MONASH University

School of Chemistry

Alumni Newsletter 2008, Issue 2

TEACHING AND RESEARCH NEWS FROM THE
SCHOOL OF CHEMISTRY, MONASH UNIVERSITY

Features:

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From the Head of School

Emeritus Professor
Ronald Drayton Brown AM

10.10.1927 - 31.10.2008

It is with great sorrow that we mourn the passing of Professor Ron Brown. Professor Brown was the Foundation Chair of Chemistry and inaugural Head of Chemistry at Monash University. He had a long and distinguished academic career which spanned over 40 years.

He will be sadly missed by present and past members of the School of Chemistry.

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TEACHING AND RESEARCH NEWS FROM THE
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Each issue we will highlight one of our staff members. This issue's staff profile is Professor Stuart Batten.

Staff Profile – A/Prof. Stuart Batten

Short Biography

Stuart R. Batten was born and raised near Wangaratta, in country Victoria. Upon leaving school he did a BSc(Hons) followed by a PhD (1996) at the University of Melbourne, the later under the supervision of Richard Robson and Bernard Hoskins, working on coordination polymers. Following a postdoc at the University of Bristol, he came to Monash to work in Keith Murray's group. He then obtained an ARC Australian Postdoctoral fellowship (1998-2000, working in the Murray group), followed by an Australian Research Fellowship (2001-2005). In 2004 he was appointed to a Lectureship which began in 2006 on completion of his fellowship. He was then appointed to Senior Lecturer in 2007 and Associate Professor in 2009.

His research, detailed in more than 175 publications, is mainly in the areas of crystal engineering, coordination polymers, supramolecular chemistry, inorganic chemistry, and crystallography. He is also lead author of a book just published by the Royal Society of Chemistry entitled *Coordination Polymers: Design, Analysis and Application* (2008; with DR Turner and SM Neville). His work has been highly cited (more than 6500 citations, h-index = 39), as recognised by the awarding in 2008 of a Thomson Scientific Citation Award for the highest average citation rate amongst Australian researchers in the field of Chemistry for 1997-2007. Other awards include Fellowship of the RACI (2008), the Le Fèvre Memorial Prize (2008), a Cosmos Bright Sparks award (2007), a Young Tall Poppy Award (2006), the inaugural Vice-Chancellor's Early Career Researcher Award (2006), the HG Andrewartha Medal (2005), the Edgeworth David Medal (2003), and the Rennie Memorial Medal (2002). He is the current secretary of the Society of Crystallographers in Australia and New Zealand (SCANZ), chair of the Inorganic Chemistry group of the Victorian branch of the RACI, a member of the International Union of Crystallography (IUCr) Commission on Structural Chemistry, and an Associate Editor of the Australian Journal of Chemistry. He is also the current Third Year Coordinator within Monash Chemistry.

Research

Broadly, our research seeks to understand the way molecules come together to form larger assemblies, which can be either discrete (supramolecules) or infinite (crystal engineering). We then try to take this understanding and apply it to designing and controlling the structure of new assemblies.

The ability to control the way the molecules assemble, particularly in the solid state (crystal engineering), is important because many of the properties of materials are governed by the packing arrangements of their constituent molecules. To take an elemental example, both diamond and graphite are both made up of only carbon atoms, but in different arrangements. One arrangement gives the hardest substance known to man, while the other is soft enough to rub off on a page. One is an insulator while one is a conductor. One is a whole lot more expensive than the other.

In our work we are trying to learn how to coax molecules (rather than atoms) into valueable arrangements which will give useful properties.

