, there is some loss of permeability, so an older barrel will have much lower oxygen ingress than a new barrel.

Some years ago, the Australian Wine Research Institute reported oxygen uptake levels by red wine in various storage

vessels and as a consequence of some winemaking procedures. For example, oxygen permeation rates in new oak barrels may vary from 20 to 30 mg O₂/L/year, whereas a four-year old barrel would be closer to 10 mg O₂/L/year. Wine in bottle sealed with natural cork has an oxygen ingress rate of just over 1 mg O₂/L/year while a Stelvin seal is <0.5 mg O₂/L/year. Pumping a wine from tank to tank (racking) can introduce the equivalent of around 10 mg O₂/L/year, while MOX rates may be up to 60 mg O₂/L/year. The original 1000-litre Flextank had an oxygen permeation rate of 17 mg O₂/L/year and the newer Flexcubes are available at 22, 17 and 12 mg O₂/L/year. The lowest rate may be more suitable for white wine development, as the phenolic content is much lower. The Flexcube permeation rates are thought to remain consistent over the cube's life and not decrease with re-use as occurs with oak barrels. Oak characters can be obtained by inserting staves or other pieces of oak into the cube, in much the same way as discussed in my May 2014 column (p. 39) for stainless steel tanks and old barrels.



The results of several Flexcube winemaking trials that I have seen are rather impressive, although the image of a cellar of Flexcubes may not have the same romantic appeal as a barrel hall. Sadly, Tony Flecknoe-Brown died in August 2010. The Flexcube concept has clearly stamped Tony's creativity on and commitment to the wine industry, both nationally and internationally.



Geoffrey R. Scollary FRACI CChem (scollary@unimelb.edu.au) was the foundation professor of oenology at Charles Sturt University and foundation director of the National Wine and Grape Industry Centre. He continues his wine research at the University of Melbourne and Charles Sturt University.

A case of under-exposure

These days, the notion of ‘personal care products’ seems long removed from the time when people made do with soap, tincture of iodine and Condy’s crystals. Today, huge numbers of products are available to cleanse, moisturise, deodorise, disinfect and rejuvenate. One consequence of this is the readiness of the media to report how such products have a deleterious effect on the users, or on the environment. Three examples of media coverage in the past six months have given me cause to think that identifying hazards is easy, but few writers on this topic appreciate the importance of exposure pathways in causing actual harm, or the risk of it. The exposure pathway is the mechanism by which a hazardous substance comes into contact with a sensitive receptor (whether human or environmental), thereby causing actual or potential harm. In the absence of an exposure pathway to link the hazard to the receptor, no harm, or risk of harm, will occur.

In November 2013, researchers from the University of Michigan reported on a study that purported to show a link between the presence of phthalates in the urine of pregnant women and an increased risk of preterm birth. I won’t pursue the epidemiology by which they reached this conclusion, but their recommendations interested me. Pregnant women were advised to avoid exposure to phthalates in plastics, foods and cosmetics/personal care products. The only problem is that phthalates aren’t generally additives in these products.

Phthalates are used as plasticisers in a range of rigid plastics, most notably PVC, and some more specialised products such as beverage container seals. They are hydrophobic and lipophilic, and will leach into fatty foods or products, and into alcohol mixtures, with which they make contact. Although some cheaper cling wraps are made of plasticised PVC, few (if any) plastic containers for household and personal care items contain phthalates. I haven’t checked out the inside of any perfume bottles to identify the plastic components of the atomiser spray. On this basis, how the phthalates entered the bodies of the study subjects would seem unclear. There can be no guilt by association. Just because the container is made of plastic, it doesn’t mean you will be exposed to phthalates if you hold it or use the product. If the researchers at the University of Michigan have identified a significant cause of preterm births, a closer search for the source of the cause, and the exposure pathway, might be required.

More recently, in the *Medical Journal of Australia*, a study reported an increase in the prevalence of skin conditions such as dermatitis linked to the use of disposable baby wipes. In this case, the culprit (or hazardous substance) was identified as methylisothiazolinone, which is part of the bactericide within the moisture on the wipes. Baby wipes are applied to the skin, and here the exposure pathway is clear – direct application to the sensitive receptor.

