

DR TIM SCHMIDT WINS 2010 COBLENTZ AWARD

Dr Tim Schmidt is the first Australian to win the Coblentz Award from US vibrational spectroscopy association, the Coblentz Society. The Coblentz Award is presented annually to an outstanding young molecular spectroscopist under the age of 36. Tim received his award and delivered his Coblentz Award Lecture in June this year at the Ohio State University International Symposium on Molecular Spectroscopy.

FOR MORE INFORMATION PLEASE VISIT:

www.usyd.edu.au/news/science/397.html?newsstoryid=4460

ULTRAFAST SPECTROSCOPY

BY DR TIM SCHMIDT

In early 2008, the School of Chemistry took delivery of one of the most sophisticated laser systems in the world.

“You can fit this time into one second as many times as you can fit one second into the time since *Homo sapiens* first emerged in Africa, 200,000 years ago.”

Our femtosecond laser system, housed in the bowels of the Madsen building, puts out 1000 pulses of light a second, with wavelengths tunable from 190 nm to 2.2 μm . But what makes this laser different from others in our laboratories is that the pulses are only 150 femtoseconds long. This is about one sixth of a millionth of a

millionth of a second. You can fit this time into one second as many times as you can fit one second into the time since *Homo sapiens* first emerged in Africa, 200,000 years ago. This is seriously fast – in this time, light only travels 50 microns – about half the width of a human hair – but it is also the timescale of chemical dynamics.



Figure 1. Sydney's ultrafast spectroscopy laboratory in action.

Using light paths in the lab, we can use micropositioning stages to accurately control the time delay between two laser pulses, at femtosecond resolution. This is the basis of femtochemistry (ultrafast spectroscopy), where one endeavors to watch molecules in action on ultrafast time-scales.

The desire to observe phenomena on shorter and shorter timeframes may be traced back to the early days of photography. Leyland Stanford, who founded the university in honour of his son, commissioned in 1872 an experiment to test if a galloping horse ever had all four feet off the ground. The apparatus used a set of trip wires to take a series of photographs which proved that this was indeed the case. In pump-probe spectroscopy, we use one laser pulse to trigger a chemical event (like opening the barriers for the galloping horse), with a second laser pulse acting like the camera shutter. The experiment is repeated many times, with the delay between the trigger and the shutter (the pump and the probe) being scanned to reveal a series of frames which make up a chemical movie. The time scale on which you can make such a movie depends on the duration of the laser pulse that one uses as the "shutter".

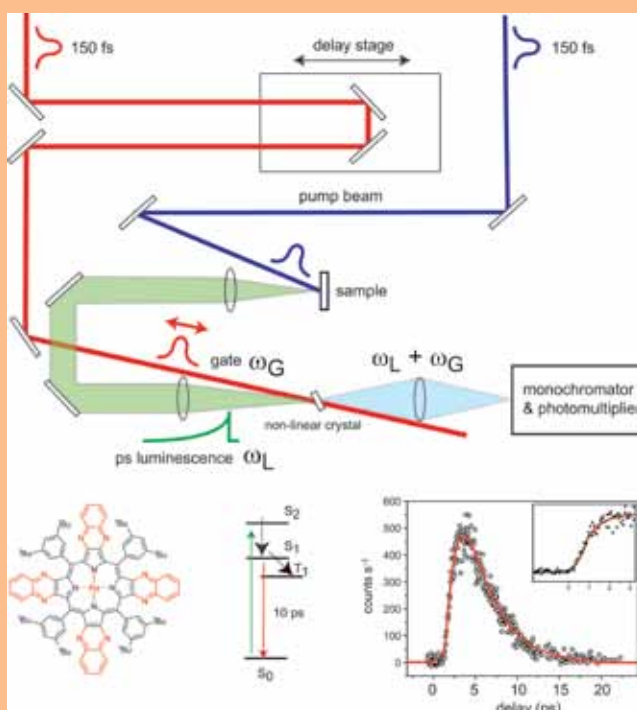
The duration of laser pulses decreased steadily since the first pulsed laser, some 45 years ago. Indeed, by 1990 a linear extrapolation suggested that the 0fs laser pulse should be imminent. The observation of the 0fs laser pulse was put forward by Wayne Knox, in an article co-authored by Knox, Hoose and Zare, on 1 April 1990¹. Notwithstanding academic humour, by the early to mid-nineties many laboratories were using laser pulses on the hundred femtosecond timescale to observe molecular vibrations, dissociations and curve-crossings. In 1999, while I was undertaking my PhD in this field, the Nobel Prize in Chemistry was awarded to Ahmed Zewail, for "for his studies of the transition states of chemical reactions using femtosecond spectroscopy". My PhD supervisor at Cambridge, Gareth Roberts, had been previously awarded a NATO fellowship to Zewail's lab. This was a pretty exciting time for a graduate student.