These include aspects such as long-range magnetic ordering, and porosity for a number of applications, including gas storage. Some of the more interesting results from our ongoing projects are listed below:

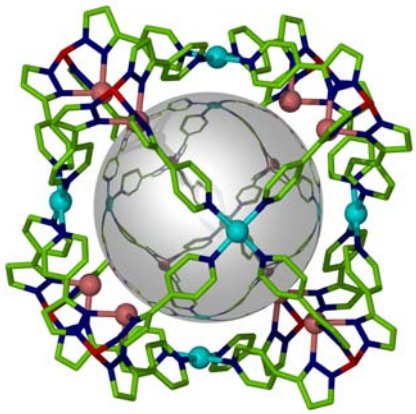


Figure 3. Nanoball

Coordination Polymers

A very effective way to control the packing of molecules in the solid state is through the use of the coordination bond to direct the structure. If ligands and metals are designed or chosen with care, they will react and form coordination polymers in which the topology of the network reflects the geometries and connectivities of its components. We are currently studying the synthesis of new coordination polymers with a view to creating new materials that, in particular, show long range ordering (see below) or porosity. Porous materials are of significant current interest for a range of reasons. Heterogeneous catalysts and molecular sensors need to be porous (unless working through surface based mechanisms) to allow reactants or molecules into the appropriate active sites. There is significant interest also in gas storage, such as for on-board hydrogen storage systems for hydrogen fuelled transportation. Other gases of interest include methane, another potential fuel source, and CO_2, a major pollutant which needs to be trapped. In our work we are currently designing and testing porous coordination polymers for sorption of H_2 and CO_2, in collaboration with Matthew Hill (CSIRO) and Alan Chaffee (Monash).

We also have an interest in the analysis of the topology of coordination polymers, and the phenomenon of interpenetration, whereby two or more independent networks, usually identical, weave through each other in order to maximise the crystal packing efficiency.

