

# news letter

CENTRE FOR GREEN CHEMISTRY  
Chemistry for a sustainable future

## GREEN CHEMISTRY DOWNUNDER

Centre for Green Chemistry

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### From the Director

Professor W. Roy Jackson, Director  
Centre for Green Chemistry, Monash University



The research output of the Centre continues to be at a high level and many projects are now producing publications, a full list of which is available on our web site. In addition, at least two provisional patents have been taken out with collaborating companies and support from major international companies is being pursued to extend some of our commercially applicable work. It was gratifying that several of our members, Steve Langford, Milton Hearn, Andrea Robinson and myself were successful in obtaining ARC Discovery and Linkage Grants for projects which are outside the core business of the Centre.

The local community continues to show an interest in Green Chemistry and our interactions with secondary schools is described below. In addition I have talked to the Altona Complex Neighbourhood Consultative Group and the Rutherglen Rotarians and Janet Scott has addressed the Gippsland Branch of the RACI, the Queensland Institute of Environmental Engineers in Brisbane and a One-Day International Workshop on Cleaner Production at Monash University. Although these community interactions involve a considerable amount of work the enthusiasm and interest that they generate makes the effort really worthwhile.

Members of the Centre have been involved in maintaining and extending international contacts. Tony Patti, together with postdoctoral fellow Brett Roberts and postgraduate student Waldo Correa attended the Fourth Summer School on Green Chemistry in Venice, which Professor Pietro Tundo had organised. As a result of this interaction we are now going to participate in a major Italo-Australian exhibition and conference on technological innovations which is to be held in Melbourne in March of next year. This promises to be an important opportunity for us to advertise our activities as the Italian ambassador and several ministers from the Italian government will be present in addition to the Australian Industry minister and the CSIRO Chief Executive.

I visited our former deputy director, Colin Raston, at his new offices and laboratories at the University of Leeds. Leeds has really looked after him as he has some very well refurbished laboratories and an office worthy of at least a vice-chancellor in Australia. I returned home Green with envy.

### Green Chemistry and Schools

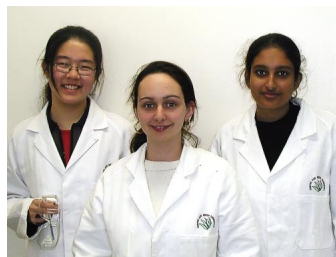
The Green Chemistry Community outreach program has taken off this year with the appointment of Michael Clarke, a chemistry graduate with wide experience in the preparation of electronic presentation materials and the performing arts!

Mike, working with Janet Scott, has developed an exciting demonstration lecture, which includes whistles, bangs (well, explosions actually), colours, frothing solutions, glow-in-the-dark light sticks and chocolates. A full version of this lecture was presented as the RACI sponsored, Hartung Youth Lecture with the theme 'Green Chemistry'. A combination of multimedia technology and good old-fashioned chemistry demonstrations is used to illustrate the key ideas behind this exciting area of chemistry.

While it is relatively easy to carry out demonstrations and give a multimedia presentation, including video, animation and stepwise building diagrams, in well-equipped lecture theatres, this presents more of a challenge when taken out to individual schools. In spite of this the response has been very enthusiastic, particularly when it comes time to hand out the caffeine rich chocolate bars used to demonstrate a use for caffeine extracted from coffee using supercritical CO<sub>2</sub>!

The co-ordination of school visits is done in collaboration with the Monash Science Centre and future developments will include production of 'hands-on' experiments, which relate to the material covered in the VCE syllabus and handouts with more detailed information. If you are interested in a demonstration lecture at your local high school or community group, please contact us (contact details overleaf).

A group of secondary school students participating in the 'CSIRO Student Research Scheme' each spent 20 hours working alongside a postdoctoral fellow or research assistant in the Centre. The goal of this program is to give scholars a taste of 'real



Minnie Mao, Stav Papadopoulous and Arlinda Chowdhury (Safety glasses removed for the photo only!).

research' and, after completing the laboratory work, the scholars produce a report and a poster which they present to their peers and guests at a closing function.

This year, five students, from various high schools around Melbourne, worked in the Centre alongside Dr Brett Roberts and Ms Stavroula Papadopoulous. In spite of the hard work required, much fun was had by all and, as in past years, we were struck by how quickly the girls picked up the principles of Green Chemistry and how enthusiastically they applied themselves to the physical and intellectual tasks at hand.



