

chemistry

May/June 2019

in Australia



Empowering women in chemistry

chemaust.raci.org.au

- *The Australian Journal of Chemistry*: 70 years of publication
- Understanding uranium's journey in arid Australia
- Top stories from the periodic table

www.rowe.com.au

Online 24 hours 7 days a week, by phone or face to face,
we give you the choice.

INSTRUMENTS - CONSUMABLES - CHEMICALS - SERVICE & REPAIRS



Bel-Art Products



cowie



Gilian

Kartell LABWARE

WMA-ALDRICH



MERCK

METTLER TOLEDO



SIMAX

Tarsons
TRUST DELIVERED



Techno Plas
Dedicated to Plastic Consumables & Quality Packaging

VELP
SCIENTIFICA

witeg
GERMANY

A 100% Australian owned company, supplying scientific laboratories since 1987.

South Australia & NT
Ph: (08) 8186 0523
rowesa@rowe.com.au

Queensland
Ph: (07) 3376 9411
roweqld@rowe.com.au

Victoria & Tasmania
Ph: (03) 9701 7077
rowevic@rowe.com.au

New South Wales
Ph: (02) 9603 1205
rowensw@rowe.com.au

Western Australia
Ph: (08) 9302 1911
rowewa@rowe.com.au



chemistry

in Australia

May/June 2019



30



istockphoto/undefined undefined

cover story

Empowering women in the chemical sciences

In mid-February this year, breakfast was the order of the day, with 5000 women across more than 50 countries gathering at more than 200 breakfast events to take part in a special Global Women's Networking Breakfast.

18

14 AJC's 70th: sharing a virtual issue with chemistry friends

To celebrate its 70th birthday, the *Australian Journal of Chemistry* has released a special online collection of published papers. CSIRO Publishing's Jennifer Foster highlights some of the selections.

30 Profile: Understanding uranium's journey in arid Australian environments

A project mapping the impact of radiation around mine sites is providing new knowledge on whether uranium mining can affect flora and fauna in arid Australian settings.

news & research

- 7 News
- 7 On the market
- 8 Research
- 42 Events
- 42 Cryptic chemistry

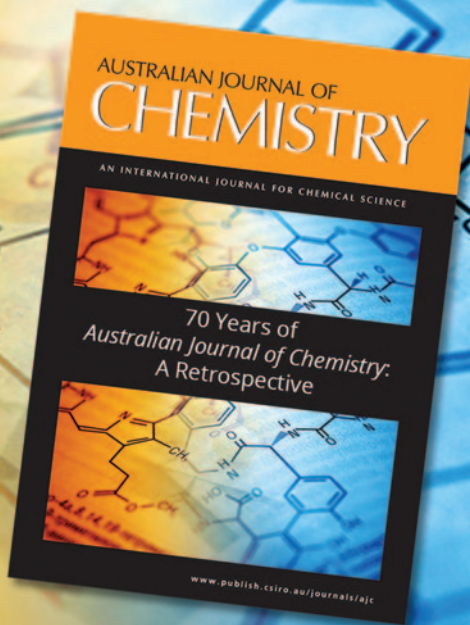
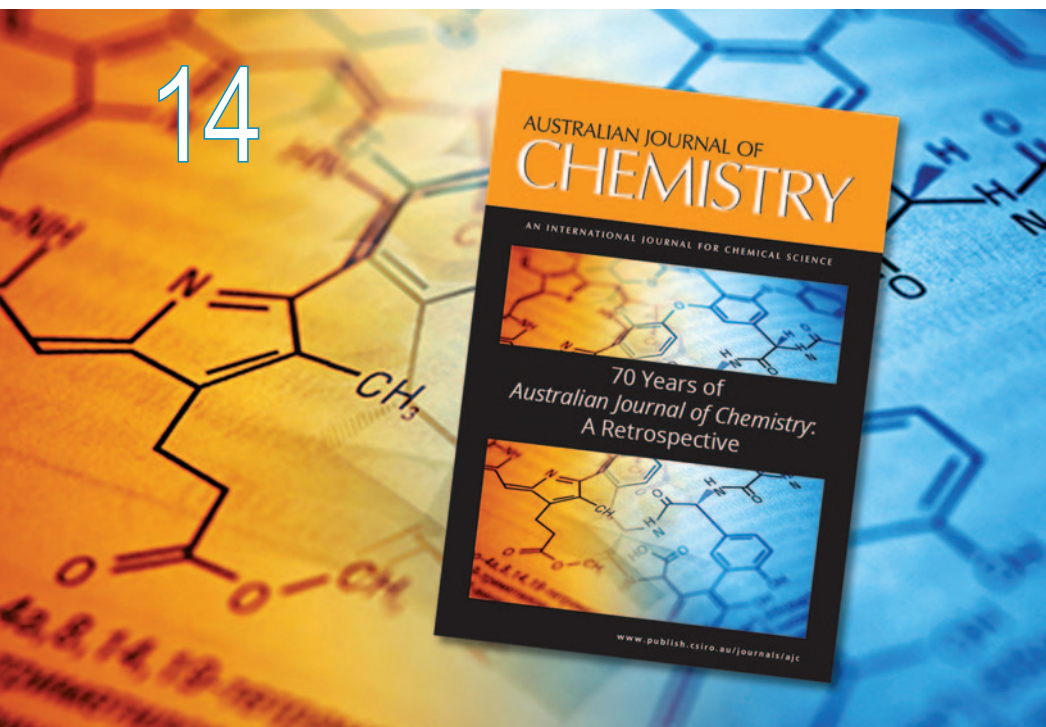
members

- 22 RACI inclusion and diversity: a report on progress
- 26 Top stories from the periodic table
- 27 Call for nominations
- 28 New Fellows

views & reviews

- 4 Editorial
- 5 Your say
- 32 Books
- 36 Science ↔ Society
- 37 Environment
- 39 Grapevine
- 41 Letter from Melbourne

chemaust.raci.org.au



From past to present

This issue marks 10 years for me as editor of *Chemistry in Australia*, so I've revisited my first issue.

In 2009, the eight beamlines at the Australian Synchrotron in Clayton were relatively new, and construction was shortly to begin on a high-performance computer facility for rapid analysis of beamline data. Facility director Robert Lamb and staff writer Nancy Mills reported on the techniques available and the users' meetings hosted. The Australian Synchrotron is now under the ANSTO umbrella and has 10 beamlines, with plans under Project BRI-GHT to construct several more.

In our news section of my inaugural issue, we reported the recent launch of the Institute of Photonics and Optical Science (IPOS). Then IPOS director Professor Ben Eggleton said that one of IPOS' core objectives was to 'ensure the power the net uses won't be a source of future energy crises'. According to the International Telecommunications Union, the number of people in developed countries using the internet has jumped from about 60% to more than 80% since then, and Google is processing more than 3.5 billion searches per day globally. Last year, researchers at IBM Research in Zurich reported 'the fastest data transmission speed to date' – an aggregate bandwidth of 160 Gb/s, using a chip manufacturing technique based on a complementary metal-oxide-superconductor (bit.ly/2H0TyqS). Now, there's something for Australia's NBN to aspire to.

In the same issue, Helmut Hügel talked chemical engineering with Professor Rose Amal, who had been awarded the inaugural Freehills Innovation Award in Chemical Engineering by the Institute of Chemical Engineers and RACI. Amal continues to lead the Particles and Catalysis Research Group at the University of NSW, and is a Scientia Professor and ARC Laureate Fellow. A recognised pioneer in fine particle technology, photocatalysis and functional nanomaterials, over the past decade she has attracted more than \$25 million from the ARC and industry partners.

Dr Martin Schlegel, Managing Director of Advanced Polymer Technology Australasia, discussed the manufacture and performance requirements of artificial sporting surfaces, and how the properties of turf systems are a game-changer in sports such as soccer, lacrosse, hockey and basketball. The 9th World Congress on Science and Football will be held in Melbourne in June, so I hope to bring you some updates in this area later in the year.

My first issue as editor was mostly in black and white. In those days, along with a 'lack lustre' look came the more technical issues of depicting colour in graphs, molecular structures, solutions and spectra. Although *Chemistry in Australia* can now publish images in colour, the editorial team still has problems finding images depicting the real world of chemistry and other sciences. Images often feature rainbow-coloured solutions and a lack of safety gear. It's a struggle to find realistic images of women scientists, of a range of ages and appearances, working independently and confidently across all fields of science.

Madeleine Schultz, Michelle Coote and Alex Bissember report in the current issue (p. 22) on inclusion and diversity in the RACI, comparing past and present data on women's participation in RACI membership, conferences and awards. 'Further to the attempts to improve the diversity of representation within chemistry', they say, 'effort must be directed to maintaining inclusion and providing support to aid retention and progression into senior roles'. Exploring women's career progress was a focus for the hundreds of gatherings worldwide in February as part of this year's Global Women's Networking Breakfast, which IUPAC Bureau member Mary Garson and co-chair of the IUPAC centenary management committee Laura McConnell describe (p. 20).

As I write this, it's Women's History Month in the US. To mark the event during this International Year of the Periodic Table, the American Chemical Society's video series Reactions is 'sharing the story of two of chemistry's most brilliant and bold women [Marie Curie and Ida Noddack (nee Tacke)], their paths to elemental discovery and how they changed the world as we know it': <https://youtu.be/Zv8jECGdZAY>. Equally interesting are the stories of women in science currently being published by authors and editors at Springer Nature (<https://bit.ly/2V1TQRr>). The faces on this page would be a great reference point for stock photo libraries who wanted to bring some diversity to their depiction of women, and women scientists in particular.



Sally Woollett (editor@raci.org.au)

chemistry
in Australia
chemaust.raci.org.au

EDITOR

Sally Woollett
Ph (03) 5623 3971
wools@westnet.com.au

PRODUCTION EDITOR

Catherine Greenwood
catherine.greenwood@bigpond.com

ADVERTISING SALES

Mary Pappa
Ph/fax (03) 9328 2033/2670
mary.pappa@raci.org.au

PRODUCTION

Control Publications Pty Ltd
science@control.com.au
www.control.com.au

BOOK REVIEWS

Damien Blackwell
damo34@internode.on.net

RESEARCH HIGHLIGHTS

David Huang
david.huang@adelaide.edu.au

EDUCATION RESEARCH HIGHLIGHTS

Reyne Pullen
r.pullen@unsw.edu.au

GENERAL ENQUIRIES

Robyn Taylor
Ph/fax (03) 9328 2033/2670
chemaust@raci.org.au

PRESIDENT

Vicki Gardiner FRACI CChem

MANAGEMENT COMMITTEE

Renate Griffith, Helmut Hügel, Colin Scholes, Madeleine Schultz, Richard Thwaites

CONTRIBUTIONS

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.

© 2019 The Royal Australian Chemical Institute Inc. unless otherwise attributed. Content must not be reproduced wholly or in part without written permission. Further details on the website (chemaust.raci.org.au).
ISSN 0314-4240 e-ISSN 1839-2539



Is biological better than organic?

I appreciate Anthony Zipper's comments on attempts to define 'natural' and 'organic' (March/April, p. 5). I agree that 'natural' is a term that is essentially impossible to define – it is, as I noted in my November/December 2018 column (p. 40), essentially what the consumer prefers to call a wine. Perhaps the best image I have seen for natural wines is a bunch of grapes being squeezed directly into a glass, being 'transformed' as it were into wine along the way! But it was a human hand squeezing the grapes, so maybe it is not natural anyway!

'Organic' is for me a nonsense term. This must be, as Anthony mentioned, what any chemist would think. When I first encountered 'bio' on a wine bottle in Europe, it took a while to recognise that this was 'organic'. So, in France, regulations refer to *l'Agriculture Biologique*, abbreviated to 'Bio'. This gives *le vin bio*, while in Germany there is *Bio-Wein*. 'Biological' has become my preferred term for wines and grape production systems that are labelled as 'organic'. But I doubt if my preference will change the regulators.

Geoffrey Scollary FRACI CChem

Sequestration of sulfides

The details of the complex mechanisms involved in the sequestration of the active foul tasting and smelling sulfides was really fascinating (March/April, p. 40). I have spent 40 years working on copper sulfides as corrosion products on historic shipwrecks, and the interactions of polysaccharides is opening new thought processes regarding the biodynamic interactions with marine colonising organisms.

Reading of wines is all the more compelling because of my Lenten fast from all forms of alcohol, so we only have four weeks or so to go and then it is back into the reds. Many thanks for opening my mind in such a stimulating fashion.

Ian MacLeod FRACI CChem

Refinery classification

Duncan Seddon's article on gasoline (March/April, p. 38) has come at a time when I am compiling information on refineries for a book that I hope will have seen the light of day by the September/October issue. From what I have learned, I might be able to add a little to his classification of refineries. He applies the terms 'simple', 'complex' and 'very complex' to refineries in an attempt to classify them. I will consider these here alongside an alternative basis for classification.

A refinery having atmospheric distillation only can be called a topping refinery (= simple refinery?). Sometimes at such a refinery the desired product is in the residue, as it would be at a refinery set up to make large amounts of asphalt. The distillate can be passed along to another refinery for further treatment. A refinery with limited capability beyond atmospheric distillation, perhaps just a means of reforming naphtha, can be called a hydroskimming refinery. A refinery in which, by processes such as vacuum distillation, fluid catalytic cracking and

hydrotreatment, distillate equivalents are made by residuum conversion is called a conversion refinery. D. Seddon places in the complex refinery category a refinery capable of that, and informs us that cheap crude oils have to go to a very complex refinery. Often, a crude is cheap because it is dense, in which case the heavy residual component can be converted to distillate equivalents in a role he assigns to a complex refinery.

Refineries are classified according to the Nelson complexity index. A refinery with no capability beyond atmospheric distillation would have a complexity index of 1.0. Any further operation raises that. In the notional asphalt-producing refinery, the Nelson complexity index would exceed unity by an increment reflecting the complexity of asphalt production from the residual material. For a hydroskimming refinery, processes that follow atmospheric distillation each add an increment to the complexity index (e.g. naphtha reforming and desulfurisation).

All of the processes at a conversion refinery would raise the Nelson complexity index. For example, the Tesoro Carson Refinery in California, which has all of the features attributed to a conversion refinery plus one or two more, including a means of making propylene, has a Nelson complexity index of 13.2.

Clifford Jones FRACI CChem



As your RACI member magazine, *Chemistry in Australia* is the perfect place to voice your ideas and opinions, and to discuss chemistry issues and recently published articles.

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

WHERE THE PERIODIC TABLE
COMES TO LIFE

IYPT EXPO

11 August 2019
Melbourne

raci.org.au

In celebration of the International Year of
the Periodic Table of Chemical Elements

national
science
week 2019

raci
Royal Australian Chemical Institute

Element 92 for Australia?

As I have a special interest in alternatives to carbon as a source of power, I was fortunate to attend, on 25 February, a lecture entitled 'Legal Aspects of Nuclear Energy', sponsored by the Royal Society and the Australian Institute of Energy. The speaker was Helen Cook, a lawyer specialising internationally in this subject.

Ms Cook indicated that she sees the core problem at present in delivering nuclear energy successfully not in evaluation of its net benefits, or the technical issues of engineering, safety, reliability, or even waste disposal, but in contracting and governments. Here are some of my notes on her presentation.

If the fates of various stalled or abandoned attempts to get a plant up and running in numerous countries are analysed, the typical picture that emerges is failure to draft a contract that doesn't collapse somewhere between signing and throwing the switch. One problem is that contracts are complex and all tend to be 'bespoke': each different in some way from all others. Other difficulties lie primarily with working in the unfamiliar territory of the interface between law, commerce and engineering, but also with inexperienced governments and contractors who do not learn from the mistakes of others. With the infamous Westinghouse projects (How Westinghouse, symbol of US nuclear power, collapsed, *Power*, 30 March 2017), construction was begun before the engineering was complete!

Nuclear projects must begin, explained Ms Cook, with the requirements of international, multi- or bi-lateral conventions or agreements and with international law, codes and standards. Examples of these are nuclear non-proliferation, prevention of terrorism and waste management. Australia is regarded as a serious signatory to many and has a good safety record but limited experience.

Where different technology is introduced for the first time, new risks have to be defined and liability has to be allocated: failure to do this well has been a frequent case of disagreement and delay. Fixed-price contracts are 'Very brave, Minister' as Sir Humphrey would say.

Financing is tricky because investors are often looking at returns over a short time frame, whereas a nuclear project requires thinking 60 or even 100 years ahead and a guaranteed supply of the raw material. Which leads to the need for government direction and support or, even better, state ownership. Russia, India and China are all building new stations: with dictatorial governments in charge they are more likely to succeed, according to Ms Cook.

If we were to proceed in Australia, where would we start? Ms Cook said it would be with reversal of the legislative ban now in force, a new single Authority, new over-arching legislation and total agreement regarding no State or local overlap or interference.

Ms Cook asked, 'Are we wasting time even discussing it in Australia?'. My summary of her longer answer is 'Yes, until we have a stable and forward-looking government'.

Bruce Graham FRACI CChem

Do Australia's regulations measure up?

The Australian Government has released a second set of discussion papers for public consultation as part of its ongoing Measurement Law Review into Australia's measurement framework.

The Measurement Law Review seeks to streamline, simplify and modernise the framework to meet current and future needs of industry and consumers. Three discussion papers have been released, each addressing a specific issue under review: Traceable Measurements, Measuring Instruments and Measurement-Based Transactions.

These follow on from the first discussion paper – Scope of Australia's Measurement Laws – released in 2018, which attracted a wide range of ideas and input for redeveloping the measurement framework.

The new consultation equally invites public input on a range of issues, from what measurements should apply when buying particular goods or services (Measurement-Based Transactions), to how we can safeguard confidence in the measuring instruments used to price those goods and services (Measuring Instruments), as well as how to ensure our measurements are consistent with international standards (Traceable Measurements).

National Measurement Institute (NMI) Chief Executive Officer and Chief Metrologist, Dr Bruce Warrington, said the discussion papers were an opportunity for Australians to have their say on what works and what can be improved about the use and regulation of measurement in everyday life.

'The issues raised by these papers affect every Australian', Warrington said.

'Measurement is a key pillar for our economic and social wellbeing, from industry and research to our health and the environment.'

Warrington noted the broad role of the NMI in ensuring effective and trusted measurement in Australia, from calibrating measuring instruments to delivering specialised chemical analysis to working with industry on new measurement methods.

'The NMI's role in administering measurements for trade helps make sure that Australians get what they pay for when buying goods and services by measure.'

Submissions for the second round of public consultation close on 31 May 2019.

Visit www.industry.gov.au/measurement-law-review to access the discussion papers and find out more.

National Measurement Institute

Shimadzu's Nexera UHPLC series with AI and IoT enhancements

Shimadzu's new Nexera UHPLC series with AI and IoT enhancements sets industry standard for intelligence, efficiency and design. The Nexera series makes lab management simple by integrating IoT and device networking, enabling users to easily review instrument status, optimise resource allocation, and achieve higher throughput.