Another difference between this example and the phthalates case is that methylisothiazolinone is an active ingredient in making the product functional. Preventing bacterial infection can



be one way of avoiding nappy rash. However, if the agent applied to deal with one skin irritation causes another irritation, the product’s efficacy can be questioned. In the case of phthalates, they aren’t part of the product formulation, but would need to transfer from the container or packaging into the product before its application or consumption. With the baby wipes, the exposure pathway is more direct and, it seems, the harm is seen more clearly and quickly.

The headline ‘Facial scrubs rub planet wrong way’ appeared in a recent Sunday paper. The article discussed the environmental fate of plastic microbeads used in facial creams, dermal scrubs and toothpaste. These products are generally used in the bathroom, and are rinsed away by the user. From the bathroom sink, the microbeads make their way to a sewage treatment plant where, it was stated, their small size and buoyancy mean that they pass through the final filtration process and into the receiving water. Various experts were quoted discussing the harm that microbeads could cause, with the discussion focusing on fish species, and how microbeads might ultimately be transferred to humans through ingestion.

How these buoyant particles are eaten by fish was not discussed but, presumably, surface-feeding species might ingest them. One of the quoted experts noted that ‘a whole gamut of species’ have these plastic particles in their guts, and that microbeads are being found in fish tissue as well. While not wishing to ignore the potential impact on the fish, it seems a long bow to draw that this might cause an increased risk of harm to humans. Fish guts are rarely consumed, to the best of my knowledge, nor the gills (the other possible part of fish where microbeads might lodge). As for microbeads in fish flesh eaten by humans, this might pose a risk but, given that such particles are directly applied to the mouth in toothpaste, the risk of ingestion by a human through this direct exposure would seem greater than the far longer, and more convoluted, pathway involving sewage, waterways and fish. I won’t be foregoing the traditional barbecued fish on Good Friday because of it.



Paul Moritz MRACI CChem (Paul.Moritz@douglaspartners.com.au) is a Principal with Douglas Partners, and an EPA-appointed Environmental Auditor in Victoria.

What's in a name?

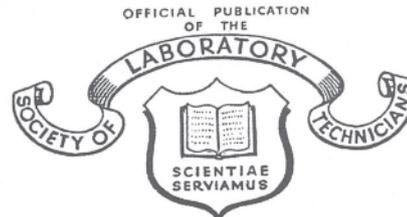
Every professional society likes to have its journal, providing a venue for members to publish their work or their views, but also serving in many cases to bring news of relevance to the profession and to encourage 'bonding'.

Even a short-lived journal can tell a historian a lot about the profession that spawned it, and such is the case with the *Laboratory Journal of Australasia*, which was published in four volumes covering the years 1936 to 1948. It was the official publication of the Society of Laboratory Technicians, and in June 1939 (volume 2, number 1) it carried an article about the development of the Society from its inception. The inaugural meeting was held in Sydney in June 1913, where it was decided to form an organisation along the lines of the Pathological & Bacteriological Laboratory Assistants' Association of Great Britain, which had been founded in 1912. Over the next year, it was confirmed that it would be the Australian branch of the British Association but confirmation at a committee meeting was delayed until June 1914, partly due to the smallpox epidemic in Sydney.

The authors of the article were J. Englisch of the X-Ray Laboratory at Royal South Sydney Hospital, and W. Bagnall of the Sydney University's Department of Histology. The membership was largely drawn from people involved in medical research, the editor of the journal being A.J. Bearup of the School of Public Health and Tropical Medicine, Sydney. 'The title of the Association was evidently the cause of dissatisfaction', the authors write, 'as it was changed twice in three years'. In March, 1921, it was decided to drop the word "laboratory" from the title; in October, 1923, this "Pathological & Bacteriological Laboratory Assistants' Association" put it back again by assuming the name, "Medical Sciences Laboratory Assistants' Association", and here it was left until March, 1932, when it became the "Society of Laboratory Technicians".

