

chemistry



October 2017

in Australia

A single-cell view of metals

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- 2018 anniversary for *Australian Journal of Chemistry*
- Chemical warfare: protection and prevention
- RACI Centenary Congress wrap-up

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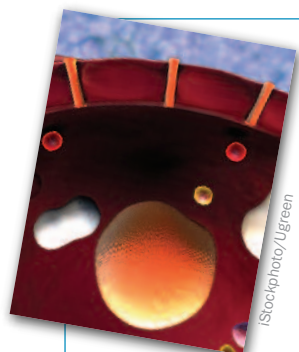
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From the President

The RACI celebrated its 100th birthday at the Centenary Congress in Melbourne, 23–28 July 2017. The conference was an outstanding success, and right from the outset I would like to thank the CEO of the RACI, Roger Stapleford for his inexhaustible contributions. Roger oversaw much of the logistics of this congress, and, as one could imagine, the organisational aspects were enormous. There were many other contributors to this congress, the Chair Professor Mark Buntine, the Chairs of the respective conferences and divisions that contributed to the congress, the RACI office staff, the staff of the PCO, ICMS Australasia, the staff at the Melbourne Convention Centre and of course the delegates who contributed to all aspects of making sure the conference was intellectually stimulating, and socially excellent. No doubt I have left someone out of these acknowledgements, and I apologise, but the size of the Congress meant this will always happen. The amount of networking taking place was overwhelming, with formal and informal meetings being held simultaneously throughout the Convention Centre and, needless to say, bars and restaurants nearby.

This was easily the biggest chemistry conference organised in Australia, being well in excess of double anything previously. The numbers elaborate on the size of the Congress (see box).

As part of the 100th celebration, a coffee table book covering highlights of the first 100 years of the RACI was launched. This book, *RACI – a century of bonds*, was compiled by Helmut Hügel, but had considerable contributions from many others throughout the RACI. The book is an excellent overview of the first 100 years of the RACI and has snippets of research, education, timelines etc. If you would like to acquire a book, please contact the RACI (see p. 35).

This was easily the biggest chemistry conference organised in Australia, being well in excess of double anything previously.

Counting up the Congress

Number of delegates	3317: including 126 exhibitors, 3 media, 36 staff, 6 sponsors, 26 visitors, 31 volunteers
Number of Branch/Division meetings	10 Divisional + 2 symposia
Number of affiliated conferences	8 international conferences
Number of affiliated seminars	4: ACES, SCI, RSC Panel, A2CS
Other meetings	Decadal plan RACI diversity and equity Women in chemistry RSC commonwealth round table
Receptions	Royal Society of Chemistry Chemical Engineering SCI
Number of Nobel Laureates	4
Number of plenaries for our Congress	11 for the main congress
Total number of plenaries and keynotes	189
Total number of invited speakers	211
Total talks	1398
Total posters	1401
Total rooms	32
Total number of sponsors	16
Total number of booths	74
Number of lunches served	11 000
Number of official dinners organised	6 large 3 small

I have attended many more focused conferences in Australia, but this broad congress brought many people together who I have not run into for years, old friends from PhD days, work colleagues from years ago, and many ex-students whom I haven't seen for some time. Conferences are for learning new chemistry and forming networks, but also for the social stimulation of catching up with old friends, and on this basis, it was an incredible success. I only wish I would be around in 2117 for RACI Congress 200.



Peter Junk FRACI CChem (president@raci.org.au) is RACI President.

chemistry
in Australia
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Contributors' views are not necessarily endorsed by the RACI, and no responsibility is accepted for accuracy of contributions. Visit the website's resource centre at chemaust.raci.org.au for information about submissions.

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ISSN 0314-4240 e-ISSN 1839-2539



Soil lead contamination of Sydney backyards

We thank Dr Moritz for bringing to the readers' attention (August issue, p. 5) our recent article 'VegeSafe: a community science program measuring soil-metal contamination, evaluating risk and providing advice for safe gardening' (<http://bit.ly/2v45gba> and summarised in the June issue, p. 34).

Our Macquarie University community science program, VegeSafe, is the only pro bono service in Australia that provides gardeners with free soil metal testing. This service informs gardeners of potential metal contamination in their backyard soils. Our program also offers practical advice on simple and effective remedies to minimise exposure to toxic metals in their soils where present above levels of concern. Since 2013, we have provided over 8000 free soil screening tests to over 2000 Australian households and community garden groups.

In the August issue, Dr Moritz explained briefly how the Australian health investigation levels (HILs) set by the *National Environment Protection Measure 1999* (NEPM) are used for contaminated site investigations in Australia. Dr Moritz argues that we may have misused the HILs in our research of soil lead contamination in Sydney backyards. Our June summary restated the factual results of our study: '40% of 203 Sydney homes we sampled contain lead in garden soil above the Australian health guideline of 300 mg/kg'. We used the Australian HIL-A for lead in soil (300 mg/kg) and coupled this to known natural background lead concentrations (20–30 mg/kg) to provide relevant context for the results of our study. Neither of our articles states that the HIL values are clean-up values, response levels or desirable soil quality criteria. They are 'investigation' levels as the NEPM states. However, we provide advice to homeowners on the basis of the precautionary approach and the known toxicity of lead, especially to young children.

One in seven Sydney homes (in our study) have soil lead concentrations greater than 1000 mg/kg, while one in six homes have individual sample concentrations in excess of 250% of the HIL (750 mg/kg). Yet, regardless of the extent of lead contamination in these home environments, it is unlikely any further investigation or remediation of these properties will occur as the NSW EPA exempts 'widespread diffuse urban pollution' from its Duty to Report on the basis that the contamination 'is not attributed to a specific industrial, commercial or agricultural activity' (Section 2.6 of the Guidelines on the Duty to Report Contamination under the *Contaminated Land Management Act 1997*). This regulatory approach means that any effective action needs to be executed by individual homeowners on the basis of relevant information – such as that provided by VegeSafe.

As environmental scientists, our end goal is to enable Australian gardeners to utilise their garden spaces in a safe, and sustainable, manner. Hence, our motto 'Carry on gardening'.

Marek Rouillon and Mark P. Taylor

More reflections on Sydney Technical College

I gained my Chemistry Diploma in December 1950 after five years of part-time study. The lessons and experience I gained at Sydney Technical College were invaluable to me for the remainder of my working life. Working as a bucket-and-stick chemist for most of my career, I treasured the input of lecturers such as Dwyer and Nyholm in inorganic chemistry and the high standards set by the remainder of the teaching staff.

One of my outstanding memories is of working late one evening in the industrial chemistry laboratory, preparing a quantity of nitrobenzene. The batch size was about 10 litres and the equipment was a 15-litre earthenware open crock with a small stainless steel electric mixer. I experienced only a slight exotherm but persisted in adding the acid mix. After closing time, Val Rawson appeared and asked me what I was doing. He found that the braised agitator blade had become detached. Rawson calmly told me to turn on all the laboratory water taps and we tipped the mix down the drain! No need to repeat this experiment my boy, just write it up!

Ken Jones FRACI CChem



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Send your contributions (approx. 400 words) to the Editor at wools@westnet.com.au.

A chem lab in your phone

Using your mobile as a diagnostic tool

The mobile phone in your pocket could be used for medical diagnostics and environmental testing if Associate Professor Conor Hogan and his team from La Trobe University have their way.

This could be potentially life-changing for people in developing countries and remote areas with limited resources, by making such chemical measurements more accessible and extremely inexpensive.

‘There are two ways you can bring the cost of medical diagnostics down,’ says Conor.

First, you can use less expensive materials and fabrication methods to make the sensors, so Conor’s team have developed a microfluidic sensor printed on paper rather than using more traditional materials such as silicon or glass. The second approach is to do away with the need for a scientific instrument to make the measurements, instead using your phone.

The combination of these two approaches can bring the cost of chemical analysis to negligible levels. ‘Scientists around the world are investigating ways in which to use mobile phones as a way of bringing health care to developing countries and remote communities’, Conor says.

‘With mobile phone penetration now over 80% in the developing world and close to 100% worldwide, the idea is sensible.’



They’ve demonstrated the possibility of diagnosing disease or detecting harmful chemicals in drinking water using only a disposable paper-based sensor and a mobile phone.

One approach uses a highly sensitive scientific technique known as electro-chemiluminescence or ECL where electricity triggers a light-producing chemical reaction.

Science in Public

Nobel Laureate tackles acid rain by getting the sulfur out of diesel



Robert Grubbs’ discoveries have enabled industry to produce plastics and drugs more efficiently and with less hazardous waste.

Robert was awarded the Nobel Prize in 2005 for his work on the chemical reaction metathesis – where carbon atom groups change places.

While the reaction was first described in 1971, Robert developed a catalyst that improved this reaction, and was stable in air, making this process more available to industry.

It’s now used daily in the production of pharmaceuticals and advanced plastic materials.

Now he’s developed a method to drastically reduce the sulfur content in diesel fuel more simply and cheaply.

Reducing the sulfur content in diesel will significantly reduce acid rain – which occurs when the diesel is burned and the sulfur is converted to sulfur dioxide, which reacts with water to form acid rain.

Professor Robert Grubbs is based at the California Institute of Technology.

Science in Public

Tesla to pair world's largest lithium ion battery with Neoen wind farm in SA



ScottDavis/CC-BY-SA-3.0

The world's largest lithium ion battery will be installed in South Australia under a historic agreement between French renewable energy company Neoen, US sustainable energy company Tesla and the South Australian Government.

The energy storage systems from Tesla will be paired with Neoen's Hornsdale Wind Farm and installed before summer.

Confirming the commitment from Tesla CEO Elon Musk to deliver the battery within 100 days or it will be free, it has been agreed between Tesla and the South Australian Government that the starting date for the 100 days will be once the grid interconnection agreement has been signed.

After leading the nation in renewable energy, the 100 MW/129 MWh battery places South Australia at the forefront of global energy storage technology.

The battery will operate at all times, providing stability services for renewable energy, and will be available to provide emergency back-up power if a shortfall in energy is predicted.

The deal will also bring other investments by both Neoen and Tesla into South Australia's economy, with details to be announced in the future.

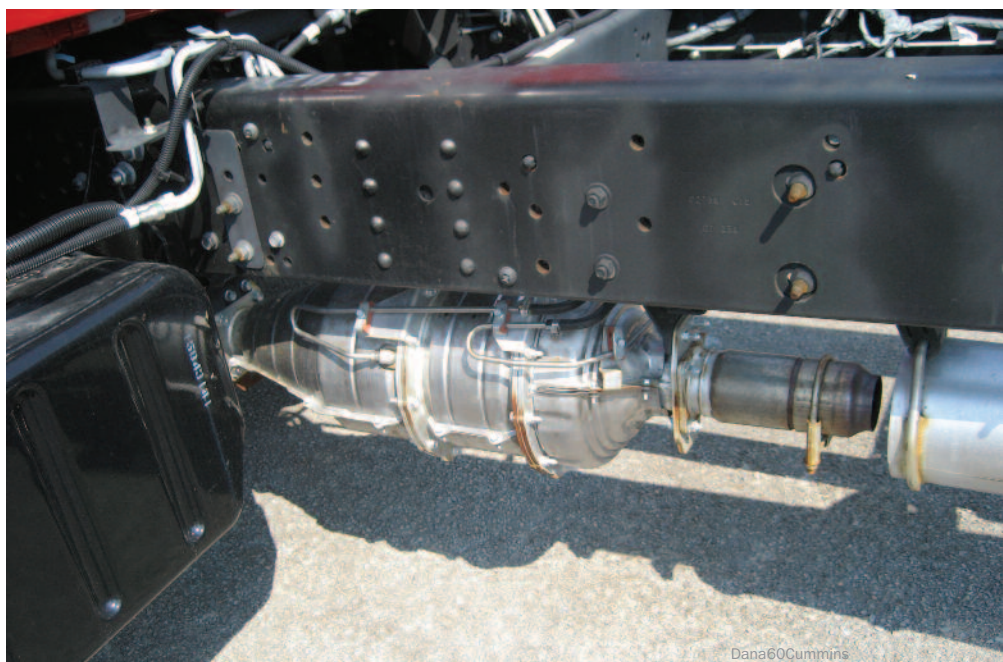
Jay Weatherill

Certain emissions may be higher from petrol cars than some diesel cars

Petrol cars produce more carbonaceous particulate matter (PM) emissions than diesel cars equipped with diesel particle filters (DPFs; pictured) and catalysts, according to initial laboratory tests published in a study in *Scientific Reports* (<http://dx.doi.org/10.1038/s41598-017-03714-9>). The authors note that emissions from vehicles are sensitive to the sampling location, fleet age and ambient temperature, and they suggest that further studies that calculate an aggregate of emissions are required.

Carbonaceous PM consists of black carbon, primary organic aerosols (including solid particles from combustion) and secondary organic aerosols (produced via the atmospheric ageing of organic compounds released during combustion), and is a toxic component of vehicle exhausts. However, the relative contributions of diesel cars equipped with DPFs and petrol cars to these emissions have not been quantified.

In laboratory investigations, André Prévôt and colleagues quantified carbonaceous PM from 11 petrol and six diesel cars equipped with DPFs at 22°C



Dana60Cummins

and -7°C. The authors found that petrol cars emitted on average ten times more carbonaceous aerosol at 22°C and 62 times more at -7°C than the diesel cars. They also found that the diesel cars tested produced no detectable secondary organic aerosols.

The authors note that compared to the cars tested, PM emissions are much higher from diesel cars that do not have a DPF, which will produce the largest fraction of PM emissions for some time.

Springer Nature

Surprise just beneath the surface in carbon dioxide experiment

While using X-rays to study the early stages of a chemical process that can reformulate carbon dioxide into more useful compounds, including liquid fuels, researchers were surprised when the experiment taught them something new about what drives this reaction.

An X-ray technique at the US Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab), coupled with theoretical work by a team at the California Institute of Technology, Pasadena (Caltech), revealed how oxygen atoms embedded very near the surface of a copper sample had a more dramatic effect on the early stages of the reaction with carbon dioxide than earlier theories could account for.

This information could prove useful in designing new types of materials to further enhance reactions and make them more efficient in converting carbon dioxide into other products.

The research team developed computer models and revised existing theories to explain what they were witnessing in experiments. Their results were published online in the *Proceedings of the National Academy of Sciences* (12 June).

Copper is a common catalyst and, although it is not efficient, it aids in the

production of ethanol when exposed to carbon dioxide and water.

'We found more than we thought we were going to find from this fundamental investigation', said Ethan Crumlin, a scientist at Berkeley Lab's Advanced Light Source (ALS) who co-led the study with Joint Center for Artificial Photosynthesis (JCAP) researchers Junko Yano, at Berkeley Lab, and William Goddard III, at Caltech.

The X-ray work brought new clarity in determining the right amount of subsurface oxygen – and its role in interactions with carbon dioxide gas and water – to improve the reaction.

'Understanding this suboxide layer, and the suboxide in contact with water, is integral in how water interacts with carbon dioxide in this type of reaction', Crumlin said.

Goddard and his colleagues at Caltech worked closely with Berkeley Lab researchers to develop and refine a quantum mechanics theory that fit the X-ray observations and explained the electronic structure of the molecules in the reaction.

'This was a good looping, iterative process', Crumlin said. 'Just being curious and not settling for a simple answer paid off. It all started coming together as a

cohesive story.'

At Berkeley Lab's ALS, researchers used APXPS (ambient pressure X-ray photoelectron spectroscopy) as they exposed a thin foil sheet of a specially treated copper – known as Cu(111) – to carbon dioxide gas and added water at room temperature. In proceeding experiments, they heated the sample slightly in oxygen to vary the concentration of embedded oxygen in the foil, and used X-rays to probe the early stages of how carbon dioxide and water synergistically react with different amounts of subsurface oxide at the surface of the copper.

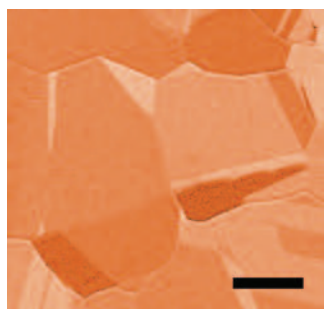
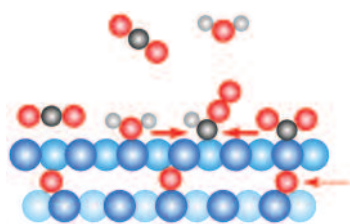
The X-ray studies, planned and performed by Marco Favaro, the lead author of the study, revealed how carbon dioxide molecules collide with the surface of the copper, then hover above it in a weakly bound state. Interactions with water molecules serve to bend the carbon dioxide molecules in a way that allows them to strip hydrogen atoms away from the water molecules. This process eventually forms ethanol.