The Nexera UHPLC series maximises reliability and uptime with fully unattended workflows that span from start-up to shut-down. Operators can set the Nexera to start up at a specified time, so that it can complete auto-purge, equilibration, baseline checks and system suitability in advance, and be ready for analysis before they arrive at the lab. In addition, FlowPilot ramps up the flow rate gradually, reducing the possibility of damage to columns. The Nexera also has auto-diagnostics and auto-recovery capabilities that allow it to monitor pressure fluctuations to check for anomalies.

With remote mobile phase monitoring and integrated consumables management, the system maximises uptime and reliability. Real-time monitoring of mobile phase levels allows lab personnel to efficiently run batches and respond accordingly if there isn't enough mobile phase before starting a run. In addition, Nexera tracks consumable usage and sends alerts when parts need replacing, allowing users to keep the system running at peak performance. The Nexera UHPLC series allows analysts to confirm parameters and monitor chromatograms in real time directly from a web browser on their smart device.

The Nexera UHPLC increases efficiency by automating workflows and maximising throughput analysis. The SIL-40 autosampler can process the entire injection cycle time in as little as seven seconds, and continuous analysis can be carried out on up to 44 MTPs (using three plate changers). The SIL-40's plate changers enable non-stop temperature-controlled analysis of thousands of samples. The Nexera automatically blends mobile phases at any set ratio, which speeds up the preparation of buffer solutions and the dilution of solvents. Because it prepares the exact amounts required for analysis, the Nexera reduces waste and labor.

The Nexera's elegant and compact design saves valuable bench space. Notably, the Nexera UHPLC uses more than 80% less electricity in standby mode, thereby significantly reducing running costs and supports an environmentally friendly lab.

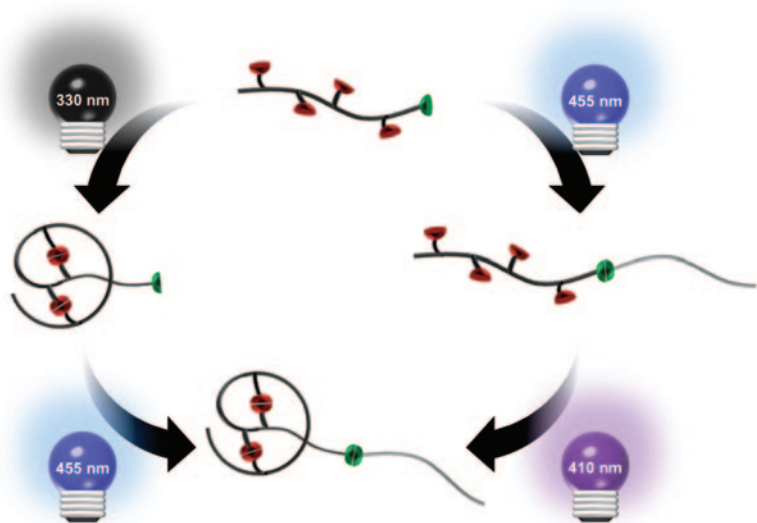
For more information, visit www.shimadzu.com.

Sequence-independent wavelength-orthogonal polymer ligations

Photochemistry is a powerful tool for the spatiotemporal control of chemical reactions and is the basis of sophisticated light-based fabrication methods. Taking a step further, finely tuning the employed wavelength – with nanometre precision – would afford additional powerful control

by allowing different photoreactive groups to be selectively triggered by irradiation with specific wavelengths of light. This strategy had not previously been exploited, but now QUT's Soft Matter Materials Laboratory have unleashed the potential of such light-controlled reactions

by developing the first wavelength-orthogonal photoligations (Frisch H., Bloesser F.R., Barner-Kowollik C. *Angew. Chem. Int. Ed.* 2019, **58**, 3604–9). Two photoligations were performed on one macromolecule triggered solely by different colours of light and, critically, in any desired order. One of the two reaction pathways was exclusively triggered by colours of visible light (violet and blue), fulfilling the quest for mild reaction conditions avoiding biologically harmful UV light. The orthogonal photoligation strategy was used to generate hierarchical macromolecular architectures that combined the single-chain folding of polymers with a covalent single-chain ligation. In the emerging field of single-chain nanoparticles, i.e. synthetic mimics of proteins by means of advanced polymer chemistry, these structures are a first step towards architectures beyond secondary and tertiary structures, approaching the complexity of their natural paragons.

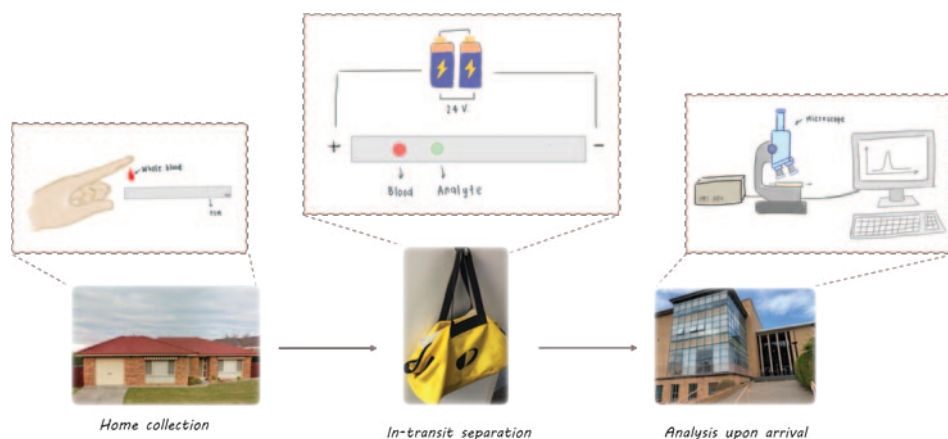


Electrophoresis through the mail

The treatment of biological samples after collection is one of the most time-consuming processes for clinical diagnostics and adds to the cost of an analysis. Even though current point-of-care diagnostic technology addresses the issue by allowing rapid off-site analysis, it is not yet applicable for all target

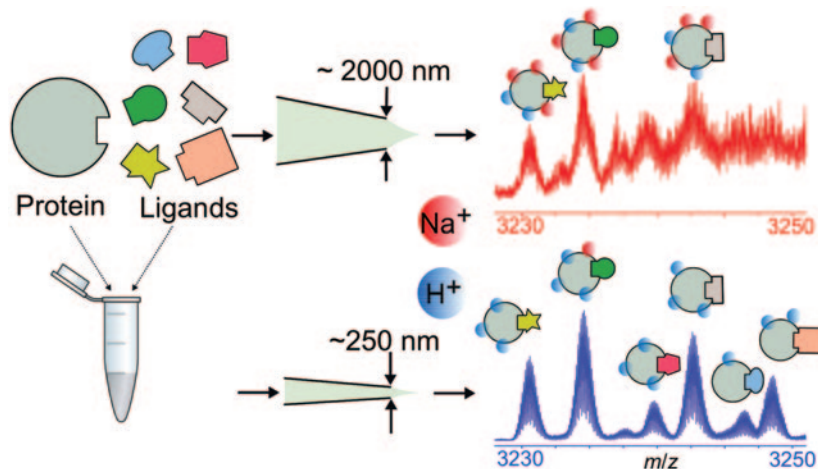
analytes, particularly small-molecule therapeutics and diagnostic markers. Thus, transportation and sample preparation, such as solid-phase extraction, followed by chromatographic analysis are unavoidable. Now, a team led by Michael Breadmore of the University of Tasmania has developed a new platform that allows

sample preparation to be done while the sample is sent through the mail (Nanthasurasak P., See H.H., Zhang M., Gujit R.M., Breadmore M.C. *Angew. Chem. Int. Ed.* 2019, **58**, 3790–4). The portable platform is based on a polymer inclusion membrane (PIM), a completely dry conducting film, on which electrophoresis is performed using two 12 V batteries. The 15–20 μm thick PIM is made from cellulose triacetate, 2-nitrophenyl octyl ether and 1-ethyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide, and is used as a base upon which a small drop of blood is placed. To test the new platform, a blood drop spiked with the alkaloid berberine – a model small molecule pharmaceutical – was used. As the blood drop dried, the berberine was extracted into the PIM and then separated from the blood matrix by electrophoresis in the PIM. The film was then scanned with a fluorescent microscope for quantitation without any additional processing.



Nanoscale ion emitters for measuring binding affinities in native mass spectrometry

Electrospray ionisation mass spectrometry is crucial for rapidly determining the interactions between small molecules and proteins with ultrahigh sensitivity. However, non-volatile molecules and salts that are often needed to stabilise the native structures of protein–ligand complexes can readily adduct to protein ions, broaden spectral peaks, and lower signal-to-noise ratios in native mass spectrometry. William (Alex) Donald and co-workers at the University of NSW, in collaboration with the groups of Stephen Bell (University of Adelaide) and Claudiu Supuran (University of Florence, Italy), have developed electrospray emitters with narrow tip diameters (~250 nm) to significantly reduce the extent of adduction of salt and non-volatile molecules to protein–ligand complexes (Nguyen G.T.H., Tran T.N., Podgorski M.N., Bell S.G., Supuran C.T., Donald W.A. *ACS Cent. Sci.* 2019, **5**, 308–18). The

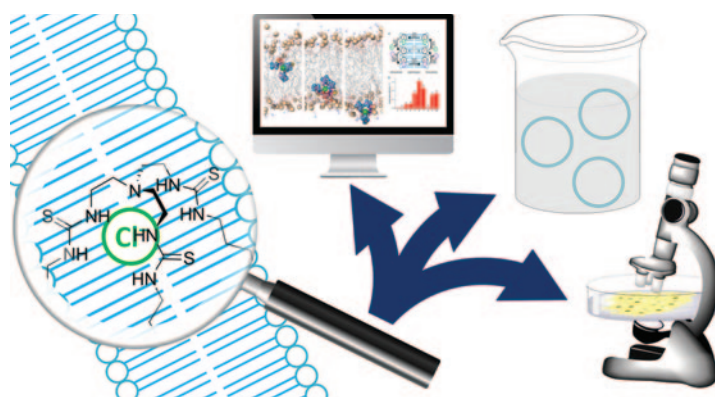


methodology can be used to measure ligand–protein binding constants more accurately than by use of conventional emitters. Peaks corresponding to protein–ligand complexes that differ in relative molecular weight by as low as 0.06% can now be readily resolved. Owing to the improved spectral resolution, binding affinities can be simultaneously obtained

for at least six ligands to a single druggable protein target from one spectrum for the first time. Overall, it is anticipated that nanoscale emitters will be beneficial for rapidly screening small-molecule libraries to accurately identify ligands that bind potently to druggable protein targets with high sensitivity.

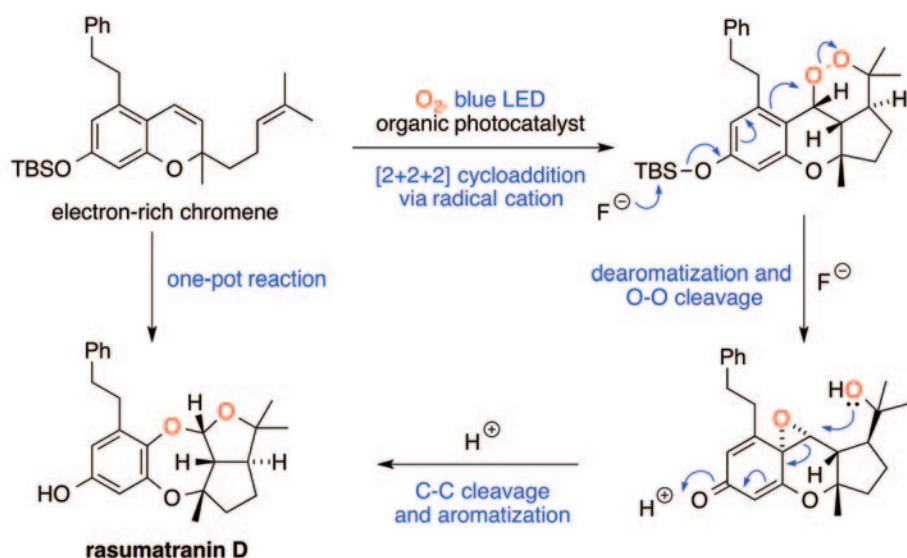
Transmembrane anion transporters and how they work

The design, synthesis and investigation of small synthetic transmembrane anion transporters is an important focus of supramolecular chemistry research due to the potential biomedical application of these compounds in the treatment of disease. A multidisciplinary team headed by Phil Gale at the University of Sydney, together with collaborators at the Universities of Southampton and Bristol (UK) and the University of Aveiro (Portugal), have used a combination of experimental and computational methods to study the anion transport properties of fluorinated anion transporters in model lipid bilayer membranes and in cells (Spooner M.J., Li H., Marques I., Costa P.M.R., Wu X., Howe E.N.W., Busschaert N., Moore S.J., Light M.E., Sheppard D.N., Félix V., Gale P.A. *Chem. Sci.* 2019, **10**, 1976–85). Fluorinated anionophores displayed an unusual transport mechanism because the free transporter failed to rapidly cross the membrane in vesicle-based pH discharge assays and required complexation to the carboxylate form of fatty acids present in the bilayer in order to do so. Consistent with these data, molecular modelling revealed strong interactions of fluorinated anionophores with phospholipid bilayers than non-fluorinated analogues. The researchers



demonstrated that transport activity relies on a finely tuned balance between lipophilicity and anion binding affinity for each transporter and they concluded that integration of computational and experimental methods provides a strategy to optimise transmembrane anion transporter design for biomedical applications.

Visible-light photoredox catalysis for biomimetic synthesis of natural products



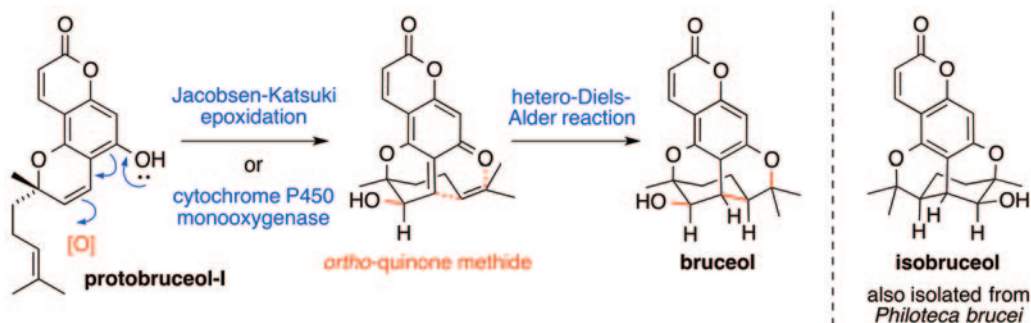
Adelaide using a photoredox catalysed [2+2+2] cycloaddition as the key step (Hart J.D., Burchill L., Day A.J., Newton C.G., Sumbly C.J., Huang D.M., George J.H. *Angew. Chem. Int. Ed.* 2019, **58**, 2791–4). Computational studies indicated that this [2+2+2] cycloaddition likely proceeds via a radical cation formed by single-electron oxidation of the electron-rich chromene substrate, which is then trapped by triplet oxygen to give a cyclic endoperoxide. Fluoride-mediated cleavage of the weak endoperoxide O–O bond resulted in dearomatisation of the aromatic ring to give an epoxide, which then underwent acid-catalysed C–C bond cleavage to form rasumatranin D. Remarkably, these three reactions could be combined into a one-pot operation in which one C–C and four C–O bonds, three stereocentres and two rings were formed. This work also resulted in the structure revision of rasumatranin D, alongside the synthesis of several proposed ‘undiscovered natural products’.

Recent developments in visible-light photoredox catalysis have given organic chemists many new ways to access radicals and radical ions by single electron transfer processes. These methods are ideally suited to the biomimetic synthesis

of natural products, since single-electron oxidations and reductions are ubiquitous in biosynthetic pathways. For example, total syntheses of nyingchinoids A, B and D, and rasumatranin D, were recently achieved by chemists at the University of

Bruceol Mighty

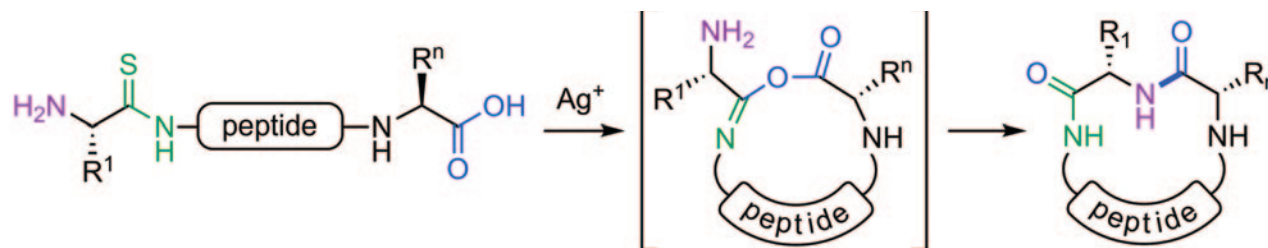
Bruceol is a polycyclic meroterpenoid natural product (of mixed polyketide and terpene origin) first isolated from the Western Australian flowering shrub *Philotea brucei* in 1963. This work was conducted at the University of Western Australia (UWA) by Jefferies, Maslen and co-workers, who used X-ray crystallography (but not NMR spectroscopy) to determine the structure of bruceol. The NMR spectrum of bruceol was then reported by Waterman at the University of Strathclyde in 1992 upon its re-isolation from the same plant species. Recently, researchers at the University of Adelaide have achieved a biomimetic synthesis of bruceol from its proposed biosynthetic precursor, protobruceol-I, via an intramolecular hetero-Diels–Alder



reaction of a reactive *ortho*-quinone methide intermediate (Day A.J., Lee J.H.Z., Phan Q.D., Lam H.C., Ametovski A., Sumbly C.J., Bell S.G., George J.H. *Angew. Chem. Int. Ed.* 2019, **58**, 1427–31). This biomimetic cascade reaction was triggered via asymmetric epoxidation of the electron-rich chromene of protobruceol-I using either a transition metal catalyst or a cytochrome P450 enzyme. Intriguingly, the NMR spectrum of

synthetic bruceol did not match the published data of Waterman et al. Remarkably, the original 55-year-old isolation sample of bruceol was obtained from UWA, which was shown to have an identical NMR spectrum to the synthetic material. Finally, it was proposed that Waterman had in fact isolated a structural isomer of bruceol (‘isobruceol’), which was confirmed through synthesis and re-isolation of this new natural product.

