Welcome to the first newsletter of 2006. We anticipate that this will be a great year for the School, and it has certainly started well with another stunning performance in the NH&MRC and ARC Discovery grant rounds. Of 24 Discovery applications submitted from the School, 15 were successful, a 62.5% success rate in the context of a national average of 24.5%. Particularly pleasing were the award of a Professorial Fellowship to Dr Jeff Reimers, Australian Research Fellowships to Meredith Jordan, Palli Thordarson, and Klaas Nauta, and Discovery grants to “first timers”, Tim Schmidt and Chris Ling. Total new funding to the School from this Discovery grant round was $6.52 million. Kate Jolliffe and Ron Clarke were awarded NH&MRC grants, our first successes in this arena for some time.

Members of the staff of the School have been recognised by two major awards in recent months. Emeritus Professor Hans Freeman has been made a Member of the Order of Australia for his many contributions to bioinorganic chemistry and crystallography. This is long overdue recognition of the seminal role Hans has played in these now vibrant research areas. Professor Cameron Kepert was awarded the Malcolm McIntosh Medal by the Prime Minister. This medal is the nation’s premier award to a physical scientist under the age of 35 and crowns an outstanding few years for Cameron.

Staffing changes are continuing apace with Drs Meredith Jordan and Toby Hudson appointed to Lectureships in Computational Materials Chemistry. Dr Peter Rutledge has just joined us from University College, Dublin as a Lecturer in Organic Chemistry and Peter Harrowell has been promoted to Professor. We are in the process of appointing a new Professor of Organic Chemistry and a new Director of First Year Studies, and will make two other academic appointments during the year. I keep hoping that the pace of staffing change will slow down, but, with the success of the School, it is inevitable that our staff will receive attractive offers from elsewhere.

The building is also undergoing some dramatic changes with major renovations on a number of fronts. A state-of-the-art Materials Chemistry Laboratory is about to be constructed at a cost of more than $1 million. This will house Cameron Kepert’s group and other materials chemistry groups. Construction is also about to start on a multilab spectroscopy facility incorporating mass spectrometry, vibrational spectroscopy and laser spectroscopy including a new femto-second laser. This too will cost close to $1 million and other renovations on a similar scale will take place either later this year or early next year. At that point, all of the School’s research space will have been renovated over a 15 year period and our focus will move to the increasingly urgent need to find additional space though the construction of a new building.

Professor Trevor Hambley
Head of School
Molecular Materials
by Professor Cameron Kepert

The past decade has seen something of a sea change in the investigation of molecular solids: once regarded as little more than symmetrical arrangements of discrete molecular entities, these materials have taken their rightful place next to non-molecular solids as extended lattices capable of interesting and useful cooperative effects. Much of the impetus for pursuing these materials and their novel properties has come from the considerable diversity afforded by molecular chemistry, a feature that is the key to the exploration of new materials and their novel properties.

The various research directions in my group can all be traced to a fascination with how the structures of molecular materials relate to their physical and chemical properties, be they host-guest, electronic, magnetic, optical, mechanical, etc. In short, the goal is an improved understanding of how chemical structure impacts specific material properties. In exploring this knowledge in the design of new systems with new properties, we are tackling a number of exciting challenges: e.g., Can new materials be designed to perform highly specific host-guest functions such as the recognition of right-/left-handed or paramagnetic/diamagnetic molecules? Is it possible to control the interactions that change colour, shape, magnetism, etc. in response to changes in environment, and therefore act as sensors or data storage media? Can hydrogen gas be stored efficiently in nanoporous materials? Can molecular materials be designed that shrink upon heating?

Nanoporous Molecular Frameworks

A principal focus of my research group is the synthesis of new materials that display nanoporosity, i.e., the ability to retain structural integrity following the desorption and sorption of guest molecules. Examples to come out of our lab include crystals that are 80% porous, i.e., only a fifth of the material is made up of atoms, the rest being a vacuum. New in-situ single crystal X-ray diffraction and diffuse X-ray scattering techniques have been developed to map out the immensely rich host-guest chemistry of these phases, which includes extreme flexibility in some of the framework hosts.