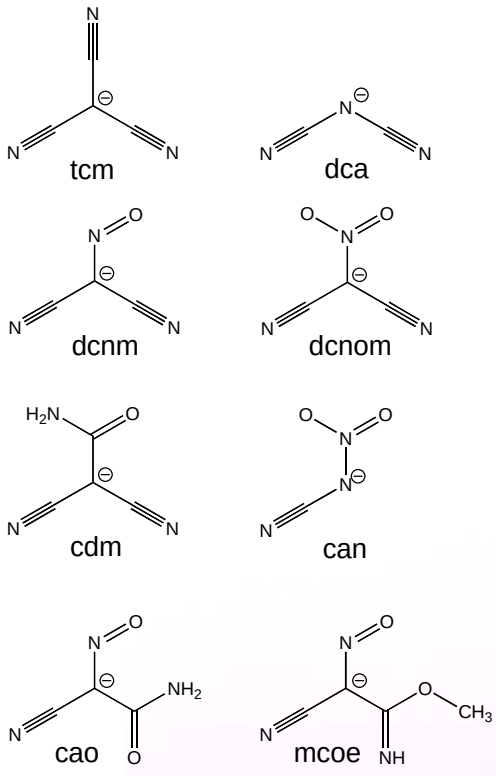


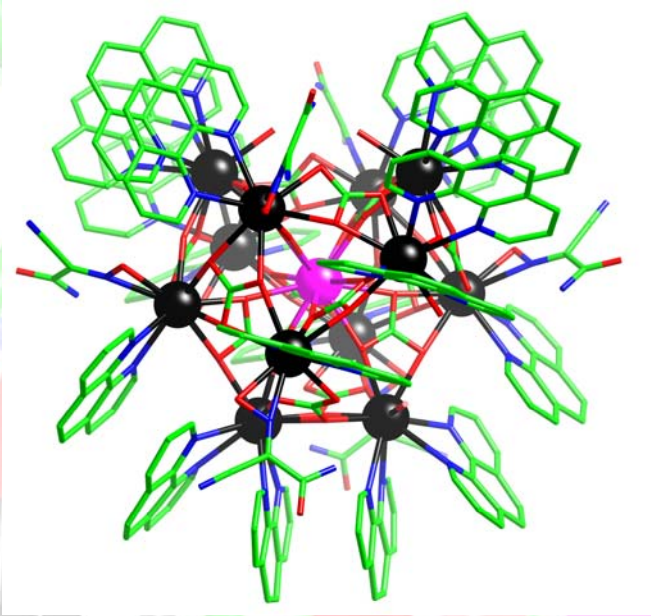
Figure 1. Small nitrile anions

Small Nitrile Anions

Our work in this area began with the discovery, while I was a member of the Murray group, of the $M(dca)_2$, dca = dicyanamide, $N(CN)_2^-$ series of new molecule-based magnets. Following this initial study of the binary metal dicyanamide complexes, we studied the modification of network topologies through the introduction of bridging and terminal coligands. The metal-dca system was found to be very malleable; subtle changes in coligands can lead to dramatic changes in structure. Furthermore, it was found that cations could template the topology of anionic $M(dca)_3^-$ and $M(dca)_4^{2-}$ networks.

Following on from this work, we has very recently focussed on other small nitrile anions, such as $C(CN)_2(X)^-$, X = NO, NO_2, $CONH_2$ (Figure 1) These anions have shown a remarkable variety of properties, including the ability to undergo nucleophilic addition of alcohols and amines to generate new families of related anions. For example,

Figure 2. Lanthaball



the ligands ONO and MeONO shown in Figure 1 are derived from addition of water and methanol to dcnm, respectively. These anions and their derivatives also show novel hydrogen bonding motifs in the solid state. One particularly notable example is the formation of "Heterotapes" – 1D tape motifs in which two different intermolecular motifs (synthons) are used to connect the anions into tapes (*Chem. Asian J.*, 2007, **2**, 1534). These heterotapes are fairly robust, forming in both simple salts and metal complex structures (the later generating an overall 2D network), however variation of cation (*CrystEngComm*, 2008, **10**, 170; *New J. Chem.*, 2008, **32**, 719) or introduction of competing hydrogen bond donors (*CrystEngComm, in press*; *CrystEngComm, in press*) can disrupt these motifs and induce new packing arrangements.

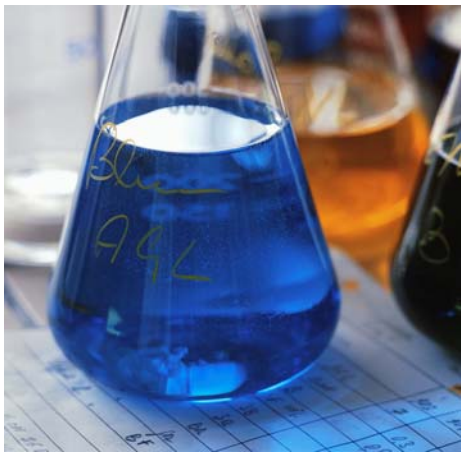
The anions also form unusual new homoleptic lanthanide complexes (e.g. $Ln(dcnm)_6^{3-}$), and have a great ability to form a vast variety of homo- and heterometallic clusters, including Ni_2Ce, $MnGd_2$, Zn_2Ce, Zn_2Pr_2, Er_2Mn_2, Mn_8, Fe_8, Dy_8, Fe_{10}, Ln_{13} (Ln = La-Gd), and Gd_{14} species. The Fe_{10} clusters (*Dalton Trans., in press*) are notable because they are bonded into a 2D coordination polymer supported by hydrogen bonding, giving a regular 2D array of the clusters. The Ln_{13} species (*Angew. Chem., submitted for publication*), which have been given the nickname 'Lanthaballs', consist of spherical Ln/CO_3 clusters (Figure 2) which can be made in three different forms. These clusters are all of significant interest for their possible single molecule magnet properties. Single molecules magnets are nanometer sized metal clusters which act in many ways like tiny little magnets.

This work is being undertaken in collaboration with Keith Murray (magnetic properties) and Glen Deacon (lanthanoid complexes). Furthermore, we are looking at the ability of these anions to form ionic liquids, in collaboration with Doug MacFarlane.