Cyclic peptides made easy

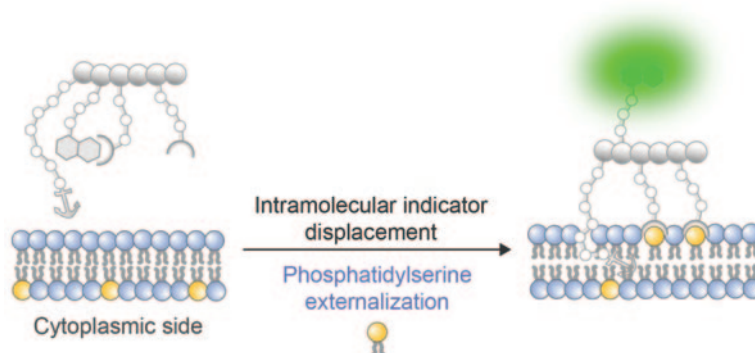


Peptide macrocyclisation is often a slow process, plagued by epimerisation and cyclodimerisation. Now, the Hutton group at the University of Melbourne has developed a new method for peptide macrocyclisation employing the Ag^{I} -promoted transformation of peptide thioamides (Thombare V.J., Hutton C.A. *Angew. Chem. Int. Ed.* 2019, **58**, 4998–5002). The Ag^{I} has a dual function: chemoselectively activating the thioamide and tethering the N-terminal thioamide to the C-terminal carboxylate. Extrusion of Ag_2S generates an isoimide

intermediate, which undergoes acyl transfer to generate the native cyclic peptide, resulting in a rapid, traceless macrocyclisation process. Cyclic peptides are furnished in high yields within one hour, free of epimerisation and cyclodimerisation. In essence, a single atom substitution ($0 \rightarrow \text{S}$) on the peptide backbone enables a chemoselective macrocyclisation, triggered by Ag^{I} . The process was applied to a diverse group of naturally occurring and designed cyclic peptides of 5–10 residues.

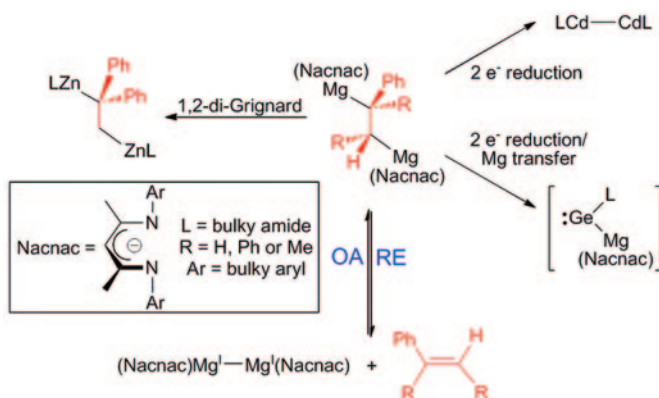
Lighting up dying cells with a fluorescent probe

Apoptosis, or programmed cell death, is a vital process in multicellular organisms. One of the earliest hallmarks of apoptosis is the externalisation of phosphatidylserine to the outer leaflet of the cell membrane. Annexin V–fluorophore conjugates, which consist of a fluorescent label attached to a protein that binds to cell-surface phosphatidylserine, are the current tools of choice for studying apoptosis. However, these conjugates possess a number of drawbacks, including temperature sensitivity, Ca^{2+} dependence, and slow binding kinetics. A team led by Kate Jolliffe at the University of Sydney has developed a novel probe to study apoptosis that circumvents these drawbacks and displays superior performance compared with annexin V conjugates in fluorescence imaging and flow cytometry experiments (Zwicker V.E., Oliveira B.L., Yeo J.H., Fraser S.T., Bernardes G.J.L., New E.J., Jolliffe K.A. *Angew. Chem. Int. Ed.* 2019, **58**, 3087–91). The success of the



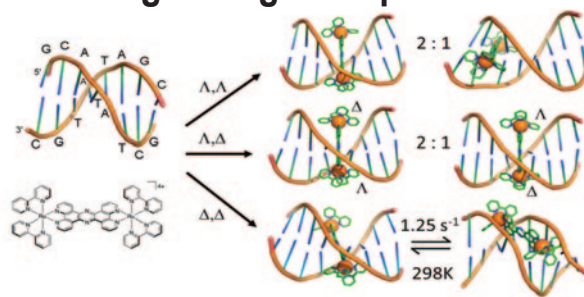
novel probe can be ascribed to its sensing mechanism: an intramolecularly bound coumarin fluorophore is released in the presence of externalised phosphatidylserine, resulting in a fluorescence ‘turn-on’ response. Importantly, this enables the visualisation of apoptosis in real time using confocal fluorescence microscopy.

Acyclic 1,2-di-Grignard reagents make their debut



For more than 100 years, and since initial efforts by Victor Grignard himself, stable acyclic 1,2-di-Grignard reagents have eluded synthetic chemists. Now the team of Cameron Jones at Monash University has built upon their recent work (see March 2018 issue, p. 14), to prepare a series of such compounds by the reversible oxidative addition of their magnesium(I) dimers across a series of 1,1- and 1,2-disubstituted alkenes (Dange D., Gair A.R., Jones D.D.L., Juckel M., Aldridge S., Jones C. *Chem. Sci.* 2019, **10**, 3208–16). Not only does this extend the new field of reversible redox molecular magnesium chemistry created in their lab, but the compounds have proved to be multi-talented with respect to their further organometallic chemistry: when treated with bulky amido-metal halide complexes, they can be electronically and/or sterically tailored to behave as either 1,2-di-Grignard reagents, two-electron reducing agents, or two-electron reductive magnesium transfer reagents. These abilities have allowed entry to hitherto unknown compound types, such as 1,2-dizincioethanes and magnesio-germylenes, which have considerable synthetic potential in their own right. This potential is currently being explored in the Jones lab.

Threading through a duplex needle



Reprinted with permission from Fairbanks S.D. et al. *J. Am. Chem. Soc.* 2019, **141**, 4644. Copyright 2019 American Chemical Society.

The so-called 'light switch' complexes turn on emission when bound to DNA. An example is the dinuclear species $[\{\text{Ru}(\text{bpy})_2\}_2(\mu\text{-tpphz})]^{4+}$ (shown in the picture). Until recently there was no definitive evidence of how it binds to DNA, but now the three stereoisomers ($\Delta\Delta$, $\Lambda\Lambda$, $\Delta\Lambda$) of this compound have been chromatographically separated and characterised by X-ray crystallography, and have had their individual interactions with a DNA octanucleotide, d(GCATATCG).d(CGATATGC), assessed by high-field 1D and 2D NMR (^1H and ^{31}P), and restrained molecular mechanics calculations (Fairbanks S.D., Robertson C.C., Keene F.R., Thomas J.A., Williamson M.P. *J. Am. Chem. Soc.* 2019, **141**, 4644–52). Selective deuteration of the bipyridyl rings allowed sufficient spectral resolution of the bridging tpphz ligand to characterise the bound structures. The three stereoisomers bind differently to the octanucleotide sequence and chirality plays an important role. The $\Lambda\Lambda$ and $\Delta\Lambda$ structures show slow-exchange kinetics as they bind by threaded intercalation. The $\Delta\Delta$ /DNA complex exists in two bound states in intermediate exchange on the NMR time scale, suggesting a dynamic exchange between minor groove binding and intercalation. This study provides the first NMR-based structures of a DNA-threaded metal complex. An interesting implication is that it may be possible to detect cancer-associated non-canonical DNA structures – such as mismatches – using related ruthenium light switches.

ROWE SCIENTIFIC
PTY LTD. ABN 62 626 627 726
www.rowe.com.au
Pledge to Chemists

If chemists in Australia are experiencing difficulty in obtaining supply, please send me an email, peter.sommers@rowe.com.au and I promise to help you.

This is not a 'subtle' attempt to obtain more business, but a sincere pledge to help fellow scientists source the items they need to do their work, and thereby help Australia grow. This is the raison d'être for Rowe Scientific Pty. Ltd. **Peter Sommers (FRAC)**

ADELAIDE
08 8186 0523
rowesa@rowe.com.au

BRISBANE
07 3376 9411
roweqld@rowe.com.au

HOBART
03 6272 0661
rowetas@rowe.com.au

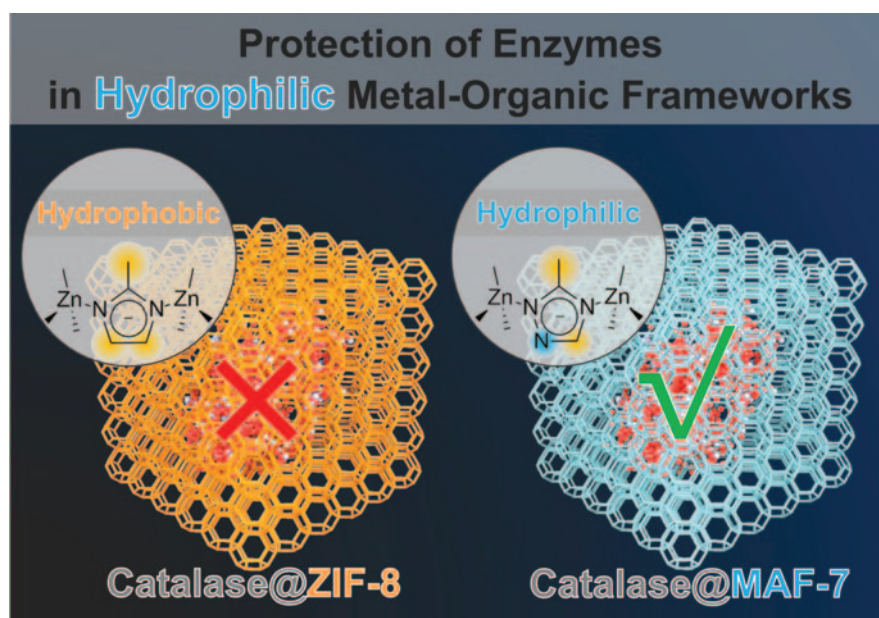
MELBOURNE
03 9701 7077
rowevic@rowe.com.au

PERTH
08 9302 1911
rowewa@rowe.com.au

SYDNEY
02 9603 1205
rowensw@rowe.com.au

Protecting enzymes in hydrophilic MOFs

An emerging body of research has shown that the functionality of biomacromolecules, such as proteins or DNA, and even viruses and cells can be preserved in harsh environments by encapsulation in metal-organic frameworks (MOFs). But limited consideration has been given to the importance of the chemistry of the MOF and the MOF-bio interface. Recent work by researchers at the University of Adelaide, Fudan University (China), Graz University of Technology (Austria) and Elettra Sincrotrone (Italy) has demonstrated that catalase encapsulated within hydrophilic metal azolium framework-7 (MAF-7) or zeolitic imidazolate framework-90 (ZIF-90) retains a significant degree of enzymatic activity, even when exposed to high temperatures, denaturing or proteolytic agents, or organic solvents (Liang W., Xu H., Carraro F., Maddigan N.K., Li Q., Bell S.G., Huang D.M., Tarzia A., Solomon M.B.,



Amenitsch H., Vaccari L., Sumbly C.J., Falcaro P., Doonan C.J. *J. Am. Chem. Soc.* 2019, **141**, 2348–55). Catalase@MAF-7 biocomposites could be reused multiple times without enzyme leaching or loss of activity. In contrast, encapsulation in the isoreticular but hydrophobic material


ZIF-8 essentially deactivates catalase. Based on these observations the researchers posit that optimising hydrophobic/philic interactions between enzymes and MOFs is critical for the effective encapsulation and stabilisation of biomolecules in a functional state.

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.*) are encouraged to contribute general summaries, of no more than 200 words, and an image to David.

Our 2019–20 media kit is now available at chemaust.raci.org.au.

For further information, contact
mary.pappa@raci.org.au or
jane.okeefe@raci.org.au
 (03) 9328 2033





AJC's 70th

Sharing a virtual issue
with chemistry friends

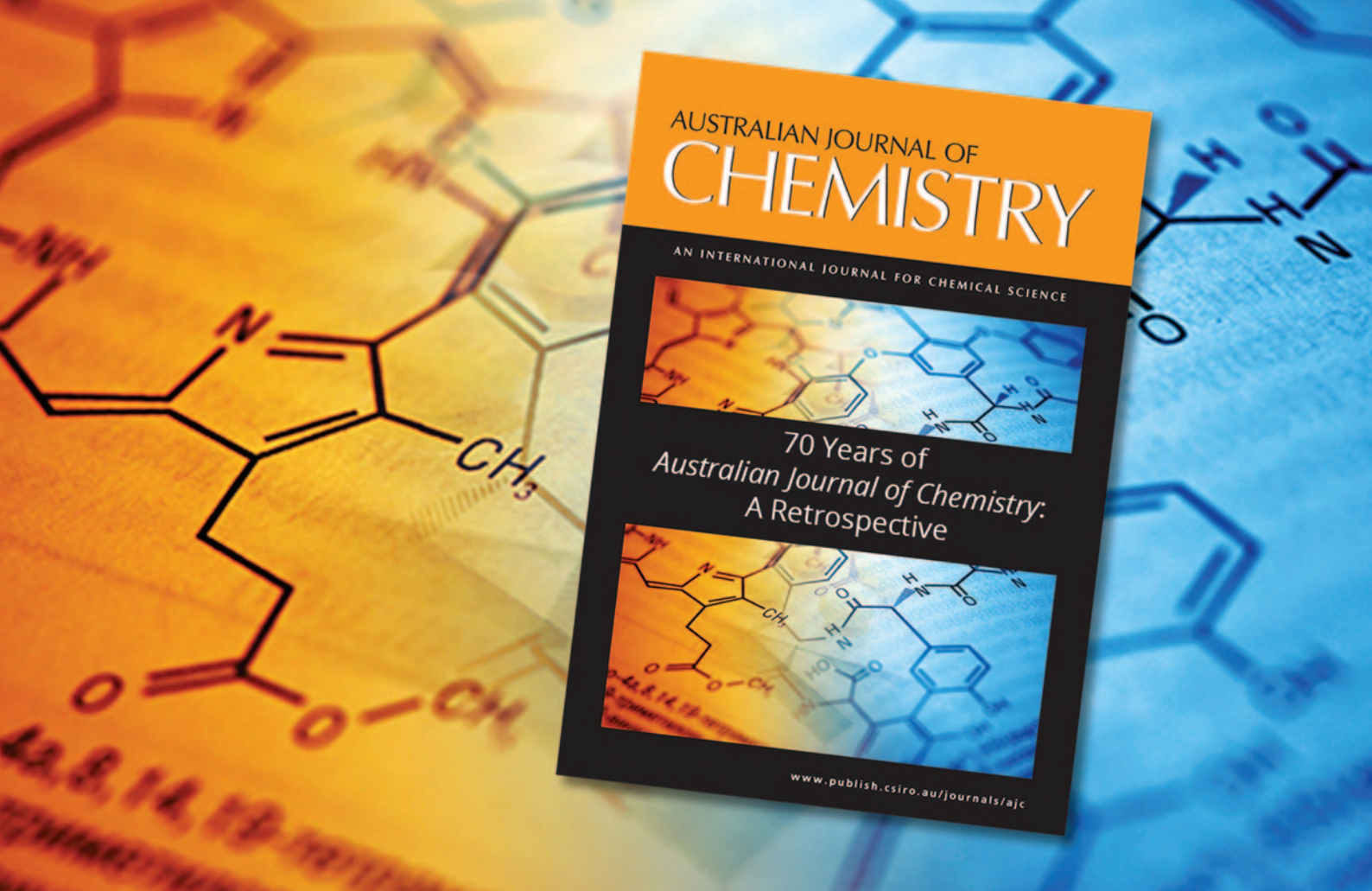
To celebrate its 70th birthday, the *Australian Journal of Chemistry* has released a special online collection of published papers. CSIRO Publishing's **Jennifer Foster** highlights some of the selections.

Milestone birthdays deserve appropriate celebrations. At his 80th birthday a few years ago, surrounded by close family and old and new friends, my dad* gave a speech that included reflections on the highlights during his lifetime, describing how the people in his life had influenced and shaped those highlights. In pondering a fitting celebration for the *Australian Journal of Chemistry's* recent 70th birthday, reflecting on the highlights of its lifetime seem an equally fitting way to celebrate – surrounded by friends and family and reflecting on how its scope, its future directions and its reputation have been moulded by its authors over the past 70 years. To do this, we created a virtual issue (www.publish.csiro.au/ch/virtualissue/2482) – a free online collection of 12 papers showcasing the best chemical science from Australasia, along with publishing important international contributions, to share with our chemistry friends until 30 June 2019. The selection of the papers for this virtual issue by AJC's Editorial Board was largely subjective – choices were informed by hard data (citations and downloads), but also by diversity

in topic and in authorship. There are many papers that one could argue could and should have made the list but didn't. The paper that first and foremost comes to my mind is the famous (and freely available) series of RAFT Reviews by CSIRO RAFT inventors Ezio Rizzardo, Graeme Moad and San Thang. The first of these (*Aust. J. Chem.* 2005, vol. 58, pp. 379–410), plus three subsequent updates, have accrued more than 3500 citations to date, with the original attracting more than 1600, the most amassed by any paper published in AJC. The contents of the Reviews were largely based on the work of these authors, which with related work was largely responsible for the transformation of free radical polymerisation to the great activity we see today. Such was the impact of their work that Rizzardo, along with David Solomon, shared the 2011 Prime Minister's Prize for Science, and the CSIRO group were contenders for the 2014 Nobel Prize.

In short, RAFT polymerisation put Australian polymer science at the forefront of research into free radical polymerisation. However, because Reviews attract a disproportionately high number of citations, the Board decided against their inclusion in the

*RACI Honorary Fellow Professor Don Cameron



Virtual Issue. They do, however, deserve a gong in their own right.

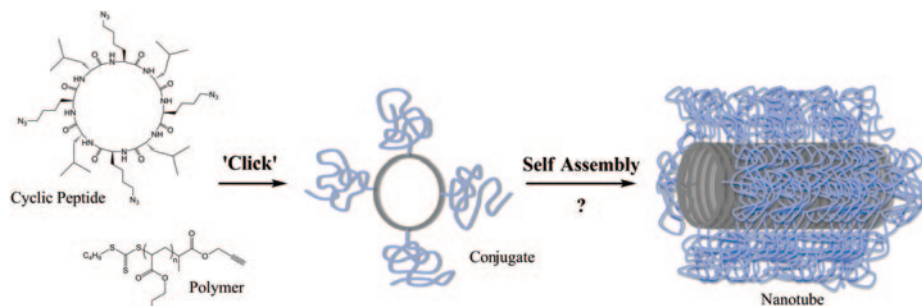
One of the outstanding challenges in the RAFT area is the design of RAFT agents capable of controlling monomers with distinct reactivities. Included in this collection is a landmark paper by Michelle Coote and co-workers (*Aust. J. Chem.* 2005, vol. 58, pp. 437–41) describing a viable synthetic route to a novel class of RAFT agents bearing a fluorine Z-group. Such F-RAFT agents are predicted to allow living free radical polymerisation of various monomers without affecting the rate of polymerisation, and should also facilitate the construction of block copolymers from monomers with disparate reactivity.