'The modest amount of subsurface oxygen helps to generate a mixture of metallic and charged copper that can facilitate the interaction with carbon dioxide and promote further reactions when in the presence of water', Crumlin said.

Copper has some shortcomings as a catalyst, Yano noted, and it is currently difficult to control the final product a given catalyst will generate.

'If we know what the surface is doing, and what the model is for this chemical interaction, then there is a way to mimic this and improve it', Yano said. The ongoing work may also help to predict the final output of a given catalyst in a reaction. 'We know that copper works – what about different copper surfaces, copper alloys, or different types of metals and alloys?'

DOE Science



(Left) In this atomic-scale illustration, trace amounts of oxygen (red) just beneath a copper (blue) surface, play a key role in driving a catalytic reaction in which carbon dioxide (black and red molecules) and water (red and white molecules) interact in the beginning stages of forming ethanol. Carbon dioxide molecules hover at the copper surface and then bend to accept hydrogen atoms from the water molecules. X-ray experiments at Berkeley Lab's Advanced Light Source helped researchers to understand the role of subsurface oxygen in this process. (Right) This false-colour scanning electron microscopy image shows microscopic details on the surface of a copper foil that was used as a catalyst in a chemical reaction studied at Berkeley Lab's Advanced Light Source. The scale bar represents 50 micrometres. Berkeley Lab

Turning dirty foil into biofuel catalyst



A researcher at Queen's University Belfast has discovered a way to convert dirty aluminium foil into a biofuel catalyst, which could help to solve global waste and energy problems.

In the UK, around 20 000 tonnes of aluminium foil packaging is wasted each year – enough to stretch to the moon and back. Most of this is landfilled or incinerated as it's usually contaminated by grease and oils, which can damage recycling equipment.

However, Ahmed Osman (pictured) an Early Career Researcher from Queen's University's School of Chemistry and Chemical Engineering, has worked with engineers at the university to create an innovative crystallisation method, which obtains 100% pure single crystals of aluminium salts from the contaminated foil. This is the starting material for the preparation of alumina catalyst.

Usually, to produce this type of alumina it would have to come from bauxite ore, which is mined in countries such as West Africa, the West Indies and Australia, causing huge environmental damage.

Osman has created a solution that is much more environmentally friendly, effective and cheaper than the commercial catalyst that is currently available on the market for the production of dimethyl ether – a biofuel that is

regarded as the most promising of the 21st century. Osman says making the catalyst from aluminium foil costs about £120/kg (\$200/kg) while the commercial alumina catalyst comes in at around £305/kg (\$500/kg).

Its unique thermal, chemical and mechanical stability means it can also be used as an absorbent, in

electronic device fabrication, as a cutting tool material or as an alternative for surgical material for implants.

The research has been published in *Nature Scientific Reports* (<http://dx.doi.org/10.1038/s41598-017-03839-x>).

Osman commented: 'I have always been inspired by chemistry and I believe that catalysis especially can make the world a better place. One day I took a walk through our laboratories at Queen's and found lots of aluminium foil waste so I did a little digging and after speaking to my colleagues, I ran my experiment and was astonished by the ultrapure single crystals – I didn't expect it to be 100% pure.

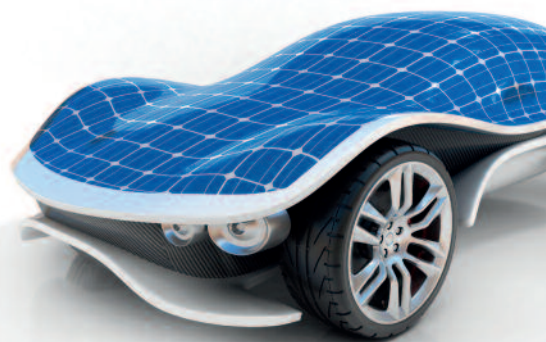
'This breakthrough is significant as not only is the alumina more pure than its commercial counterpart, it could also reduce the amount of aluminium foil going to landfill while also sidestepping the environmental damage associated with mining bauxite.'

Osman is hoping to continue his research into how these catalysts can be further improved and explore the opportunities for commercialisation of biofuel production or use the modified alumina catalyst in the catalytic converters in natural gas vehicles.

Queen's University Belfast

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ANSTO expertise helps prove earliest Aboriginal occupation

Thomas Schoch/CC-BY-SA



Scientists at the Australian Nuclear Science and Technology Organisation's (ANSTO) Centre for Accelerator Science and Australian Synchrotron were part of a team who have found new proof of the earliest occupation in Australia – some 65 000 years – in Kakadu National Park (pictured).

The team, which included archaeologists and dating specialists, located the evidence at Madjedbebe, a site found on the traditional lands of the Mirarr people, surrounded by the World Heritage-listed Kakadu National Park.

The research, published in July in *Nature* (<http://doi.org/10.1038/nature22968>), was led by Associate Professor Chris Clarkson from the University of Queensland.

ANSTO's Dr Quan Hua oversaw the radiocarbon dating of charcoal samples on ANSTO's STAR accelerator. At ANSTO's Australian Synchrotron in Melbourne, Dr Helen Brand, used powder X-ray diffraction to identify the minerals present in pigment samples of artefacts.

These methods, alongside extensive optically stimulated luminescence dating conducted at the University of Wollongong, show the site has a deeply buried, dense occupation layer dating to 65 000 years ago.

Hua said that the charcoal samples

that were analysed were collected during excavations in 2012 and 2015. Most of the charcoal samples are isolated fragments but several samples were collected from in situ hearths.

'With the STAR accelerator, we were able to measure carbon-14 or radiocarbon by accelerator mass spectrometry, to help determine the age of the samples', Hua explained.

Brand's expertise enabled the analysis of powder pigments from ochre found at the site, using the Australian Synchrotron, a source of light a million times brighter than the sun.

'Using the powder diffraction beamline, we investigated the characteristics of the ochre, which was found quite extensively through the site', Brand said.

'The brilliance of the synchrotron allows us to see tiny amounts of minor minerals, giving the site a unique X-ray fingerprint.'

'It is wonderful to see, after contributing one piece of the scientific puzzle, that the impact of the broader research is so far-reaching.'

The excavations, scientific analysis of artefacts and sediments, and dating have extended the known duration of human occupation of Australia by 18 000 years.

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Placarding requirements for hazardous chemicals in bulk containers

When hazardous chemicals require a bulk storage placard, they do not need a label.

Dr Paul Taylor, Director of Chemicals at Safe Work Australia, said that this will reduce costs to businesses because warning information does not need to be duplicated for chemicals stored in bulk.

Correctly labelling hazardous chemicals stored in bulk is an important aspect to managing their risks.

'Correctly labelling hazardous chemicals stored in bulk is an important aspect to managing their risks.'

'Businesses that use hazardous chemicals must check that they are correctly labelled in accordance with the WHS Regulations, and if they're unsure they should speak to their WHS Regulator', Taylor said.

Safe Work Australia Members agreed to amend the model WHS Regulations in March 2017. These amendments are currently being progressed to allow them to be implemented in each jurisdiction.

Safe Work Australia

New mineral discovered in Hekla volcano in Iceland

In January 1991, the Icelandic volcano Hekla erupted in a dramatic geological event that would last for two months.

Half a year after the eruption, geologist Sveinn Peter Jakobsson set out to study some of the cracks in the lava. Inside the cracks, temperatures reached 170°C and toxic gases were oozing out from the volcano.

Jakobsson collected some of the yellowish encrustations inside the cracks and took them to the laboratory at the University of Copenhagen, where they were studied carefully.

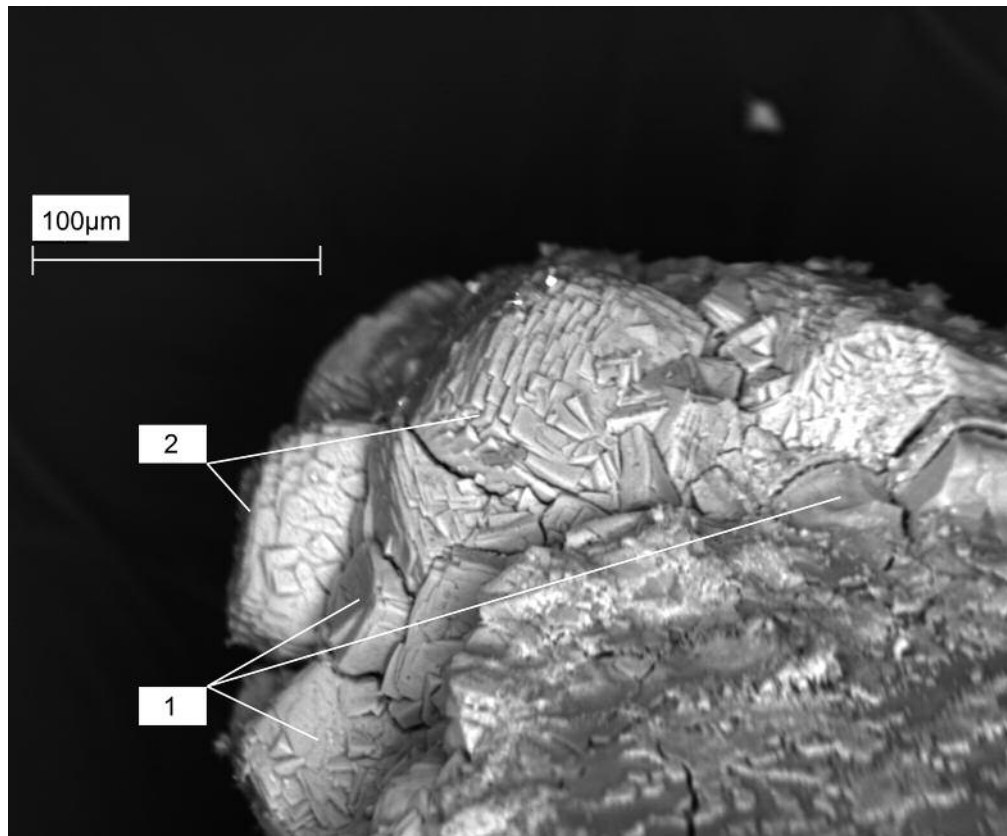
Now, a quarter of a century later, these investigations have led scientists to conclude that the volcanic material contained previously unknown minerals. The new mineral is described in *Mineralogical Magazine* (<http://doi.org/10.1180/minmag.2017.081.022>).

'We chose to name the mineral topsøeite, after the Topsøe family. When you have a Danish family that has given so many important people to science, then I think there's a reason to name a mineral after them', said Tonci Balic-Zunic, associate professor in mineralogy and crystallography at the Department of Geoscience and Natural Resources, University of Copenhagen, Denmark.

Topsøeite is one of seven new minerals discovered in Iceland since 2009. Balic-Zunic led the investigations into the new minerals from Hekla and Eldfell volcanoes.

'It's a relatively unexplored area. There are some special geological processes in the volcanoes, and that means that there are some unique minerals here that you don't see anywhere else', said Balic-Zunic.

'Imagine that you are a biologist who has discovered a place with new species of animals or plants. That would grab the public's attention. Unfortunately, geology is not so popular. So when we say we've



Geologists have discovered a new mineral, topsøeite, in Iceland. It is named after the family behind the Danish chemical company Haldor Topsøe. Anna Garavelli, University of Bari

discovered a place with seven totally new minerals, it's only academics that are excited', he said.

Topsøeite is formed by the elements iron and fluorine, along with water molecules.

Scientists have seen this chemical structure before, but this is the first identification of it in mineral form, said Hans Dieter Zimmermann, a mineralogist at Aarhus University, Denmark.

For a substance to be recognised as a mineral, it cannot just be created in a laboratory.

'Before Tonci's study we didn't know that it could also occur in nature as a mineral', said Zimmermann.

There are approximately 5200 known

minerals on Earth. Any new discovery has to go through the International Mineralogical Association (IMA) before it is officially recognised as a mineral.

Balic-Zunic and Zimmermann estimate that about 100 new minerals are registered every year.

'There's been an increase in the number of new minerals in recent years. Half of the minerals we know today were discovered since 1980. That's because we have new methods that make it easier to describe minerals and identify their chemical composition', said Balic-Zunic.

Recently, an American study showed that human activities have led to a dramatic change in the Earth's minerals.

By Lise Brix, Science Nordic

Review of Australia's climate science capability reveals a mixed picture

Australia can improve coordination of national climate science programs to deliver better climate information to farmers and infrastructure planners, and to guide national efforts to mitigate the future impacts of climate change, according to a review by leading scientists.

The Australian Academy of Science report recommends that government consider mechanisms to ensure better coordination of climate research across Australia's universities and climate agencies. It also recommends increasing climate science capability in a number of critical areas, amounting to around 80 new research positions over the next four years.

The review surveyed all of Australia's climate research agencies and centres, including the Bureau of Meteorology, the CSIRO, the Australian Antarctic Division and universities, to identify how many Australian researchers are working across the various disciplines and subdisciplines of climate science, and how well these different areas are performing.

It reports that while Australia is strong in areas such as thermodynamics and extreme weather events, there are some significant weaknesses in areas such as climate model development. This includes the Australian Community Climate and Earth System Simulator (ACCESS), micrometeorology (the branch of meteorology that deals with weather conditions on a small scale), boundary layer dynamics (the dynamics of the lowest part of the Earth's atmosphere) and the modelling of two-way human-climate interactions.

Academy Fellow Professor Trevor McDougall, who led the review, said under-resourcing in specific areas detracts from Australia's ability to deliver necessary climate and weather

information to domestic end users and national and international organisations.

'Australia's climate research sector is a fraction of the size of those in America or Europe, but we cover most of the Southern Hemisphere in terms of climate modelling and understanding', McDougall said.

'Many of our universities are considered to be world-class in this effort, but as a country we are falling behind in areas such as climate modelling.'

The report found that there are around 420 dedicated climate scientists across all of Australia's universities and research agencies, with their research providing constant improvements in weather prediction and climate models in Australia and throughout the world.

The area most in need of attention is climate modelling, where critical under-resourcing means that Australia's climate models are failing to keep pace with world's best practice. To address this issue, the review estimated that around 30 new climate modellers and scientists would be needed over the next four years.

'These capability requirements are brought into sharper focus when you consider that our country is potentially more exposed to the impacts of climate change than most developed nations', McDougall said.

'Our location means that key factors that influence the climate in our region are not well represented in climate models developed by other countries. It is in our national interest to ensure our national climate science capability, built up over the past 50 years, is maintained. This will also mean Australia maintains its custodianship of many aspects of climate science research in the Southern Hemisphere.'



... the review estimated that around 30 new climate modellers and scientists would be needed over the next four years.

Other key recommendations from the report include ensuring the work of the Antarctic Climate and Ecosystems Cooperative Research Centre is funded beyond 2019 and that a broader review of climate-related research capabilities is undertaken by the Australian Government.

For a copy of the report visit the Australian Academy of Science website (science.org.au).