And thus it stayed until the end of the 1940s, when there began a series of name changes for the organisation and its journal. In 1950, it was the Australasian Institute of Medical Laboratory Technology and the *Australasian Journal of Medical Technology* and from 1956 it was the Australian Institute of Medical Technologists. The journal name remained unchanged but the journal ceased publication after 1957, only to be reincarnated in 1959–60 as *Medical Technology in Australasia* and then for the remainder of the 1960s as *Medical Technology in Australia*. The Kiwis had gone their own way in 1946, founding the NZ Institute of Medical Laboratory Science. In 1970, the Australian body changed again to the *Australian Journal of Medical Technology*, which title survives to this day.

The early society was much concerned with certification of members, and one reason for the move away from the British society was their requirement of 15 years' training before a



certificate could be issued. In the 1930s, the Australians set up their own examining system and arranged for appropriate courses to be taught at Sydney Tech, with senior members of the profession helping out as honorary lecturers. Originally, all the action was in New South Wales, where membership reached 100 in 1930, but inoculation of the Victorian scene was successful in starting the growth of a Victorian branch in June 1937, with initial membership of 40. Other branches followed over the years.

While most of the articles in the journal had a basis in medical science, some touched on matters chemical. For example, an article about the preparation of aesculin (the 6- β -glucoside of aesculetin, 6,7-dihydroxycoumarin) from *Bursaria spinosa* (sweet bursaria) was copied from a CSIR report. Aesculin was in short supply at the time, but was an important diagnostic aid for microorganisms such as *Enterococci* and *Listeria* for which purpose it was included in the agar along with ferric citrate. Organisms like this were able to hydrolyse the glucoside, and a positive result is due to the resulting 6,7-hydroxycoumarin forming a black complex with the iron.

Another piece of DIY chemistry, this one copied from the *School Science Review*, was the preparation of 'soluble anhydrite – a universal dessiccant' (sic – but the original paper had it right, as 'desiccant'). This substance, CaSO_4 , second only to phosphorus pentoxide as a drying agent and better than sulfuric acid or calcium chloride, was said to be useful in balance cases and storage cabinets. It could be prepared by heating gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$), in which case it maintained its volume and was quite porous. In use, it rapidly absorbed water, to the extent of 6.6% of its weight as it converted to the hemihydrate, $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$. Curiously, the recommended source was 'blackboard crayon', which was to be broken up into 'pea-size lumps', place on a wire gauze, heated to 230° over a Bunsen burner for 1–2 hours, and packed away while hot.

Ah, for the good old days.



Ian D. Rae FRACI CChem (idrae@unimelb.edu.au) is a veteran columnist, having begun his Letters in 1984. When he is not compiling columns, he writes on the history of chemistry and dispenses advice on chemical hazards and pollution.

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2014 International Biophysics Congress (IUPAB 2014)

3–7 August 2014, Brisbane, Qld
www.iupab2014.org

18th International Microscopy Congress (IMC 2014)

7–12 September 2014, Prague, Czech Republic
www.imc2014.com

7th Asian Biological Inorganic Chemistry Conference (AsBIC-7)

30 November – 5 December 2014, Gold Coast, Qld
www.asbic7.org

RACI National Congress

7–12 December 2014, Adelaide, SA
www.raci.org.au/events-awards/raci-national-congress-2014
 Call for abstracts opens 2 December 2013
 Registration opens 2 December 2013
 Abstract submission closes 9 May 2014
 Acceptance of abstracts June 2014
 Early Bird registration closes 1 August 2014

Advanced Materials & Nanotechnology (AMN7)