Indeed, modern polymerisation techniques have revolutionised chemists' ability to create materials with tailored properties, but these synthetic capabilities are still far outstripped by nature's. As scientists try to synthesise more complex

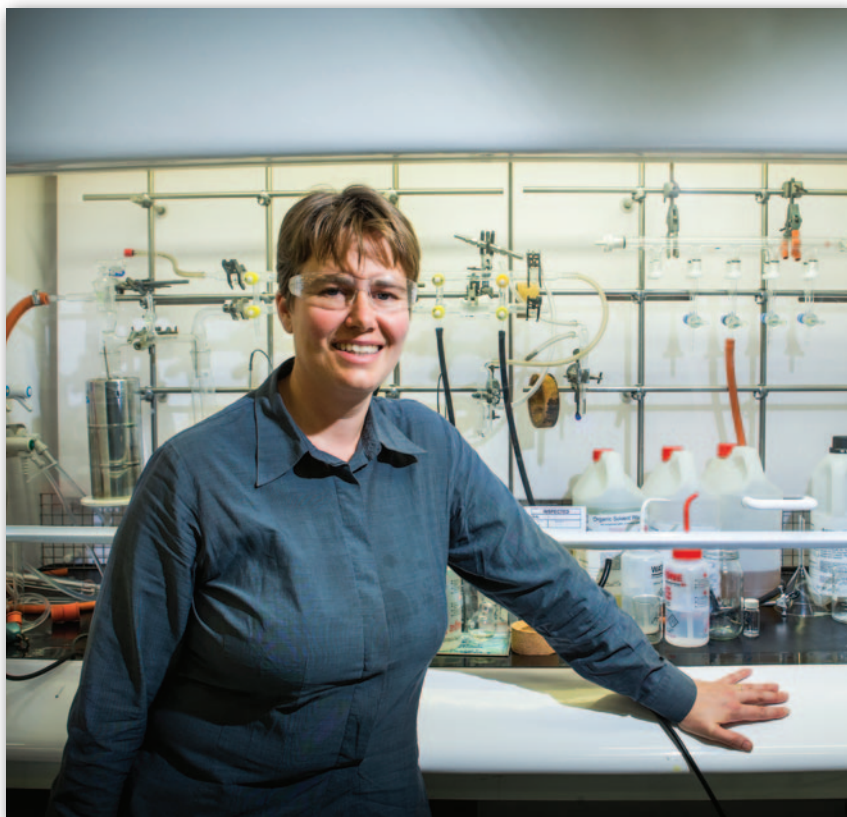
materials, the challenge to do so by traditional synthetic methods is hugely significant. Recent research has taken inspiration from the way that nature builds well-defined and complex structures through the self-assembly of smaller molecules. This 'bottom-up' approach has proved to be the most promising route to design materials with structures controlled at the nanoscale. In their paper 'Synthesis of self-assembling cyclic peptide-polymer conjugates using click chemistry' (*Aust. J. Chem.* 2010, vol. 63, pp. 1169–72), Chapman, Jolliffe and

Perrier demonstrate that click reactions enable the conjugation of polymeric chains to cyclic peptides, and that the resulting conjugates show natural self-assembly into nanotubes.

All authors featured in this collection are international figures in chemistry, but many also dedicated themselves to the Australian research community as mentors for the next generation of this country's scientists. Arthur Birch was one such figure, perhaps best known for the reaction that bears his name, the Birch reduction of aromatic compounds by solutions of sodium



'Synthesis of self-assembling cyclic peptide-polymer conjugates using click chemistry', by Robert Chapman, Katrina A. Jolliffe and Sébastien Perrier.



Michelle Coote, co-lead author of the F-RAFT paper and a past associate editor of AJC.

and ethanol in liquid ammonia. This process has wide application, most notably in the commercial synthesis of oral contraceptives, giving rise to his title 'the father of the pill' (www.science.org.au/fellowship/fellowships/biographical-memoirs/arthur-john-birch-1915-1995). His seminal but lesser known work towards the polyketide theory, written with Frank Donovan, which accounts for the biosynthetic origins of a wide range of natural products, including many of the important antibiotics used in human chemotherapy today, was published in *AJC* in 1953 (*Aust. J. Chem.* 1953, vol. 6, pp. 360–8) and appears in this collection. In short, it supports the hypothesis that the molecules in that study are elaborated, at least in part, by the head-to-tail linkage of acetate units.

Sir John Cornforth was a year behind Birch at the University of Sydney and followed him to Robinson's laboratory at Oxford. Cornforth's

successful studies at Sydney were achieved under difficult conditions. He was deaf, so could not attend lectures, and instead learned German so that he could read the original literature. Those who knew him described him as a colourful character, who was well known for his quick wit. Cornforth received the Nobel Prize in Chemistry in 1975 for his work on the stereochemistry of enzyme-catalysed reactions, and is still the only Australian chemist to have received that accolade. His outstanding prose makes the paper 'The trouble with synthesis' (*Aust. J. Chem.* 1993, vol. 46, pp. 157–70) a delight to read.

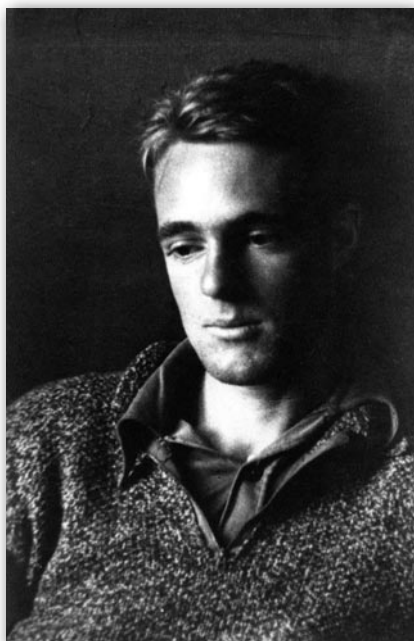
Rodney Rickards joined Birch in Manchester in 1956, the same year he published his first paper in *AJC*. Ironically, Rod, then at the ANU, had just completed a biographical memoir of Birch (with Cornforth), when he died suddenly at home in December 2007. Rod was known for his outstanding achievements in the

organic and biological chemistry of compounds of medical, biological, agricultural and veterinary importance, encompassing a remarkable breadth of chemistry and diversity of structural types. One of his papers, featured in this compilation (*Aust. J. Chem.* 1989, vol. 42, pp. 717–30), presents a very early example of using a chiral solvate of known configuration to set the absolute configuration of a natural product using X-ray crystallography.

In physical chemistry, McNeill and co-workers (*Aust. J. Chem.* 1963, vol. 16, pp. 1056–75) from the CSIRO Division of Physical Chemistry authored a landmark series of papers appearing in *AJC*, predating the work of Heeger, MacDiarmid and Shirakawa, who were eventually awarded the Nobel Prize in Chemistry in 2000 for the discovery and development of conducting polymers. The first of these papers, 'Electronic conduction in polymers. I. The chemical structure of polypyrrole', appears in this collection.

The use of computational techniques in chemistry is undoubtedly very important, and growing. A relatively early study by Patricia Hunt (Imperial) and Barbara Kirchner (Bonn) (*Aust. J. Chem.* 2007, vol. 60, pp. 9–14) on using computational techniques to understand the properties of ionic liquids is included for its historical value. Certainly, computational techniques have moved on in the last 10 years, and while some subsequent studies appear to agree with all the findings, some agree only with parts of it. Those in the field will no doubt continue to discuss what is 'correct', as understanding ion pairing remains a very hot topic in the field.

A paper of immense historical significance entitled 'Internal rotation in some organic molecules containing methyl, amino, hydroxyl, and formyl groups' by Leo Radom and Sir John Pople (*Aust. J. Chem.* 1972, vol. 25, pp. 1601–12) was published in the



John W. Cornforth as an 18-year-old student. Photo by his friend Dick Welsh, from the family album of daughter Philippa Cornforth.

Cornforth received the Nobel Prize in Chemistry in 1975 for his work on the stereochemistry of enzyme-catalysed reactions ...

very early days of combining quantum chemical methods with computers in order to solve chemical problems, and these calculations were carried out on early mainframe computers with punched cards. It was one of the very first systematic explorations of conformational energies of organic molecules using quantum chemical methods. These studies became more and more sophisticated (and popular) with the advancement of theoretical

procedures and supercomputers, and eventually contributed to Pople's Nobel Prize in 1998.

Enriching this collection of papers is the synthetic masterpiece by Alan Sargeson and co-workers ('Mono- and bis(2,2'-bipyridine) and (1,10-phenanthroline) chelates of ruthenium and osmium. IV. Bis chelates of bivalent and trivalent osmium', *Aust. J. Chem.* 1964, vol. 17, pp. 325–36), with no less than 50 compounds reported. This paper was a very important contribution to the understanding of osmium ligand substitution reactions. At the time, crystallography and NMR spectroscopy were far less accessible than they are today, and the authors used more traditional methods of characterisation including UV-vis, elemental analysis and conductance measurements.

Another article continuing the theme of Australian inorganic chemistry, authored by Michael Bruce and Neville Windsor (University of Adelaide) (*Aust. J. Chem.* 1997, vol. 30, pp. 1601–4), paved the way for the organometallic chemistry of cyclopentadienyl ruthenium bis(phosphine) moieties as a consequence of its simplicity and efficacy. Prior to the publication of this paper, the title compound was only accessible by far more tortuous routes, and in poorer yields. In essence, the synthesis of cyclopentadienyl ruthenium(II)-bis(triphenylphosphine) chloride is a one-pot reaction from which the product crystallises in quantitative yield, and has led to thousands of papers using this complex.

Starting in 1970, Richard Robson (University of Melbourne) developed new types of ligands, based on Schiff-base chemistry but now known as Robson ligands, that were, for the first time, rationally designed to bind to two or more metal atoms in close proximity. This paper (*Aust. J. Chem.*

1970, vol. 23, pp. 2225–36), the third in the series, reported the first macrocyclic binucleating ligand, and thus was a landmark achievement in the synthesis of polynuclear metal complexes.

It would be remiss to complete this historic collection without including a paper authored by Allan White. In addition to being a talented organist, Allan was an ISI Highly Cited Scientist, publishing nearly 1850 scholarly articles (643 of those appearing in *AJC*) containing over 5000 structure determinations. Allan possessed a trademark reluctance to publish material until late in the project, when it could be appreciated in its entirety. Work was usually submitted as one colossal paper (we called them 'bricks') that told as much of the story, as completely as possible, in one hit. With some journals, this approach caused difficulties with indigestibility in refereeing and the editorial process. With the guidance of editors Bob Schoenfeld and John Zdyszewicz, numerous 'bricks' found a home in *AJC* on a regular basis throughout the 1980s and 90s. His paper on structural studies in the 1 : 1 copper(I) halide–pyridine base system (*Aust. J. Chem.* 1977, vol. 30, pp. 1937–45) accurately reflects the chemistry Allan was doing.

It's worth reflecting on why we have an *Australian Journal of Chemistry* and how much we care about its future. I hope it reminds you of the people who were, or still are, longstanding supporters of the journal throughout their careers.

My dad concluded his 80th birthday speech by thanking his family and friends for sharing his special celebration, and his life. On behalf of *AJC*'s past and present editors, thank you to those who have helped shaped our beloved journal over the last 70 years. Here's to the next 70!

Jennifer M. Foster FRACI CChem
(jenny.foster@csiro.au) is publisher of the *Australian Journal of Chemistry*.

Empowering women in the chemical sciences

In mid-February this year, breakfast was the order of the day, with 5000 women across more than 50 countries gathering at more than 200 breakfast events to take part in a special Global Women's Networking Breakfast.

BY **MARY GARSON**
AND **LAURA MCCONNELL**

On 12 February 2019, women chemists from more than 50 countries shared breakfast. They were taking part in the international networking event Empowering Women in the Chemical Sciences, an activity to celebrate the centenary of the International Union of Pure and Applied Chemistry (IUPAC). Women have made enormous contributions to the advancement of chemistry over the past 100 years, including as winners of Nobel Prizes and many other major international awards, but they rarely take time to celebrate these achievements.

Worldwide, there were more than 200 breakfasts, with more than 5000 women involved, almost certainly making it the largest 'virtual' gathering of women chemists worldwide. The first events were held in New Zealand, with Wellington and Palmerston sharing the honour of initiating the breakfast events. In her role as global co-convenor, Mary Garson skyped the Wellington breakfast from her Brisbane base at 5 a.m. local time to acknowledge their significant role. The final breakfast was launched in Hawaii 22 hours later. Dunedin, New Zealand, and Gothenburg, Sweden, hosted the most southerly and northerly breakfasts, respectively.

In Australia, a total of 13 different breakfasts took place in nine different cities (Adelaide, Brisbane, Cairns, Geelong, Hobart, Melbourne, Perth, Sydney and Townsville). Some breakfasts were arranged by local sections (Western Australia, Queensland), by newly formed Women in Chemistry groups linked to RACI (Adelaide, Sydney), or were linked to Divisional conferences such as the PhysChem2019 meeting held in Perth.

Breakfast programs

A major aim of the IUPAC100 celebrations has been to encourage chemists to network. Individual breakfast meetings announced the opening and closing of their event by posting a short video to Twitter or Instagram with the hashtags #IUPAC100 and #globalbreakfast. A global map displaying the locations of individual breakfasts was hosted on the IUPAC100 website, and as groups announced themselves, blue placeholders corresponding to their locations were converted into red hearts; it was after all only two days before Valentine's Day! In this way, a virtual 'handwave' was created that travelled around the globe.

As the celebration progressed, groups were able to find out about the activities that had taken place in other



The Global Breakfast held in Brisbane.

cities. The Twitter message feed shared photo images and short videos in real time, and also presented an opportunity for those who could not join in directly to connect to the event. In particular, the final breakfast in Hawaii was identified on Twitter, and recognised by an email exchange between Margaret Baker (Hawaii), Joanne Harvey (Wellington) and Mary Garson (Brisbane), thereby completing a global handwave link.

Individual breakfast groups were encouraged to bring their own creative ideas to designing their individual event. Here in Australia, Macquarie University encouraged their participants to prepare a poster about an inspirational woman figure while at the University of Calgary in Canada, small groups were invited to make a duck from Lego pieces (no other instructions were provided). The Potsdam (Germany) group undertook a team-building activity involving buckminsterfullerene models. Participants at the University of Manitoba created a wall-size periodic table with the names of elements linked to the names of women in science, such as Cu for Marie Curie and Ar or Fr for Frances Arnold. In Korea, following breakfast, there was a technical session in which female speakers spoke about their research.

Some breakfasts were able to attract sponsorship and provide prizes or takeaway 'goodie' bags. Catering was equally creative; individual cupcakes iced with the symbols of individual chemical elements, sponge cakes with periodic table designs (celebrating IYPT). Breakfasts in Germany and Italy celebrated in great style with prosecco and fruit juice.

Scope and opportunity

Although every country arranged their events to suit the needs of their own local audience, it was envisaged that a focal point for individual breakfasts would be to explore career progression for women chemists. A set of questions compiled for use at the December 2018 inaugural Women in Organic Chemistry symposium of RACI were shared with individual breakfast organisers worldwide to assist them in constructing panel discussions or question and answer sessions. Two webinars were made available; one with Dr Raychelle Burks (St Edwards University, Texas, USA) explored the use of social media to expand career networks, while a second webinar was of a conversation with Kate Jolliffe (University of Sydney) in which Mary Garson (University of Queensland) asked her about her career history and her tips on career advancement.

'It's exciting, and humbling, to think that there are groups of women, just like us, all over the world, hosting breakfasts just like this, sharing this moment together. Today we join together, women across the world, to support each other, make new connections and spark new collaborations.' (Dame Carol Robinson, President Royal Society of Chemistry (UK))

'... it was somewhat humbling to think that we were a small part of something much bigger ... it's perhaps the first time I've felt that way with the internet.' (from blog about the Potsdam, USA breakfast)

'Powerful. That's how we feel today, tomorrow and always! Thank you IUPAC for this wonderful event; we are proud.' (Lebanon)

'Promising and very active movement' (Russia)

An editorial in the *Journal of Chemical Education* by Marcy Towns (2019, vol. 96, pp. 1–2) neatly explained the benefits of joining in one of these global breakfast events. She summarised

research on the benefits of networking for persistence within the STEM field, and gave insight into how a mentoring experience had been beneficial in her own career development.

A number of countries who had not previously engaged with IUPAC joined in the celebration. IUPAC is currently interested in feedback from breakfast groups about whether their networks could be used to form a global alliance of women chemists. Therefore, a PowerPoint display highlighting the role and activities of IUPAC was made available for download from the IUPAC website.

Australia breakfasts

The NSW Branch breakfast was the launch event of the newly formed local Women in Chemistry group and featured advice on how to juggle a career in science as a woman by a panel of influential speakers, including Professor Margaret Harding. At Macquarie University, attendees chose a figure who inspired them, and submitted posters to display during the breakfast. Guests were encouraged to vote for their favourite poster, discuss why a particular figure was special to them, and play games focused on identifying female scientific heroes.

One of several Victorian group meetings, held by the Victorian Women in Chemistry group at CSIRO headquarters in Clayton, enjoyed a presentation on the periodic table by Jenny Sharwood, OAM. Another breakfast was held at Swinburne University, and there was also a small, but enthusiastic, group at the Waurn Ponds campus of Deakin University.

In Hobart, Tasmania, conversation centred on how to encourage women into a career in science.

There were three breakfasts in Queensland. Breakfast in Brisbane was organised by the local RACI branch (Dr Mary Fletcher (Past President, Queensland branch) and Associate Professor Joanne Blanchfield (President-Elect, Queensland branch), ably assisted by Ruth Meaney in her final contribution as Branch Coordinator). A panel of three senior women (academic Avril Robertson, patent agent Simone Vink and environmental scientist Michele Neil)



Global breakfasts held in (top) Bangkok, Thailand; (middle, left) at the Women in their Element symposium in Murcia, Spain; (middle, right) in Iloilo City, the Philippines; (bottom) in Uyo, Nigeria.

discussed their individual career progressions, and commented on work-life balance and childcare issues. Breakfast participants also reflected on why they were inspired by chemistry, and shared their own experiences with younger chemists. Yang Liu arranged breakfast in Townsville (in spite of the major flood event). Among the eight women who joined in, it was agreed that they would get together frequently to share support and advice, given that they had not previously met each other despite working in the same university. The Cairns campus of James Cook University North Queensland held breakfast arranged by Claudia Cobos from the Australian Institute of Tropical Health and Medicine.

The South Australian Women in Chemistry group held a panel discussion, including South Australia's Chief Scientist, Caroline McMillen. Students from two local high schools participated.

Finally, there were two breakfasts in Perth; the local RACI Branch attracted a broad mix of members to their event at the Bentley Technology Park. Skype contact was made with colleagues attending a breakfast event at the RACI Physical Chemistry Division conference on the University of WA campus, and internationally with breakfasts in Taipei and China, in this way adding to the global 'handwave'.

Outcomes

Once the Global Breakfast Day was completed, individual breakfasts submitted video footage and photo images, and these were archived on the IUPAC website for use in preparing reports and promotional materials, such as videos. From the many messages received since the event, it is clear that there has been a genuine mood of togetherness. A big factor that contributed to the success of the event, and the ease of communication between different events, was the interactive website set up by IUPAC.

Our aim is that the enthusiasm and interest generated by the event will translate into ongoing support for IUPAC, as this global organisation reviews its developing role as an umbrella organisation prioritising diversity and inclusiveness. An important outcome is the reminder to women chemists that they should step up and take a role in their own professional societies; the leadership opportunities that are created by working on professional society business are worthwhile because they are so often beneficial to career development.

By coming together, participants gained exposure to new role models or research, industrial and educational contacts, thereby expanding their own individual networks.