Electronic Switching

We have recently exploited the versatility of molecular chemistry to develop truly “smart” nanoporous materials that can switch between different electronic states. This has been shown to occur in response both to the exchange of guest species, an effect that provides a new mechanism for chemical sensing, and to changes in temperature, pressure and irradiation. The coupling of these effects is expected to lead to highly unusual host-guest properties and to instances where guest-exchange processes can be stimulated externally, e.g., by shining a light on the material.

Chirality

The separation of right- and left-handed molecules within nanoporous materials is an important long-standing challenge that has, until recently, been severely hampered by the elusive nature of chirality in solids. We have successfully developed two approaches to overcome this challenge: the use of chiral ligands, and the incorporation of chiral molecular templates. Notable achievements include the synthesis of the first homochiral nanoporous phases and the demonstration of enantioselective guest-loading in these materials.

Magnetism

Materials displaying both nanoporosity and magnetic ordering – properties that are largely inimical – have long been sought for systematic investigations of molecular magnetism and magnetic host-guest interactions. We have recently created the first truly nanoporous magnets by bridging inorganic chains and layers through short molecular linkers. Of particular note here is a material that converts to a magnet when dehydrated, despite there being no associated change to the framework structure (see figure). Efforts are underway to determine the influence of other guests, including paramagnetic molecules, on the magnetic properties of such host lattices.

Hydrogen Storage

Recent results have shown that nanoporous molecular frameworks are outstanding candidates for the efficient storage of hydrogen gas, an essential step in the development of a proposed hydrogen economy. Current efforts are directed at mapping out the structural features that maximise both the surface-dihydrogen physisorption interaction, thereby favouring loading under ambient conditions, and the surface area per mass and volume, thereby increasing total hydrogen loading capacity for transport and stationary storage applications.

Other Properties

With the limitless versatility of coordination chemistry and ligand design at our fingertips, endless further exciting challenges exist. These include guest-dependent fluorescence and electrical conductivity, and the combination of multiple structural features within the one material, e.g., chirality and spin-crossover, to achieve a chiral salt.

Negative Thermal Expansion Materials

Over the past four years my group has established a broad new family of materials that display the highly unusual property of negative thermal expansion (NTE; i.e., contraction upon warming). This family provides the most pronounced NTE behaviour ever observed – up to three times that of any material previously discovered. Using a combination of diffraction, scattering, spectroscopic techniques and theoretical approaches we have successfully elucidated the structural mechanism for NTE in these phases: in a simplified picture, this can be understood as the transverse displacement of molecular units within the structure – a so-called “molecular skipping rope” effect – where increasing vibrational amplitude draws distant atoms closer together with increasing temperature (see figure). The pursuit of commercial applications for these materials has led to the initiation of a University of Sydney spin-off company, UCOM Ten. This company has secured substantial venture capital investment and has a CEO of the highest pedigree!

Nanotubular Clays

Whilst there has been considerable excitement in recent years in the formation of new nanotubular systems such as those of carbon, the fact that naturally occurring nanotubes exist and may be obtained at low cost and high volume has been largely overlooked.

Of these, we have been interested particularly in exploring the host-guest chemistry of the clay halloysite, which forms with 20 nm tubular pores. Exciting achievements include the molecular surface modification of these phases to favour the loading of a range of different guests, and the development of strategies for filling the nanotubes (see figure). We are currently pursuing high-volume applications of these materials in molecular controlled release (e.g., of agrochemicals) and as selective molecular sorbents (e.g., for environmental clean-up).

Brief History

Cameroon grew up in Perth, Western Australia, and completed his Honours degree in Chemistry at the University of Western Australia under the supervision of Prof. Brian Figgis in 1991. Following a 6 month period as a Research Associate, he travelled to London on a Hackett Scholarship to undertake a PhD in Chemistry at the Royal Institution of Great Britain/University of London under the supervision of Professor Peter Day. His PhD research involved the synthesis and characterisation of molecular charge transfer salts, with focus on novel electronic phenomena including conductivity/superconductivity and magnetic ordering transitions.

In 1995, Cameron took up the position of Research Fellow (Chester Church) at the University of Oxford, a position allowing him the academic freedom to launch into a new field of research – namely, molecular framework materials (and, happily, the opportunity to again live in the same city as his partner, Dale, who undertook a doctorate in Medical Imaging/Engineering). During this time he collaborated closely with Prof. Matt Rossinsky in the Inorganic Chemistry Laboratory, where he also had interactions with Prof. Dermot O’Hare and Prof. Paul Beer. Research achievements in those formative years included the first demonstrations of nanoporosity in hydrogen bonded coordination framework materials.