The seeds of our femtosecond laboratory were sown when Ned Ekins-Daukes, a lecturer in the School of Physics specializing in solar cells, approached us to support a LIEF bid to the Australian Research Council. The ambitious proposal for over \$2 million was supported

by University of New South Wales (UNSW), and duly funded, with about half this for a new femtosecond spectroscopy facility to undertake ultrafast chemistry and photovoltaics experiments, the latter in collaboration with Martin Green's group at UNSW. With Ned's departure to Imperial College, London, we inherited not only full responsibility for the system, but took over as principal investigator on a project subsequently funded by the Global Climate and Energy Project (GCEP), through Stanford University, to work on Hot Carrier Cells. This project, and the nascent collaborations with Ekins-Daukes marked our entry into the world of photovoltaics. The GCEP grant was enough to fund a doctoral level researcher to manage the laboratory day-to-day, and Dr Raphaël Clady (Raf) joined us in late 2007. Raf has since set up a number of ultrafast spectroscopy experiments in the lab including time-resolved photoluminescence, and transient absorption spectroscopies. At the time of writing, we have collaborations with the Crossley, Maschmeyer/Masters, Carter and Perrier groups within the School, Green, Conibeer (PV Ren. Enrg. Eng.) and Thordarson (Chem.) at UNSW, Kee (Chem.), Fischer and Abbot (Elec. Eng.) at Adelaide and Wild at UWA (Chem). International collaborations are ongoing with Ekins-Daukes at Imperial (Physics) and McIntyre at Stanford (Mat. Sci. Eng.).

So, what kind of data do we end up with? We obtain some signal as a function of the time delay between two laser pulses (pump and probe). For instance, in time-resolved photoluminescence experiments, we initiate the photoluminescence (fluorescence) by excitation with one 150 fs laser pulse (the pump, see figure 2). The ensuing luminescence (ω_L) is imaged onto a non-linear crystal coincident in time with a second 150 fs laser pulse (gate, ω_G). Photons from the two light beams are conjoined by sum-frequency generation (SFG), which is then detected. The SFG signal is proportional to the luminescence intensity where the two light signals intersect, so changing the delay

Figure 2. Experimental set-up for ultrafast time-resolved photoluminescence experiments.



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of the gate pulse allows to temporally map out the photoluminescence. The set-up is shown in the figure 2. We have used this to observe a Crossley porphyrin fluorescing for about 10 ps before it makes its way to the dark, long-lived triplet state, where we store the energy for later use.

To conclude, femtosecond spectroscopy has arrived in Sydney. As chemists, we no longer have to imagine processes happening on ultrashort time-scales, we can observe them directly using pulses of light.¹

¹Knox, WH; Knox, RS; Hoose, JF and Zare, RN, Observation of the 0-fs pulse, *Optics & Photonics News*, 1 (4), 44-45, 1990.

SPOTLIGHT



Senior Research Associate, Dr Zheng-Li Cai along with collaborators from the School of Biological Science of the University of

Sydney, Macquarie University, the University of NSW and University of Munich, recently discovered the fifth form of Chlorophyll in over 60 years. This work has been published in some of the world's leading journals. Please visit <http://bit.ly/cLfMFG> for more information about this exciting research.

Dr Deanna D'Alessandro's research on a material that can soak up large amounts of greenhouse gases has been featured in an ABC news report. To view this report visit <http://bit.ly/ciAolj>. Read more about Deanna's research on page 8 and in the following two publications:-

D'Alessandro, DM; Smit, B and Long, JR. *Angew. Chem. Int. Ed.*, **49**, 6058-6082, 2010.

Demessence, A; D'Alessandro, DM; Foo, ML; and Long, JR. *J. Am. Chem. Soc.* **131**, 8784-8786, 2009.