Acknowledgements

We thank Eduardo Gallo-Cajiao (University of Queensland) for his assistance with registration and the website, and Dr Lynn Soby (Executive Director, IUPAC) for her inputs in facilitating the event and on 12 February with converting placeholders to red hearts. Staff at TheeDigital, including Keri Giordano and Gabrielle Tardive, prepared the website in consultation with IUPAC staff. Ula Alexander (Adelaide), Ruth Meaney (Brisbane), Claudia Cobos (Cairns), Duncan Wild (Perth-Crawley), Nathan Kilah (Hobart), Jordan Gardner (Melbourne-Swinburne), Marzi Barghamadi (Melbourne-Clayton), Ben Fletcher (Perth-Curtin), Elysha Taylor (Sydney), Nicole Rijs (Sydney-UNSW), Alison Rodger (Sydney-Macquarie), Yang Liu (Townsville) and Madeleine Schultz (Geelong) were the contact points for Australian breakfasts.

Mary Garson FRACI CChem is a professor of chemistry at the University of Queensland, Brisbane, and an elected member of the IUPAC Bureau. **Laura McConnell**, a principal scientist at Bayer Crop Science working in the area of environmental safety, is the Chair of the US National Committee for IUPAC. Mary and Laura co-chair the Management Committee overseeing arrangements for the celebration of the centenary of IUPAC.

'... the event helped to foster a sense of community and create an environment where chemists from all backgrounds are welcome to share their perspective.' (Canada)

'Inspired promising young women to consider careers in the sciences' (High school teacher (USA))

'We had great fun and wonderful opportunity to network.' (Korea)

'It was a little bit therapeutic, and we had a lot of laughs.' (Italy)

'We not only learnt that the power to do anything is within us but also that women possess infinite potential and capacity to excel in any field. The role models were right there in front of us.' (India)

'Our round table discussion talked about the obstacles women still face in the workplace.' (Greece)

'Fascinating connecting with women globally' (Nigeria)

'Uncountable hugs and smiles of satisfaction' (Portugal)

'We will set up a women's network in science and research using WhatsApp.' (Peru)

'Awesome event, strong supportive community behind women in chemistry' (New Zealand)

'There were many smiles, pancakes, stories, and an atmosphere of celebration and positivity!' (Australia)



RACI inclusion and diversity: a report on progress

Professor Mary Garson giving the 2018 Melbourne University Chemical Society Lady Masson Lecture.
Photo taken by Kane Roussiyen.

The issue of underrepresentation of women and minority groups in academic fields hit the headlines repeatedly during 2018.

Sexual harassment was repeatedly found to be a factor contributing to this underrepresentation, and this garnered significant media attention in parallel with the #MeToo movement. Many women recounted stories of choosing to leave science in order to avoid their harasser (see, for example, *Chem. Eng. News* 2017, vol. 95(37), pp. 28–37 and <https://go.nature.com/2HaoVhp>). The RACI has a strong Code of Ethics (www.raci.org.au/document/item/90) that prohibits sexual harassment by its members.

Separate to the issue of harassment, bias is also known to affect women's careers (and those of racial minorities) in science. Numerous publications have appeared in the past year providing evidence of this; for example, showing the effects on publication and grant success when names are removed (a useful summary can be found in Grogan K.E. *Nat. Ecol. Evol.* 2019, vol. 3, pp. 3–6, doi: 10.1038/s41559-018-0747-4).

Recognition of underrepresentation has led to a growing focus on introducing programs and initiatives to improve the diversity of representation within science, including chemistry, across the globe (Matlin S.A. et al. *Angew. Chem. Int. Ed.* 2019, vol. 58, pp. 2912–13; Mehta G. et al., *Angew. Chem. Int. Ed.* 2018, vol. 57, pp. 14 690–8). To this end, like many professional chemistry organisations, RACI is striving to become a model of good systemic practice by working to improve and modernise its policies and procedures.

In order to improve understanding and awareness within the community about issues related to equity, diversity and inclusion, it is important to provide a robust evidence base. For this reason, the collection and dissemination of quantitative data that reveal the magnitude of ongoing problems and the progress that has been made is critical. In addition, transparency and disclosure provide a measure of accountability.

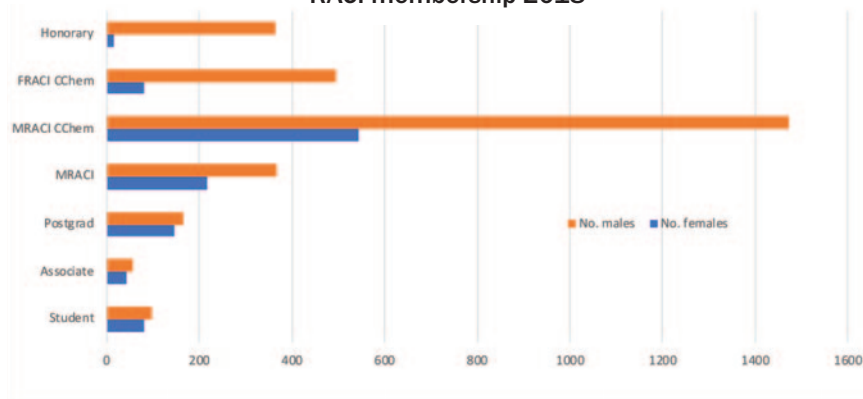
We are publishing some 2018 RACI data in this article to inform our society about the current status and provide a baseline for future observations. Although the RACI has not yet collected data with respect to race or ethnicity, we have recorded data that provides a snapshot of gender diversity within the context of the RACI, the national awards and conference attendees and speakers. This should be read in the context of the RACI Inclusion and Diversity Strategy available at www.raci.org.au/theraci/advocacy/the-raci-inclusion-and-diversity-policy.

Women across RACI membership categories

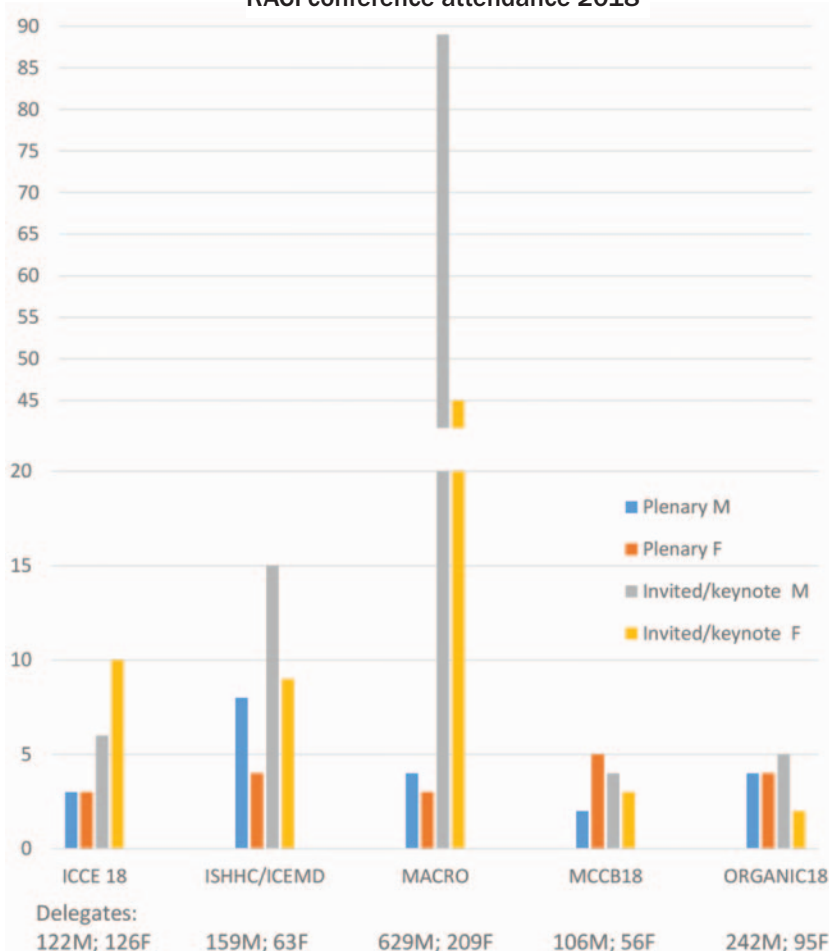
In the November 2016 issue of this magazine, membership statistics were publicised based on 2014 data. A comparison with data from December 2018 shows a significant increase in the number and proportion of FRACI who are women, from 10 to 14%. This is a direct result of the appointment of new Fellows as part of the centenary celebrations 2017, which involved awarding FRACI status on 40 female and 47 male members. There were also increases in the percentage of postgraduate student members (from 39 to 46%) and CChem (from 22 to 27%) who are women, along with a slight increase in the overall proportion of female members (from 23 to 27%).

Related societies internationally are also currently working on whether and how to collect and report similar statistics. The American Chemical Society (ACS) collects and reports data on gender, ethnicity and race; this is at a global scale for chemistry degrees and membership. The UK Royal Society of Chemistry published a comprehensive report on diversity in chemistry in 2018 (available at www.rsc.org/globalassets/02-about-us/our-strategy/inclusion-diversity/cm-044-17_a4-diversity-landscape-of-the-chemical-sciences-report_web-2.pdf), including statistics on awards and conference participation (pages 37–38 of the pdf document). In Canada, their new

RACI membership 2018



RACI conference attendance 2018



Working Group for Inclusion, Diversity and Equity (formed at a similar time to the RACI Inclusion and Diversity Committee (RIDC)) is grappling with how best to handle this issue.

Women at RACI conferences

Over the past three years since the formation of RIDC, the RACI has aimed to

improve the gender balance of RACI-sponsored events by setting diversity targets (see box p. 25) pertaining to the composition of conference organising committees and invited speakers. Imposing such targets was seen as the only way to effectively achieve gender equality in these areas. Although improving female representation in

committee and speaking roles at conferences has been a major focus, reporting on events to date has been sporadic. This is now a mandatory requirement for conference chairs, as outlined in the strategy above, and from 2019 this requirement will be followed up with conference chairs.

The RACI National office has collated some data for several conferences (see graph below); organisers of upcoming meetings should plan to prepare a similar table. Note that this is a complex task given the plethora of different types of talks (award winners, invited speakers, keynote speakers etc.) and also given last-minute program changes, so this data may be slightly incorrect. This data shows that for these conferences, in general, the number of women offered plenary and invited speaker roles is equal to or higher than their representation in the delegate group.

Women receiving RACI awards in the past five years

A new framework for the structure of award committees, together with guidelines on taking research opportunity and career interruptions into account, has been developed by the RIDC to try to minimise effects of bias. This will be publicised once it has been approved by the Board. Statistics for the last five years of RACI awards are encouraging, particularly for the highest research award, the H.G. Smith medal, where the last three recipients (and only three in RACI history) have been female (see table page 24). Nonetheless, women remain underrepresented in many award categories, notably at the highest levels, such as the Leighton medal, the citations and the distinguished fellowships. At the same time, it appears that this underrepresentation occurs at the nomination stage, and it is hoped that more women will be nominated in these categories in the future. For example, no women have been nominated for citations in this five-year period.

This table only includes RACI national awards; however, there are also many prestigious awards from RACI Divisions.



Professor Frances Separovic speaking at the IUPAC World Chemistry Congress in 2017 in Sao Paulo, Brazil, at which she received an IUPAC 2017 Distinguished Women in Chemistry award. Photo taken by Mary Garson.

Statistics are not readily available for these, but a cursory glance at the websites of the Divisions shows that some (such as the Athel Beckwith Lectureship, Birch Medal, Burrows and Organometallic awards) have seldom or never (Batteard Jordan Medal) been awarded to women. At the same time, it appears that this underrepresentation occurs at the nomination/application stage, and it is hoped that more women will be nominated or apply in these categories in the future. For example, no women have been nominated for citations or distinguished fellowships in this five-year period, and all nominated men received an award.

The journey of the ACS in this space is relevant to the RACI. The following information has been provided by George Bodner, former Chair of the ACS Board of Directors' Grants & Awards Committee.

One of the four goals of the ACS is to 'Empower an inclusive community of members with networks, opportunities, resources, and skills to thrive in the global economy', so it is not surprising that diversity and inclusion activities are numerous. Due to the scale, data about gender distribution of papers presented at meetings is difficult if not impossible to collect, as would be information about invited speakers. The Society therefore has no information about diversity and inclusion within its technical meetings. The ACS has put a lot of effort into following the gender distribution of its membership. This provides us with a baseline against which we can compare the distribution of national awards, for example.

In 2016, it was found that data for a six-year period clearly indicated that the underrepresentation of women among recipients of ACS National Awards could be directly linked to their underrepresentation in the pool of nominations for these awards.

Gender distribution of nominees/applicants and awardees in the RACI national awards over 2014–2018

| Award | 2014 | | | 2015 | | | 2016 | | | 2017 | | | 2018 | | | Total |
|---------------------------------|------------------|---|------------|------------------|---|------------|------------------|----|------------|------------------|----|------------|------------------|----|------------|-------|
| | NomIn./AppL M | F | Awd | NomIn./AppL M | F | Awd | NomIn./AppL M | F | Awd | NomIn./AppL M | F | Awd | NomIn./AppL M | F | Awd | |
| Applied Research* | 4 | 1 | M | 3 | 0 | M | 4 | 0 | M | 1 | 0 | M | 3 | 1 | M | 0 |
| Chemistry Educator of the Year† | 2 | 0 | M | 1 | 1 | F | 1 | 2 | F | 1 | 2 | F | 3 | 1 | M | 60 |
| Citations* | 2 | 0 | 2 M | 3 | 0 | 3 M | 1 | 0 | M | 5 | 0 | 5 M | 2 | 0 | 2 M | 0 |
| Cornforth* | 2 | 2 | F | 2 | 0 | F | 0 | 1 | F | 2 | 3 | F | 4 | 0 | M | 80 |
| Distinguished Fellowship* | 0 | 0 | - | 0 | 0 | - | 0 | 0 | - | 1 | 0 | M | 1 | 0 | M | 0 |
| Fensham* | 2 | 0 | M | 4 | 0 | M | 2 | 0 | M | 0 | 1 | F | 3 | 0 | M | 20 |
| Graduate Student† | 7 | 8 | 1 M 6 F | 11 | 9 | 2 M 4 F | 10 | 11 | 5 M 2 F | 17 | 11 | 9 M 7 F | 16 | 19 | 3 M 3 F | 52 |
| H.G. Smith* | 4 | 0 | M | 5 | 0 | M | 0 | 2 | F | 1 | 2 | F | 6 | 1 | F | 60 |
| Leighton*† | 2 | 0 | M | 5 | 0 | M | 4 | 0 | M | 4 | 0 | M | 3 | 0 | M | 0 |
| Margaret Sheil†¶ | | | | | | - | | | | 0 | 3 | F | 0 | 4 | F | 100 |
| Masson*† | 0 | 0 | 0 | 1 | 0 | M | 0 | 0 | 0 | 2 | 0 | M | 2 | 2 | M | 0 |
| Rennie* | 1 | 3 | F | 3 | 0 | M | 2 | 0 | M | 4 | 2 | F | 9 | 2 | M | 40 |
| Rita Cornforth†¶ | | | | | | | | | | 0 | 2 | F | 0 | 8 | F | 100 |
| Weickhardt*† | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | M | 2 | 1 | F | 50 |

* By nomination

† By application

¶ Awarded only to women. These awards were first introduced in 2017.



Dr Madeleine Schultz
speaking at IC11 in Perth.
Photo taken by Richard Keene.

RACI's Inclusion and Diversity Strategy

That for all RACI sponsored events:

- 1 The RACI inclusion and diversity policy is available on the conference website.
- 2 30% of organising committee must be female.
- 3 A minimum of 30% of all plenary, keynote and invited speakers must be female.
- 4 40% of session chairs must be female.
- 5 Anonymous participant diversity tracking must be integrated into the registration process (gender, non-English-speaking background, Aboriginal or Torres Strait Islander, disability).
- 6 Targets must be set and the final report must include a section on performance to target.

That for all RACI awards:

- 1 All RACI awards will be judged on opportunity and performance evidence. Candidates will be encouraged to put in a statement on opportunity and performance evidence.
- 2 All award committees will have both male and female representation.

Additionally:

- 1 Data will be published annually on the percentage of women and other diversity at different levels of membership, in leadership roles at Board, Branch and Divisional level and for all RACI-sponsored events.
- 2 All assembly members will be required to undertake unconscious bias training.
- 3 The RACI Board will undertake an annual review of the inclusion and diversity strategy and achievement of targets. Results will be reported to the RACI Assembly meeting in November each year before dissemination to the wider membership.

The percentage of women nominated for National Awards is roughly half of their percentage in the ACS membership. Furthermore, there were no nominations of women for as many as 16 of the National Awards for the 2014 through 2016 award cycles.

Through a NSF-funded project entitled 'Advancing Ways of Awarding Recognition in Disciplinary Sciences' (AWARDS), the ACS created an Awards Equity Implementation Team that developed a set of 'best practices' to ensure that all nominees are evaluated fairly, that is provided to all national Award Selection Committee members. The representation of women on National Award Selection and Canvassing Committees has been dramatically increased. We have also created new Canvassing Committees for awards having few or no female nominees. Each July, letters are sent to ACS technical division officers with a list of National Awards closely tied to their division requesting help in nominating individuals from underrepresented groups. In addition, letters have been sent to department chairs of chemistry departments at RI universities requesting their assistance in increasing the numbers of women nominated for National Awards.

Looking beyond quotas and statistics

While targets and quotas have a role to play in improving equity, diversity and inclusion within the chemistry community, these are only extrinsic measures and do not directly address the root causes. Normative changes can only occur when longstanding and deeply ingrained views, opinions and biases (both conscious and unconscious) are overturned. Developing this 'cultural competence' requires

institutions, individuals and, in particular, senior leaders to reflect upon and define the values, attitudes and conduct that will foster a more inclusive environment. Furthermore, beyond simply paying lip-service to these ideals, unacceptable behaviour will only be eradicated through strong leadership and action.

Further to the attempts to improve the diversity of representation within chemistry, effort must be directed to maintaining inclusion and providing support to aid retention and progression into senior roles. Such support might include providing an accessible, supportive and family-friendly environment at conferences and events, giving all younger scientists better opportunities to present their work, and showing zero tolerance for harassment and other offensive, discriminatory or bullying behaviour.

These changes are long overdue and will hopefully contribute to creating a more collegial, collaborative and successful professional community.

Please direct any comments or inquiries to Alex Bissember, the incoming Chair of the RACI Inclusion and Diversity Committee.