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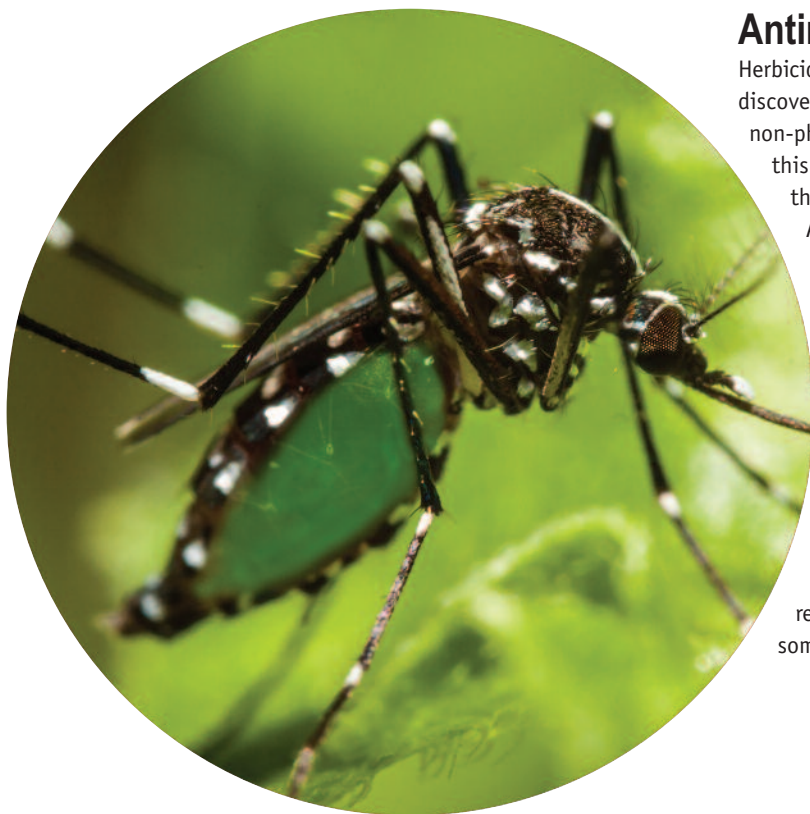
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Antimalaria agents as herbicides

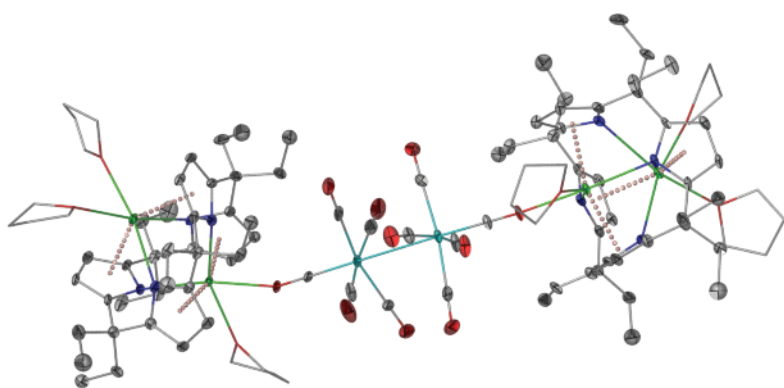
Herbicides were used over 20 years ago to prove that a newly discovered plastid in malarial parasites was an essential but non-photosynthetic chloroplast. Used in drug research since, this plant/malaria connection was only recently proposed by the Mylne and Stubbs labs at the University of Western Australia (UWA) as a way to identify novel herbicides (*Sci. Rep.* 2017, **7**, 45 871). Screening the Malaria Box, a publicly available library of antimalarial leads, the UWA researchers have now found MMV006188 to be an effective herbicide in soil against a model plant and some common weeds. By using physiological profiling, the molecule's mode of action was also established (Corral M.G., Leroux J., Tresch S., Newton T., Stubbs K.A., Mylne J.S. *Angew. Chem. Int. Ed.* 2017, **56**, 9881–5). This test case draws attention to the wealth of antimalarial compounds that could be drawn upon to address the alarming rise of herbicide resistance by bringing a new mode of action to market – something that has not happened in almost 30 years.

Trap got your tungsten

In a recent special issue of *Angewandte Chemie International Edition* dedicated to 150 years of the GDCh (the German Chemical Society) and 100 years of the RACI, researchers from James Cook University and Monash University have contributed a paper on the use of a highly reactive divalent lanthanoid species to reduce and trap a rare $[W_2(CO)_{10}]^{2-}$ anion (Deacon G.B., Guo Z.,

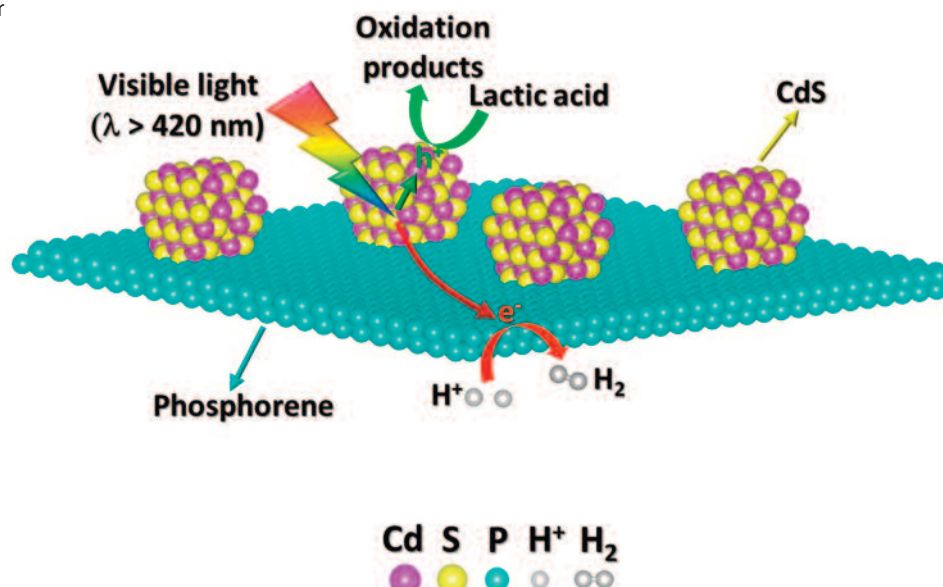
Junk P.C., Wang J. *Angew. Chem. Int. Ed.* 2017, **56**, 8486–9). The powerful reductant bis(pentamethylcyclopentadienyl)-samarium(II) ($SmCp^*_2$) has a history of trapping unusual fragments, from earlier breakthroughs with N_2^{2-} , Bi_2^{2-} , Sb_3^{2-} and $[OC_3O_2]^{2-}$ to the recent spectacular enclosure of $[P_8]^{2-}$, trapping of iron carbonyl sulfide clusters and the complex reduction of arsenic sulfide

species. Likewise, the analogous but less powerfully reducing $YbCp^*_2$ has displayed similar behaviour, for example trapping triiron, hexairon, monocobalt and tricobalt carbonyl clusters. In the latest work, Professors Glen Deacon and Peter Junk report the reduction of tungsten hexacarbonyl by the divalent samarium(II) complex $[Sm^{II}(N_4Et_8)(thf)_4]$ ($(N_4Et_8)^{4-}$ = *meso*-octaethylcalix[4]pyrrolide) in toluene at ambient temperature to yield the remarkable heteronuclear mixed-valent samarium(II/III)/tungsten complex $[{(thf)_2Sm^{II}(N_4Et_8)Sm^{III}(thf)}_2\{(\mu-OC)_2W_2(CO)_8\}]$, which features the trapping of a rare and previously not structurally authenticated $[W_2(CO)_{10}]^{2-}$ anion, which has an unsupported W–W bond. Work is ongoing with this fascinating divalent $[Sm^{II}_2(N_4Et_8)(thf)_4]$ system with various carbonyls, unsaturated organic molecules and other reactive species.



Phosphorene for light-driven hydrogen fuel production

The production of hydrogen fuel using solar energy is considered a promising strategy to solve global energy and environmental issues. Recently, Professor Shi-Zhang Qiao and co-workers at the University of Adelaide have for the first time used phosphorene, a two-dimensional allotrope of phosphorus, as a highly active metal-free co-catalyst for metal sulfide photocatalysts to produce hydrogen (Ran J., Zhu B., Qiao S.-Z. *Angew. Chem. Int. Ed.* 2017, **56**, 10373–7). The team found that phosphorene-coupled CdS exhibits a high apparent quantum yield of 34.7% at 420 nm. Density functional theory calculations and advanced characterisation by techniques such as synchrotron-based X-ray absorption near-edge spectroscopy suggest that this outstanding activity arises from the strong electronic coupling between phosphorene and CdS, as well as the favourable band structure, high charge mobility and plentiful active sites of phosphorene. This work not only opens up new possibilities in the emerging field of

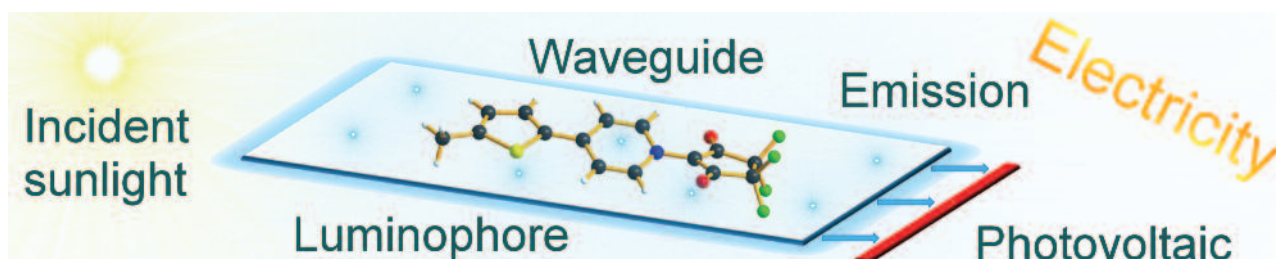


metal-free co-catalysts, but also provides insight into interface engineering of heterostructures for applications in fields besides photocatalysis, such as electronics and optoelectronics.

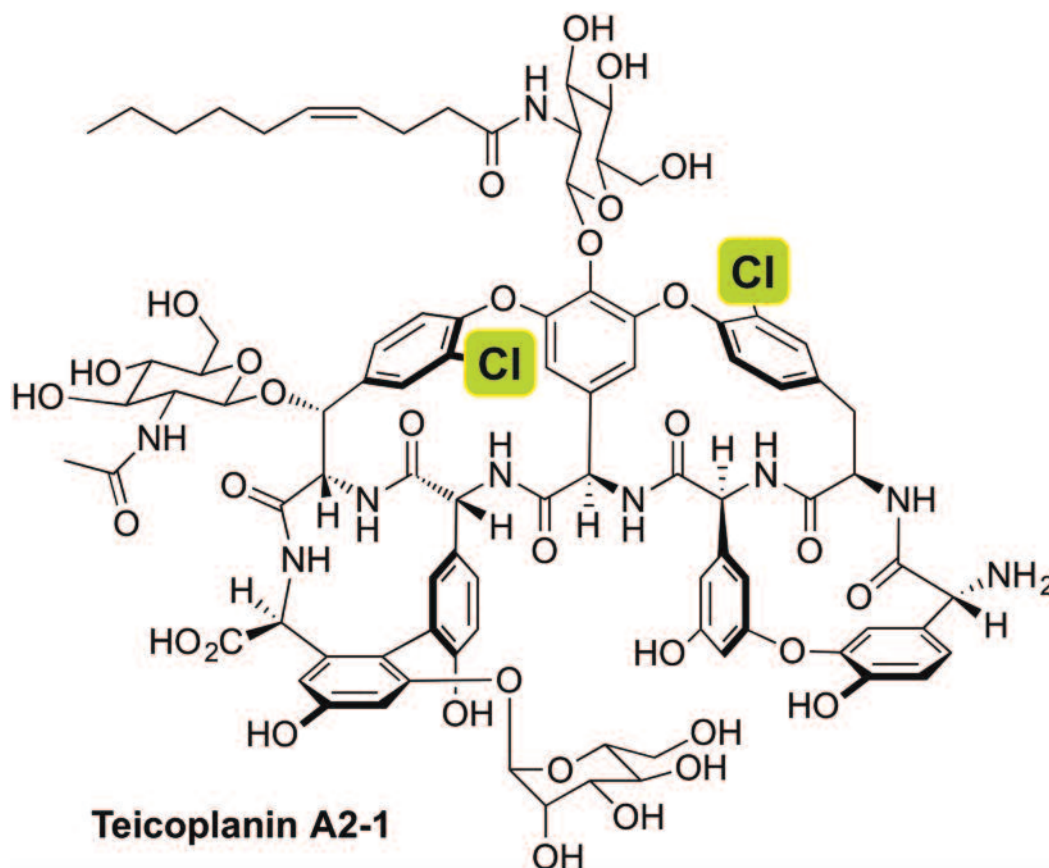
Transparent light harvesters

In the transition towards a more carbon-neutral society, the development of aesthetically acceptable building materials able to passively collect solar energy is highly desirable. One strategy to achieve this goal is to harvest light from transparent surfaces such as windows by incorporating efficient luminophores with absorption bands in the UV or IR region of the solar spectrum. Such light-harvesting devices are known as luminescent solar concentrators. Device operation is based on the absorption of light by the luminophore, whose emitted light is trapped in the wave-guiding matrix and concentrated at the

edges of the device. The concentrated light can then be efficiently converted into electric current by high-performance solar cells. In a recent breakthrough as part of an ongoing experimental and theoretical collaboration, researchers at the University of Melbourne have identified unusually fluorescent pyridinium enolates as ideal light-harvesting chromophores for use in fully transparent luminescent solar concentrators (Xu J., Zhang B., Jansen M., Goerigk L., Wong W.W.H., Ritchie C. *Angew. Chem. Int. Ed.* 2017, <https://doi.org/10.1002/anie.201704832>).




Understanding halogenation during glycopeptide antibiotic biosynthesis



The glycopeptide antibiotics (GPAs), which include vancomycin and teicoplanin, are heptapeptide natural products used as last-resort antibiotics to treat serious bacterial infections. The chemical complexity of GPAs – which contain 3–4 cross-links between aromatic residues – makes their chemical synthesis unfeasible at scale. Thus, all GPAs in clinical use are derived from bacterial fermentation. GPA biosynthesis combines peptide synthesis (catalysed by non-ribosomal peptide synthetases) and oxidative cross-linking (catalysed by cytochrome P450s) along

with modifications such as halogenation, but the timing and mechanism of halogenation was previously unclear. Recently, Associate Professor Max Cryle and co-workers at Monash University, together with colleagues in Germany, have demonstrated that GPA halogenation occurs during synthesis of the peptide and that halogenase enzymes use amino acid residues bound to key carrier protein domains of the non-ribosomal peptide synthetase as substrates (Kittilä T., Kittel C., Tailhades J., Butz D., Schoppet M., Büttner A., Goode R.J.A., Schittenhelm R.B., van Pee K.-H., Süßmuth R.D., Wohlleben W., Cryle M.J., Stegmann E. *Chem. Sci.* 2017, <http://doi.org/10.1039/C7SC00460E>). Given that halogenation improves activity and allows synthetic diversification of GPAs, this new understanding will allow the re-engineering of GPA biosynthesis to generate new versions of these important antibiotics.




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Compiled by **David Huang** MRACI CChem (david.huang@adelaide.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.*, *Chem. Sci.*) are encouraged to contribute general summaries, of no more than 200 words, and an image to David.

Alan Bond's 70th birthday Research Front

The September's issue of the *Australian Journal of Chemistry* contains a number of papers that seek to acknowledge the contribution of Professor Alan Bond in inorganic and electroanalytical chemistry in Australia. We are indebted to Lisa Martin and Anthony O'Mullane for guest-editing this issue. They have both worked closely with Alan over a number of years and these collaborations will undoubtedly continue into the future, as Alan's passion for science seems undiminished.

The foreword to the issue certainly charts Alan's course through academia from a PhD with Tom O'Donnell (another giant of Australian chemistry (see Bond A.M., Martin R.L., 'Vale Tom O'Donnell: Australia's leading fluorine chemist', *Chem. Aust.* 2010, vol. 77(6), p. 13), during which he survived an exploration of the chemistry of HF. He subsequently became the Foundation Chair of Chemistry at Deakin University, 1978, creating a new department that continues to thrive today.

A key feature of Alan's interests was the application of electroanalytical approaches for applied research that led to valued interactions with companies and colleagues from other disciplines, which continues to this day. Alan moved on from Deakin to La Trobe and subsequently to Monash University in 1995, where he is currently Emeritus. In pursuing his passion for chemistry, Alan has been recognised through a number of awards. A small selection includes: Fellow of the Australian Academy of Science (1991); Royal Society of Chemistry Lecturer in Australia 1990; 150th Anniversary Robert Boyle Fellowship awarded by the Royal Society of Chemistry 1991; Stokes Medal 1992

(award given by the Electrochemistry Division of the RACI); Liversidge Award 1992 awarded by the Australian and New Zealand Association for the Advancement of Science; Royal Society of Chemistry Award for Electrochemistry 1997; RACI H.G. Smith Medal 1998; Burrows Medal 2000 awarded by the RACI Inorganic Division; and Craig Medal from the Australia Academy of Science 2004.

The special issue contains articles from former students, collaborators and friends from around the world. A review of the controlled grafting of aryldiazonium salts to form monolayers is a highlight. Metal tetracyanoquinodimethane (TCNQ) complexes feature in two papers. In the first, the Cd complex reported by Roland DeMarco and co-workers (including Alan) undergoes an oxidation to form a bridging 3D terephthalate ligand. The other TCNQ paper published by guest editor Lisa Martin, and Alan, reports two related complexes, $[\text{Pt}(\text{NH}_3)_4](\text{TCNQ})_2 \cdot (\text{DMF})_2$ and $[\text{Pt}(\text{NH}_3)_4](\text{TCNQ})_2$, and the discovery that the latter is not a catalyst for the redox reaction of ferricyanide and thiosulfate.