Above: Dr Stuart Thickett, Dr Chiara Neto and Associate Professor Andrew Harris

The School of Chemistry's Dr Chiara Neto, Dr Stuart Thickett, along with Associate Professor Andrew Harris from the School of Chemical and Biomolecular Engineering, have appeared on the ABC Radio program 'Innovations' for an interview regarding their research. The segment was called 'Desert Beetle Inspires Water Collection.' To read more about this fascinating story please visit: <http://bit.ly/dCN2yv>



HISTORY NEVER REPEATS

Did you know that there is one large part of the School of Chemistry that is still almost unchanged from the original opening of the new building? As an alumnus or alumna, think back to the many happy hours you spent in second or third year inorganic chemistry practicals making those brightly-coloured crystals (or trying to find a reliable endpoint). Well, soon those labs will be no more. The University has promised a substantial injection of funds to completely renovate those laboratory spaces, and the School has responded with an ambitious plan to restructure our undergraduate laboratory program.

Senior chemistry labs are in many ways the last vestige of our old departmental structure, in which laboratory teaching is compartmentalised into three "adjectival" disciplines of chemistry. This comes along with substantial administrative and convenience costs of rotating between three different physical spaces and their associated "operating systems." Under the new structure, and in the new laboratories, third year students will have a home in chemistry for their entire year. They will undertake an integrated laboratory program taking them from synthesis through characterisation and physical property measurement, calculation and simulation – a much better representation of modern chemistry, not chopped up according to the constraints of physical infrastructure.

For the first time, we will be able to properly embed a research experience into our undergraduate program.

There is much to do to get there from here, but members of the school have embraced this opportunity for a radical upgrade of our laboratory program. This should be no surprise. Over the last few years a team led by Peter Harrowell has developed a brand new First Year laboratory program, finally due for full-scale implementation in 2011. This program develops experimental laboratory skills in an environment focussed on careful observation, discovery, and deduction. Our Second Year laboratory has been undergoing more-or-less continuous reorganisation in parallel with changes in the lecture curriculum, but it, too, will come in for a radical re-think. A consolidated Second Year laboratory will also be created as part of our renovations, finally allowing an integrated approach to laboratory teaching from years 1-3.

So, if you yearn for a year made up of three terms, or love to reminisce about wooden fume cupboards, then visit the 2nd and 3rd year inorganic labs soon. It may be your last chance to see. The future of undergraduate practicals may not have shiny black benchtops, but I think they look brighter.

Professor Greg Warr
Head of School



The late Dr Michael Bishop



The late Emeritus Professor Hans Freeman with Chemistry Alumnus, Dr Thomas Barlow, who as a secondary school student of Dr Bishop spent a period of time in Professor Freeman's research group and recently made a substantial financial contribution to establishing the Michael Bishop Award in Chemistry.

IN MEMORY OF REMARKABLE CONTRIBUTORS TO SCIENTIFIC RESEARCH AND EDUCATION

BY PROFESSOR PETER LAY

Emeritus Professor Hans Freeman AO and Dr Michael Bishop, who passed away in late 2008 and 2009, were dedicated teachers and mentors, both keenly aware that early involvement in research and exposure to world-leading researchers can be inspirational to young scientists. Two funds have been established by the Foundation for Inorganic Chemistry to commemorate the substantial and lasting contributions of these remarkable men. These are aimed at building on their many contributions to the research and teaching activities of the Foundation.

THE HANS C. FREEMAN LECTURESHIP FUND

The Hans C. Freeman Lectureship was established in 2010 by the Foundation for Inorganic Chemistry within the University of Sydney, with generous support from the Freeman family, to mark both the many outstanding contributions of Professor Hans Freeman AO, to Australian science and his co-founding of the Foundation with Dr Alexander Boden AO. The aim of the lectureship is to enhance the international standing of the School of Chemistry and the University by fostering new collaborations and linkages with outstanding academics from around the world. The recipient of the annual lectureship will have an outstanding record in any field related to inorganic chemistry or its teaching and will present a series of lectures within the School of Chemistry over a period of weeks. During his/her stay at the University, the lecturer will be expected to interact with postgraduate and honours students in a way that will enhance their appreciation of science and the international opportunities that it offers.