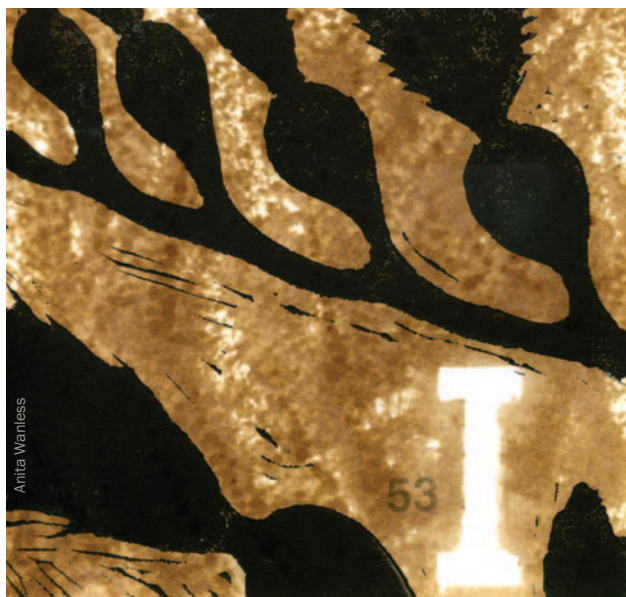
Madeleine Schultz FRACI CChem is a synthetic chemist and chemistry education researcher based at Deakin University in Geelong. She maintains an email list for Australian women in chemistry; to join please email madeleine.schultz@deakin.edu.au. **Michelle Coote** FAA, FRSC, FRACI CChem, is a physical organic chemist at ANU. She is the outgoing chair of the RIDC. **Alex Bissember** MRACI CChem is a synthetic chemist at the University of Tasmania and the incoming chair of the RIDC.

Top stories from the periodic table

Storytelling brings people closer together. Conceived by the RACI in recognition of the International Year of the Periodic Table, *Stories from the Periodic Table* collects, publishes and celebrates the personal connections we have to the periodic table and its elements. We'll share some of the best stories over the next few issues.

Iodine

BY **BRYNN HIBBERT**



Although in awe of the modern element hunters – finishing the seventh row of the periodic table is a fantastic achievement – I wish I was around in the heyday of the great element hunters, of whom Sir Humphrey Davy was the greatest. (I love the clerihew: *Sir Humphry Davy, Hated gravy, He died in the odium, of discovering sodium.* But I digress.)

Sir Humphry Davy's greatest discovery might have been Michael Faraday, but he also is credited with the discovery or isolation of sodium, potassium, calcium, magnesium, strontium, boron and barium. He also proved that 'Substance X' was an indivisible element, which he named iodine, in a bizarre episode during the Napoleonic wars between France and England. French chemists had made violet flakes of a new and unknown substance from burning seaweed, but could not decide if it was a new element or a mixture or a compound. Humphry Davy was the most famous chemist in the world and was offered the Napoleonic Gold medal for his contributions to knowledge. He was to receive it on 2 November 1813 in Paris.

Despite being on the wrong side in the middle of a fierce war, Davy, his wife and his young assistant Faraday were given passports to travel to France to collect the medal. They were not treated kindly by the border guards, Davy noting they stole all of his silk stockings, but they made it to Paris and Davy duly was given his medal. He was then approached by a bunch of great French scientists, including Ampere and Gay Lussac, to help with understanding the chemical properties of 'Substance X', recently isolated from seaweed.

Superstars trashing hotel rooms are not confined to modern rock bands – scientists have been there and done that. Davy and Faraday set up a lab in their Parisian hotel room and proceeded to conduct experiments, several resulting in explosions and clouds of noxious gases. Faraday writes in his Continental journal on 1 December:

when a solution of ammonia is poured on the new substance and left in contact with it for a short time a black powder is formed which when separated, dried and heated, detonates with great force.

'Great force' usually meant the disintegration of the glassware, nearby furniture and occasionally bits of the experimenters.

By 11 December, Davy was satisfied that 'Substance X' was a new element, similar in chemical properties to chlorine, and he gave it the name iodine (from the Greek for 'purple').

Brynn Hibbert's FRACI CChem research interests, at UNSW Sydney, are in metrology and statistics in chemistry, ionic liquids and electroanalytical chemistry. He also moonlights in expert opinion, scientific fraud and presenting science to the public. Long a member of the International Union of Pure and Applied Chemistry, he has helped name elements, revise the SI units and write the terminology of chemistry. Read more on Brynn in the January/February 2019 issue (bit.ly/2TLwRsR).

To participate in and for more information on this project, visit bit.ly/2ABHUGP.

2019 RACI National Awards

- MRACI Post Graduate Student Travel Bursary – opens 1 March, closes 5 May
- Applied Research
- Centenary of Federation Teaching Awards in Chemistry
- Citations
- Cornforth Medal
- Distinguished Contribution to Economic Advancement – Weickhardt Medal
- Distinguished Fellowship
- Fensham Medal for Outstanding Contribution to Chemical Education
- H.G. Smith Memorial Medal
- Leighton Memorial Medal
- Margaret Sheil Leadership Award
- Masson Memorial Prize
- RACI Chemistry Educator of the Year
- Rennie Memorial Medal
- Rita Cornforth Lectureship

2019 FACS Awards and Citations

- FACS Foundation Lectureship
- FACS Distinguished Young Chemist Award
- FACS Award for Distinguished Contribution to Economic Advancement
- FACS Award for Distinguished Contribution to Advancement in Chemical Education
- FACS Citations for Contributions to Chemistry in the Asia Pacific



Lisa Stevens' entry into the world of chemistry and the RACI is different from most. Stevens educational path was not one of universities and PhDs but one of TAFE qualifications in Occupational Health and Safety, and postgraduate diplomas culminating in a Masters of Occupational

Health and Safety (Occupational Safety) from Edith Cowan University. After many years working for regulators, insurers, universities and medical research facilities as a specialist OHS consultant, Stevens commenced working at RMIT, teaching undergraduate students in the BSc Applied Sciences (Multi Major) laboratory safety.

Stevens was introduced to the world of academia and chemistry when she was invited to become a project officer for a Safe Work Australia commissioned research project developing learning resources in the context of Nanotechnology and Work Health and Safety legislation. This led to her assisting Dr Neale Jackson in developing RMIT's Safety in Laboratories three-day safety course into one of Australia's foremost laboratory safety training courses, and introducing laboratory safety auditing as part of the successful commercial activities run by the then School of Applied Science.

It was this transition from industry to academia that triggered an interest in the world of dangerous goods, chemistry and regulations. Today, she spends much of her time teaching health and safety to students in the HE and VE sectors. In 2018, Stevens founded her own consultancy, providing training courses in laboratory safety and chemical management as well as laboratory safety auditing services to commercial, research and teaching facilities. She has been, and continues to be, a strong advocate to ensure that chemistry students have a greater understanding of the role that health and safety has in laboratory management, developing industry ready scientists. Having presented at both National and International Conferences, on the subject, Stevens considers that health and safety (in its broadest terms) should not be a barrier to chemical innovation and discovery, but something that impacts on all aspects of the discovery, use, handling, transportation, storage and disposal of chemicals.

Aside from her career, Stevens and her partner Neale enjoy a range of activities, including gardening, cycling and sailing.



Tim Davey undertook his undergraduate and honours degrees in chemistry at Victoria University of Wellington in New Zealand. He then completed a PhD in chemistry at the University of Otago in Dunedin, focused on the synthesis and self-assembly behaviour of novel surfactants, with supervisors Professor

William Ducker and Dr Alan Hayman. Davey then undertook a first post-doc with Raoul Zana at the CNRS in Strasbourg, France, working on characterising the solution behaviour of some industrial gemini surfactants. He then completed a second postdoc with Professor Greg Warr at the University of Sydney, focused on the adsorption of surfactant mixtures at interfaces, along with the synthesis and characterisation of novel gemini surfactants (in collaboration with Dulux Australia and Huntsman Surfactants).

Davey began working for Dulux in Melbourne in 2001 in the Polymer Technology group, where he progressed from the role of research chemist to group leader. His work in the polymer area included the commercialisation of a number of novel latexes for use in waterborne coatings products. Davey was also involved in investigations of the use of RAFT chemistry to build polymers of controlled composition for latex morphology control and pigment encapsulation, which resulted in the filing of a number of patents. He also managed a number of activities with external research providers, most notably a longstanding collaboration with the Key Centre for Polymer Colloids (KCPC) at the University of Sydney, along with research projects with CSIRO, Monash University and the University of Melbourne.

In mid-2018, Davey moved into the role of Exterior Products Technical Manager, leading a team developing next-generation exterior products under the Dulux Weathershield and British Paints 4 Seasons brands. Davey is on the board of the Australian Innovation Research Group (AIRG) and recently completed a four-year board role with the Australasian Colloid and Interface Society (ACIS). Davey has co-authored a number of papers and patents, as well as a reference book on New Zealand rock music.



Rowe Scientific PTY LTD
www.rowe.com.au

Suppliers of:

CERTIFIED REFERENCE MATERIALS

Reference materials from all major worldwide sources including:

NIST (USA), CANMET (Canada), SABS (South Africa), BAS (UK), Standards Australia, BGS (UK), BCR (Belgium), NWRI (Canada), NRCC (Canada), Brammer (USA), Alpha (USA), Seishin (Japan)

ADELAIDE
08 8186 0523
rowesa@rowe.com.au

BRISBANE
07 3376 9411
roweqld@rowe.com.au

HOBART
03 6272 0661
rowetas@rowe.com.au

MELBOURNE
03 9701 7077
rowevic@rowe.com.au

PERTH
08 9302 1911
rowewa@rowe.com.au

SYDNEY
02 9603 1205
rowensw@rowe.com.au



Wake up somewhere new

Create your own adventure through your benefits program

raci.memberadvantage.com.au

More travel, less stress with
worldwide travel insurance

[Get an online quote today](#)

SAVE on:
Emergency cover
Single trips or on your annual multi-trip premium



[Hire a car and save](#)

Freedom with great car hire offers

SAVE on:
Put yourself back in control of getting from A to B
without a timetable with special offers from Avis,
Budget, Europcar and Hertz



[Explore the range and book now](#)

You've earned the right to be
comfortable

SAVE on:
700,000 hotels worldwide across 71,000 destinations



Understanding uranium's journey in arid Australian environments

BY MEGAN ANDREWS

A project mapping the impact of radiation around mine sites is providing new knowledge on whether uranium mining can affect flora and fauna in arid Australian settings.

With an undergraduate degree in archaeology and a PhD in radioanalytical chemistry, Associate Professor Rachel Popelka-Filcoff from Flinders University is interested in how humans influence the landscape, and how we in turn are influenced by our environment.

Megan Andrews sits down with Rachel to discuss one of her exciting projects – investigating the radioecology of uranium in arid Australian environments surrounding mining sites and shedding new light on the pathways of uranium and its daughter isotopes through local soil, flora and fauna.

So Rachel, what location is your research looking at?

We're examining the environment surrounding BHP's Olympic Dam mine in northern South Australia and Beverley uranium mine, operated by Heathgate Resources.

And are the uranium isotopes there a result of the mining activities, or naturally present in the environment?

In the case of Olympic Dam, the background radiation in some areas is lower than it is in Adelaide. Beverley is a little bit

different because there's some naturally occurring radioactivity on the surface.

In particular for Olympic Dam, the mine is hundreds of metres below ground; therefore, there was no indication of the ore on the surface when the mines were discovered and this remains the case today. This is excellent from an environmental perspective but does make our role quite challenging! However, we do need analytical data to understand the impacts, if any, of the mining process on the surrounding environment.

But I gather you are managing to find some?

Although we have not found the levels of isotopes to be elevated, we are able to detect them and reconstruct their pathways in the environment and understand the processes involved. In this environment, we are concerned about the detection of very small amounts of radioactivity and this means that radioanalytical chemistry can be used in a way that's quite different from other branches of chemistry. We have a high-resolution gamma spectrometer in our laboratory and access to other high-end equipment at Flinders University, and other excellent facilities through our partners.

We are combining it with traditional analytical methods to come up with a powerful way to understand these complex systems.

Who are your partners?

The project is funded by National Energy Resources Australia (NERA) and industry partners BHP and Heathgate Resources. A true testament to the value of the project is that we also have JRHC Consulting, ANSTO (the Australian Nuclear Science and Technology Organisation) and ARPANSA (Australian Radiation Protection and Nuclear Safety Agency) providing significant in-kind support to make the project a success. ANSTO has an excellent radio-ecology group that we're collaborating with at the Lucas Heights facility. ARPANSA is the federal regulatory body for radiation, and we are collaborating with them in the use of alpha spectroscopy as well as understanding the regulatory framework.

It's a really exciting university-, industry- and government-based initiative, which is great because we're bringing all three sectors together. This collaboration is also valuable for students as it helps to provide skills to the future workforce by giving them exposure to working with industry and government.

Do you get out in the field yourself to obtain samples?

Our team does, yes. We have a few students and a postdoctoral researcher working on the project and they do much of the groundwork in terms of soil and plant samples. And we are working with Arid Recovery, a wildlife sanctuary near Olympic Dam that is reinstating native species in that area. We have been able to acquire some native species like bettongs, and non-natives like feral cats, both of which have been trapped as part of monitoring operations.

And then you analyse these back in the labs.

Yes, but we need to look at it holistically. For example, we need to understand the animals' roaming ranges, which differ for each species, and try to match their location. And we need to look at the concentration of what we find in the plant or animal relative to the soil, which helps us understand how the plants take up nutrients and materials from the soil.

There is modelling involved and it gets quite complex as we are not just looking at one set of samples and one analytical technique; we're investigating in terms of both radiation science and chemistry. We are doing some analysis that involves advanced methods that haven't been used in this area before.

Are there benchmarks you can compare your results to?

There are a couple of recent manuscripts on Australian environments; however, there needs to be a more comprehensive study, which is what we are doing. There are international frameworks for modelling impacts of radiation on the environment, but these are based on organisms that do not



Sample preparations in Rachel's laboratory that demonstrate two flora species collected on site, then freeze-dried and powdered, together with corresponding soil samples. This is the essential data for the concentration ratios for the project.

live in arid Australia. Therefore, we are establishing baseline data for arid Australian regions, and also figuring out if these international models work in arid Australian environments.

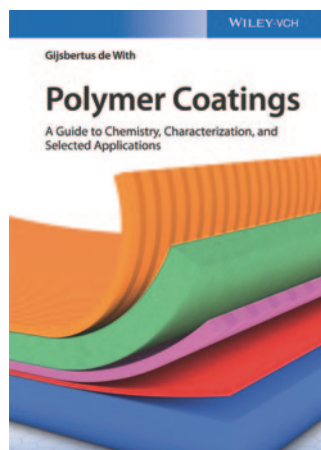
This must be relevant then to other mines then.

Absolutely. The results will be relevant to anyone who needs to undertake radiological risk assessments as part of larger environmental impact assessments. These assessments are often required for mineral sands, rare earths, copper and oil and gas projects. Our results will be available to mining companies and other entities; that's an important part of the project. The data will be published in journals but will also be freely available in a database for others working in arid Australia – which is most of the country.

When will it be available?

The current project will run until the end of March 2020; however, we have been working in this area since 2016. We are already starting to publish some results as well as presenting them at national and international conferences.

Megan Andrews works in Corporate Communications at Flinders University, and has an eight-year background in communications and marketing within South Australia's mining sector.



Polymer coatings: a guide to chemistry, characterization, and selected applications

De With G., Wiley-VCH Verlag GmbH and Co., 2018, hardback, ISBN 9783527342105, pp. 570, \$277.95

Polymer coatings: a guide to chemistry, characterization, and selected applications is a major work, assembling polymer chemistry, surface chemistry, adhesion and cohesion science, rheology, formulation science,

characterisation procedures (chemical and morphological as well as thermal and mechanical) and applications technology to present a comprehensive review of the area. Additionally, the book concludes with chapters exploring novel and emerging trends (electrically conductive coatings, marine antifouling coatings, self-replenishing and self-healing coatings).

In short, if you want to know everything about polymeric coatings, this book is an excellent place to find it. Since many of the areas covered have spawned books of their own, it is a significant achievement to fit it all into 570-odd pages. The corollary of this is the author sets a cracking pace, admitting in the preface, 'a certain initial acquaintance with several aspects of physical and polymer chemistry is probably an advantage for the reader.' Oh, yes indeed! This is not a book for neophytes, which is not to say it isn't well worth grappling with. Each chapter is well referenced and provides a guide to further reading. Some readers would find this a useful approach to fill in any gaps in background.

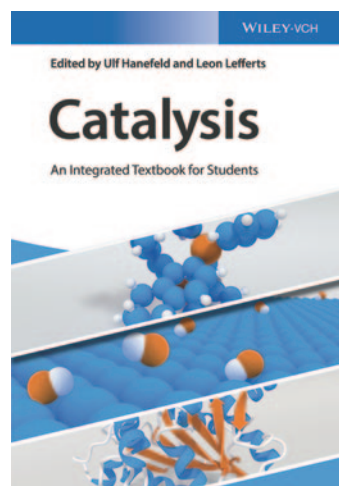
Author Gijbertus de With is a senior long-time faculty member and leader in materials science at Eindhoven University of Technology in the Netherlands. His research interests have spanned structure and interfacial phenomena associated with chemical and thermomechanical behaviour of multiphase materials. Additionally, his decade-long, organisational involvement with the Coating Science International conferences confirms his excellent pedigree as author for this work. In some senses, *Polymer coatings* is a distillation of his professional life in coatings.

My only quibble with the book, and it is a minor one, is the cracking pace it sets. It is easy to find yourself lapsing into 'information overload'. I suppose the alternative is a book twice as long, or two volumes, options obviating all the advantages of having a comprehensive work in a single, conveniently sized (but heavy enough, nonetheless!) volume.

The book is aimed at chemists in industry, materials scientists, polymer scientists and surface chemists. If you read it from cover to cover, you will master a complex and interesting field. If you add it to your professional library, you will have an excellent, enduring reference covering a wide range of the chemistry and physics of polymeric coatings. If you are

looking for a text to underpin a master's degree in coatings technology, then look no further. This is it. This is a very useful and worthy book, which I thoroughly recommend. If nothing else, after reading *Polymer coatings*, you will be able to undertake your future domestic painting chores in a confident, competent, reflective and thoughtful manner, or, at the very worst, you will have great knowledge of why you failed! A tad of theory, well applied, never hurt anyone.

R.J. Casey FRACI CChem



Catalysis: an integrated textbook for students

Hanefeld U., Lefferts L., Wiley-VCH Verlag GmbH & Co., 2018, soft cover, ISBN 9783527341597, pp. 384, \$150 (also available as an e-publication ISBN 9783527810925, \$120)

Catalysis: an integrated textbook for students is an interesting, timely and well-

thought-out text that aims to pull together the three traditional paradigms of heterogeneous catalysis, homogeneous catalysis and enzyme catalysis. If you enhance these three with discussion of reaction kinetics, reaction engineering, catalyst characterisation and synthesis of catalysts and their supports, then you have this text, an 'integrated textbook for students'.

The book is based on the Catalysis an Integrated Approach postdoctoral course, which has run since 2001, over one week, by Nederlands Instituut voor Onderzoek in de Katalyse, on a North Sea island (Schiermonnikoog). Schiermonnikoog is about 16 km long by 4 km wide, population just under 1000 and only about 200 cars, which sounds like an ideal location to confine a group of postdocs and hammer them hard with everything they always wanted to know (and some things they probably did not know they wanted to know) about catalysis. All very full-on!