Supramolecules

Our most significant result in this area has the synthesis of multifunctional, nanometre sized molecular balls (*ca.* 3 nm in diameter) containing 8 ligands and 14 metal ions (*Angew. Chem.*, *accepted*). The inside surfaces of these 'nanoballs', one of which is shown in Figure 3, are decorated with potential ligand binding sites, and the nanoballs can be made with a range of different metals. Three different crystalline forms have been obtained. One form shows a remarkable series of properties, depending on the nature of the metal ions. These include significant adsorption of hydrogen gas, reversible absorption/desorption of a range of liquid vapours, heterogeneous catalysis, and magnetic switching (spin-crossover) induced by temperature, light

irradiation and guest exchange. This last result is particularly significant as it is the largest discrete species known to show this property. Another form has the largest known cubic unit cell solved by single crystal crystallography for a 'small molecule' structure – 100 Å cell lengths put it in the range of protein molecules! This work has been performed in collaboration with Keith Murray, John Cashion (Physics), John Boas (Physics), Cameron Kepert (Sydney), and Jean-Francois Letard (Bordeaux), as well as data collection at the Australian Synchrotron.



News and Events – ACR Discovery Grants

NH&MRC Grants

Prof Harald Schmidt, A/Prof Patrick Perlmutter, Dr Russell Brown, and Dr Kirstin Wingler

Underlying mechanisms of cardiovascular disease $475,800

The School of Chemistry has some great successes in ARC LIEF bids in the recently announced funding outcomes:

- **Steve Langford** led a bid from Chemistry, VCP, Biochem and UniMelb that received $1.4M to purchase a 600MHz NMR spectrometer with cryoprobe capabilities.
- **Udo Bach** combined with University of Adelaide to acquire **$400,000** to purchase Organic Solar Cells Fabrication and Characterisation Facility.
- **Ian McKelvie** and **Mike Grace** received **$150,000** in collaboration with UniMelb to purchase Ion Chromatograph with Automated Sampling Facility.
- **Stuart Batten** received a Near Miss Grant for his ARC Project for being in the top 5% of those grants that missed funding in the recent ARC round. This was awarded by the Research Office at Monash University.

Prof AM Bond; Dr LL Martin
Electrochemically, photochemically and magnetically tuneable organic semi-conducting electrodes for probing biologically important redox chemistry and catalysis

2009: $160,000
2010: $90,000
2011: $110,000

Prof M Forsyth; Prof DR MacFarlane; Dr PC Howlett
Interphase Engineering of Reactive Metal Surfaces Using Ionic Liquids

2009: $350,000
2010: $200,000
2011: $200,000

Dr EJ Bieske; Dr EG Robertson; Prof JM Lisy
Lighting up the charged brigade: laser spectroscopy of protonated and metal-containing complexes

2009: $100,000
2010: $80,000
2011: $80,000

A/Prof AW Western; Dr MR Grace; Prof JJ McDonnell; Prof RE White An integrated investigation of nutrient generation and delivery processes and pathways from paddock to small catchment scales	**2009: $140,000** **2010: $120,000** **2011: $120,000** **2012: $60,000**
Prof PC Junk; Prof GB Deacon Rare Earth Metal-Organic Compounds - A Source of Continuing Excitement	**2009: $200,000** **2010: $140,000** **2011: $140,000**
Dr M Massi; Dr F Biscarini Design and synthesis of novel lanthanoid complexes for the fabrication of light emitting devices	**2009: $65,000** **2010: $65,000** **2011: $65,000** **2012: $65,000**

Congratulations

Professor Cameron Jones who was recently awarded a Humboldt Senior Research Award from the Alexander von Humboldt Foundation in Germany. These awards are the highest of those awarded to foreigners by the German system. Past winners include more than 40 Nobel Prize winners. The pressure is now on for Cameron!