8–12 February 2015, Nelson, New Zealand
www.amn-7.com

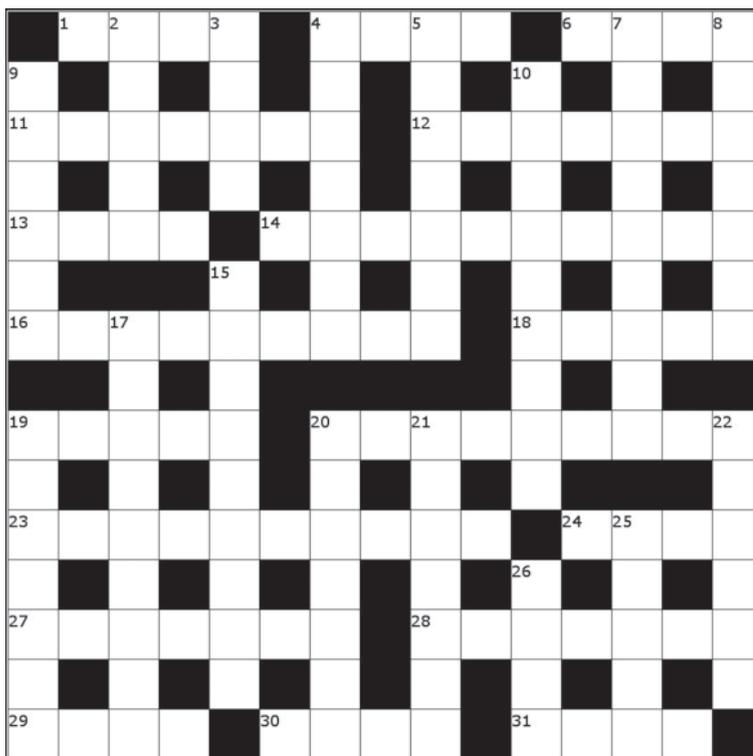
35th Australasian Polymer Symposium

13–15 July 2015, Gold Coast, Qld
www.35aps.org.au

Pacificchem 2015

15–20 December 2015, Honolulu, Hawaii
www.pacificchem.org
 Round 2 symposium proposals close 1 March 2014

RACI events are shown in blue.



Across

- 1 Star backing up Shakespeare's stream. (4)
- 4 Drive away from HSO₂ explosion. (4)
- 6 Knife four elements. (4)
- 11 Papers in count currently showing ups and downs. (7)
- 12 Valueless if I hear 'cancel'. (7)
- 13 Acidic if you move sulfur belonging to us. (4)
- 14 Breaking up iodine-sulfur ring in panel damage. (10)
- 16 They ensure obedience for Centres losing time in reorganisation. (9)
- 18 Applaud 6268. (5)
- 19 Positive gold is a heterocyclic acid! (5)
- 20 √2 perhaps covers unfashionable beat. (9)
- 23 Approvals for room above. (10)
- 24 Charge iodine transport. (4)
- 27 Cheese after fat turned fabric. (7)
- 28 Ends under canvas? (7)
- 29 Little room for energy storage device. (4)
- 30 Call time. (4)
- 31 Long girl. (4)

Down

- 2 Direct the German to pursue oxygen radical. (5)
- 3 Use xenon and aluminium shaft. (4)
- 4 Horizon links five elements. (7)
- 5 Transport compilation. (7)
- 7 Pilosity share is in decay. (9)
- 8 Someone going a long way gave your missing uranium a shake-up. (7)
- 9 Tried for way over structure. (6)
- 10 Doctor Ni₂/NaCl/C reaction. (9)
- 15 Crier goes off for goods. (9)
- 17 Tending not to remember to add last phosphate to golf turf mix. (9)
- 19 Spartan acid captured sulfur. (7)
- 20 Feeling Senate's crippled. (7)
- 21 The last stable element to be discovered by placing two others in liquor. (7)
- 22 Most uninteresting wine with the least sugar. (6)
- 25 Gold neurotensin represents second-degree relatives. (5)
- 26 Come from a small branch. (4)

Graham Mulroney FRACI CChem is Emeritus Professor of Industry Education at RMIT University. Solution available online.

Seize the moment

I recently attended the 247th ACS National Meeting and Exposition at Dallas, Texas, 16–20 March 2014. Most of my time was spent at the sessions of the Division of the History of Chemistry, which ran over a period of two and a half days. The first day, Sunday, contained general papers in the morning and a historical look at the popularisation of chemistry in the afternoon. The day contained some excellent papers and about 20–40 delegates attended the earlier sessions. The room used was comparatively small, being long and narrow and slightly curved, with the speaker opposite the narrow central portion of the room, meaning that the audience at either end of the room found it difficult to see the screen. However, for the small audiences envisaged, the room was satisfactory.