This is a sophisticated book. Naturally, to fit its fairly comprehensive coverage in a modest-sized book, a lot of the content is quite condensed. After all, each of the areas covered has been the subject of major monographs. My suggestion is that you bring a strong background across a fair number of chemical (physical, inorganic, organic, analytical, surface, to name a few) and chemical engineering (particularly reaction engineering) fields, if you wish to get maximum value from this book. If you want to cherry pick it, then each chapter more or less stands alone and is well-referenced, including where you might find appropriate background materials.

The Swedish physician, wizard and pioneering chemist Berzelius (1779–1848) is credited with coining the term 'catalyst' when he invoked a 'recondite catalytic force' to

explain the enhanced rate of some reactions in the presence of an apparently unchanged substance added to the reaction mixture. Since then, heterogeneous catalysis has proved to be an astonishing driver of chemical industry, contributing enormously to the betterment of humanity. Similarly, application of homogeneous catalysis to produce interesting and useful materials, such as stereospecific polymers, has revolutionised our lives. Biocatalysis is absolutely vital for life: without it we would not be here. More recently, the design and harnessing of enzymes to create, with great specificity and selectivity, under mild reaction conditions, various industrial and medicinal compounds (like statins) are doing their bit to ensure we stay here a tad longer.

Catalysis: an integrated textbook for students is too complex for undergraduates. It would be suitable for its intended use (postdoctoral level), as well as for honours and master's degree students, but only with the addition of appropriate background materials. If you are interested in one facet of catalysis and want to know about the other two-thirds, this is the book for you. If you want a good overview of catalysis, this is a really useful book as well. It is not for neophytes. Yet another example of the more you know, the more you will learn!

R.J. Casey FRACI CChem



Wonders of water: the hydrogen bond in action

Ivar Olovsson I., World Scientific Publishing Co. Pte. Ltd. (WSPC), Singapore, 2018, soft cover, ISBN 9789813235168, 145 pp, approx. \$40

Just as Peter Hoeg's *Miss Smilla* had a feeling for snow (If you haven't read *Miss Smilla's feeling for snow*, I would recommend it as a rattling good whodunnit), so Ivar Olovsson has a truly magnificent feeling for all things aqueous. Olovsson (b. 1928) is a grand old man of Swedish science and professor

emeritus in the Department of Chemistry (Ångström Laboratory) at the University of Uppsala. His book, *Wonders of water: the hydrogen bond in action*, an extended and rewritten version of his earlier *Snow, ice and other wonders of water: a tribute to the hydrogen bond* is an absolutely superb little book. You will love it!

Water is fascinating stuff. We begin life cushioned in an aqueous environment and, when we emerge, one of the first things we do is pass it. After that, we can no longer live independently submerged within it, nor indeed can we live for very long without it. Our bodies consist of a goodly percentage of water, which perforce we carry around all of our days, and yield back to the earth on our demise. Such is life. Some say you really have to take water in the right spirit, while W.C. Fields allegedly claimed never to drink water because fish fornicated in it.

Almost everything you can think of about water is somehow anomalous, pretty much down to the hydrogen bond. Our very existence on earth is intimately and inexorably tied to the hydrogen bond. So much more *raison d'être* for Olovsson's, admittedly brief, text. His aim is to whet (sorry!) the reader's interest and encourage a motivation for enhancing one's interest in and understanding of water. The book is splendidly illustrated, often in colour, with wonderful photographs of snow and ice particles. My only quibble as I read the book (format approx. 240 mm h × 170 mm w) was the pity it was not in 'coffee table' format, the better to display the pictures.

There are chapters in the book that are 'serious' physical chemistry, but essentially the book would appeal to a wide range of people, both scientists and non-scientists as well as mid-teens and upwards (There, I've re-classified humanity!) Olovsson even makes a good fist of trying to analyse the Mpemba effect, with a great photograph illustrating it. This effect, named after a Tanzanian student who observed it in 1963, basically claims that hot water freezes faster than cold water. Believe it or not, Aristotle (384–22 BCE) wrote of this phenomenon in his *Meteorologica*, so it considerably predates Erasto Mpemba. However, it is the devil's own job to prove this observation: it is virtually impossible to eliminate every conceivable variable that just possibly might be causative, other than temperature. Mind you, in this era of global warming, the Mpemba effect has major implications for snow makers seeking to replenish the piste.

You will also enjoy reading about pykrete, a mixture of ice and wood pulp developed by the physical chemist Herman Mark. Pykrete is a hard material, proposed for building floating airfields and even aircraft carriers during World War II. It may seem like fruit-loopery now, but it was serious stuff in 1942. Alas, the model carrier, built on the Canadian lakes, failed due to sagging (cold flow). Early demonstrations of pykrete versus ice reportedly resulted in two near misses. Lord Mountbatten brought along a block each of ice and pykrete, and his pistol, to a conference in Quebec in 1942 and proceeded to demonstrate, using said pistol, to Churchill and Roosevelt, and their accompanying admirals and generals, just how good pykrete was. The first shot shattered the block of ice. The second shot ricocheted off the pykrete block and, grazing the leg of an admiral *en passant*, buried itself in the wall. *Quod est demonstratum*, I guess! In a similar incident in London, the Chief of Imperial Staff was shot in the shoulder. All of which goes to prove that demonstrations can be hazardous!

This really is a great little book. You will enjoy it enormously and, despite my whinges about the size, if nothing else – and there is a lot else – it has the best pictures of ice and snowflakes you are ever likely to see, and it will work wonders on the coffee table too.

R.J. Casey FRACI CChem

Juggling life and work is both rewarding and challenging.

With the EOFY just around the corner, you want tools designed to **save you time, money** and provide the best possible foundation, **now and into the future**.

Member Advantage understands your time is precious.

That's why we have sourced **trusted, smart** and **value-driven** financial solutions to make **your EOFY the best yet**. Access these and more through your benefits program:

American Express® Professionals cards

Explore the range and get exclusive offers and bonuses:

- The Professionals American Express® Essential
- The Professionals American Express® Platinum Edge
- The Professionals American Express® Platinum Charge

[Choose your credit card](#)

1 Simple yet Powerful Solution for a Healthy EOFY

Protect yourself so life can go on

Get **tailored cover now** so your life-style and financial needs are met should you become unable to work due to injury or illness.

As a RACI member, you receive:

- A **dedicated** Claims Department
- Personal insurance review
- A written explanation of the insurance cover
- Insurance advice for family and friends

[Get advice now](#)

For more information,

email info@memberadvantage.com.au or call 1300 853 352

Manage your money with MYOB

MYOB makes life easier, with *any time, anywhere* access to financial information, live reporting and straightforward bank entries plus, get three months access for free.

[Find a MYOB Plan](#)

End of financial
YEAR

raci.memberadvantage.com.au

Terms and conditions apply

Get 50% off financial planning with a panel of experts

A financial plan is your roadmap to creating a secure future and achieving goals. Get advice on wealth accumulation & investment plans, taxation, debt management and more.

[Book a consultation](#)

Stop that patent!

Andrew Gregory, Associate, FB Rice



Protecting your intellectual property (IP) is important, but you should also be aware of third-party IP rights that may affect your ability to commercialise and/or license your IP.

Prior to filing any IP application, we recommend conducting a brief search to identify published material that may be cited during examination ('prior art'), but

also potentially uncover third-party IP rights that may affect your ability to use and/or market your IP.

If a potentially problematic application or granted third-party right is identified, then there are a number of options available. Some options for dealing with pending or granted patents are shown below. The costs, duration and ability to act in relation to these options vary. It is therefore important that you talk to an attorney to make an informed choice regarding your options.

Third-party observations

For a pending application, the least expensive option is to make IP Australia aware of earlier published information by filing 'third-party observations'. These can be filed anonymously.

An Examiner will determine whether a novelty and/or inventive step objection should be raised in relation to one or more pending claims, based on the filed information.

Third-party observations can be particularly worthwhile in cases involving non-patent literature (e.g. journal articles), as Patent Office searches typically focus on patent publications and Examiners may overlook relevant non-patent literature.

Once third-party observations are filed, the third party plays no further part in examination of the patent application.

Opposition to the grant of a patent

Patent opposition proceedings are initiated by filing a Notice of Opposition within three months of the publication of the acceptance of a standard patent application.

Evidence, in the form of a declaration, must be filed to support one more grounds for the opposition. Relevant grounds include: a lack of novelty and/or inventive step; the invention not being enabled over the entire scope of the claims; and/or the claimed invention not being justified by the contribution to the technical field (support).

Both sides have an opportunity to file evidence supporting their positions. Once the evidentiary period has been completed, a formal hearing is conducted by the Patent Office and both sides are invited to participate. After the Hearing, the Patent Office issues a decision, which may indicate that the opposition has been completely or partly successful, or completely unsuccessful. The decision is appealable to the Federal Court.

A patent opposition typically costs upwards of \$100 000, with the cost being dependent on the grounds pleaded, amount of prior art information considered, and the complexity of the evidence filed.

Re-examination

An alternative means to challenge the validity of an accepted application or a granted patent is to file a request for re-examination. Supporting evidence is not always required and all the grounds that may be utilised in an opposition can also be raised in a re-examination. Re-examination requests can be filed anonymously.

Although the requestor plays no further part in the re-examination once the relevant documents are filed, they are provided with copies of re-examination reports and informed of the outcome.

Depending on the number of documents involved and the complexity of any accompanying submissions, the cost of requesting re-examination may be in the order of \$5000–10 000.

Litigation

Litigation before the Federal Court is the most expensive option (potentially \$1 million plus), for dealing with third-party IP rights. However, it provides parties with the option of seeking an injunction and/or damages. Prior to the final hearing (which may take several years), there is usually a long period of gathering and filing of evidence by both sides. All of the grounds available under opposition and re-examination are also available in litigation, in addition to the ground of the patent being obtained by fraud or misrepresentation.

Summary

By taking into account the particular circumstances of your case, an attorney can outline your options and the expected costs for possible actions to deal with any potentially problematic third-party IP rights.

For more information, email agregory@fbrice.com.au.

FB RICE



The IP Navigators

Careful thinking needed about future of chemical weapons convention

The chemical weapons convention (CWC) is one of the most successful arms control treaties in existence. It outlaws the production, stockpiling or research on offensive lethal chemical weapons, and places dual-use chemical industries under a monitoring and inspection program overseen by the Organisation for the Prohibition of Chemical Weapons (OPCW).

The CWC is a legacy of the end of the Cold War. The collapse of the Soviet Union reinvigorated the long-dormant chemical weapons control. This culminated with most nations signing and ratifying the treaty, which came into force in 1997.

Only four UN recognised nations have not acceded to the CWC. North Korea is widely accepted to have large stocks of various agents. Egypt and Israel both take a 'will neither confirm, nor deny' stance, but equally have not agreed to allow monitoring of their industries. Finally, South Sudan has expressed intention to accede, but has not yet done so.

Each nation is responsible for the destruction of its own stockpile of weapons (either alone, or with the help of others), with compliance monitored by OPCW. So far, about 96% of declared stocks of chemical weapon agents have been eliminated, including all of Russia's declared stockpile.

Yet, chemical weapons have recently been used in state-actor-supported attacks on large (Syrian civil war) and small scales (the murder of Kim Jong-nam and the alleged attempted murder by poisoning of former Russian spy Sergei Skripal in the UK). Fear exists that these incidents may represent a falling back by the world's governments on the principle that chemical warfare should never occur.

Modern militaries can operate in a chemical or other toxic threat environment (CBRN from chemical, biological, radiological and nuclear), and assume their peers can do the same. This leaves chemical weapons as an anachronism, with only limited offensive value against an enemy of similar technological sophistication.

However, civilians remain vulnerable to attack, either by applying military techniques (Iraq, Syria) or to targeted assassination. Equally, non-state actors have succeeded in producing lethal agents and using them in terrorist attacks (Tokyo).

If the outlawing of chemical weapons is slipping, that may lead to nations attempting to circumvent the spirit of the treaty by developing pseudo-non-lethal agents, or by the offensive use of agents produced under the convention for

defensive testing. These issues, often overlapping, leave the convention as it stands facing questions about its relevance as we enter the mid-21st century. As reported in *Science* (doi: 10.1126/science.aav5129), this is an important opportunity to get some key things back on track.

What is a chemical weapon?

It's important to clear up a common misconception about the CWC and how it handles lethal chemical agents.

Under the convention, the use of the pharmacological effects (what the chemical does to the body) of any chemical to achieve a military outcome (death or permanent disability) makes that material a chemical weapon.

This means that novel agents, such as the Novichok (or A-series) chemicals alleged to have been used against the Skripals, are illegal, not because of their structure, or mode of action, but simply because they are toxic and someone attempted to use them to kill.

This definition can create some complexities. If we take as a given that many chemicals are potentially lethal – it's the dose that makes the poison after all – how do you regulate compounds that are likely to be used as weapons? How should these be distinguished from those that could be fatal, but aren't typically applied for ill-purpose? For example, the anticancer drug mustine – also known as nitrogen mustard – is a schedule 1 weapon under the chemical weapons convention (under the codename HN2), but has also been on the list of drugs that the World Health Organization considers essential for a functional national healthcare system [<http://archives.who.int/eml/expcom/expcom15/deletions/Mustine.pdf>].

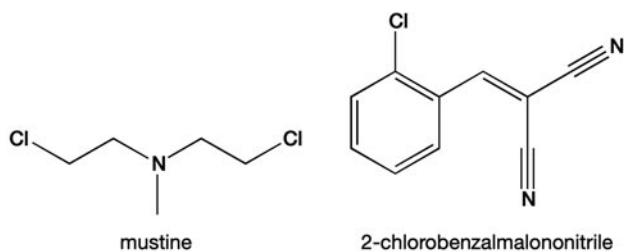
This last thought leads to the potential issue that a country could develop a new weapon, but claim that it is designed for civilian law enforcement.

Police action or short cut to new weapons?

Riot control agents (RCA) are those such as pepper spray, or 2-chlorobenzalmalononitrile (better known, slightly erroneously, as CS-gas). These compounds are designed to cause the victim discomfort. The effects of RCA dissipate soon after the victim is removed from exposure – similar to how, if you get capsaicin in your eyes while cutting chillies, you can wash the compound away with lots of water or milk.

These agents are only lightly regulated under the chemical weapons convention. Their use is allowed as part of normal law enforcement, but prohibited in war.

Different from these, incapacitating agents are defined as those that cause the victim to lose consciousness, or otherwise become systemically incapacitated – but the effects of these are not reversible by removing exposure. Examples that nations experimented with before their outlawing include chemicals that cause massive sensory hallucinations and prevent the



victim from recognising reality.

There is much debate about the ultimate safety of RCA, but in general they are seen as safe unless incorrectly used. On the other hand, a Russian incapacitating agent is believed to have caused many of the fatalities during the 2002 Moscow theatre siege.

So how can these agents be legal, while the agent used in Salisbury is immediately considered illegal? What is an appropriate level of chemical force that should be acceptable when applied to a person as part of civilian policing?

What level of research into, or stockpiling of, such compounds would suggest the goal is no longer to develop countermeasures, but is part of an offensive chemical weapons program? The CWC was written to outlaw offensive weapons research, but has its success only moved the goalposts?

Responsibility of scientists

Questions about how responsible a scientist is for the use of their work probably go to Fitz Haber and beyond. The 1918 Nobel Prize winner is generally considered the father of modern chemical warfare for his suggestion that the Imperial German Army use chlorine, the first lethal chemical weapon of World War I.

Today there are several questions about how scientists should interact with the world, using their knowledge to educate the public through the media, while avoiding drawing

attention to possible misuses of that knowledge (or allowing their messages to be manipulated to cause panic).

Is it a greater good for society for me to explain that nitrogen mustard (from the example above) treats cancer, than the risk that someone will now try to steal some mustard from the oncology clinic to misuse it?

There is also the problem of dual-use technologies. These are techniques that can equally be used to develop a new pharmaceutical or be applied to develop a new nerve agent.

How much regulation of day-to-day research and commerce is acceptable to prevent those who would do us harm having access to materials and knowledge?

In the 20 years since the ratification of the CWC, we have made discoveries and improved access to technologies that may make it easier to create a truly effective improvised chemical weapon.

The CWC has almost reached the initial goal of the signatories – the elimination of chemical weapons. Now the convention needs to move with the times, to prevent backsliding from the prevailing culture that considers chemical weapons to be unspeakably barbaric.

Martin Bolland is Senior Lecturer of Medicinal and Pharmaceutical Chemistry, Charles Darwin University. Adapted by the author from his article first published at www.theconversation.com.

How chemistry can be heard by policymakers

As a community, chemists are able to provide significant value and evidence to contribute to the policymaking process. However, how do we as chemists make sure the impact of our science, evidence and voice are being heard during this process?

As an RACI member, you have exclusive access to Science & Technology Australia's crafted series of videos that assist in making a difference to the policymaking process.



In this collection you will hear from:

- Dr Alan Finkel – Australia's Chief Scientist
- Catriona Jackson – head of higher education peak body Universities Australia
- Professor Helen Sullivan – director of the ANU's Crawford School of Public Policy
- Dr Amber Beavis – scientist turned policymaker working with Australia's Square Kilometre Array Office



Go to <https://scienceandtechnologyaustralia.org.au/>
member-verification and register as an RACI member.



Reasons to join

- * access to chemistry experts
- * annual chemistry lectures to inspire
- * quizzes and competitions including the ANCC
- * access to education resources and tools
- * industry outreach
- * subscription to the RACI Magazine Chemistry in Australia
- * professional recognition for teachers
- * student and teacher days at RACI conferences
- * careers and further education advice

TO FIND OUT MORE ABOUT THE RACI'S
SCHOOL AFFILIATE MEMBERSHIP VISIT...

www.raci.org.au/schools



Copper speciation in wine

The chemistry of copper in wine is both complex and fascinating. Fascinating to me perhaps because of the many years that I have spent working with the measurement of copper and trying to relate this to its role as a mediator of chemical reactions. When I first started this research, the question was copper's role as a mediator of oxidation. Winemakers were adding, and many still do add, copper(II) sulfate to remove any hydrogen sulfide off-odour. Internal winery communication did lead to an intriguing mistake in one case. The winemaker asked the cellar hand to add 2 mg/L 'copper', or '2 parts' in wine industry jargon, to the wine. As the mass ratio of copper to copper sulfate is 1:4, the winemaker meant 'add 0.5 parts Cu as 2 parts CuSO_4 '. Of course, the cellar hand assumed that '2 parts Cu was 8 parts CuSO_4 ', resulting in a considerable excess of residual copper. Fortunately, yeast cells are effective bioremediators of metals, including copper, so most of the excess copper could be removed in this way.

It is now apparent that copper may also mediate the development of reductive processes by leading to an increase in H_2S . Trying to interpret the onset of either oxidative or reductive processes using the total copper concentration has not been helpful. Critical values of total copper between 0.2 and 0.6 mg/L have been proposed as the reported threshold concentration for the onset of wine spoilage. Copper speciation is potentially a better way forward.