A collaboration between Edith Chow (CSIRO) and Justin Gooding (University of New South Wales) has resulted in the preparation of a potentiometric sensor for pH monitoring. They demonstrate that a Prussian blue/polyaniline-based read-out system changes colour depending on the voltage output of the sensor, which can be correlated to the pH of the sample solution.

Thomas Maschmeyer and Tony Masters examine the electrodeposition of Zn, using an aqueous electrolyte containing 1-ethylpyridinium bromide, and

unexpectedly observe the passivation of the redox couple after a single deposition/stripping cycle, the anomaly attributed to the reduction of 1-ethylpyridinium cations to pyridyl radicals and their subsequent reactions.

John Bullock (Vermont) shows that the oxidation of $\text{W}(\text{CO})_4(\alpha\text{-diimine})$ gives the dication $[\text{W}(\text{CO})_4(\alpha\text{-diimine})]^{2+}$. The electrogenerated radical cations are unstable towards disproportionation and loss of carbonyl ligands in weakly coordinating media and undergo a variety of ligand substitution and coupled disproportionation reactions.

In more fundamental electrochemical studies, Alexander Harris and Antonio Paolini examine the oft-used bionic electrode material iridium oxide, correlating the impedance of anodically formed iridium oxide films (AIROF) with effective electrode area. They conclude that the high charge density and low impedance of AIROF may provide improved neural stimulation and recording properties compared to typically used platinum electrodes.

Alexandr Simonov (and Alan!) demonstrate that there are issues associated with electrochemical determination of mass-transport parameters.

It is clear that Alan retains an unbridled enthusiasm for science and chemistry, which is demonstrated by some lines borrowed from the foreword:

... the 'sparkle that appears in his eyes' when he has data or challenging results that defy the obvious interpretation ... these are the hallmarks of Alan Bond.

Happy birthday Alan!

George Koutsantonis FRACI CChem and
John D. Wade FRACI CChem Co-Editors-in-Chief,
Australian Journal of Chemistry

A key feature of Alan's interests was the application of electroanalytical approaches for applied research that led to valued interactions with companies and colleagues from other disciplines, which continues to this day.



Inside running

A cell-by-cell view of metals

iStockphoto/ClaudioVentrella

Single-cell inductively coupled plasma mass spectroscopy offers a potentially significant breakthrough in detailed biological studies.

BY **DAVE SAMMUT**

‘We’re very interested in understanding metals in cells’, says Dr Elizabeth New, Westpac Research Fellow at the University of Sydney. Metals in cells are potentially critical to cancer treatments, biological systems affected by environmental pollution, and the potentially deleterious effects of society’s increasing exposure to nanoparticles.

ICP-MS (inductively coupled plasma mass spectroscopy) is well established as the go-to method for metals analysis. It has enabled researchers to identify correlations between metal levels and diseases, metabolic disorders, environmental exposures and nutrition.

However, the technique has had its limitations, most particularly in the level of detail it can provide. Traditional

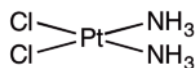
ICP-MS methods digest the biological matrix, effectively capturing an average concentration across the sample. Until now, the technique has been unable to provide information about the concentration distribution across a biological cell population.

The Australian Institute for Nanoscale Science and Technology (AINST) at the University of Sydney is eagerly anticipating the delivery of the southern hemisphere’s first single-cell ICP mass spectrometer from PerkinElmer. ‘We already use ICP-MS very heavily, because it is very helpful in telling us about the uptake and accumulation of metals in cells,’ says New, ‘but this technology is really exciting because it will let us look at an individual cell and its metal content. That means that we can now look at different types of cells in a cell population and see exactly which has

When I heard about it, it was exactly what we needed for our research.

been specifically affected, by a disease or by a certain metal treatment.'

Cisplatin (*cis*-diamminedichloro-platinum(II)) is a commonly used chemotherapy drug used to treat multiple types of cancer. It is used to destroy rapidly growing cells by binding to the DNA and interrupting cell replication, so that the cell must repair the DNA damage or die. However, experience has shown that while many patients initially respond to this platinum-based treatment, the drug is less effective if there is a relapse and further therapy required.



cisplatin

One of three proposed mechanisms for this reduction in efficiency is that the cancerous cells evolve to have altered cellular accumulation (reduced uptake of the drug and/or increased export), but to date there has been little or no data about the distribution of the drug in the complex array of cells in a tumour. The existing ICP-MS techniques can only measure the average concentration across the

whole cell population. Single-cell ICP-MS promises to measure the metal concentrations of individual cells down to the attogram (10^{-18} gram) level, to yield critical data about the metal distribution in the cell population, yielding up to 100 000 data points per second.

Using the first of the new instruments in the US, a team at the National Institutes of Health (NIH) has been looking at individual cell populations and their responses to platinum. By comparison, New and her team are eager to look at heterogeneous populations, with a view to how different cell types respond to platinum drugs. 'One of the real challenges in studying cancer is that the tumour contains so many different types of cells. If we can begin to identify certain cells in a tumour that have a particular metal fingerprint or a particular way of handling metals, then that will really help us think about how to treat tumours.'

'We're interested in understanding the relationship between copper and platinum drugs – how cisplatin and other drugs affect copper in the cells', says New. 'And we're also interested in understanding oxidative stress in cells.'

'Oxidative stress is thought to be involved in pretty much every disease associated with ageing, but nobody knows whether it is the cause of disease or whether it is just an effect, whether we can measure oxidative stress and predict the outcome of the disease or response to treatment. If we

can understand the interactions between the disease and the metal pools, or observe certain cell types with higher metal level and higher oxidative stress, then that would be a really exciting discovery.'

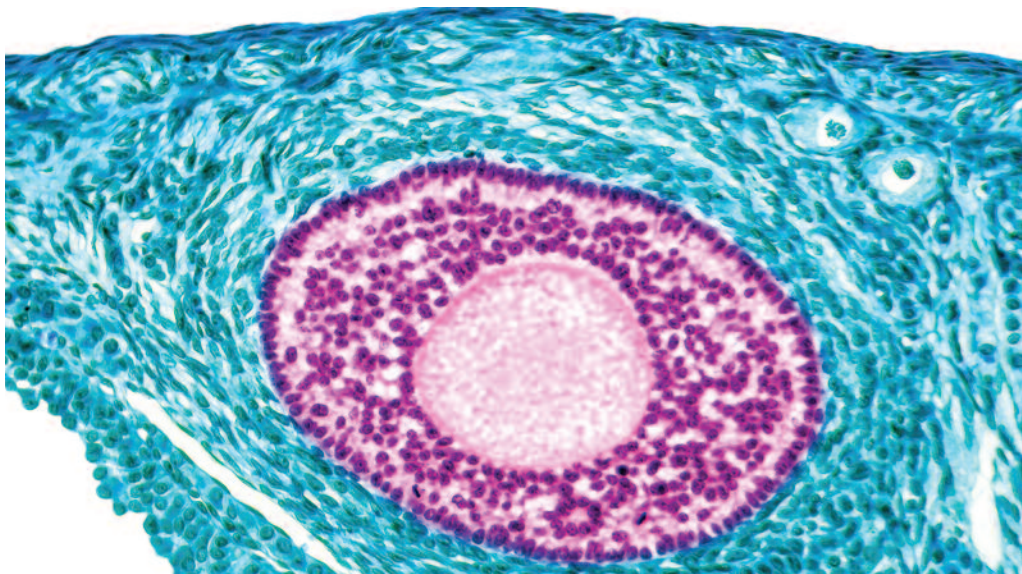
'It really was serendipity. I hadn't particularly looked for this, but now every time I think about something I think that this would be a great new use for the new equipment. It fits perfectly with what we're interested in. When I heard about it, it was exactly what we needed for our research.'

Sharing New's sense of anticipation is colleague Dr Wojtek Chrzanowski, senior lecturer and researcher at the Faculty of Pharmacy and the Australian Institute for Nanoscale Science and Technology. One key focus for Chrzanowski's team is nanotoxicity, based on the growing body of evidence that suggests that nanoparticles may have a causal role in various forms of disease, including cancer.

Nanoparticles occur in many products, including food, make-up, sunscreen, cosmetics, toiletries, baby formula and chewing gum. 'The main concern for us', says Chrzanowski, 'is the nanoparticles in food. One of the problems is that we are continuously exposed to these nanoparticles, but we don't know what exactly happens in the body and whether they have a toxic effect or not, and how they affect gut microbiota. There is already a lot of evidence that nanoparticles cause problems in our bodies, exacerbate

'The NexION SC-ICP mass spectrometer allows for the quantification of metal at the level of a single ovarian cancer cell' [pictured], Chady Stephan, Senior Leader of Applications at PerkinElmer and a co-researcher on the [NIH-PerkinElmer] ovarian cancer cell study, says. 'The technique is based on the ability to measure discrete signals generated from a cell when it enters the plasma, and allows for the quantification of cisplatin within individual cells', Dr Lauren Amable, NIH National Institute on Minority Health & Health Disparities, explains.

(Text and image: PerkinElmer)



symptoms of many diseases (e.g. colitis) and may even impact on the function of common drugs.'

'There are a lot of factors – stress, contamination etc. – but we strongly believe that nanoparticles are one of the factors contributing to the increase in immune disease, asthma, autism, fertility problems or cancer, as well as an impact on the gut microbiota, thus the overall host community.'

Chrzanowski's expectation is that as nanoparticles are incorporated into cells, they consume critical energy as the cell seeks to consume or reject the

particle, which interferes with the normal functioning of the cell. He then sees single-cell ICP-MS as a critical technique to allow his team to precisely screen for how many nanoparticles are taken up by individual cells, and how the cells change their normal metal concentrations in reaction to nanoparticle exposure. This aligns with and complements New's research questions.

Chrzanowski and his team are also looking at possibilities for the beneficial use of nanoparticles in

targeted drug delivery. Malignant cells may take up nanoparticles and drugs like cisplatin differently, and the team would like to understand how this happens, why it happens, and how heterogeneous the responses really are. 'This instrument will allow us to put the nanoparticles onto the malignant and non-malignant cells and screen for how much of the nanoparticles were uptaken by which of the cell population. Based on this method, we should be able to design new drug delivery carriers.'

Another key functionality of interest

The single-cell ICP-MS instrument



One of the key challenges for single-cell ICP-MS is getting the cells into the plasma. Typical spray chambers (pictured) are designed to reject larger water droplets (>4 micrometres), but most biological cells are substantially larger than this.

As such, traditional ICP-MS techniques have involved digestion of the biological samples prior to analysis. PerkinElmer has developed its new Asperon™ spray chamber to incorporate new flow patterns that transport the larger single-celled organisms to the plasma, as well as limiting lysis (rupture) of the cells from impacts with the chamber walls.

However, prior to aspiration, the cells need to be washed and separated from the matrix, which may also contain the analyte. For example, a blood sample being tested for platinum distribution from cisplatin may contain the drug in both the serum and the cells. So the sample is first put through multiple wash and spin (gravity separation) cycles.

PerkinElmer's latest offering builds on the success of the NexION 350 ICP-MS instrument, introduced a couple of years ago. At just 10-microsecond dwell time, the company confirms that its high-speed detector gives it at least an order of magnitude speed advantage over its nearest rival. And this speed has been leveraged to create the capability to analyse biological samples at the single cell level of detail.

Let's take two groups of algal organisms as example. *Chroomonas* species have a typical size range of

5–7 micrometres. With a cell culture at about 250 000 cells/mL and a sample flow rate of about 15 µL/min, this gives a flow of approximately 63 cells/s, requiring a maximum read time of 16 microseconds for individual analysis, comfortably greater than the 10 microseconds claimed by PerkinElmer.

Gonyostomum semen is a much larger organism. A typical size of 50–70 micrometres, with a population of about 4500 cells/mL, translates to approximately 11 cells/s and a maximum read time of 89 microseconds. However, because of its larger cell size, this organism is more vulnerable to the higher pressures exerted at higher sample and gas flow rates, and PerkinElmer recommends a cell viability test prior to analysis.

According to Scott Fraser, National Product Specialist for PerkinElmer, 'I see a day coming where every medical institute (at least) will have one of these instruments, and this will become a routine part of personal, patient specific medical regimes – minimising the side effects of chemotherapeutic treatment and also maximising the efficacy of drugs within what we now understand to be heterogeneous populations of cancers.'

'There is also going to be a great development of understanding of the movement of metals through the biosphere', says Fraser, 'We'll better assess, per cell, how waste materials from various processes transfer in the food chain. That will become much more important as time goes on.'

Chrzanowski's expectation is that as nanoparticles are incorporated into cells, they consume critical energy as the cell seeks to consume or reject the particle, which interferes with the normal functioning of the cell.

to Chrzanowski is the ability of the technique to distinguish the sizes of the nanoparticles. He expects that nanoparticles will aggregate, either within the cells or within the bloodstream. Being able to measure the size of particles in individual cells should then allow Chrzanowski to better understand the differing mechanisms and capabilities that relate to the cell's uptake of individual nanoparticles versus larger aggregates.

"The new single-cell ICP mass spectrometer will be a fantastic addition to our existing equipment, which can do both physical (size) characterisation and chemical characterisation. We have state-of-the-art facilities here at the University of Sydney that are still not available anywhere else in Australia. We will link it together to create a nano toolbox which can probe nanotoxicity and response from different angles to give the full picture."

Dave Sammut FRACI CChem is principal of DCS Technical, a boutique scientific consultancy, providing services to the Australian and international minerals, waste recycling and general scientific industries.

Follow that cell: an NIH challenge

In June, the US National Institutes of Health named two biological engineering researchers as winners in phase 2 of its Follow that Cell Challenge. The winners will share \$400 000 in prizes awarded for development of new tools and methods for predicting the behaviour and function of a single cell in complex tissue over time – and how that reflects the health of the tissue. They were chosen from among several phase 1 finalists.

Dr Nader Pourmand, University of California Santa Cruz, is the first place winner with a prize of \$300 000. A team led by Dr Paul Blainey, of the Broad Institute, Cambridge, Massachusetts, will share the second place prize of \$100 000.

Pourmand developed an advanced 'nanopipette' technology with such a fine tip that it makes it possible to non-invasively sample tiny amounts of intracellular material to measure biochemical changes, multiple times in the same cell – without disturbing its function. Coupled with parallel development of 'nanogenomics' technology, this will enable scientists to track molecular changes in cells that develop in response to treatments, such as the development of drug resistance in cancer.

"This is the only technology I know of that enables us to repeatedly interrogate a single cell without killing it", said Pourmand.

Blainey's team designed a new molecular technology to streamline cellular analysis and allow for wide adoption by labs. Instead of requiring complex physical sampling of cellular components, it takes advantage of cell secretion pathways to access molecules of interest inside the cell – at multiple time points. Blainey's findings demonstrated the ability of a cell to 'self-report' gene expression.

Launched in August of 2014, Follow that Cell seeks to incentivise innovation by awarding prizes on the basis of completed work, in contrast to NIH's traditional, prospective grant and contract mechanisms, which provide funding in advance.

The challenge is aimed at finding new ways to learn how cells transition from a healthy to a diseased state, become responsive to treatment, and offer opportunities for early detection and precision medicine.

In March 2015, NIH announced selection of 16 finalists from phase 1 of the competition, which sought proposed theoretical solutions rather than hands-on experimentation. All of the phase 1 finalists were eligible to participate in phase 2, during which they were encouraged to execute their ideas in proof-of-concept studies.

"The prize winners have brought some creative ideas to the study of single cells", said NIBIB director Roderic Pettigrew, "We challenged competitors to develop new ways to monitor biochemical changes in individual living cells and they have demonstrated an impressive capacity for problem solving and innovation."

Read the winners' own brief descriptions of their prize-winning solutions at bit.ly/2sSuv0f.

National Institutes of Health

AUSTRALIAN JOURNAL OF CHEMISTRY

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Celebrating 70 years of chemical science publishing

BY **JENNIFER M. FOSTER**

Next year, the *Australian Journal of Chemistry* will celebrate 70 years of publishing research papers from all fields of chemical science, with a focus on multidisciplinary chemistry and emerging areas of research.

In 2018, the *Australian Journal of Chemistry* (AJC) will achieve the milestone of reaching 70. To appreciate where AJC now stands, it is important to understand its roots.

