My chemistry romance

NANCY MILLS

Whether you're hopelessly smitten or just passing through, chemistry can lead you down some surprising paths.

Australian Synchrotron staff with chemistry qualifications don't just do chemistry. They run the control room, develop new experimental capabilities, help external researchers carry out synchrotron experiments, provide administrative services, and write about science.

> Chemistry opens doors, even if you're unsure what you'll do with it. It's up to you and how you package the skills you gain.
> *Kia Wallwork, powder diffraction team*

Kia didn't originally plan to pursue chemistry, but she says it's been a fascinating journey, starting with a BSc from Flinders University in South Australia.

'One of my lecturers saw something in me that I didn't see and became a kind of mentor,' she says. 'He lured me into a PhD that involved travelling overseas to examine mineral samples using synchrotron powder diffraction methods.'

Kia joined the Australian Synchrotron in April 2005 as one of the facility's beamline team leaders.

'It was really exciting getting the job of my dreams so early in my career,' Kia says. 'Building the powder diffraction beamline has presented many challenges and opportunities. My work involves everything from project management, research, customer service and leadership to equipment maintenance. I love the variety.

'Synchrotron powder diffraction takes the technique to a whole new level. Experiments are faster, and we can show you features of your samples you've never seen before. Be prepared for the possibility of a big surprise!'

> Chemistry encompasses a wide range of careers. Follow your interests and keep your options open.
> *Don McGilvery, head accelerator operations*

Don studied chemistry at the School of Physical Chemistry, La Trobe University. He initially intended to major in physics but decided that he enjoyed the less theoretical approach of chemical physics. After his PhD, he accepted a postdoctoral fellowship in the School of Chemistry at Cornell University in the USA – with winter temperatures down to –35°C.

As lead accelerator operator, Don is responsible for the daily operations of the nine-member accelerator team, fault diagnosis and improvements to the synchrotron light source, also known as the 'machine'. In other words, he 'keeps the electrons whizzing around the ring to provide a stable source of photons for synchrotron users'.

'The Australian Synchrotron is a brilliant light source that puts within easy reach many experiments that chemists could only dream about a generation ago.'

> Follow the things you enjoy, but don't be afraid to step outside your comfort zone.
> *Adrian Hawley, scientific support officer, SAXS WAXS (small- and wide-angle X-ray scattering) beamline*

'I was hesitant to go interstate or overseas but these moves proved to be among the most rewarding experiences of my studies.' Due to an administrative oddity associated with changing from the University of Melbourne to the Australian National University, Adrian has two BSc degrees – one with honours and one without. He also has a chemistry PhD from the University of Bath, UK, and an arts diploma in history, which he completed 'for fun and relaxation' at the University of Melbourne.

'My current role is essentially as a problem solver,

Don McGilvery runs the control room at the Australian Synchrotron. Image credit: Nancy Mills.

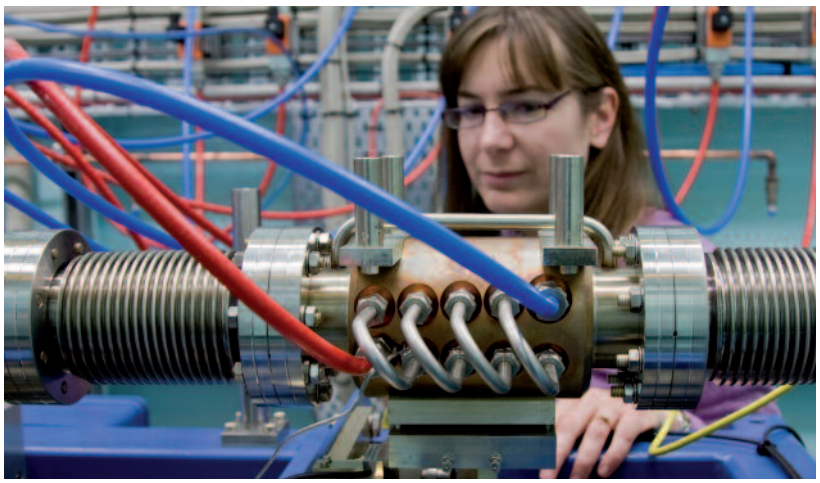
finding ways to get things to work for research users. There's considerable variety and no shortage of challenges.