Two general strategies for speciation have been examined. One utilises the electrochemical technique of stripping potentiometry (SP) and the other uses a solid phase fractionation method. Much of this work has been carried out by Dr Andrew Clark and Dr Nikos Kontoudakis and colleagues at the National Wine and Grape Industry Centre (NWGIC) at Wagga Wagga in association with the Chemistry Group at the Australian Wine Research Institute. Andrew in his PhD thesis used SP for measuring the total copper concentration in wine along with some initial studies of copper speciation. He became so 'infected' with the technique that he has continued using it with marked success in developing meaningful speciation measurements.

The initial strategy was to use SP in combination with medium exchange (ME); that is, an enrichment or electrodeposition step in wine and then a manual transfer of the electrode still under potentiostatic control to a clean, non-wine solution for stripping using a constant current. The time for re-oxidising the deposited copper is proportional to concentration. The fraction of copper that was deposited on the electrode and then stripped is the 'labile' fraction, with the difference between the total copper concentration and the labile fraction commonly referred to as the non-labile fraction. The labile fraction consists of copper ions plus weakly bound copper that dissociates during the electrodeposition step, while the non-labile fraction refers to 'tightly bound' copper.

The NWGIC group subsequently modified the manual ME

strategy by using a flow cell. Here, the stripping solution is pumped over the electrode surface during stripping. As the process can be automated, it is more efficient than the classic batch method of physically transferring the electrode from one solution to another.

The surprising outcome of the flow cell ME procedure was that the labile concentration was generally lower than assessed by the batch method (*Talanta* 2016, vol. 154, pp. 431–7). This led to a study of potential binding agents for copper that could influence the labile/non-labile ratio. Compounds used included polysaccharides, tannins and proteins previously extracted from wine as well as catechin-type compounds and sulfur compounds that are known to exist in wine. Perhaps not surprisingly, hydrogen sulfide was the only additive found to decrease significantly the labile fraction (*Food Res. Int.* 2017, vol. 98, pp. 95–102). A solid phase extraction technique showed that the hydrophobic fraction was specific for sulfide-bound copper (*Food Chem.* 2019, vol. 274, pp. 89–99) and this correlates with the non-labile form assessed by SP.

... copper may also mediate the development of reductive processes by leading to an increase in H_2S .

The SP labile/non-labile measurement gives detailed insight into the copper activity. In the *Talanata* study, the authors found that of the 52 wines examined, only three had labile concentrations above 0.015 mg/L, the practical limit of quantitation, with the average as a proportion of the total being 11%. This is considerably lower than the 53% labile found in an earlier study using the manual batch method.

When a wine sample was left exposed to air, the labile concentration actually increased to the extent that after two months, the measured labile concentration equalled the total. This would explain in part why the batch study, with its agitation due to stirring with the sample exposed to air, gave higher labile concentrations. When sulfide was added to the oxidised wine, the labile concentration was found to decrease.

There is clearly a set of complex reactions/equilibria occurring in wine that lead to the loss of sulfide via binding to copper and then its release over time. By providing insight into the changes occurring in the non-labile/labile distribution, the flow-based SP methodology will allow an assessment of the rates of release and binding of copper to sulfide. All part of the on-going story.



Geoffrey R. Scollary FRACI CChem (scollary@unimelb.edu.au) has been associated with the wine industry in production, teaching and research for the last 40 years. He now continues his wine research and writing at the University of Melbourne and the National Wine and Grape Industry Centre at Charles Sturt University.



CELEBRATE THE INTERNATIONAL YEAR OF THE PERIODIC TABLE

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|----------|--|----------|--|----------|--|-----------|--|-----------|--|-----------|--|-----------|--|-----------|--|-----------|--|-----------|--|-----------|--|-----------|--|-----------|--|-----------|--|-----------|--|-----------|--|-----------|--|-----------|--|
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 H | | | | | | | | | | | | | | | | | | 2 He | | | | | | | | | | | | | | | | | |
| 3 Li | | 4 Be | | | | | | | | | | | | | | | | 5 B | | 6 C | | 7 N | | 8 O | | 9 F | | 10 Ne | | | | | | | |
| 11 Na | | 12 Mg | | | | | | | | | | | | | | | | 13 Al | | 14 Si | | 15 P | | 16 S | | 17 Cl | | 18 Ar | | | | | | | |
| 19 K | | 20 Ca | | 21 Sc | | 22 Ti | | 23 V | | 24 Cr | | 25 Mn | | 26 Fe | | 27 Co | | 28 Ni | | 29 Cu | | 30 Zn | | 31 Ga | | 32 Ge | | 33 As | | 34 Se | | 35 Br | | 36 Kr | |
| 37 Rb | | 38 Sr | | 39 Y | | 40 Zr | | 41 Nb | | 42 Mo | | 43 Tc | | 44 Ru | | 45 Rh | | 46 Pd | | 47 Ag | | 48 Cd | | 49 In | | 50 Sn | | 51 Sb | | 52 Te | | 53 I | | 54 Xe | |
| 55 Cs | | 56 Ba | | 57-71 | | 72 Hf | | 73 Ta | | 74 W | | 75 Re | | 76 Os | | 77 Ir | | 78 Pt | | 79 Au | | 80 Hg | | 81 Tl | | 82 Pb | | 83 Bi | | 84 Po | | 85 At | | 86 Rn | |
| 87 Fr | | 88 Ra | | 89-103 | | 104 Rf | | 105 Db | | 106 Sg | | 107 Bh | | 108 Hs | | 109 Mt | | 110 Ds | | 111 Rg | | 112 Cn | | 113 Nh | | 114 Fl | | 115 Mc | | 116 Lv | | 117 Ts | | 118 Og | |
| 57 La | | 58 Ce | | 59 Pr | | 60 Nd | | 61 Pm | | 62 Sm | | 63 Eu | | 64 Gd | | 65 Tb | | 66 Dy | | 67 Ho | | 68 Er | | 69 Tm | | 70 Yb | | 71 Lu | | | | | | | |
| 89 Ac | | 90 Th | | 91 Pa | | 92 U | | 93 Np | | 94 Pu | | 95 Am | | 96 Cm | | 97 Bk | | 98 Cf | | 99 Es | | 100 Fm | | 101 Md | | 102 No | | 103 Lr | | | | | | | |

REGISTRATIONS NOW OPEN

The ANCQ is the perfect initiative for your school to celebrate the 150th anniversary of the Periodic Table of Chemical Elements.

Students will join over 94,000 participants worldwide.

The Quiz is available in hard copy and online formats.

REGISTER ONLINE

racichemedcentral.com.au/ancq

REGISTER 120+
STUDENTS & RECEIVE

FREE

500 PIECE
PERIODIC TABLE
PUZZLE

ENTRY COST

\$6

INC. GST

PER STUDENT

REGISTRATIONS CLOSE: Friday 7 June 2019

QUIZ DATE: Tuesday 30 July 2019

ENQUIRIES: ancq@raci.org.au

Brought to you by



Proudly supported by



A Russian penfriend

It was sometime around 1980, when I was still a stamp collector, that I received a letter from a Russian chemist, Dr Igor E. Dolgy, proposing an exchange of stamps from our two countries. Years later I discovered chemists in other countries who had received similar invitations; some declined, but others, like me, joined in. For me and Igor, however, it began an exchange that lasted for 15 years until we finally lost touch.

Dolgy was working at the N.D. Zelinsky Institute of Organic Chemistry of the Russian Academy of Sciences in Moscow. Nikolai Dimitrievich Zelinsky (1861–1953) completed his degree studies in 1884 at the Novorossiysk University near Odessa, and the following year, with support from a scholarship from the chemistry department, he went to Germany to gain research experience. He worked with Wislicenus at Leipzig and then Victor Meyer in Göttingen, where he was the first to prepare dichlorodiethyl sulfide $\text{S}(\text{CH}_2\text{CH}_2\text{Cl})_2$... and the first to suffer such serious burns from it that he was hospitalised for several months. Years later, this substance was used for exactly that purpose on the battlefields of World War I.

Returning to Russia, Zelinsky was awarded his MSc and PhD degrees for work on stereochemistry and isomerism of organic compounds, and he was appointed to a chair at the University of Moscow in 1893. The Zelinsky Institute was created in 1934 by bringing together the laboratories of Zelinsky, A.E. Favorsky, V.N. Ipatiev and A.E. Chichibabin, with Favorsky as its first director. One of the later directors was A.N. Nesmyanov, so you can see that the senior members of the Institute constituted something of a Who's Who of Russian (later Soviet) chemistry. Zelinsky headed a department in the Institute and worked there on hydrocarbon chemistry and catalysis. This was a field in which Ipatiev made important contributions, especially after he migrated to America.

I wasn't sure where Igor Dolgy fitted into a society about which I, like most people outside the Soviet Union, knew very little. Was he an 'insider', a Party member with a good job and the trappings of life to go with it, or was he from less exalted stock with social status determined, instead, by technical proficiency? I couldn't find much of his published work, just a paper on some cyclopropane carboxylic acids (in Russian) and a couple on their mass spectra that were published with co-authors in Hungary. Along the way I learned that his father had a farm and until he died in 1985 at 84, he had been sending apples to augment the peripatetic supplies available in Moscow. I'm not sure whether Dolgy Senior owned that farm or was just a tenant.

A possible indication of Dolgy's status were the travels he undertook. From time to time, for professional reasons, he was in Leningrad and once sent me a photograph of the headstone on Borodin's grave, after I expressed interest. Later, I was able to photograph it myself. He was several times in Ufa, which he described as the capital of Bashkiria (Bashkortostan), a city of about a million people, on the Trans-Siberian Railway about halfway from Moscow to Kazan. One holiday involved a three-



week boat trip down the Volga to Astrachan with excursions to Jaroslavl, Stalingrad, Gorky, Kazan, Volgograd and other towns. By 1985, he had been promoted to professor, which meant, among other things, that his holiday entitlement increased from 36 to 48 working days, effectively two months off! All this was adding up, in my mind, to very senior status and quite likely, Party membership.

In 1990, Igor moved to a more responsible position in the Zelinsky Institute, and the following year he was sent on a two-week management course. It wasn't all work, however, because the lectures were given aboard the 750-passenger motor ship *Leonid Sobinov* as it made its way south. They spent a couple of days in Greece, one on Kipr (Cyprus) and four days in Istanbul. He had been in Turkey before, in 1975, and noted in 1990 the increased car numbers and the richness of goods available in shops and markets. Back home, things were tough in the early 1990s as the Soviet Union disintegrated, prices were high and food was scarce. The address on the letters changed from USSR to Russia.

Mentioning letters reminds me that not all of our letters got through, so we took to numbering them. In some cases, my letters arrived in Moscow without the stamps I had included, so I switched to registered mail, which proved to be secure. Finally, I had the chance to visit, as I'll relate in my next Letter.



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.

Runaway Reactions (online course)

Modules commence 29 May 2019
www.icheme.org/runaway-reactions

VCE Chemistry Unit 2&3: Investigating the Electrochemical Series, Electrochemical Cells and Faraday's Law

5 June 2019, RMIT University, Melbourne, Vic
Register by 17 May at <https://bit.ly/2toHpTs>

Australasian University Safety Conference

25–27 June 2019
Crown Perth, WA
ausa.org.au/ausa-conference-2019

12th Australasian Organometallics Meeting (OZOM12)

9–12 July 2019, Melbourne, Vic.
<https://ozom12.wordpress.com>

NSW Polymer Group Symposium:

Synthesis and Application of Functional Polymers and Polymer Architectures

15 July 2019, University of Sydney, NSW
markus.muellner@sydney.edu.au

Asian Federation for Medicinal Chemistry International Medicinal Chemistry Symposium

8–11 September 2019, Istanbul, Turkey
aimecs2019.org

International Congress on Engineering and Food

23–26 September 2019, Melbourne Convention Centre, Vic.
icef13.com

Chemeca 2019

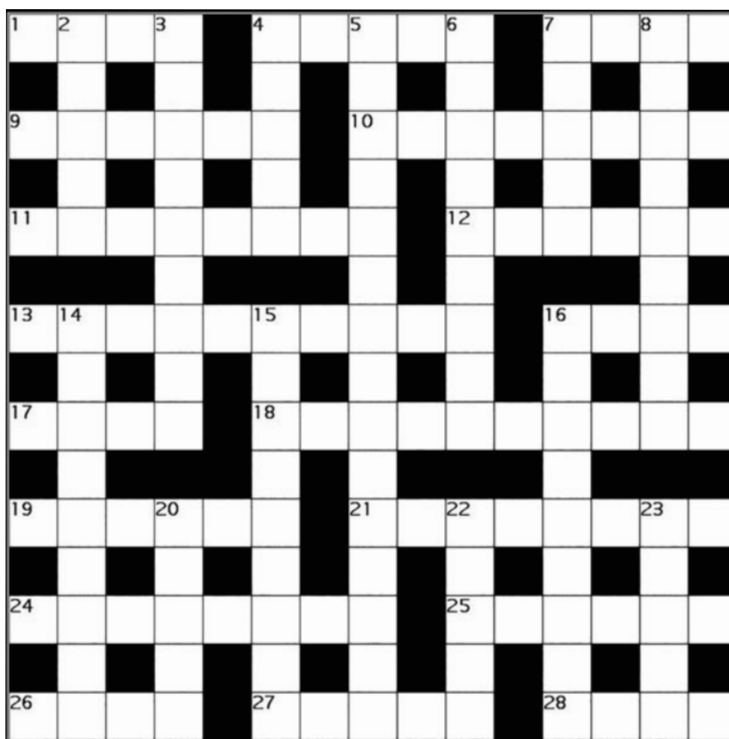
29 September – 2 October 2019, Sydney, NSW
chemeca2019.org

RACI events are shown in blue.

New Periodic Table on Show available

In celebration of the International Year of the Periodic Table in 2019, we are pleased to launch the latest Periodic Table on Show (see outside back cover). With new artists' impression artwork completed for elements 112–118 by printmakers Linda Abblitt (113, 115, 117) and Tina Curtis (114, 116, 118), the Periodic Table on Show is now up to date.

RACI Periodic Table on Show posters are now available to purchase online for \$15 plus postage (racichemedcentral.com.au) or discover the science and artists' descriptions at raci.org.au/IYPT.



Across

- 1 Pollution brought back first group on Methodological Safety. (4)
- 4 Pioneer Spooner's unit. (5)
- 7 Points towards a first-rate analytical method. (4)
- 9 Acetylene, hydrogen, neon yet mixed. (6)
- 10 Flinching at the opening. (8)
- 11 See 8 Down.
- 12 Two-thirds of 32? Language! (6)
- 13 Stem emails about bismuth, graphite, etc. (10)
- 16 Two in charge of this publication. Take it to heart. (4)
- 17 Available without charge. (4)
- 18 Heads audio standards. (10)
- 19 Almost a blue ion reaction over mine. (6)
- 21 Models and former partner around maples. (8)
- 24 Limits or qualifies the sense of new idiom (Ref.). (8)
- 25 $\text{H}_2\text{NC(O)CO}_2^-$ and CaO mix stirred. (6)
- 26 Small piece of land is the French. (4)
- 27 Premature count, add 39. (5)
- 28 Uncomplicated and tolerant. (4)

Down

- 2 Equal competition. (5)
- 3 Salicin, for example, from the three finishes, unsurprisingly, politics decide. (9)
- 4 $\theta = 90 + \eta$. (5)
- 5 It isn't random. I rest my case. Rort demolished! (10,5)
- 6 Ceasing aluminium production eases the pain. (9)
- 7 Subsequently hold back secret fantasy. (5)
- 8 & 11 Across Anagram's theme once used for pigment. (9,8)
- 14 Without a reason, euro gets smashed. It's wrong! (9)
- 15 Newly solve π after former partner blows up. (9)
- 16 Pay shop he used? That's dense! (9)
- 20 A compound of formula $\text{RN}=\text{CR}_2$ from iodine extract. (5)
- 22 Compounds of formula $\text{RN}=\text{N}^+(\text{O}^-)\text{R}$ as the beginning and end? Bull! Why? (5)
- 23 Deem it satisfactory to include discharges. (5)

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

Periodic Table of Younger Chemists: nominations open



In celebration of the 100th anniversary of IUPAC and of the 2019 International Year of the Periodic Table, IUPAC and the International Younger Chemists Network (IYCN) are creating a Periodic Table of Younger Chemists. From July 2018 to July 2019, a diverse group of 118 outstanding younger chemists from around the world will be honoured. The resulting periodic table will highlight the diversity of careers, creativity and dedication of the young chemists leading this community into the next century. Each Young Chemist Element is profiled on the IUPAC100 website.

Elements are revealed over time and in order of scientific discovery, and announced monthly at various chemistry events, many being IUPAC-endorsed conferences. More than 40 Young Chemist Elements have already been revealed, including some for RACI members! The final elements will be revealed at the IUPAC World Chemistry Congress in Paris, France, in July 2019.

Nominations are ongoing, and are currently being accepted for the elements below. More information is available on the website, along with detailed criteria and access to the submission form.

If there are younger chemists who inspire you, nominate them now!

<https://iupac.org/100/pt-of-chemist>

Nominate by 1 May for:

einsteinium, fermium, mendelevium, lawrencium,
nobelium, rutherfordium, dubnium, seaborgium,
bohrium, meitnerium

Nominate by 15 May for:

hassium, darmstadtium, roentgenium, copernicium,
nihonium, flerovium, livermorium, oganesson,
tennessine, moscovium



Celebrating the International Year of the Periodic Table 2019



The Printmakers

Linda Abblitt (Al,Sm,Ar,Nh,Mc,Ts) Annick Ansellin (Cl,Ga,Tc) Bert Aperloo (Ag,Zr,Pr) Marhelle Basson (U,Rc,Cf) Alicia Boyd (Ne,Kr,Sc) Nicki Burns (Ru,Rn,Lr) Carolyn Canty (V), Selena de Carvalho (Rh,Ra,Db) Denise Campbell (Na,La,Er) Tina Curtis (O,Ar,Nb,Fl,Lv,Og) Fred Duncan (K,Yb,Pa) Cath de Little (Zn,Ti,Fm) Pippa de Salis (As,Ir,Mt) Alisa Fergusson (Hg,Bi,Ho) Diane Foster (Ti,Cd,Pm) Kaye Green (P,Gd,Fr) Brittany Guy (Br,Th) Mard Hargreaves (Sn,Nd,Lu) John Ingleton (Fl,Os,Es) Iona Johnson (Pb,Bi, No) Brett Littleton (N,Be,Y) Jan Luckman (Si,Np,Hs) Key Marlet (Cu,Xe,U) Margaret McAteer (Au,Sr,Ti) Brent Meeker (Fe,Ba,Dy) Ron Moss (C,Sb,Rb) Leonie Oakes (S,W,Os) Antonette O'Brien (F,Co,Cn) Stephanie Parkyn (H,Mn,Ge) Bianca Peters (Mg,Po,Md) Sarah Robb-Tissot (Li,Ta,Bk) JoSculthorp (Cr,Se,Ir) Robyn Slik (Rf,Cm) He Carrie-Ann Smith (Pb,Cr,Ag) Anita Wanless (I,Hf,Am) Patzi Bauer (Pd,Mo,Rg).

Coordinated by Carolyn Canty and Dr Vicki Gardiner

raci.org.au/IYPT