Since coming to the University of Sydney in 1999 as a Lecturer in Inorganic Chemistry, Cameron moved through the ranks to Senior Lecturer (2002) and Associate Professor (2005) before taking up the position of Professor and ARC Federation Fellow at the beginning of this year. He is the recipient of the Malcolm McIntosh Prize of the Australian Government (2005), the Le Fèvre Memorial Prize of the Australian Academy of Science (2004), the Edgeworth David Medal of the Royal Society of NSW (2004), the Rennie Medal of the Royal Australian Chemical Institute (2003), the Selby Research Award of the University of Sydney (2002), and the Young Tall Poppy Award of the Australian Institute of Political Science (2001). Members of his research group have taken up prestigious postgraduate and postdoctoral fellowships at Cambridge, Stanford, Princeton and Argonne, and have won numerous awards, including the Cominco Medal of the Royal Australian Chemical Institute.
did Pharmacy first, under the old apprenticeship system – apprenticed to a Master Pharmacist for three years, going to the Uni part-time and working the rest of the time in a chemist shop. There were exams at the end of the second and third years, followed by the Pharmacy Board Final. This involved prac dispensing exams, as demanding as any exams I ever did, and a prescription-ready paper – to test how well we could decipher very bad handwriting! Back in the shop, I was often surprised by what customers would ask me, an 18- or 19-year-old, to give them advice about. It must have been the white coat.

Through the Pharmacy years, I always had in mind to continue on into Science. When I did, I enjoyed the extra chemistry, especially the Honours year I spent in Professor Le Fèvre’s Physical Organic Group. Working with Le Fèvre was a privilege, as many others, I’m sure, would be happy to confirm. So I went on, for an MSc and PhD with the Prof as my supervisor. Along the way and with his support, I worked towards a BA, mainly in maths and statistics.

After a postdoc in London I joined the staff here and, when Le Fèvre retired, became a member of Hans Freeman’s newly formed Inorganic Department. From the start I gave Third Year courses on environmental inorganic chemistry and, with Neville Gibson, supervised Honours and Postgraduate students working on problems in Applied Coordination Chemistry. We developed new methods of chemical analysis that used transition metal complexes in a variety of ways – as selective extracting agents (in surfactant analysis), to produce intense colour (in the determination of sulphide and sulphite) and as carriers for the preconcentration, by coprecipitation, of trace elements from solutions at µg L-1 (parts per billion) level. At a time when the emphasis in this field was on developing efficient non-selective procedures for multi-element analysis, we showed that coprecipitation can be highly selective and took advantage of this effect to study individual forms of elements in marine and estuarine waters.

At Edinburgh University and the Woods Hole Oceanographic Institution in Massachusetts, I had the benefit of working with a colleague who was using novel methods to study the behaviour of trace elements in natural waters. And here of course, there were the students who trained with me. How can I do justice to the ideas, the enthusiasm and the good humour they brought to the place? They made it fun.

I retired in 2002. ♦

Our heartiest congratulations to Professor Cameron Keper who has been awarded the Malcolm McIntosh Prize for Physical Scientist of the Year as part of the Prime Minister’s Science Prizes for 2005. This outstanding award is in recognition of Cameron’s many seminal contributions to molecular engineering. Read more about Cameron on pages 2 & 3.

The 2005 Selby Research Award was awarded to Dr Lou Rendina. This award is worth $6,500 and is given to an academic staff member with dual teaching and research responsibilities in the physical, chemical, or biochemical disciplines.

Double congratulations to Associate Professor Tony Masters. Not only has Tony won the Vice-Chancellors Award for Excellence in Postgraduate Supervision for his ongoing commitment towards his postgraduates, he has also won the Australian College of Educators and Minister for Education’s 2005 Quality Teaching Award.

The School of Chemistry’s 2005 Science Teachers’ Workshop was held last December and declared by all as an overwhelming success. Over 60 high school teachers attended this stimulating two-day workshop which gave teachers the opportunity to operate equipment such as a Atomic Absorption Spectrometer and a Gas Chromatograph. In particular, the School would like to thank Dr Jeanette Hurst, HSC Liaison Officer, for organizing this event.