A little before 4 pm on Sunday, the room started to fill up. The remaining seats soon became occupied and as the numbers increased, those sitting on the floor and standing soon filled the room, leaving little space for the speaker. Most of the audience was now made up of students in their twenties. The cause of this excitement was a talk by Dr Donna J. Nelson, Professor of Organic Chemistry at the Chemistry Department, University of Oklahoma. Her talk was entitled 'Breaking Bad: Getting good science to the public via TV'.

The TV show *Breaking Bad* is a very popular series, now six years old (started January 2008), that has almost a cult following in the US. It concerns a secondary school chemistry teacher, diagnosed with terminal lung cancer, who uses his chemical knowledge to make drugs (methamphetamine) in order to provide money for his family on his demise. This series was created and produced by Vince Gilligan, who was previously a writer for *The X-Files*, and



... history of chemistry topics can gain the interest of students.

the show has rated extremely highly. Wikipedia provides full details of the cast of the show, some plots and evidence of its popularity.

This report may be relevant to the Australian situation as it shows that history of chemistry topics can gain the interest of students. Dr Nelson explained that she saw a notice in *Chemical & Engineering News* indicating that a proposed new TV series was looking for a science advisor to ensure that the program's science content was correct. After some heart searching, she asked the editor of *Chemical & Engineering News* to arrange a meeting between her and Vince Gilligan. Since then, she has given advice to the producer and actors in the series on numerous occasions. She pointed out that the position was offered as unpaid and remains unpaid.

Dr Nelson may be approached for advice about scientific matters, but it is not her role to proffer advice unasked. She has accepted that if the plot demands a specific item that is not scientifically correct needs to be included for the sake of the story, then that is the end of the matter; she can exert no power. The story is fiction, so on rare occasions the science may be fiction too. She finds that nothing can happen for a long period, and then she can be asked to provide a comment very quickly. She has enjoyed the challenge immensely and her services are greatly appreciated. But she pointed out that opportunities crop up where science (chemistry) can be placed in the spotlight. When this happens, we must seize the moment as she did!

William Palmer FRACI CChem

Royal Australian Chemical Institute National Congress

Confirmed Plenary Speakers



**Associate Professor
Alán Aspuru-Guzik,**
Harvard University



Professor Phil Baran,
The Scripps
Research Institute



Dr Stacie Canan,
Global Health Division,
Celgene Corporation



Professor Makoto Fujita,
The University of Tokyo,
Japan



Professor Hubert Girault,
Ecole Polytechnique Fédérale
de Lausanne



**Professor Katharina
Landfester,**
Max Planck Institute



Professor David Leigh,
University of Manchester



Professor Daniel Nocera,
Harvard University



Professor Greg Scholes,
University of Toronto

For the full biographies of confirmed speakers to the RACI 2014 National Congress please visit the Congress website at www.racicongress.com

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- Analytical & Environmental Chemistry Division
- Biomolecular Chemistry Division
- Carbon Division
- Chemical Education Division
- Colloid and Surface Chemistry Division
- Electrochemistry Division
- Industrial Chemistry Division
- Inorganic Chemistry Division
- Materials Chemistry Division
- Organic Chemistry Division
- Physical Chemistry Division
- Polymer Chemistry Division
- Radiochemistry Division
- Health, Safety & Environment Division

Key Dates

Call for Abstracts Opens 2 December 2013

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Notification of Acceptance of Abstract June 2014

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Accommodation Booking Deadline 30 September 2014

Congress Dates 7-12 December 2014

Scientific Program Themes

- Synthetic Chemistry
- Fundamental Interactions in Chemistry
- Advanced Materials
- Chemical Health and Safety
- Chemistry in Health
- Chemical Analysis and Sensing
- Community Engagement

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