THE MICHAEL BISHOP AWARD IN CHEMISTRY FUND

The Michael Bishop Award in Chemistry was established in 2010 by the Foundation for Inorganic Chemistry within the University of Sydney, to mark the many contributions of Dr Michael Bishop to the Foundation, the School of Chemistry, and the teaching of chemistry within secondary schools. The award has arisen out of a program that was initiated and fostered by Dr Bishop and Professor Hans Freeman AO, to enable talented Sydney Grammar School students to be involved in research projects within the School of Chemistry at the University of Sydney. The successful candidate will be involved in a research team that includes both the student's chemistry teacher and a research group within the School of Chemistry. In order to have the greatest impact on generating enthusiasm for chemistry among fellow students and the secondary school faculty, the bulk of the research will be designed to be undertaken at the secondary school under the supervision of an appropriately qualified teacher. Access to specialist equipment and expertise within the School of Chemistry

SPOTLIGHT



Dr Mat Todd, Senior Lecturer, has been awarded the 2010 Faculty of Science Citation for Excellence in Teaching for the

School of Chemistry. The citation acknowledges the contribution of staff in the Faculty of Science to high quality teaching and enhancing the student learning environment. The citation recognises innovation, scholarship and excellent practice in teaching and learning as well as exceptional curriculum design, development and review.



Dr Richard Payne has been awarded a prestigious Young Tall Poppy Award. These awards recognise young scientists who are doing

outstanding work in their field and actively engage and educate the community about their work.



Professor Leo Radom has been awarded the 2010 RACI Physical Chemistry Division Medal for his outstanding achievements

in theoretical and computational chemistry research.



Dr Deanna D'Alessandro, Postdoctoral Research Fellow, has been awarded one of three 2010 L'Oreal Australia For Women in

Science Fellowships worth \$20,000 for her work on molecules that can capture and release gases such as carbon dioxide using light. Read more about Deanna on page 8.

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will be designed to accommodate the student's and teacher's high school commitments. Teachers involved in the program will also be encouraged to interact with the School in terms of having a shared interest in ongoing secondary school curriculum development.

The award will provide funding, to be determined from year to year, that may be used to contribute to the cost of relevant experiments within the School of Chemistry, a one-year membership of the Royal Australian Chemistry Institute for the student, and local conference travel for the student to present a poster on the research, where appropriate. In the first instance, the award will be piloted in collaboration with Sydney Grammar School. For further information on how to make a donation please visit: sydney.edu.au/science/chemistry/schools/donations.html.

The inaugural Hans C. Freeman lecturer will be Professor Harry Gray, who is the founding director of the Beckman Institute at the California Institute of Technology and recipient of the prestigious Wolf Prize in Chemistry. He will visit the School in June/July 2011 to deliver the lecture.

SCIENCE EXPOsed

Chemistry EXPOsed at the Powerhouse Museum.



The School of Chemistry was heavily represented at Science EXPOsed at the Powerhouse Museum on Saturday 21 August, the culmination of National Science Week and the Ultimo Science Festival. Our school ran two workshops for 11-16 year olds: "fantastic plastic" and "make your own blackberry solar cell". Both were highly successful. Members of the Perrier and Schmidt research groups also participated in public talks about their research. We gave six of the nine public presentations on the day. Thanks to Andy West, John Moraes, Dom Konkolewicz, Rowan MacQueen, Dennis Cheng, Jennifer Pong and Burkhard Fückel for giving up their Saturday to promote the wonders of chemistry.



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HON. DSc FOR LEN LINDOY

On 28 June 2010, Professor Len Lindoy received an Honorary Degree of Doctor of Science in a graduation ceremony at the University of Edinburgh. The award was given by the University of Edinburgh for his world-leading research in coordination chemistry and ligand design.

Professor Lindoy has had a long research connection with the School of Chemistry in Edinburgh and has been a regular visitor to the School over the past 14 years. During this period there have also been several exchanges of students and post-doctoral fellows between the Edinburgh and Sydney laboratories. Len was the inaugural EastChem International



Visiting Fellow in 2005 when he presented a series of post-graduate lectures to chemistry staff and students at both the University of Edinburgh and St Andrews. The ceremony followed time honoured traditions, some of which can be traced back to the founding of the University in 1583. A Legend has it that the cap used to touch the heads of the graduands was originally made using the cloth from the breeches of John Knox, although other rumours attribute those breeches to the famous Scottish scholar, George Buchanan.

Left: Professor Len Lindoy FAA receives an Honorary Doctorate from the President of Edinburgh University, United Kingdom.