I am pleased to be able to report that we have three new members joining the academic staff. Dr Meredith Jordan and Dr Toby Hudson have been appointed to lecturerships in Computational Materials Chemistry and will take these up when their current Research Fellowships come to an end. Dr Peter Rutledge joins us as a Lecturer from the Department of Chemistry, University College Dublin.

Congratulations to Dr Brian Hawker on his award of a Citation by the RACI Polymer Division at the 28th Australasian Polymer Symposium in Rotorua. This award is in recognition of Brian’s scientific achievement in the study of emulsion polymerization and for services to the Polymer Division.
Old Black-and-White Photos

Even in this age of digital colour images at the press of a button or the click of a mouse, quality black-and-white photos continue to have an appeal that isn’t easy to explain. Phillip Adams came close in a piece that accompanied a collection of classic Harold Cazneaux photos. Adams wrote: “In a post-modernist, deconstructionist, semiotic, global media world – in which images and ideas overwhelm in their profusion and confusion – it’s marvellous to look at a Cazneaux print. Thank heavens, the picture isn’t polychromatic. Praise the Lord, it doesn’t move.”

I’ll go along with that. So here are some more old black-and-white photos with Chemistry School connections, reproduced from the University Archives with the help of Reference Archivist Julia Mant. And on the next page, how Harold Cazneaux came to the University, to work his magic.

In the beginning, there was John Smith, the University’s first Chemistry professor, who took the two photos on this page in the 1850s. The self-portrait above shows Smith in his lab examining a sample of fleece; and on the left, he leans against a ladder (belonging to Hudson and Son, Builders of Botany Road), propped up outside a north doorway of the Great Hall. Wearing one of his trade-mark stove-pipe hats, he looks down at a watch in his hand, timing the exposure.

Two things impress me. One is how quick off the mark he was. The wet collodion process favoured by Smith had only been reported, by Frederick Scott Archer, in 1851. The other thing is the quality of the photos. As Kodak’s Krast Burke noted, writing not long after the discovery of the Smith plates in the 1950s: “Most of the great inventions of the last Century had to pass through long stages of experimental models but with photography the reverse was the case – the images produced by the daguerreotype and by the wet plate processes were perfect from their inception.”

The results may have been “perfect” in good hands, or close to it, but it wasn’t easy. In the wet collodion process, collodion containing potassium iodide was spread on a glass plate. When the coating became firm, the plate was dipped in a silver nitrate bath. When the coating became firm, the plate was allowed to dry out. Burke especially admired the photo with the ladder: “Technically this is the best of all of the Professor’s pictures – it is really magnificent.”

Overlapping with Smith and succeeding him was Archibald Liversidge and, after Liversidge, Charles Fawsitt. In the photo below, taken in 1932, Fawsitt sits at the “electro-pneumatic ivory keyboard” of the University War Memorial Carillon, playing for the benefit of the Carillon Committee. Sixty-two bells respond to his touch, the largest of them, the one called the A1F Bell, weighing over 4 tons.

Earlier there had been “some tension and much discussion” in the Senate over a proposal to erect a separate building, a campanile, for the bells but in the end, it was decided that this would cost too much. The bells were installed in the Clock Tower and their sounds have been a familiar part of University life since the Carillon was inaugurated at an Anzac Day ceremony in 1928.

The facts and quotes in this piece are from the following:

Hermes editorial, *Dust or Mud*, 32(1) (1926), 2.
Harold Cazneaux at the University of Sydney, Eds. P. Bell and T. Robinson, University of Sydney (1997).
Dr John A. Lamberton - A Legacy!