This comes on the back of the Jones group publishing two articles in Chemical Communications that have received Hot Article status as well as a follow up to their recent Science paper on their magnesium(I) chemistry that has been published in Angewandte Chemie (see Angew. Chem. Int. Ed., **2008**, 47, 9079)

Andrea Robinson and **Stuart Batten** who were recently promoted to Associate Professor.

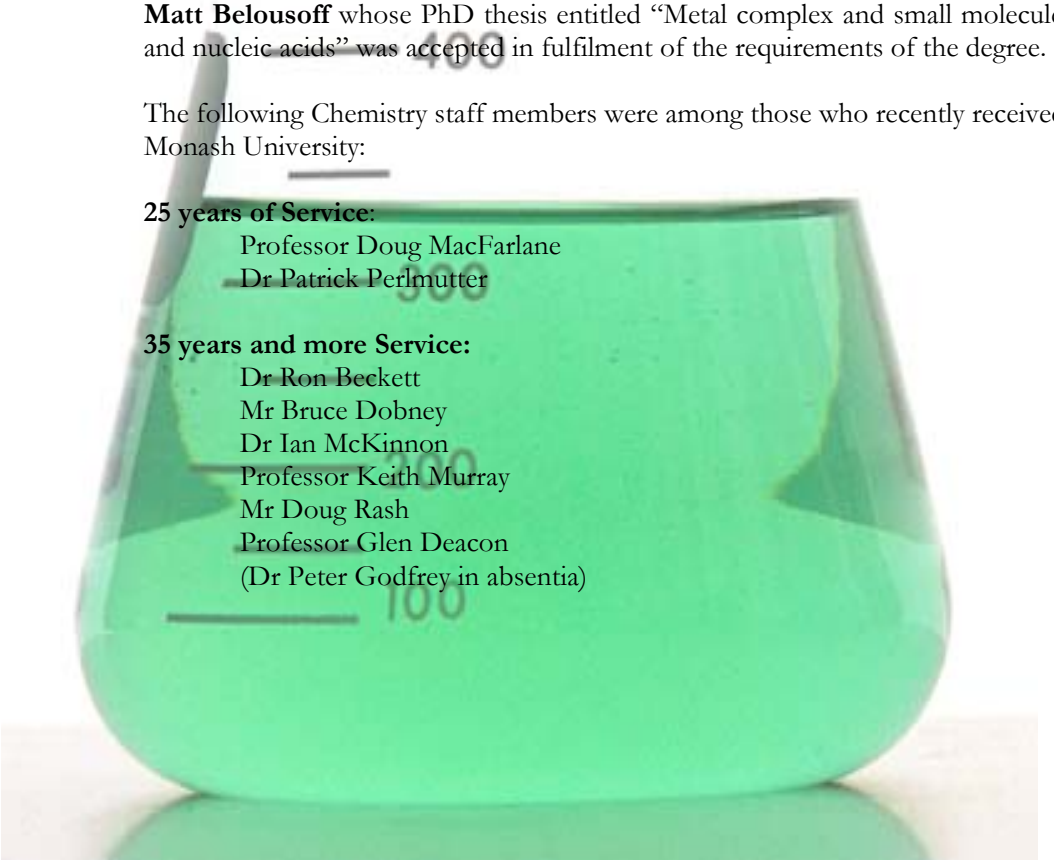
Stuart Batten who was recently elected as a Fellow of the Royal Australian Chemical Institute.

Matt Belousoff whose PhD thesis entitled "Metal complex and small molecule interactions with phosphate esters and nucleic acids" was accepted in fulfilment of the requirements of the degree.