NEWS FROM THE DEAN

BY PROFESSOR TREVOR HAMBLEY
DEAN OF SCIENCE

As some of you will know, I have recently moved into the role of Dean of Science. This is a very demanding role and many of my friends and colleagues have asked why I have made this move, particularly at a time when I have a remarkable research group doing what is probably the most exciting work of my career! In a nutshell, it is the particular combination of challenges and opportunities that face the Faculty of Science that has motivated me.

The main challenges derive from the science related crises facing the community and the fact that these come at a time when the standing and role of science in the community are being questioned in a way and to degree not previously seen. Most notable is global warming, where we have seen an extraordinary degree of denial and misrepresentation of the data, just at the point where the evidence demonstrating the expected relationship between the increased concentrations of green house gases generated by human activity and the increase in temperatures (particularly ocean temperatures) has become

almost irresistible. However, similar issues abound in the health arena where obesity and diabetes threaten the sustainability of our health systems, but as a society we seem to be unable to tackle the root causes.

The opportunities come in the form of a university that has unequivocally reaffirmed its role as one of attracting the best staff and students to provide outcomes of maximum benefit to society. For example, we are about to undertake the construction of the \$385 million Centre for Obesity, Diabetes, and Cardiovascular Disease (CODCD) in order to generate a bench to bedside and back again approach to tackling this most challenging of health areas. This pan-University centre will house more than 1000 researchers, ranging from fundamental laboratory based scientists, through social scientists and psychologists, to medical researchers, developing and delivering new approaches to tackling these problems. The scientists in the CODCD will generate new understanding of the diseases and develop new treatments while the medical researchers will test these



and provide their observations back to the scientists so that work progresses rapidly from bench to bedside, and does so in an iterative fashion.

We have also established the University of Sydney Institute for Sustainable Solutions to contribute to resolving the issues of climate change and sustainable energy generation and use. This is not an institute focused on identifying the problems, but one that aims to contribute to finding the solutions. It too is a pan-University organisation that will involve researchers from nearly all fields.

The Faculty of Science will be a major contributor to both of these new initiatives and for this we will need large numbers of highly talented people. Fortunately, Science at Sydney continues to attract an ever increasing number of the most talented students in Australia. So, whatever the challenges facing us, we have the staff and students who are able to make an impact, and being able to contribute to this is an exciting opportunity.

SOLVING COMPLEX PROBLEMS IN THE MIDDLE EAST

BY MS JENNY ZHANG
PhD CANDIDATE

A chemist's crusade into the Holy Land ...

Not many people would associate Jerusalem, an epicentre of religion, with science. Yet, it was here that I lived for three months, synthesising novel anti-cancer platinum(IV) complexes as part of my PhD.

Why Jerusalem? It is a place of immense history and significance, it is home to our collaborator Professor Dani Gibson at the Hebrew University, an experienced platinum chemist and NMR guru, and it was a rare chance to experience something outside the scope of a normal chemistry PhD.

Many have expressed to me the overwhelming feelings of sanctity when entering the ancient city of Jerusalem. It is here where the Jewish people weep at the Western Wall of the Temple Mount, where Muslims pray under the golden dome of the Al Aqsa mosque, where Christians retrace the last steps of Jesus before crucifixion. However, I was more aware of the austere and militant undertone of this religious city, with its giant dividing wall along the West Bank, no doubt a consequence of the many conflicts it has endured ever since the birth of the Israeli State in 1948.

Doing research in Jerusalem meant going to the laboratory on Sunday through to Thursday and keeping

the Shabbat from sundown Friday to the appearance of 3 stars on Saturday night. Catching a bus into work sometimes involved climbing over large rifles carried by teenagers serving in the National Military Service, and upsetting ultra-Orthodox Haredi males, who do not like females to take the seats near them. Entering the university campus, and indeed any large premise, involved an ID check, a metal detector and an occasional interrogation. Arriving at the building, I would greet my PhD peers, who were several years my senior, having served in the national army, and many would leave work early to tend to their children and families.

Amongst all of this, chemistry went on as usual (despite some things being often held up and made more difficult by bureaucracy). With the help of Professor Gibson and his collaborator, Associate Professor Yousef Najajreh of Al-Quds University, I explored several synthetic strategies for conjugating platinum(IV) complexes to bio-carriers, and successfully attached DNA intercalators onto the axial position of platinum(IV) compounds for the first time. Furthermore, I gained invaluable experience in performing NMR reduction kinetic experiments, and have since established interesting



In Wadi Rum desert with camel



Western Wall

stability trends of many new platinum(IV) compounds.