John Lamberton (1925-2002) was born in Casino, New South Wales, and completed a BSc Hons at the University of Sydney in 1946. He then moved to the University of Queensland for a year as demonstrator in physical and organic chemistry, and working with Dr. Lander, before moving to the University of Melbourne for a PhD, where he developed his lifelong interest in alkaloids. In a postdoctoral period in Liverpool, John joined Professor Alexander Robertson’s group working on the structure of quassin, followed by John’s return to Melbourne where he joined the CSIRO Organic Chemistry Section. Through the 1950s and early 1960s he worked on natural waxes including sugar-cane and eucalypts, on long-chain anacardiaceous exudates, and on isoflavones, applying the newly emerging techniques of NMR and mass spectroscopy. In 1965 he began his extraordinary studies of plant alkaloids, collaborating with Smith, Kline and French who tested the medicinal activity of many of the compounds. Through this time, John was a major contributor to Australian science, being at the forefront of natural products chemistry, exploiting new isolation and spectroscopic structure determination techniques. Following the closure of the alkaloid project by the CSIRO in the early 1970s, John worked on fruit fly attractants, the constituents of Lantana that poisoned livestock, chemo-variation in Lantana taxa to aid specificity in choice of control insects, deflecting agents aimed at chemical shearing, C4 herbicides, and anticancer antibiotics. John Lamberton produced some 200 research publications and was awarded a DSc by the University of Sydney in 1969. He retired in 1986.

The legacy of John Lamberton and other natural products chemists in Australia is evident in the large scale screening of natural products derived from Australian native plants that is now underway and the many synthetic chemists working on the synthesis of natural products identified as having medicinal application.

The Faculty of Science has recently established a new series of scholarships known as the John A. Lamberton Research Scholarships, made possible by a generous donation from Dr. Lamberton’s widow, for which the University is very grateful. The scholarships are in the area of Dr. Lamberton’s interests: the chemistry of natural products, the understanding of the relationship between chemical structure and biological activity, and the chemical understanding of brain function and malfunction. One of the goals of these scholarships is to contribute to the continued development of these fields by supporting outstanding PhD students working in these areas.

The first John A. Lamberton Research Scholarship winners are listed below. They are all outstanding and are most worthy holders of the Scholarship. It is very pleasing for the Faculty of Science to be able to support these students in carrying on the work that was of such interest to John and is of such importance to society.

2005 John A. Lamberton Research Scholarships were awarded to:

School of Chemistry
Katie Cergol
Joshua Fischer

Discipline of Pharmacology
Renee Granger
Michelle James
Katherine Locock
A Degree in Chemistry

Dr Thomas Barlow

In Australia, it is often said that education has to be “relevant”. At the school level, we hear that education must be connected to teenage interests – hence the recent dumbing-down of physics’ syllabuses in NSW schools. At the university level, it is claimed that education must be applicable to young peoples’ career aspirations – hence the rampant vocationalism of many contemporary university courses.

My experience, however, has been that the only education that matters is a good education; and, for this reason, I feel privileged to be a graduate of the School of Chemistry at the University of Sydney.

I left the School in 1992 – in which year I undertook an honours project with Tony Haymet, then Professor of Theoretical Chemistry. My research focused on the reaction dynamics of freezing in supercooled water. To my knowledge I was the first honours student to do an experimental thesis in the Theoretical Chemistry Department.

Afterwards I went on to complete a doctorate at Oxford University, with Graham Richards, doing research into drug design and protein structure prediction. In 1996 I was appointed Janssen Research Fellow in Biochemistry Department.

During the world of politics late in 2004, I have since written a book about the status of Australian science and innovation – “The Australian Miracle”. This book dispels a number of myths about Australian science, affords a somewhat wry perspective of Australian politics, and provides some much needed optimism about the prospects for innovation in our country. It will probably leave me with few friends, but it is due to be published by Picador in April this year.

Perhaps as a consequence of my varied background I am now also regularly called upon as a consultant for a variety of public and private organisations, providing advice on business and innovation strategy. This year, too, I have been appointed the CEO of a start up company called UCOM Ten. Coincidentally, this company is bringing to market some very exciting new technology that clearly described progress in areas of molecular recognition, self-assembly, molecular materials, supramolecular catalysis and molecular motors. He also visited The Australian National University, The University of Queensland and The University of Melbourne as part of his stay.

Last year the Cornforth Foundation hosted a six week visit of Professor Roeland Nolte from the University of Nijmegen in The Netherlands. Roeland Nolte is Chairman of the Editorial Board of the RSC journal Chemical Communications and a member of the Board of Reviewing Editors of the journal Science (Washington). In 2003 he was awarded the first Royal Netherlands Academy of Arts and Science Chair in Chemistry. His research interests span a broad range of topics at the interfaces of Supramolecular Chemistry, Macromolecular Chemistry, and Biomimetic Chemistry.