In the aftermath of World War II, there was something of a coming of age in Australia. We had come close to being invaded by Japanese forces during the War, and what had been considered 'the home country', Great Britain, had not been able to come to our aid. There was a sense that we had to stand on our own. In the science community, this manifested itself with the establishment of the Australian Academy of Science and the *Science and Industry Research Act 1949*, the Act under which CSIRO still operates. Scientists of the day were sending the results of their research to British and American journals, but this was a frustratingly slow process, conducted by sea mail. There was a clear need for an Australian publishing capability,

but no publisher in the country could cope with the specialist (mathematical, chemical) typesetting needed for physics and chemistry publishing, so the newly formed Academy partnered with CSIRO to establish the Australian Journals of Scientific Research.

From this partnership, the first volume of the *Australian Journal of Scientific Research* was published in 1948. It consisted of four issues, totalling fewer than 500 pages, publishing papers on both chemistry and physics. Very quickly, the volume of papers received was so great that there was a surplus in content; as a result, this journal split into two distinct publications in 1953 – *Australian Journal of Chemistry* (volume 6) and *Australian Journal of Physics* (volume 6), each consisting of four issues a year. Continued rapid growth in submissions for AJC meant that in 1962 there was enough content to fill six, rather plump, issues of the journal,



L–R: George Koutsantonis, John Wade and Jenny Foster at the RACI Centenary Congress in July.

and only two years later, in 1964, there was enough content to maintain publication of 12 monthly issues.

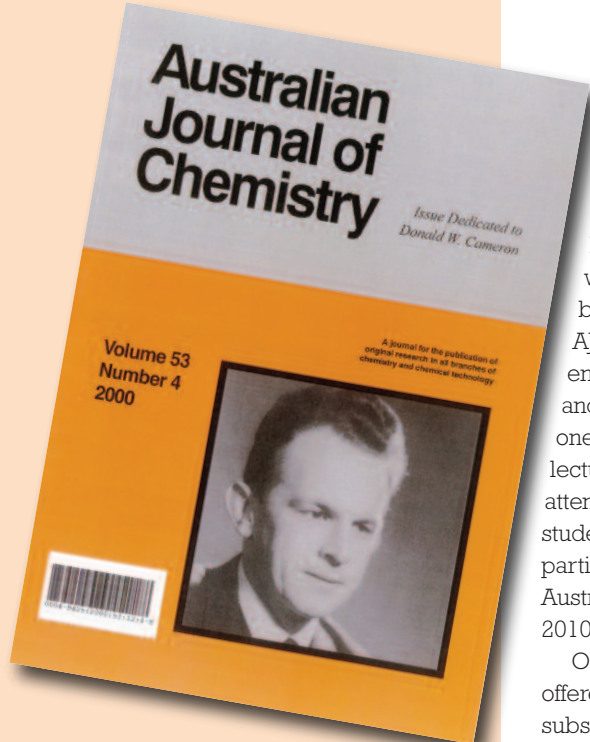
At this time, given the constraints of geographical reach, the overwhelming majority of papers published in *AJC* were from Australian authors. Disappointingly, many historical records pertaining to *AJC* have long disappeared; the earliest data I could find were in the minutes of an Editorial Advisory Committee meeting, dated 26 October 1979. That report showed the relative geographical breakdown of authorship: around 85% of published output was from Australia (mostly Australian universities and a few from other Australian institutions and around 8% from CSIRO). The remaining 15% was from authors based overseas. That 15% of overseas content was impressive compared to

the other journals published by CSIRO Publishing at the time, which averaged around 10% or less. This led to the conclusion that ‘the journals [particularly *AJC*] were by no means to be considered “CSIRO house publications”.’

The geographical distribution of published papers changed rapidly when we embraced the internet as a channel to deliver publications, probably the biggest change in publishing since Gutenberg invented the movable-type printing press around 1440, a phenomenon that introduced the era of mass communication, thereby permanently altering the structure of society. *AJC* was the first Australian journal to be published online, and we did that early – in 1996 – before Elsevier, before Springer, and before Wiley. The

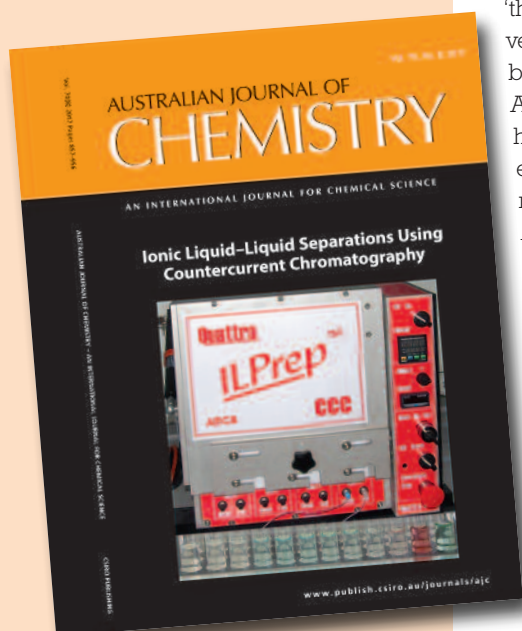
web changed the landscape of publishing rapidly – distance was no longer a deterrent to publishing in international journals, and quickly our author composition changed from an Australian majority to one with a truly international flavour. Of course, it also meant that Australian authors had more timely and straightforward options to publish in international journals.

When I starting working on the journal under the stewardship of the infamous John Zdysiewicz (or John Z, as he was affectionately known among his peers), in 1995, as an Assistant Editor, and also as an RACI member, I was interested to find that the only relationship *AJC* had with the RACI, was a 10% discount offered to personal subscribers. (At that time, personal subscriptions were plentiful, as the journal was print-only and hence not



Landmark papers in AJC virtual issue

As part of their celebrations, the *Australian Journal of Chemistry* will be sharing a virtual issue containing freely available landmark papers previously published in AJC, such as those by the late Sir John Cornforth ('The trouble with synthesis' (*Aust. J. Chem.* 1993, vol. 46(2), pp. 157–70) and 'Scientists as citizens' (*Aust. J. Chem.* 1993, vol. 46(3), pp. 265–75)), as a way of highlighting the sustained excellence over the years in publishing papers of great international significance.



so readily available.) Looking back at that period, I think John Z was instrumental in the connection between Australian chemists and AJC. He never lost an opportunity to engage with established authors and referees or to drum up new ones, he gave and sponsored lectures, he visited departments, he attended conferences, and awarded student prizes. John was a very visible participant in the corporate life of Australian chemistry (*Aust. J. Chem.* 2010, vol. 63, pp. 1139–40).

Over time, RACI members were offered greater discounts on personal subscriptions in an attempt to further connect the journal to its rightful audience, and in September 2003 an announcement formalising a new agreement between the RACI and AJC was circulated (*Chem. Aust.* 2003, 9), in which, among other things, heavily discounted (almost 50%) personal subscriptions were offered. At that time, personal subscriptions were rapidly declining, with content available to most readers through institutional online subscriptions. In that announcement, a clear vision for AJC was articulated, and that was 'to showcase the best chemical science from Australasia to the rest of the world, along with publishing important international contributions'. Further, 'this arrangement provides another very good reason to remain (or become) a member of the Royal Australian Chemical Institute. We hope that this agreement will enhance the feeling among you, the members of the RACI, that the *Australian Journal of Chemistry* is your journal'.

Five years later, in 2009, AJC moved from a publishing model with an in-house Managing Editor (Dr Alison Green, who took over the reins when John Z retired in late 2000) to an external Editorial Board under the advocacy of Professor Curt Wentrup. Curt's views were also consistent with the 2003 vision, which focused

... the ongoing tradition of inviting the recipients of research-related RACI medals and awards to publish an account ... of their work in an annual special issue of AJC ... champions our vision of showcasing exceptional Australian science carried out by exceptional Australian chemists.

on improving the status of AJC at home, and making Australian researchers see the journal as their journal, by forging closer links with the RACI, while maintaining its international impact. Curt was instrumental in further developing our relationship with the RACI back in 2012, when we met with CEO Roger Stapleford to discuss moving forward in cementing a formal relationship. From that meeting, foundations for a mutually beneficial partnership were identified. These include reciprocal arrangements for advertising and home page links, a link from the RACI website to a free monthly 'teaser' paper from AJC, space in *Chemistry in Australia* each month for an article relating to AJC, sharing costs of booths and/or receptions at agreed conferences and publishing papers from RACI prize-winners in AJC.

It has been terrific to see these ideas come to fruition under Curt's leadership. Sharing the costs of booths (e.g. at the FACS AAC 2013 Meeting, Singapore) and receptions (Pacifichem, Hawaii, 2015) allows us to make the most of our carefully monitored funds in promoting journal content and the RACI to our international friends. The most spectacular outcome of this, in my view, is the ongoing tradition of inviting the recipients of research-related RACI medals and awards to publish an account (highlight), review, or paper of their work in an annual special issue of AJC. It champions our vision of showcasing exceptional Australian science carried out by exceptional Australian chemists.

Following Curt's groundwork in fostering these strong but informal ties with the RACI, our two current co-Editors-in-Chief, Professors George Koutsantonis and John D. Wade, are

committed to finding further ways to strengthen ties with the RACI, and encourage and engage Australian chemists to publish their work in AJC, with the advocacy of a strong and refreshed Editorial Board. To complement their efforts, our recent acceptance into COPE (Committee on Publication Ethics) shows we are committed to best-practice ethical standards, an increasingly important aspect of online publication.

The vision for AJC articulated back in 2003 continues to be accurate – I still see AJC as an Australian journal for Australian chemists. However, I do not think the majority of RACI members feel a sense of belonging to AJC, and I feel the gap is widening, no doubt at least in part due to its perceived low impact and the implications of this low impact with respect to promotions and grant applications. Although we are perceived as being low impact, we publish papers that are highly cited.

Graeme Moad, Ezio Rizzardo and San Thang's landmark review (*Aust. J. Chem.* 2005, vol. 58(6), pp. 379–410, <https://doi.org/10.1071/CH05072>), on RAFT polymerisation chemistry, plus three updates, published in AJC between 2005 and 2012, have generated over 3000 citations to date. Four of our top 10 highly cited papers published in 2013 and 2014 were authored by Australian research teams, and have generated an average of 24 citations each.

What can we do to ensure Australians see AJC as an attractive choice for publishing their work? Let's open the dialogue. I know that many of you care deeply about this. George, John and I welcome your thoughts and suggestions.

Cheers and happy birthday to us! I hope both AJC and RACI have happy and strong futures to look forward to.

Jennifer M. Foster FRACI CChem is publisher of the *Australian Journal of Chemistry*.

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Protection and prevention in chemical warfare

Protection, antidotes, treatments and of course prevention are the subject of ongoing research in the face of chemical weapons attacks.

BY **COLIN A. SCHOLES**

World War I imprinted in people's minds the vision of soldiers donning gas masks during chemical weapon attacks. These respirators were designed to remove the toxic agent from the air and allow the soldiers to continue to breathe and hence fight. The first use of these was during the second battle of Ypres, in a response to a chlorine gas attack. The initial chlorine attack killed thousands, but Reserve Canadian troops were able to counter the attack by soaking cloth in their own urine and placing the cloth across their faces. The soldiers realised that the urine's urea would react with the chlorine gas, neutralising the danger, and demonstrated fast thinking acid-base chemistry.

The use of cloth respirators against chemical agents goes back to the time of Leonardo da Vinci. In the 15th century, he devised a seafaring chemical weapon based on powdered

arsenic with sulfur in shells; he also devised protection for the sailors by having them wrap wet cloth around their faces. Today, wet cloth is used by protestors and rioters globally in response to tear gas release due to police and military crowd control efforts.

Most respirators are based on an agent such as activated charcoal that removes the toxic gas through adsorption from the air and hence enables military personnel to breathe safely. These work well for a period of time, but the active agent will become saturated, and in the case of blood agents such as cyanides they offer only limited protection. For military personnel under continual attack, self-contained breathing respirators are required, and hence their ability to act is limited to the amount of oxygen they can carry.

Blistering and nerve agents, such as mustard gas and sarin, are also absorbed through the skin, meaning

additional protective clothing is required. This takes the form of full hazmat suits, which must be gastight, and are generally based on heavy duty PVC, Teflon and/or high-density polyethylene. Such bulky suits make military action difficult and are mainly found in decontamination efforts. In response to these limitations of personnel protective equipment, a significant amount of research is directed at developing antidotes and counter agents to neutralise chemical weapons.

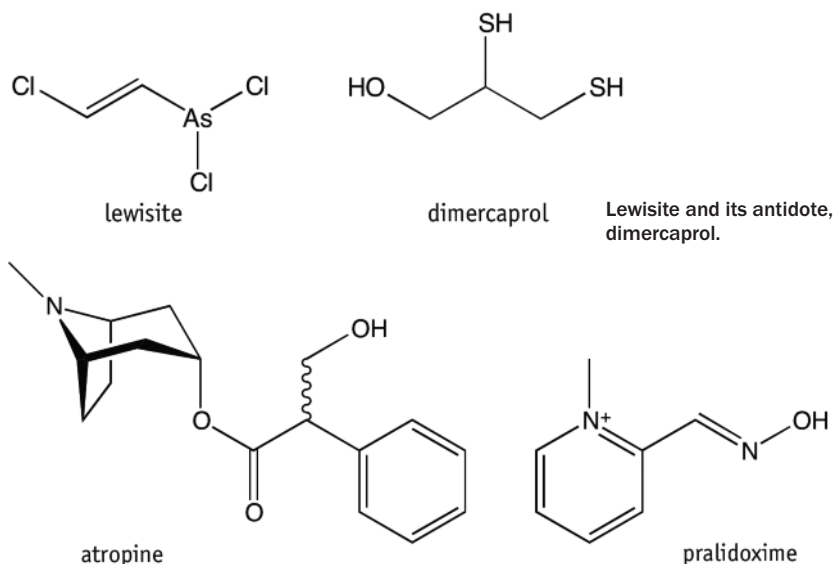
The first antidote to a chemical weapon was developed in World War I in response to lewisite (2-chloroethenyl-arsinous dichloride), a blistering agent that also led to arsenic poisoning. Lewisite easily penetrated clothing and caused immediate stinging, pain and itching to the skin, with chemical burns and large blistering occurring over a 24-hour period. Victims also suffered from hypotension because of arsenic

entering the blood. The antidote developed was dimercaprol, also known as British anti-lewisite, which is a chelating agent of arsenic and binds with the metal in the blood. This prevents arsenic from deactivating metabolic enzymes and hence stops arsenic poisoning. Dimercaprol has gone on to be a treatment for blood poisoning by a range of heavy metals, but it does not prevent the chemical burns and blistering of the skin due to lewisite exposure.

G-series nerve agents, such as sarin, can be easily neutralised by hydrolysis with a base. This is the reason why G-series agents do not persist in the environment. However, once these agents are in the body, they are fast acting on nerve cells and hence any antidote must be applied rapidly to mitigate the agents' effect, ideally by military personnel and first responders during an attack. Atropine is one such treatment to overcome nerve agent exposure, though it is not

The bulk of current hazmat suits makes them impractical during military action.

iStockphoto/Arne_Uebel



Atropine and pralidoxime are used in combination to treat exposure to G-series nerve agents.

an antidote and is only effective for small to medium levels of exposure. Atropine in conjunction with pralidoxime, binds to the counter sites of the acetylcholine enzyme in nerve cell receptors. This causes the enzyme to displace the nerve agent from the active site, returning the enzyme to full functionality. The nerve agent is then hydrolysed by the body through metabolic pathways. However, it is critically important that atropine be present in the body throughout this period of time; otherwise, it is merely delaying the effects of the nerve agent. To complicate matters,

both atropine and pralidoxime are deadly in a high enough concentration and hence they must be administered at a safe dose.

Atropine and pralidoxime are readily available in medical facilities because of their need in a range of standard surgeries and procedures. In the case of a chemical weapons attack, supplies of these compounds can rapidly run out, as was the case in Syria during the recent incidents.





Mr Ahmet Üzümcü, Director-General of the Organisation for the Prohibition of Chemical Weapons and recipient of the 2013 Nobel Peace Prize, speaking at the RACI Centenary Congress in July about eliminating chemical weapons.

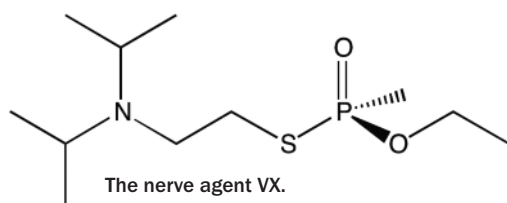
Military personnel who are likely to be exposed to nerve agents carry autoinjectors of these two compounds, which allow rapid injection into the thigh muscles in the instance of an attack.