'All the beamlines here can be used to study chemistry-related new materials, compounds, crystals or in-situ processes. In addition to synchrotron-specific techniques, we offer some techniques that can also be done in the laboratory but are better, faster and stronger at the synchrotron. Better resolution, faster data collection and superior signal strength allow experiments that would otherwise be impossible.'

> I have more of a classic chemistry background than the other staff on the macromolecular crystallography beamlines. I chose to study chemistry because it was interesting and easy, thanks to some very good high school chemistry teachers.
> *Rachel Williamson MRACI, scientific support officer*

Rachel has a BSc(Hons) from the University of Canterbury, New Zealand, and a PhD in synthetic organic chemistry from Massey University, NZ. Since 2007, she has worked at the Australian Synchrotron, where her chemistry expertise is put to good use by matching her with small molecule crystallographers wherever possible, although she also enjoys working with protein crystallographers.

'Small molecule crystallographers are among our most efficient and productive users,' Rachel says. 'They really appreciate the speed with which we can collect diffraction data.'



Rachel Williamson helps maintain the Australian Synchrotron's macro-crystallography beamlines. Image credit: Sandra Morrow.

I was undecided between chemistry and physics when I first started undergraduate studies, but the chemistry professors were great and I enjoyed the topics.
Daryl Howard, scientific support officer, X-ray fluorescence microprobe

Daryl has a BSc and MSc from Canada (University of Prince Edward Island and University of Guelph, respectively) and a PhD from the University of Otago, NZ. His two colleagues on the XFM beamline are both physicists.

'One of my first jobs involved travelling to rural primary schools to help dispose of dangerous items such as nitric and sulfuric acids that had been stored for decades. Science classes must have been quite adventurous back then!

'X-ray fluorescence microspectroscopy is a powerful technique that can directly probe the oxidation states of transition metals,' Daryl says. 'I help train users and assist with their experiments, maintain and improve beamline hardware and document beamline procedures, as well as conducting some of my own research.

'Chemistry graduates are in a diverse range of occupations, so graduates shouldn't be surprised if they find themselves in a non-traditional chemistry job after graduation.'

At the Australian Synchrotron, chemists don't just do chemistry. From left to right: Bruce Cowie (seated), Don McGilvery, Ljiljana Puskar, Ian Gentle, Kia Wallwork, Daryl Howard, Rachel Williamson, Adrian Hawley, Lauren Green. Image credit: Nancy Mills.

I wanted to do chemical physics, but there weren't enough students, so I did a BSc(Hons) in chemistry instead. I did my PhD in chemical physics at Sussex and then moved to a postdoc position at Monash University.
Ljiljana Puskar, infrared beamline scientist

Ljiljana studied food technology in Serbia before moving to the UK to learn English and attend the University of Sussex. Two of her colleagues on the beamline also have chemistry qualifications.

'On the infrared microspectroscopy beamline, we look at interactions between molecules in many diverse samples. Applications include studies of individual human and animal cells, works of art and polymer thin films, so I'm constantly using my knowledge of chemistry.'

The word that best sums up my scientific career is 'interference'.
Bruce Cowie, soft X-ray spectroscopy beamline

'It started with high school physics when I had to measure the wavelength of light using Young's double-slit diffraction experiment and different colours of light. The experiment uses interference between light waves to show the wave nature of light. To me it was almost magical.

'I studied chemistry at Heriot-Watt University in Edinburgh because I was interested in atoms and how they joined together.'

After his PhD, which involved learning about interference between two X-ray waves, Bruce ran a surface science analytical facility for the UK Ministry of Defence, where he used X-ray photoelectron spec-

… for someone studying chemistry, it's a potential career path that could be very satisfying.

I really love science; it's very organised, but I didn't enjoy the repetition that's a feature of some jobs in science.
Lauren Green, executive assistant to synchrotron director

Lauren has a BSc(Hons) in forensic science from Deakin University. 'Working in product development for a paint manufacturer basically meant watching paint dry, although it's nice to know some of the products I helped develop are now on the market.'

Lauren decided instead to combine her love of science with her interest in administration. She returned to the Target discount store chain, where she had worked part-time to finance her degree, and trained in management, administration and human resources.