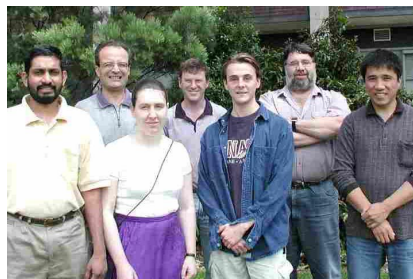
Alex Edgar, Lauren Carroll, Chelsea Hiscock and Brett Roberts.

# RESEARCH ACTIVITIES

## Benign Gold Processing Methods

Cyanide leaching remains the most effective and commercially viable method for processing low-grade gold ores. However, the environmental impact of recent cyanide spills (e.g., Baia Mare, Romania and Papua New Guinea), the banning of cyanide use in parts of the world, and the generally more stringent control of cyanide levels, are stimulating research on more benign gold-processing technologies that do not use cyanide leaching. In this regard, the thiosulfate-copper-ammonia lixiviant system is the most promising of the new systems being investigated and is attracting attention from many quarters. In this process, a copper(II)-ammine complex is believed to catalyse the oxidation of gold to gold(I) which forms a soluble thiosulfate complex. Following leaching, the gold-rich solution is separated from the ore mass and processed to give metallic gold. While this process has been developed to the extent that it is economically viable for some types of ores, cyanide leaching remains most efficient for the majority of ores. A significant problem is that, although thiosulfate is much cheaper than cyanide, the oxidation of thiosulfate to polythionates causes high reagent consumption during leaching significantly increasing costs making the process less commercially viable.

In our research, spectroscopic methods are being used to identify the complexes and species that are likely to be present in the leachates, to measure their stability and thermodynamic properties and to establish how they affect the efficiency of the leaching process. This information will be used in numerical modelling calculations aimed at developing optimised processing conditions for various types of ores. We are also examining the ability of a variety of alternative reagents to promote the more effective leaching of gold or to minimise unwanted side-reactions such as thiosulfate oxidation. In parallel with these investigations, we are developing the capability to conduct mineralogical/geochemical studies on ore samples and leaching trials aimed at demonstrating the effectiveness of new processing methods. These bench-top leaching trials



Researchers working on the *Benign Gold Processing* project: (from left) Don Leelarathna, Leone Spiccia, Tiffany Brown, John Waters, Jay Black, 'Bear' McPhail, and Weihua Liu.

will enable the testing of alternative reagents and assist in the optimisation of the leaching process. Given the wide variety of naturally occurring ore types a number of alternative reagents, specific to particular ore types may need to be developed.

## Student Profile - Andrew Downie Honours Student, Centre for Green Chemistry



Andrew graduated from Camberwell Grammar School in 1996. His interest in science and legal studies prompted him to undertake a Science/Law double degree at Monash University. During the degree, he enjoyed chemistry immensely, seeing it as a realistic science attempting to define the microscopic in understandable terms. His interest in this subject led to his successful application for a Summer Scholarship after 2<sup>nd</sup> year chemistry.

Through the scholarship Andrew worked on solventless Aldol, Knoevenagel and Imine formation reactions for Prof. Colin Raston and Dr Janet Scott. After completing the scholarship, he was employed by Professor Raston as a Research Assistant during 2000 and 2001. Andrew's work is included in a paper published in the *Journal of the American Chemical Society*, "Understanding Solid/Solid Organic Reactions". The results achieved and pleasure derived from his chemistry research work encouraged Andrew to apply for Honours in Chemistry working with Dr Scott. His Honours project, involving solventless oxidative coupling and enantioselectivity, has proceeded well and he is currently preparing a poster for the 26<sup>th</sup> Annual Synthesis Symposium and a journal article for this project.

Andrew's future holds one more year of his law degree, after which he hopes to continue with a PhD in chemistry and to pursuit of his interests, no matter what disparate paths they may take him on.

### Student's Papers Highlighted

Two recently published papers describing research undertaken by students within the Centre for Green Chemistry, "Understanding solid/solid organic reactions" by Gadi Rothenberg, Andrew P. Downie, Colin L. Raston and Janet L. Scott and "Solvent-free, two-step synthesis of some unsymmetrical 4-aryl-1,4-dihydropyridines" by Waldo H. Correa and Janet L. Scott, published in *Journal of the American Chemical Society* and *Green Chemistry* respectively, have been highlighted by chemistry writer David Bradley on the ChemWeb Magazine. These can be accessed on-line at <http://www.chemweb.com/alchem/articles/997691269826.html> and <http://www.chemweb.com/alchem/articles/1004024119835.html>