There is active research into developing treatments that are fast acting and destroy nerve agents in the blood faster than the metabolic rate. These treatments are based on the chemical similarities between organophosphate nerve agents and some agricultural pesticides. Continual pesticide spraying of agricultural regions has resulted in enzymes evolving in soil bacteria that can break

down pesticides. These enzymes have also shown selectivity for the hydrolysis of nerve agents. Hence, there is potential to develop and enhance these enzymes for treating nerve agents in vivo, because these enzymes will break down the nerve agents at a fast rate. This will also overcome the danger of atropine poisoning. German and Israeli scientists using this approach have developed a therapeutic enzyme against the nerve agent VX. It has been successfully tested in guinea pigs; however, human trials of this treatment are still years away.

Da Vinci's chemical bullets were a precedent for the 1675 Strasbourg Agreement, thought to be the first international accord to prevent the use of such weapons. Prevention is better than cure, and the Convention on the Prohibition of the Development, Production, Stockpiling and use of Chemical Weapons and on their Destruction is the modern-day international treaty aimed at their eradication, administered by the Organisation for the Prohibition of Chemical Weapons (OPCW). The convention has a broad scope and considers any chemical used in warfare as a chemical weapon, and hence does not need to be continually updated with the development of new chemical agents or the adaptation of existing chemicals for warfare. The convention was only drafted in 1992 and came into effect in 1997, which is very recent given the long history of chemical warfare, and relied upon the reduction in global tensions at the end of the Cold War. The convention has been signed and/or ratified by almost all countries, with the exception of Egypt, South Sudan and North Korea. This marks the convention as one of the most successful international treaties.

The convention prohibits the production and use of chemical agents for warfare, the destruction of all existing chemical weapons and their production facilities, assistance between countries and the OPCW when



Atropine is on the World Health Organization Model List of Essential Medicines. Skirtick/CC BY-SA 4.0

incidences of chemical weapons are used, including inspection, as well as global cooperation on the peaceful use of chemical agents. This last condition is required because many chemical agents that have been weaponised are also used in numerous industrial applications, such as synthesis precursors. Hence, these chemicals are controlled substances whose production, use and transportation are heavily monitored to ensure they are used for benign purposes.

The convention aims to destroy the world's stockpiles of chemical weapons. As of 2015, a total of 72 524 tonnes of chemical agents had been declared to the OPCW, along with 97 production facilities. The majority of these have been in the US and Russia, and their stockpiles and munitions are currently being destroyed, although both countries missed their deadline of April 2012. Other countries to have declared chemical weapons facilities have been the UK, Syria, Serbia, Libya, Japan, Iraq, Iran, India, France, China and Bosnia and Herzegovina, plus one non-disclosed country. As of October 2016,

Type 45 destroyer HMS *Diamond* escorting the merchant ship *Ark Futura* during Operation Recsyr (Removal of Chemical Weapons from Syria) in February 2014. The operation, commencing with OPCW inspection, began in late 2013. HMS *Diamond* has completed her role escorting ships carrying Syria's chemical weapons stock for disposal. HMS *Diamond* joined the Danish-led, Norwegian and British Task Group to provide maritime force protection to merchant vessels transporting chemical agents from Syria.

Photo: MM140092/MOD/OGI

93% of the world's reported chemical stockpile has been destroyed, an outstanding achievement of the OPCW.

In some instances, cooperation between countries has been required. Japan is responsible for significant stockpiles of chemical agents across China, left over from World War II. The amount of chemical munitions left behind by Japan during its retreat has been estimated from 700 000 to 2 million units. One such depot is the Nanjing stockpile, which was only unearthed in February 2000. Syria's chemical weapon stockpile is currently being processed and destroyed offshore on a US merchant navy ship specially configured to handle the dangerous agents. Similarly, the OPCW is monitoring the destruction of the last of the aforementioned countries' stockpiles of chemical agents.

The convention conveners' hope was that chemical agents would never again be used in warfare, and that the convention would generate a strong international effort to eradicate them. The dramatic reduction in the global stockpile of chemical weapons over the preceding decade, as well as the global outrage and response to recent incidents, is making this a reality.

Colin Scholes FRACI CChem is a lecturer in the Department of Chemical Engineering at the University of Melbourne. A partner article about chemical warfare was published in the September issue of *Chemistry in Australia* (p. 20).



New fabric coating could thwart chemical weapons, save lives

Chemical weapons are nightmarish. In a millisecond, they can kill hundreds, if not thousands. But, in a study published in *Chemistry of Materials* (<http://dx.doi.org/10.1021/acs.chemmater.7b00949>), scientists report that they have developed a way to adhere a lightweight coating onto fabrics that is capable of neutralising a subclass of these toxins – those that are delivered through the skin. The life-saving technique could eventually be used to protect soldiers and emergency responders.

Since their first use in World War I, dozens of chemical weapons with devastating potential have been developed. For example, just a pinprick-sized droplet of the nerve gas sarin on the skin is lethal. Recently, scientists have begun exploring the use of zirconium-based metal-organic framework (MOF) powders to degrade and destroy these harmful compounds. MOFs are miniscule, porous structures that have large surface areas that allow them to absorb vast amounts of gases and other substances. The zirconium within them helps neutralise toxic materials. But making MOFs can be tedious, requiring high temperatures and long reaction times. Plus, most MOF powders are unstable and incorporating them onto clothing has proven challenging. Dennis Lee, Gregory N. Parsons and colleagues wanted to see if they could 'grow' MOFs onto fabric at room temperature, potentially creating a lightweight shield that could be used on uniforms and protective clothing.

Building on previous work, the researchers exposed polypropylene, a non-woven fabric commonly used in reusable shopping bags and some clothing, to a mixture consisting of a zirconium-based MOF, a solvent and two binding agents. To ensure that the coating spread evenly across the cloth, they treated the fabrics with thin layers of aluminium, titanium or zinc oxide. They tested this combination with dimethyl 4-nitrophenyl phosphate (DMNP), a relatively harmless molecule that has similar reactivity as sarin, soman and other nerve agents. They found that the MOF-treated cloths deactivated the DMNP in less than five minutes, suggesting this process is a viable means to create improved protective clothing.

American Chemical Society

International diplomacy requires chemistry

Profile: Dr Brendon Hammer

BY **SIMON COPLAND**

It's fair to assume that the most likely outcome of a degree in chemistry is a life in the laboratory. While the lab can lead to a lifetime of discovery, chemistry can also open up doors to all sorts of careers. Even international diplomacy.

Don't believe it? Just ask Dr Brendon Hammer, a Research School of Chemistry (RSC) alumnus and Australia's current Ambassador to Austria, Bosnia-Herzegovina, Hungary, Kosovo, Slovakia and Slovenia.

Dr Hammer completed several courses at the Chemistry Department at the ANU, which at the time was part of the School of General Studies. As an undergraduate he finished courses in chemistry, physics, biochemistry, maths and philosophy, before specialising in inorganic chemistry for his honours. From here Dr Hammer continued his studies at the ANU, completing a PhD under the supervision of Dr Howard Bradbury, in which he worked on the isolation and characterisation of plant proteinase inhibitors.

It looked as though Dr Hammer was building for a long and fruitful career

in the chemistry lab. However, after ten years of research, Dr Hammer took a job at the Office of National Assessments (ONA), changing his life forever. This wasn't a plan, Dr Hammer explains, but one that opened up a world of opportunities.

'I was happy doing research in chemistry, and was gearing up to get a further postdoctoral position, this time in the US', Dr Hammer explains. 'I'll admit that I was thinking, though, that if I went to the USA I would probably try to stay there where bigger budgets and excitement levels seemed likely. As such a big step approached, I guess my overall attitude towards what I might do next became more labile.'

'And as it happened, right then, while I was in that zone, I met a person quite by accident at a dinner where, as a result of a bit of a debate ranging from economics to how chemotherapy works – and then some further conversations – I got encouraged to try work at ONA.'

While this was a significant career change, in moving to the public service Dr Hammer was able to directly apply his research skills to

very important public policy issues.

'There was a specific link between my work in chemistry, and science more broadly, and my initial work at ONA', Dr Hammer explains. 'At that time, in 1989, the Australian Government – led in this area by Foreign Minister Gareth Evans – was driving an international effort to ban chemical weapons and roll back any further proliferation of chemical, biological and nuclear weapons. My job at ONA was in support of that effort.'

'My subsequent two jobs with the Department of Foreign Affairs and

There was a specific link between my work in chemistry, and science more broadly, and my initial work at ONA.



Dr Brendon Hammer (right) talking with a scientist in Seibersdorf, Austria, who is working on tracing the provenance of foods using naturally occurring isotopic ratios.

Trade – one in Canberra, and one posted as a diplomat to Washington – were also focused in this area. Having a science background was extremely helpful – and recognised as such by government and others – to my understanding and development of ideas and policies in relation to trying to stop the spread of these weapons of mass destruction.'

From these early jobs, Dr Hammer built a career in international diplomacy. This has included postings in Washington DC and Tokyo, chairing international meetings of experts in Paris under the umbrella of the Australia Group, and working on the production of the 2000 Defence White Paper. Dr Hammer has now been posted, not just as Australia's ambassador to Austria, Bosnia-Herzegovina, Hungary, Kosovo, Slovakia and Slovenia, but also as a Permanent Representative to the UN agencies in Vienna, to the International

Atomic Energy Agency and to the Organisation for Security and Cooperation in Europe.

Dr Hammer says that in many ways this has been a pursuit in understanding one of the most complex systems around.

'The international system may be the most complex semi-ordered system human beings have to deal with. So there is a lot of intellectual satisfaction in trying to fathom what's going on there, discuss that with others on the same team, and try to find ways to take advantage of it.'

Amongst all of this, however, Dr Hammer has not forgotten his roots at the ANU, stating his studies were integral to his success.

'I found that the cast of mind I believe attracts people to chemistry and what I learned in chemistry – particularly in research – helped a great deal and still does in all of the jobs I've had', Dr Hammer says. 'In

particular some of the general attributes and elements relating to chemistry that I have found most helpful have been the ability to develop highly analytical and sceptical approaches to problem solving, and the ability to turn abstract ideas into hands-on practical steps.'

While Dr Hammer has had a career of amazing successes, he still has a soft spot for his time at RSC.

'Doing a PhD in chemistry at the ANU has also been a highlight. I had some fabulous times in the lab, both on the scientific front and socially.

'There really was a great sense of camaraderie among the research students both in the group I was in and more widely. Having visited RSC a couple of times recently – including Hambly's bar – I can see that tradition is alive and well!'

First published at chemistry.anu.edu.au. Reproduced with permission.

Chem-E-Car Competition: controlling chemical reactions

Why would a patent attorney organise the Chem-E-Car Competition, held annually in conjunction with the Chemeca Conference and this year as part of the Centenary Congress? Patent attorneys are good at drafting patent specifications to protect chemists' inventions but don't often have ready access to chemists' chemicals. As I found out, however, the RACI has a number of very helpful members who went out of their way to assist by supplying chemicals, glassware and other essentials for the entrants. Thank you very much to those people; you know who you are.

The goal of the competition is to have your car stop closest to a specified finish line while carrying a specified load. The competition is all about demonstrating the ability to control a chemical reaction.

The objective of the Chem-E-Car Competition is to design and construct a car that uses chemical reactions to power it and to control the distance it travels carrying a specified load. The goal of the competition is to have your car stop closest to a specified finish line while carrying a specified load. The competition is all about demonstrating the ability to control a chemical reaction.

The two teams who entered the competition were from the University of Queensland and the University of Auckland. Sadly, a team from Malaysia had to withdraw at the last minute. It was therefore a two-horse race (we were in Melbourne, after all), with comparisons to the Bledisloe Cup being made (appropriately, as it turned out, with the Kiwis convincingly winning the competition).

The University of Auckland car looked great – it had been laser cut with a kiwi badge at the front, and was driven by a bank of chromic cells containing acidified potassium dichromate with zinc and carbon electrodes. Each cell produced about 1.5 volts and 0.3 amps, which was plenty enough to drive their car, albeit faster in reverse. The University of Queensland car was originally to be driven by a zinc–air battery, but this was changed in the lead-up to the competition to an aluminium–air battery.

The University of Auckland's winning team.



Both teams used an iodine clock reaction as the stopping mechanism, where a reaction between sodium thiosulfate, starch, potassium iodide, hydrogen peroxide and sulfuric acid starts clear but turns dark blue depending on the quantity of hydrogen peroxide. The change of colour triggers a light-dependent resistor to break the electrical circuit driving the car.

The specified distance (14 metres) and load (400 millilitres of water) were decided on the day and the teams were informed an hour before the competition was due to start. The University of Auckland team were first up, and did a great job – their car stopped at just over 16 metres on the first run and about 18 metres on their second. Sadly, the University of Queensland team's battery was having problems on the day and they didn't manage to get the car off the starting line. The University of Auckland team were therefore declared the winners and collected the trophy!

The University of Queensland team didn't go home empty handed, as they won the Chem-E-Car Poster Competition, decided by popular vote by the spectators.

Andrew Jones MRACI CChem

The winning Chem-E-Car.



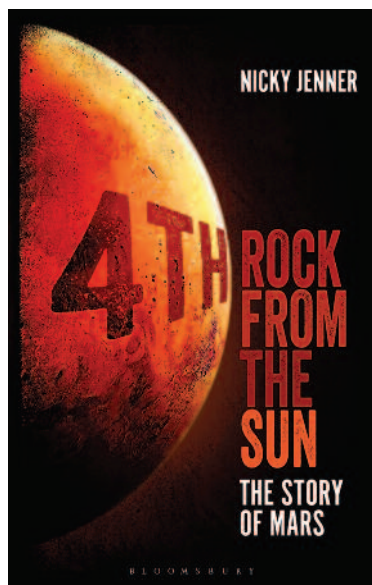
New Fellow

Derek Zamaere, an industrial chemist, is an overseas member of RACI based in Malawi, a Central African country. Growing up on a sugar plantation sparked his curiosity in chemical processes at an early age. He went on to study chemistry at the University of Malawi, graduating with an honours degree. He is currently finalising his Applied Chemistry MSc thesis for which he investigated plant-based antifoaming agents.

Zamaere's interests lie in the areas of process development and optimisation, low-cost production as well as the production of industrial chemicals from plants. Between 1996 and 2002, while heading the R&D function for Unilever Malawi, Zamaere's contribution led to some significant savings for the Malawian operations. He also collaborated in some regional projects that covered East, Central and Southern Africa. He later joined a water treatment company where he sold water and wastewater related solutions to a broad range of industries in Malawi and parts of Mozambique. Currently, Zamaere is the Operations Manager of a bioethanol production unit.

Zamaere is passionate about developing the professionalism of chemists and chemical engineers in Malawi. He is actively involved in mentoring young scientists and promoting chemical safety and security. He is currently president and one of the founding members of the Association of Professional Chemists and Chemical Engineers in Malawi and one of the founding members of the Laboratory Association of Malawi, where he has served as a board member. More recently, he has become a member of the National Authority for the implementation of the Chemical Weapons Convention in Malawi.

Aside from his career, Zamaere enjoys the outdoors, especially in the company of his wife, Maria, and three daughters. He is also deeply involved in community outreach programs.



4th rock from the sun: the story of Mars

Jenner N., Bloomsbury Sigma, 2017, ISBN 9781472922496, 272 pp. \$27

What fun Nicky Jenner must have had researching *4th rock from the sun: the story of Mars*! What fun you will have reading 'the complete book of Mars'. Jenner is eminently qualified for the job. Her writing is published in a variety of international popular science magazines, including *New Scientist*, *Nature*, *BBC Sky at Night*, *Astronomy Now*, *The*

Times Eureka and *Physics World*. She is also a copywriter for the European Space Agency and the European Southern Observatory and no doubt spends a lot of time looking at Mars.

To bring us the story of Mars, Jenner explored colour psychology, mythology, cultural studies, astrology, geology, biology, human physiology, history, geopolitics and at least a dozen other topics. Without this apparent hodgepodge of topics, it would be difficult to address the central question *4th rock* poses: Why do we want to visit Mars so badly?

We have always been fascinated by the heavens, but only recently have we seriously considered exploring the stars; only recently has it been possible. Jules Verne wrote *From the Earth to the moon* in 1865, but serious efforts to travel beyond Earth's atmosphere only began in the early 1900s. Since then, a lot has happened rather quickly. Rocket technology emerged from World War II, Sputnik 1 was launched in 1957, Neil Armstrong walked on the moon in 1969 and today we have private companies like Space X and Virgin Galactic competing with NASA to colonise Mars.