The following Chemistry staff members were among those who recently received medals for Long Service at Monash University:

25 years of Service:
Professor Doug MacFarlane
Dr Patrick Perlmutter

35 years and more Service:
Dr Ron Beckett
Mr Bruce Dobney
Dr Ian McKinnon
Professor Keith Murray
Mr Doug Rash
Professor Glen Deacon
(Dr Peter Godfrey in absentia)



The First Year Chemistry staff (including **A/Prof Phil Andrews, Ms Miranda Phelan, Dr Waldo Correa and Ms Sania Jalal**) have received a 2008 Faculty of Science OHSE Award for the introduction of new pipette and burette systems that should eliminate problematic breakages and risk of injury

Naomi Lewcenko and **Annette Koo** who were recipients of an Australian Research Council Nanotechnology Scholarships for Australian Early Career Researchers at the 17th International Conference on Photochemical Conversion and Storage of Solar Energy 2008. **Alessndra Allegrucci** and **Naomi Lewcenko** were the recipients of the Student/ECR Best Poster Awards at the same conference.

50th Anniversary Research Awards

Recentyl the University held its 50th Anniversary Reseach Awards at Government House, courtesy of His Excellency, the Governor of Victoria, Professor David de Krester AC. From the School of Chemistry the special awards/acknowledgments were:

Professor Roy Jackson Sir John Monash Distinguished Professor

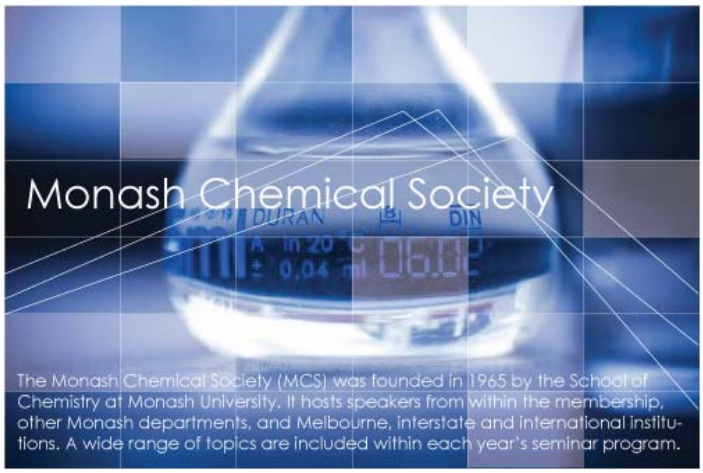
Emeritus Professor Ronald Brown AM Foundation Chair and Head of Chemistry from 1959-1992

Professor Milton Hearn Director of the ARC Special Research Centre for Green Chemistry Award for Best International Collaborations

MCS Seminar News for 2009

The Monash Chemical Society (MCS) was founded in 1965 by the School of Chemistry at Monash University. It hosts speakers from within the membership, other Monash departments, and Melbourne, interstate and international institutions. A wide range of topics are included within each year's seminar program.

The Lecture Program for second semester 2008 and first semester 2009 is available at www.chem.monash.edu.au/mcs/



Forthcoming Seminars

All seminars are held on Mondays at 1.00 pm in the Bruce West Seminar Room, Building 23 unless otherwise stated. Visitors welcome. Ticketed parking is available in the multi-storey car park located at the northern end of the campus. Enquiries: Dr. Perran Cook 9905 4091, perran.cook@sci.monash.edu.au

Student Support Fund - Donations

https://advancement.monash.edu.au/donation/index.aspx?qid=06L

The School of Chemistry has established a Student Support Fund. This fund is designed to support the undergraduate and honour students with scholarships, prizes, travel grants and other exceptional support. If you would like to donate to the fund please contact Monika Walker Manager, Academics Program 9905 1123, monika.walker@sci.monash.edu.au or Peter Junk Head of School 9905 4570, peter.junk@sci.monash.edu.au or online at https://advancement.monash.edu.au/donation and select the Dean's Scholarships fund.

Dean's Scholarship Scheme

The Faculty of Science has recently introduced the Faculty of Science Dean's Postgraduate Research Scholarship Scheme. A very generous incentive which looks to provide funding support to **all eligible**, newly commencing students in a higher degree by research within the faculty or where there are joint supervisory arrangements with other faculties of Monash University.