During the weekends, when the city came to a complete standstill for the Shabbat, I went exploring. The more special trips included the 10 km hike from Jerusalem to Bethlehem on Christmas Eve, followed by midnight mass at St Mary's Cathedral; floating on the Dead Sea whilst appreciating the extraordinary chemical composition of the hypersaline lake, with shorelines more than 400 metres below sea level; and fishing and cycling around the Sea of Galilee. In Jordan, I explored the ancient rose-stone city of Petra, camped with the Bedouins in the Wadi Rum desert, and woke to the beautiful 'call to prayer' at the crack of dawn. Perhaps the most memorable visits were the ones into the West Bank, where life goes on despite incredible difficulties as a consequence of the complexities of this land.

Wadi Rum



CAPTURING CARBON EMISSIONS



BY DR DEANNA D'ALESSANDRO

Research into capturing carbon emissions has the potential to impact climate change.

The prospect of a worsening climatic situation due to global warming is one of the most pressing environmental concerns of our age. Carbon capture and storage (CCS) from power plants is one option for reducing greenhouse gas emissions, however, currently the capture alone will increase the energy requirements of a plant by 25-40%. CCS will complement other crucial strategies such as improving energy efficiency, switching to less carbon-intensive fuels and phasing in the use of renewable energy resources such as solar energy, wind and biomass.

The CO₂ capture problem: Power plant flue gas streams consist primarily of nitrogen, water, and carbon dioxide in a 13:2:2 ratio by weight. CCS thus requires the separation of CO₂ from a high volume of effluent gas at low pressure (~1 atm). Conventional technologies are already commercially available and are focused on postcombustion separation of CO₂ from flue gases by the use of amine absorbers. Although the current technology is suitable for retrofitting existing plants, these methods are energy intensive and are *not* cost-effective for large-scale carbon emissions reduction. The key factor which underlies significant advancements lies in improved

materials that perform the capture process.

New materials for capture: In our work conducted at the University of Sydney in collaboration with Professor Jeff Long at the University of California, Berkeley, USA, we have successfully designed and synthesised air and water stable alkylamine-functionalised metal-organic frameworks that have an enhanced selectivity for CO₂ adsorption, especially at the low pressures relevant to flue gas separation. These microporous crystalline solids are composed of organic bridging ligands coordinated to metal-based units (e.g., copper, zinc) to form highly porous "sponge-like" structures. Their significant gas uptake and release abilities are attributed to their extraordinarily high surface areas; for example, one teaspoon of such a material can have a surface area equivalent to a football field!

Despite the numerous challenges surrounding CO₂ capture, and the various political, regulatory and economic drivers that will ultimately dictate the time-to-deployment for new CCS schemes, the time is ripe for us as a chemistry community to play a central role in solving the CO₂ capture problem.

ELECTRONIC NEWSLETTER

As part of the School's efforts towards a greener future, we'd like to reduce the number of paper copies of this Newsletter we mail out. If you would like to help us in this effort by electing to receive ChemNEWS electronically, please email Anne (anne.woods@sydney.edu.au).

DONATIONS

Donations can be made to the following funds by using the donation form provided in this newsletter or by using our online donation form at <http://bit.ly/9hNHf3>

Inorganic Fund; Cornforth Fund; Hush Fund; Michael Bishop Fund
Hans C. Freeman Fund*
(*Read more on page 4)*

The School of Chemistry would like to take this opportunity to thank Alumni and Friends for their very generous donations. Your support continues to make a profound impact on our various programs.

SEMINARS

Chemistry seminars are held throughout Semesters 1 and 2 on Wednesdays (9am, LT2) and Fridays (11am, LT2) unless otherwise stated. If you would like to be notified of these weekly seminars and other weekly chemistry news and events please email Anne (anne.woods@sydney.edu.au) and she will add you to the electronic mailout. Alternatively you can visit <http://bit.ly/aHrxZ7>. Seminars are also advertised on our Facebook page.

SCHOOL OF CHEMISTRY



THE UNIVERSITY OF SYDNEY

FOR MORE INFORMATION CONTACT

Editor Dr Mat Todd
E matthew.todd@sydney.edu.au

Enquiries Ms Anne Woods
T +61 2 9351 2755
F +61 2 9351 3329

E anne.woods@sydney.edu.au
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