Whether or not we get there and if we do manage to survive on the red planet is less important than we try. Jenner says it best:

Space agencies across the world are far from a drain on the economies of their home countries, instead, acting as drivers for scientific and technological research, and inspiring the next generation of innovators. Funding a space agency necessarily funds scientists of all disciplines – engineers, chemists, physicists, doctors, geologists, computer scientists, biologists – all of whom don't work in space but here on Earth, contributing to societies and economies across the world.

Books like *4th rock* are important because they help fire our collective imagination and people might start thinking colonising Mars might be a better way to spend money than building a wall to keep out illegal immigrants.

The *4th rock* is well organised. If Mars in myth and legend is not your cup of tea ('The wolf and the woodpecker') you can

skip to the intricacies of retrograde motion ('Motions of Mars') or planetary geology ('The draw of Cydonia'). Chapters 9–12 get to grips with what it will take (really) to travel to and perhaps colonise Mars. It is not going to be easy but it is possible and Jenner offers convincing reasons why it will be worth the effort.

Jenner's writing style is engaging and her explanations of scientific topics are easy to follow for readers with little or no specialist background. The *4th rock* is the perfect book for a little light reading and would make an ideal gift for anyone with an interest in the heavens around us.

Terry Erle Clayton

Hawley's condensed chemical dictionary, 16th edition

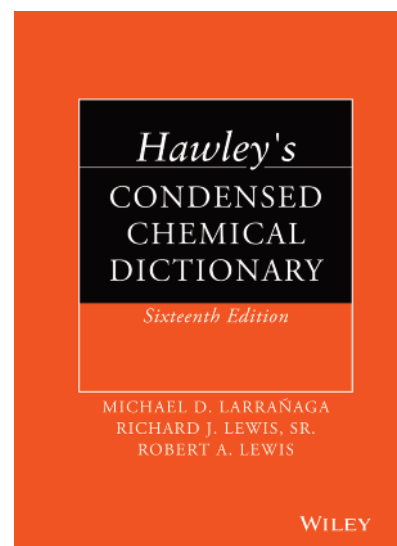
Larrañaga M.D., Lewis R.A. Sr, Lewis R.J. John Wiley and Sons, 2016, hardback, ISBN 9781118135150, 1544 pp., \$214.95 (Amazon.com US\$103.97). Online access options available at <http://au.wiley.com/WileyCDA/WileyTitle/productCd-1118135156.html>

It is hard to know where to start to write a review of a dictionary. Does it have words in it? Check. Do those definitions look broadly correct? Check. Where to go from here?

At a basic (chemistry pun fully intended) level, one could consider that two major criteria for judging the worth of a dictionary would be comprehensiveness of the field it purports to cover and the accuracy of the information it presents. On both fronts, the 16th edition of *Hawley's condensed chemical dictionary* comes up trumps. The book runs to over 1500 pages and the blurb on the website tells me it contains 1471 new definitions, plus 5236 revised or updated definitions, a new Chemical Abstract (CAS) number index and numerous other helpful additions. As it turns out, for a pleasant change, said website blurb is entirely correct.

Aside from the formal definitions, there is also a useful introduction giving some of the history of the publication (which, I was interested to learn, has been in print in various forms since 1919). There is also a list of abbreviations and five appendices: (i) on the origin of some chemical terms, (ii) highlights in the history of chemistry (both i and ii are full of interesting facts), (iii) a list of manufacturers of trademarked products, (iv) a CAS number index (iii and iv are useful), and (v) a short list of three tables (periodic, elemental and unit conversions).

Unlike a normal dictionary in which definitions are generally short, the condensed chemical dictionary is more of a compendium of technical data and descriptive information. It covers a vast array of topics, including information on not only chemistry but also biology, biochemistry, physics and more.



While some definitions can be straight to the point, there is very good cross-referencing throughout and most entries include helpful details, such as information on the substances used in the manufacture of a particular product. This can be useful to help you, for example, identify possible interferences in the measurement of a physical or chemical property of a substance. A minor negative is that it is not cheap (the RRP is more than \$200), but you certainly get value for money.

Many, if not all, entries are designed for those with minimal time to devote to a subject. However, it is possible to learn quite a lot from even a short browse in this book. I learnt, for example, that a *dram* is actually a formal unit in pharmacology, a rupture disc is a thin piece of metal between flanges that breaks at a certain pressure and that Zepel is a fluorocarbon textile finish used as a durable oil and water repellent. There certainly is a lot of information here. This could of course potentially lead to the age-old problem of going to look up one term but getting distracted by other interesting definitions (a

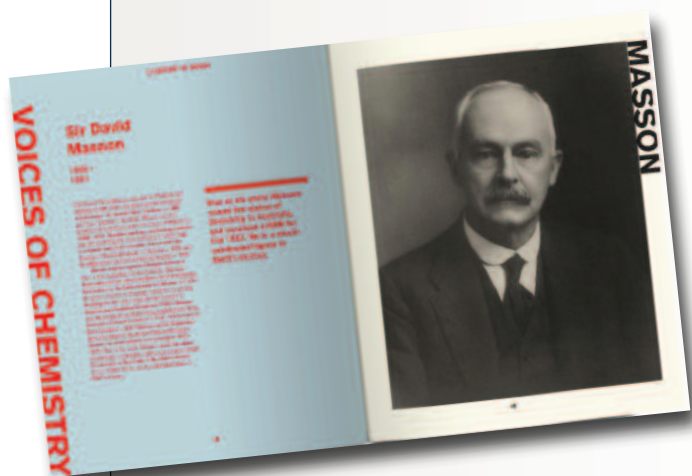
perennial problem when browsing online dictionaries such as Wikipedia). This reviewer does not see this as such a bad thing, unless of course one is short on time and/or procrastinating from tasks (such as writing a book review).

I often hear it argued that textbooks are on the way out and that everything will be digital in future. This reviewer certainly hopes this is not the case. In this age of tablets and smartphones, there is something satisfying about a good, heavy reference book (although, if you insist, there is a digital version available). Having seen the general panic that consumes the best of us when the wi-fi goes down, having a hard copy of relevant information to hand is useful (and with the book's bright orange cover you almost certainly won't lose it). Whatever form you have, *Hawley's condensed chemical dictionary* is a very helpful addition to the shelf, virtual or otherwise, of anyone associated with chemistry or chemicals.

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The new world of electric cars

In past issues, I have reviewed several approaches to using different non-fossil fuels for the propulsion of motor vehicles. In recent weeks, there have been several major announcements of proposed electrification of passenger cars, which may have long-term consequences and implications for the Australian vehicle fleet.

In Europe, there is increased level of concern about the use of diesel passenger cars, especially in congested cities. This has not been helped by the behaviour of Volkswagen and their apparent deceptive conduct. VW claimed they could both deliver high-performance passenger diesel engines and keep the level of pollution, particularly nitrogen oxides (NO_x), to very low levels without resorting to the injection of urea (blue additive used by other companies). This claim now appears fraudulent with VW equipping their sophisticated computer-controlled engines with software that could detect when the vehicle was undergoing regulatory performance testing and when it was being used by a VW customer. This was discovered inadvertently by a US research team testing emissions in real on-road conditions.

There have been several consequences of this, possibly the main one being that the claims of all the major vehicle companies on emissions are no longer believed. Early results of increased research on real road emissions, including in Australia, are showing a significant disparity between real-life emissions and manufacturers' claims for petrol engine vehicles as well as diesel-fuelled vehicles.

Internationally, the inability of petrol and diesel vehicle manufacturers to eliminate pollutants has led the French and British governments to propose the banning of all petrol and diesel engine vehicles and replacing them with all-electric vehicles by 2040. However, proposals to electrify the passenger vehicle fleet have serious hurdles to overcome, which are now starting to be realised.

The penny is starting to drop with governments that successful electrification will require an enormous increase in charging points, possibly one in every parking bay. Furthermore, electrification will cost the government's treasuries by the loss of fuel excise duty. The solution to this would be to change the taxing point by means of a usage charge, possibly using satellite geo-positioning to determine the distance travelled by each road user and to develop a road user charge accordingly.

Moving a nation's vehicle fleet to electricity will require a very large increase in power generation. At this stage, in Europe this will almost certainly be by nuclear power, which will require further significant investment. For the UK, this transition is estimated to require an additional 10 000 wind turbines or 10 nuclear power stations.

In line with this ambition, several vehicle manufacturers have announced further investments in electric vehicles. For instance, Volvo has said that it will soon stop production of diesel- and petrol-only vehicles. This has been widely interpreted as an announcement to build electric-only vehicles,

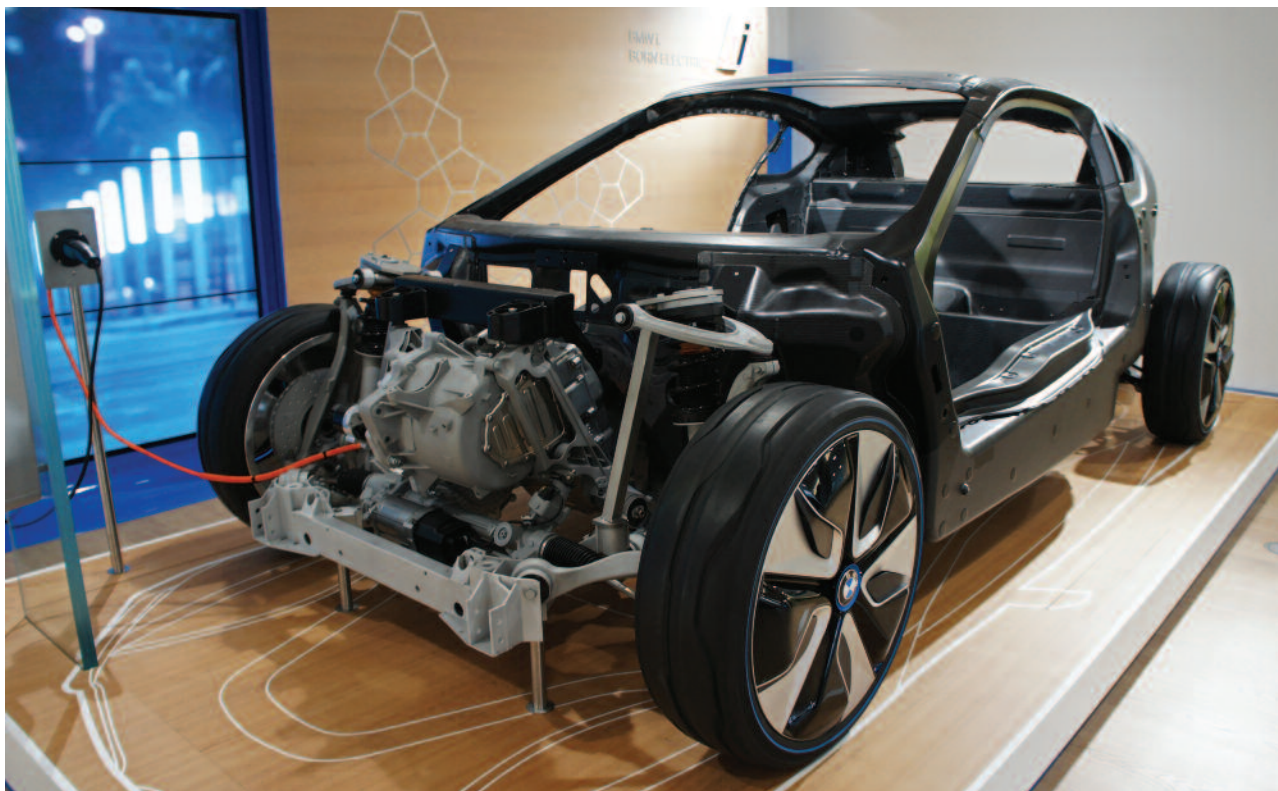
but it is more likely to mean that fossil-fuel/hybrid vehicles would replace the present diesel and petrol vehicles.

One of the major issues with electrification is that, with present knowledge, the logistics and distribution fleet (trucks etc.) are not amenable to electrification and some other source of motive power will have to be found. For zero emissions, the best option would be hydrogen propulsion, on which I have previously commented (March, p. 36). Although there is much enthusiasm for this solution, generation of hydrogen at a reasonable cost is currently beyond reach.

One issue currently missing from the discussion is what to do about jet fuel. Again there has been a lot of media interest in an electric aeroplane but unfortunately although jet engines in the form of gas turbines are used to generate electricity, the process is irreversible and electricity cannot be used to drive a jet engine. Rather, electric-driven aeroplanes would be stuck with propellers as the means of propulsion. This may be fine for a relatively short European journey but it means the end of intercontinental jet travel without an alternative approach. At this stage, the solution seems to be to use renewable fuels from agricultural sources with the risk of ongoing degradation of tropical rainforests to produce the fuel required.

The Australian demand for transport is different from that of the European major centres such as Paris and London. In Australia, the use of very small cars, such as the Smart Car, is rare. Passenger vehicles are larger and many are expected to have a significant towing capacity. For instance, in Europe, owning a boat is for the rich whereas in Australia boat ownership is more egalitarian, with many boats parked in domestic driveways to avoid high mooring costs. Not only this, but many owners expect to be able to tow caravans and small trailers, again not as common in Europe. At this stage of development, electric vehicles do not offer any significant towing capacity. It is a moot point if hybrid/electric vehicles could offer towing capacity to any significant degree.

Another field of research ... is advanced material composites, which are required to further lower the weight of vehicles, thereby improving their range. This demand should spur research into carbon-fibre-reinforced plastic construction materials and light metal alloys.



BMW i8 plug-in hybrid concept car cutaway showing the carbon fibre structure and the electric motor. Mariordo (Mario Roberto Duran Ortiz)/CC BY-SA 3.0

Another difference is that many vehicles in Australia travel long distances every day. This is true for country dwellers, but many trade vehicles also travel the breadth of the urban conurbations several times a day, covering distances of more than 200 kilometres daily. This is also true of Europe and I am not sure if the proponents of electric-only vehicles have fully taken this into account.

Fortunately for the chemist, this unbounded enthusiasm for electric vehicles will bring significant amounts of cash for research to make utopia achievable. Electric vehicles themselves require significant improvements to battery technology to improve charge-carrying capacity. This will probably require a move away from Li/Ni-Co systems and into Li metal technology and this move will require a significant level of chemical research and innovation in the chemistry fundamentals

underpinning battery design.

Another field of research into improving electric vehicles is advanced material composites, which are required to further lower the weight of vehicles, thereby improving their range. This demand should spur research into carbon-fibre-reinforced plastic construction materials and light metal alloys. The major weight problem is due to the mass of copper carried in motor windings and it would be nice if an alternative based on carbon could be found – windings made of graphene fibres perhaps?


The non-fossil fuel production of hydrogen is another area of research. The present technology is poor and there are many opportunities for improvements from the chemistry standpoint.

New chemistry input will also be required for the upgrading of lithium (and graphite) ores to reduce costs. Recently, Rio Tinto have announced the timeframe for the development of their massive Serbian Jadarite (a lithium borate) prospect, which may be cheaper to develop than the spodumene reserves currently used and under development in Australia. If Australia is to play a significant role in this vehicle electrification, then this field is the obvious one in which to make a significant investment to lower lithium production costs.

However, whatever the outcome it seems that electrification will cost a lot of money and it is not clear if the national governments promoting it can afford it.



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(Baby) food for thought: the limits of detecting toxic elements

As the seasoned mom of three grown children, I'm happy to say that they all made it through babyhood without any major health issues. While I worked as an analytical chemist at the US National Institute of Standards and Technology (NIST) during their baby years, I wasn't working on reference materials for measuring nutrients in the foods that they ate or, even worse to think about, toxic elements in them.

I mention this because recently I was asked about an article that reported traces of lead had been found in baby food. While feeding my babies I just assumed, and expected, the baby food they were eating was safe for them. After all, I thought, they are just babies, and we live in the land of milk and honey. Don't we? Of course we do, and of course their baby food was safe for them, wasn't it? And what about that milk and honey? Were those safe too?

... food manufacturers and regulators do everything they can to minimise them, but the truth is that if you want to eat, you will likely be eating some (probably tiny) amount of toxic elements with that food.

Standard reference food

For the past 10 years, I have been producing and analysing Standard Reference Materials (SRMs) for foods. Food SRMs are typical foods you might buy at the grocery store: chocolate, spinach, peanut butter and, yes, baby food. What makes these SRMs different from 'normal' food is the fact that they have been carefully tested to measure the exact amounts of minerals, vitamins, fats, proteins and other nutrients in them. When manufacturers analyse our SRMs and get the right answer, i.e. the same answer we got, chances are good that they got the right answer when they were testing their own products and can be confident about the values they publish on their nutrition labels.