Professor Nolte delivered the 2005 Cornforth & Louis Lecture entitled Bio-inspired Architectures by Programmed Assembly which gave a comprehensive overview of the history of self-assembled molecules and their discoverers, and walked us through some very exciting applications of nature’s design. As one example of their research achievements, Professor Nolte’s group has studied the catalytic activity of a single enzyme molecule isolated on a glass plate. The potential uses of this information are staggering but also put into perspective just how much we have still to learn. His second School Seminar, Self-Assembled Alignment Layers for Application in Liquid-Crystal Devices described the application of self assembly to the synthesis of liquid-crystal display (LCDs) devices. The technology offers the potential for the manufacture of larger, cheaper and improved LCDs.

In addition to these research lectures, Professor Nolte delivered a five week lecture course to the postgraduate students entitled “Mastering Molecular Matter” that clearly described progress in areas of molecular recognition, self-assembly, molecular materials, supramolecular catalysis and molecular motors. The technology offers the potential for the manufacture of larger, cheaper and improved LCDs.

We are pleased to announce that the Cornforth Lecture for November 2006 will be Professor David MacMillan, California Institute of Technology (Caltech). Prof. MacMillan is a rising star in the field of catalysis in Organic Chemistry. Between January and July 2005 his research output included three of the top ten most cited articles in the Journal of the American Chemical Society, the flagship journal of the American Chemical Society.

Donations

The School of Chemistry would like to thank the following people for their generous donations from September 2005 to April 2006:

Flush Fund

Dr George Backsby
Dr Thomas Barlow (see page 10)
Professor David Beratan
Professor David Buckingham
Emeritus Professor Hans Freeman
Dr James Friend
Professor Jill Greaves
Professor Sven Larsson
Professor George McLendon
Mrs Sandra Meyer
Professor Thomas Meyer
Professor Don Napper
Professor Bertima Pidcock
Professor Mark Barner
Dr David Swanton
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Alumni Fund

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Mr Phillip L King
Mr Christian Liedvogel
Dr Sporis Pendejakas

Organo Fund

Alpha Chemicals Pty Ltd
Dr Manuel J Aruny
Ms Carol Bar
Emeritus Prof. Hans Freeman
Mr Robert Geyer
Emeritus Professor Len Lindley

ChemNEWS

Issue 8, Autumn 2006

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I did Honours (1985) and a PhD (1989) in Chemistry at Sydney, on “Trace elements in marine waters” with Dr Jim Eckert as my supervisor. Jim says that supervising me was “never dull”. I think that’s a compliment. In search of “adventure”, I took up a two year Research Fellowship at the University of Zimbabwe, studying the distribution of trace metals in Lake Kariba and its rivers; and followed that with three years as Chief Ecologist and Project Manager for Raleigh International in Southern Africa, working in Zimbabwe and Namibia.

Much of my work at that time and since has involved the study of elephants — their movement, social behaviour and general ecology — first with Raleigh International, then as Conservation Officer of the Kalahari Conservation Society in Botswana and later, as Senior Scientist and Project Manager for the Desert Research Foundation of Namibia. I am presently the CEO and a Trustee of the Namibian Elephant and Giraffe Trust.

The desert-dwelling elephants of Northwestern Namibia are our special interest and we have now GPS-collared a number of them. But tracking the elephants is only one of the problems. Keeping the landrover running is another. And so is satisfying the locals that I’m not just another white out to abuse communal lands. On a recent field trip, the bush was very dry and the days were long and hot. I was sunburnt for the first time in seven years. The elephants were having to wander long distances (up to 25 km a day) in search of food but didn’t look too bad for it. They are truly amazing animals and every time I encounter them it gives me a fresh thrill.

What part has chemistry played in all this? Good question. I haven’t been in a chem lab since my first stint in Zimbabwe. Yet the biological implications of chemistry are all around me. Why is a particular species of grass dominant in one area of the veld and nowhere to be seen 100 m away? Or again, why do animals prefer to drink at one waterhole and not at others near by? Variations in water and soil chemistry are clearly at work. I’m sure of one thing: would-be environmental scientists do well to get themselves a good grounding in chemistry.