Following a year in the Australian Synchrotron user office, Lauren became executive assistant to the synchrotron director. She says her science background is a big help when she takes notes in some of the more technical meetings.

'My advice to anyone considering chemistry studies is that it's good to explore what's out there. Don't limit yourself until you find an area that really interests you.'

troscopy (XPS) for the first time. 'I've been using XPS ever since,' Bruce says. 'It's an old technique, but when you look into it there's a lot more to know.'

His next move was to the UK synchrotron at Daresbury. Here he experienced three 'eureka moments', all relating to insights gained by taking the time to develop a detailed understanding of the fundamental physics behind phenomena he had observed on his beamline. Although two of these proved to be rediscoveries – Bruce says he was 'only 80 years away from a Nobel Prize' – the third was genuine.

'The guy I shared an office with at Daresbury can vouch for the fact that I actually said 'eureka' and danced around the room.'

Bruce then moved to the European Synchrotron Radiation Facility (ESRF), where he set up a beamline for the technique he had developed at Daresbury. After leaving the ESRF, Bruce was recruited by the Australian Synchrotron to head its soft X-ray spectroscopy beamline.

'When I did my degree, we couldn't see individual atoms. Surface science looked at the top two or three atom layers. Then half-way through my PhD, the scanning tunnelling microscope (STM) made it

possible to see atoms. I still like to use my imagination as to why atoms behave differently when immobilised on a surface. Surfaces are really poor man's enzymes, although enzymes are much more targeted. The question is how the electrons overlap. Wave functions are crucial.

'I believe quantum computing will eventually turn chemistry into a branch of physics. We'll finally be able to calculate where all the electrons are around an atom.'

I went into a science degree without really knowing what I wanted to do in the long term, although I felt that being a researcher in science would be fascinating. I majored in physical chemistry, which combines the best of chemistry and physics.
Professor Ian Gentle, Head of Science

'My first 'hands-on' experience of chemistry was very different to my current position. Partway through my undergraduate degree, I worked for a chemical company and spent several days doing field trials sampling raw sewage as it flowed by. The smells and some of the sights were revolting. Using autosamplers was a real challenge because raw sewage has a habit of blocking filters, so it was really bucket chemistry. Enough said.'

After a PhD in physical chemistry from the University of Sydney, and a postdoc position at the University of New England in Armidale, Ian began studying interfaces and surfactants at the Australian National University, which led to working with synchrotron X-rays and neutrons.

'As the synchrotron's Head of Science, I have overall responsibility for the facility's scientific program,' Ian says. This includes a user program with over 1600 users and the management of more than 30 scientific staff. I also have a research group at the University of Queensland.

'Because the synchrotron is such a flexible and broadly applicable facility, I work with scientists from a vast range of disciplines. There are no formal courses that equip you for that sort of career, but a background in science is good preparation for a management role. Scientists are a bit of a unique breed. They don't like following orders without question, but the benefits are that you won't find a more motivated group of people.

'Many of our users are chemists, and many of our scientific staff have chemistry qualifications. Major facilities like this present opportunities for science graduates to use their skills at a very high level, so for someone studying chemistry, it's a potential career path that could be very satisfying. For those currently practising chemistry, it's worth looking into the opportunities for research that the synchrotron provides, such as infrared spectroscopy or X-ray spectroscopy with incredibly good signal-to-noise ratios on a very small sample.'

… I actually said 'eureka' and danced around the room.

Although I don't usually put myself into the story, I can't really tell you the full story of what chemists do at the synchrotron without me being in it. So here I am.
Nancy Mills, author

A teenage fascination with molecules led me into a BSc(Hons) in chemistry at the University of Western Australia. I joined the WA Maritime Museum in Fremantle as a research chemist – and realised I wanted to write about science so that people without university degrees could understand it. I also had the travel bug after visiting museum laboratories overseas and helping to investigate centuries-old shipwrecks in the Gulf of Thailand.

I talked my way into a communications job with CSIRO in Sydney and studied writing and journalism at the University of Technology, Sydney. Several moves later, I still enjoy the challenge of writing about new areas of science.

Nancy Mills <nancy.mills@synchrotron.org.au> has been writing about science for the Australian Synchrotron since 2001. She is a former editor of *Chemistry in Australia*.