Now, you may have noticed that lead, arsenic, cadmium and mercury are not listed on the food nutrition labels. So how do we know if there are toxic elements in the foods we eat?

Besides putting nutrition facts on the labels of the foods they sell, food manufacturers must also follow safety guidelines. In the US, the Food and Drug Administration (FDA) sets the guidelines, or limits, for the levels of toxic elements permitted in foods. Even though they don't list toxic elements on their labels, manufacturers still need to make sure their products are safe, and so they use NIST SRMs to do this as well.

You're probably thinking, wait a minute, it's okay to have toxic elements in our food? Well, it's complicated. We certainly don't want these toxic elements in our food, and food manufacturers and regulators do everything they can to minimise them, but the truth is that if you want to eat, you will likely be eating some (probably tiny) amount of toxic elements with that food.

One reason for this is that plants absorb elements, both good and bad, from the soil they are grown in. The toxic elements may be naturally occurring in the soil or may have come from human activity, such as mining or waste disposal. Regardless of their source, when we eat those plants, or when we eat the animals that ate the plants, we eat the toxic elements as well. When plants are grown in heavily contaminated soils, or foods are contaminated during preparation or packaging, the toxic elements become a real problem. Companies do everything they can to keep their products safe – if foods with unsafe levels of toxic elements end up being sold to the public, companies recall them. Additionally, the FDA has the authority to keep contaminated foods from entering the US.

Toxic traces in baby food

NIST SRM 2383 Baby Food Composite is a weird combination of foods and not actually a real baby food. This SRM was specifically designed to contain certain amounts of vitamins and elements so that it could be used for nutrition labelling. We did try to measure some toxic elements, though. When this material was first developed, we measured both arsenic and mercury. We found that mercury was undetectable and the arsenic concentration was only 3 nanograms per gram, or 3 parts per billion (ppb). That means if you ate half a jar of the SRM, about 35 grams, you'd be eating 0.000 001 05 grams of arsenic – a speck about 600 times smaller than a single grain of sugar.

The NIST baby food SRM had never been tested for lead and cadmium, so I wanted to know if those elements were in there too. A quick test found about 12 ppb of lead and less than 19 ppb of cadmium, lower than what I can reliably measure. Right now, I'm unable to tell how much lower.

Should we believe these very, very small numbers? I mentioned that mercury could not be detected at all and that there was less than 19 ppb cadmium. We cannot say exactly



Whether into my children or test tubes, I've had a lot of practice spooning baby food. F. Webber/NIST

how much cadmium is in the baby food since it is below what we call the limit of quantification – the level at which we're confident that our measurements are accurate. Generally, we can measure things reliably at levels that are three or four times higher than the minimum we can detect. For lead, the level where we know the measurements are accurate is even lower than cadmium, about 2 ppb. Twenty-five years ago, when my kids were babies, the state-of-the-art equipment that we used was about a hundred times less sensitive than what we have today.

Measured to the limit

The fact that we couldn't detect lead in baby food 25 years ago doesn't mean that it wasn't there. It may have always been there, but our instruments couldn't see it. Now that our tests and equipment have improved, we know it's there, and we can use that knowledge to try to improve the safety and quality of our food supply. When we cannot see an element at all in a food, we say it is below the detection limit. Mercury is below the detection limit in the NIST SRM 2383 Baby Food Composite, but we can never say it is not in there – there may just be too little to see. With new technology, elements can be detected at lower and lower levels, but we need to be careful that what we're measuring is really in the food we're testing and not from a source of contamination in the laboratory.

Mercury is below the detection limit in the NIST SRM 2383 Baby Food Composite, but we can never say it is not in there – there may just be too little to see.

So, knowing what I know now, would I still have fed baby food to my kids? In short, yes. I work closely with food manufacturers and scientists. I know that the manufacturers of baby food, and all food, have expert chemists who work hard to make sure those foods are as safe as they possibly can be for my kids – and for you.

And they use NIST's food SRMs to help them do this!

A 30-year veteran of the US federal government, **Laura Wood** is one of the Program Coordinators for the food and the dietary supplements SRM programs and for the Dietary Supplement Laboratory Quality Assurance Program (DSQAP) at NIST. In her spare time, Laura enjoys being with her husband and their three children, as well as her dogs, cat and bearded dragons. She also volunteers with her church and with the Delaplaine Arts Center in Frederick, Maryland. First published at <http://nist-takingmeasure.blogs.govdelivery.com>.

Durif – an alternative cultivar?

During my time as a distance education student in oenology at Charles Sturt University, I was required to undertake vintage work in the subject known as 'Winery Experience'. I was fortunate to meet several winemakers from north-east Victoria and this led me to seek a practical placement at Fairfield in Rutherglen with Stephen Morris as my 'guide'. Fairfield was very much an old-style winery with open fermenters and old oak barrels and casks for developing the red and fortified wines. Many of the vines were dry-grown, i.e. without irrigation, as is common practice in many parts of Europe.

It was here at Fairfield that I was introduced to the grape Durif. I was somewhat sceptical of the claimed qualities of Durif, especially as my previous knowledge was more about red cultivars that are grown in the cooler climate regions. But I soon came to see the benefits of using Durif in a red wine blend and also as a component of a fortified red wine. The greater surprise was seeing how it worked as a single-component Durif-only red wine.

Durif is the result of a crossing between Peloursin and Syrah (Shiraz). Most reports suggest that it is named after Dr François Durif, a plant breeder from the south-east of France, although the timing of this breeding activity ranges from the 1860s to the 1880s, depending on the report of the cultivar's origin. The choice of cultivars for the breeding is intriguing: Syrah is well known, while Peloursin is somewhat obscure. One has to wonder why the breeding trials were ever established. Durif has never been highly regarded in France. Perhaps the tolerance of Durif to powdery mildew was seen as a potential advantage, yet the quality of the wine from these grapes was never successful and plantings in France have almost disappeared.

In California, the cultivar is known as Petite Sirah. A research investigation into the identity and parentage of this cultivar using DNA marker analysis was carried out at University of California, Davis in 1999 (see Meredith et al. *Am. J. Enol. Vitic.*, vol. 50, pp. 236–42). This work confirmed that Durif/Petite Sirah is in fact a cross, with Peloursin being the maternal parent and Syrah (Shiraz) the pollen (or male) parent. Intriguingly, some supposedly Durif vines were shown to be actually Peloursin. In times past, as still today, it was not uncommon for errors in labelling and/or transport records to occur: the fairly recent Savignin/Albariño issue is a good example (bit.ly/2vcBkfy).

Australian wine industry statistics for 2015 list the area planted to Durif as 625 hectares, while that for Shiraz was 39 893 hectares. Plantings of Tempranillo, the rising red cultivar at the moment, amounted to 736 hectares. While Rutherglen likes to claim that the region produces special characters in Durif, it is planted elsewhere, including some cool climate regions (see bit.ly/2vnJCL7 for a listing of wineries and regions).



Durif vines in Rutherglen. Courtesy Warrabilla Wines

Rutherglen winemakers (bit.ly/2ufOpSw) argue that their climate and generally dry vintage conditions assist in the slow development of Durif on the vine. Durif is one of the late ripening varieties and warm autumn weather is important in this development. Andrew Smith of Warrabilla Wines, who describes himself as a 'Durif tragic' or latter-day convert, goes one step further by saying that Durif is 'a pig to grow viticulturally' (bit.ly/2f3H8kQ). By this, Andrew is referring to the thin skins, which can split, leading to infection, as well as difficulties in getting the crop load right to achieve physiological ripeness (see June issue, p. 40). Some of these issues are different from my experience working with non-irrigated vines on the soils on the east side of Rutherglen; Warrabilla is on the west side and closer to the Murray River and consequently prone to fog later in the harvest season.

When the ripening process all comes together, the wines are simply amazing. There is an intensity of red colour that is difficult to achieve in other red varieties: descriptors include 'black purple', 'blood plum with ruby halo', 'dark morello cherries' and 'satsuma plums'. Aroma terms include 'blackberries', 'violets' and 'aniseed'. The palate can show spice and pepper with fine tannins and a lingering finish. The huge mouthfeel is dominated by fruit and tannin characters and oak should be minimal. In some cases, all these characters can only be obtained when harvested at 15.5–16% potential alcohol.

Rather than recommend wines to try, and clearly showing my bias for Rutherglen, I simply invite you to explore what the region has to offer. The wines do not come out every year – the conditions need to be right for a stand-alone (unblended) wine. Ageing in bottle is also highly beneficial to the development of Durif. A further perspective on Durif by Peter Dry can be found in the *Wine and Viticulture Journal* (2017, vol. 32(2), p. 5) in the 'Alternative Varieties' section.



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.

Remsen visits New Zealand

We have been reading a lot about the years of the Great War, but the centenary of an important scientific meeting passed without much comment. I am referring to the meeting of the British Association for the Advancement of Science (BAAS), which held its meeting (the 184th) in Australia in 1914. European (mainly British) participants stopped off for scientific meetings in Perth, Adelaide and Brisbane, but the main action was in Melbourne and Sydney where the main sessions took place between 13 and 26 August.

Some participants had accepted an invitation to travel on to New Zealand for further meetings with Canadian and American scientists who had been invited to join them there. The official BAAS report said that while the Australian meeting was in progress, the New Zealand arrangements had to be cancelled 'owing to the effects of the European War'. The biographer of Ira Remsen (see below) wrote that the BAAS meeting was cancelled, but it was only the New Zealand add-on that did not go ahead.

The New Zealanders had invited leading scholars from America and Canada to take part in the post-BAAS meetings, and in this they were more successful. Participants were recruited by the President of the Massachusetts Institute of Technology, R.C. Maclaurin (not the Maclaurin of the famous mathematical series), who had been professor of mathematics at the University of New Zealand (Victoria University College, Wellington) from 1899 to 1907. The group consisted of Dr L.H. Bailey, formerly Director of the School of Agriculture at Cornell, but latterly Chairman of the Roosevelt Country Life Commission; Dr Charles Davenport, Director of the Institute for Experimental Evolution at Cold Spring Harbor, New York; E.G. Conklin, Professor of Biology at Princeton; Dr W.M. Wheeler, Professor of Economic Entomology at Harvard University; Dr Paul H. Hanus, Professor of Education at Harvard; and Professor Ira Remsen (1846–1927) of the Johns Hopkins University in Baltimore. Remsen had been professor of chemistry from the university's foundation in 1876, and then its president 1901–12.

The Americans set sail from San Francisco in July aboard the steamer *Tahiti*, bound for Sydney. At the Captain's request, each of them gave a talk about his work, Remsen's being particularly well received. A 24-hour stop at Tahiti enabled them to sample the local culture, and the ship also stopped at Raratonga to pick up copra and oranges for New Zealand. During this leg, the Captain asked Remsen to translate a German message that turned out to be about the declaration of war. Subsequently, the ship was ordered, by wireless, to proceed to Wellington and to travel without lights because there were German raiders in the vicinity. Arriving at Wellington on 31 July, the ship was commandeered as a troop ship, and sailed for Britain two weeks later with 800 troops and 2000 horses.

A series of lectures was organised at the University College in Wellington. Wheeler lectured on 'Ants and other social

Remsen spoke about science and industry, emphasising the value of pure research but noting how difficult it was at first for his students, who did not know how to make soap, to get places in industry. Now, they were eagerly seized upon, he said.

insects', and Hanus on 'The search for standards in education'. Remsen spoke about 'science and industry', emphasising the value of pure research but noting how difficult it was at first 'for his students, who did not know how to make soap, to get places' in industry. Now, they were eagerly seized upon, he said. The reporter who covered the talk for the Wellington *Evening Post* noted that Remsen had 'taught the art and mystery of a chemist' and that 'the audience found him a delightfully humorous man, seriously insistent upon his subject, but ready to make fun of himself'. Davenport did not linger in New Zealand, where he had been expected to speak on eugenics, but instead took ship for Sydney and then addressed the Melbourne meeting on 'Heredity of some emotional traits', drawing on the results of research into the families of '165 wayward girls in state institutions'.

Although the American visitors wished to depart New Zealand soon after the Wellington lectures, there were no ships available and so the NZ government arranged tours for them. Remsen and Bailey went to Rotorua where they 'saw the Waimangu geyser' but perhaps they saw another one, since *Lonely Planet* says the Waimangu went extinct in 1904. They then travelled by 'luxurious steamboat' down the Whanganui River for over 100 miles, and thence to Auckland by road where they boarded the *Makura* for the trip across the Pacific to Vancouver, once again travelling without lights. The ship stopped briefly at Fiji then encountered a big storm on the way to Samoa, but eventually docked at Victoria, BC, where there was some delay before they could proceed home. His biographer observed that Remsen, who had had to step down as President at Johns Hopkins on account of poor health, felt that the sea voyage was beneficial.



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 provides advice on chemical hazards and pollution.

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<http://epts17.org/index.html>

QACS 2017 – Qld Annual Chemistry Symposium

27 November 2017, Queensland University of Technology,

Brisbane, Qld

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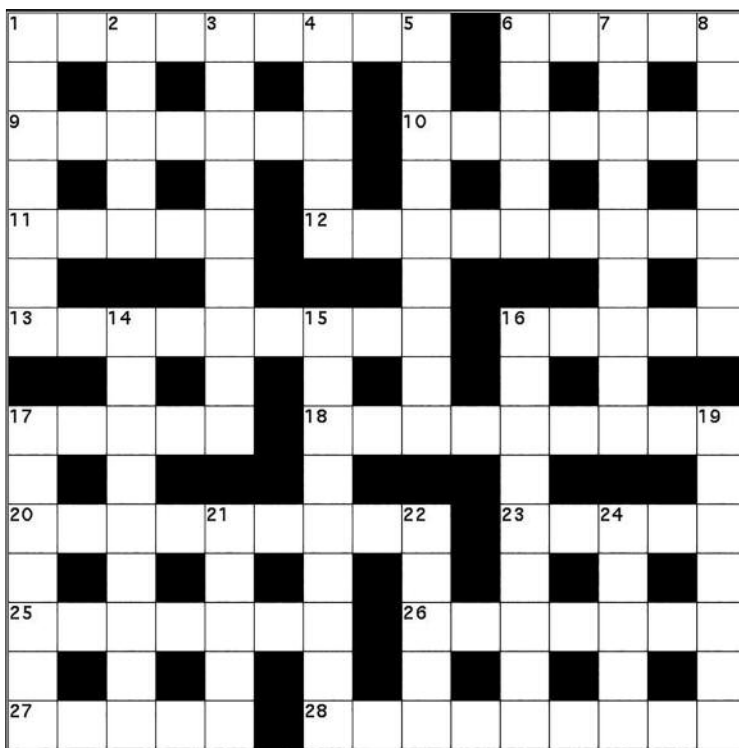
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Across

- 1 Hence core meltdown was displayed by 6 Across. (9)
- 6 Fires aluminium inclusion over beam. (5)
- 9 Bond lithium with nitrogen then add potassium and mature. (7)
- 10 Loss of iodine during baseline crash is helpful. (7)
- 11 Start on group. (5)
- 12 Indicated G&T. Guessed otherwise. (9)
- 13 Tossed dented pan; relying on another. (9)
- 16 Osmium held by the ones that are indicated. (5)
- 17 $X = 247616$. (5)
- 18 Grows due to lack of iron? (9)
- 20 Hit a polymer without using iridium? It can go either way. (9)
- 23 Prepares to lose iodine on the other side. (5)
- 25 First time radical iodine container is unimportant. (7)
- 26 Look at the cost, Spooner: it's clear-cut. (7)
- 27 Edible paper? (5)
- 28 Vault with sulfur multidentate ligands. (9)

Down

- 1 Pass back diol which is dispersed and stable. (7)
- 2 Applause for handwriting? (5)
- 3 Art stance could bring us back to where we started. (9)
- 4 Wants poverty? (5)
- 5 Strangely greet nice and forceful. (9)
- 6 Holiday permission. (5)
- 7 Mixtures of answers. (9)
- 8 Uranium in live part left. (7)
- 14 New hopes pin on hydrogen and PH_3 . (9)
- 15 Decalin is a start to locating information challenging your classic laboratory in chemistry. (9)
- 16 Does care for matter net trouble? (9)
- 17 Confused tea with oxygen. Jerk! (7)
- 19 Plans schemes. (7)
- 21 Oxygen and hot fruit. (5)
- 22 Bare drain. (5)
- 24 Chloride? Negative! (5)

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

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www.memberadvantage.com.au/RACI

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Avio™ 200 ICP Optical Emission Spectrometer



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NexION® 2000 ICP Mass Spectrometer

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