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Chemistry
IN NEW ZEALAND

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Polymers, Thermal Analysis, Plastics, Viscosity, UV Spectroscopy

Alan MacDairmid

2000 Nobel Laureate in Chemistry

for the discovery and development of conductive polymers

visits New Zealand

... inside Nobel Lecture

Chemistry IN NEW ZEALAND

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The New Zealand Institute of Chemistry Incorporated
P O Box 39-283, Howick
Auckland, New Zealand
Phone: +64-9-5356495
Fax: +64-9-5353476
Email: NZICOffice@nzic.org.nz
WWW: http://www.nzic.org.nz

Managing Editor & Publisher:
Robert B Lyon
Ancat Holdings Limited
32 Murvale Drive
Bucklands Beach, Auckland
P O.Box 38-546
Howick, Auckland, New Zealand
Phone: +64-9-5353475
Fax: 64-9-5353476
Email: chemistry@ancat.co.nz

Coming Up ...

November 2001 pH, Titration, Heating, Stirring, Mixing, Freezers, Ovens, Incubators.

Deadline for material *5th of the month of publication*

FAKE OR BREAK

By Hank Schouten

Dutch Liberation Day, May 4, was officially commemorated in New Zealand for the first time with a public ceremony at Te Papa in Wellington. It was a special moment for members of the local Dutch community, among them one of the underground's talented forgers, Dora Suuring.

"I'm only 86 you know," says Dora Suuring with a smile which still conveys the liveliness of the courageous young Dutch underground activist she was during the dark years of the Second World War.

Suuring is a tiny woman with a big story. In the lounge of her Crofton Downs home, the teacher who taught high school science in Wellington for 30 years has her story down pat.

She opens a manila folder sitting on the coffee table as she casts her mind back to the days when her expertise in chemistry was applied to the lifesaving art of forgery. There's her fake identity card and others which she picks up to explain the sorts of things she turned her hand to.

It was vital work as the Dutch underground did what it could to ensure the survival of thousands of people in hiding or on the run from German authorities.

Everybody in occupied Holland had to carry blue identity cards complete with photos, fingerprints, official stamps and signatures.

Nobody could get food rationing coupons without their card and anybody without a card was liable to be arrested. And anybody caught with a fake identity card or forging them was liable to face the harshest treatment at the hands of the Gestapo.

But they were risks that Suuring had to take for her own sake and for the survival of others in need.

She was Jewish and her family name of Polenaar was a dead giveaway – a passport to the Nazi death camps.

Suuring was a teacher in Amsterdam's Montessori secondary school when the Germans rolled into Holland in 1940.

As the Germans took control, orders were issued through Dutch civilian authorities to replicate the persecution of Jews which had been going on since Hitler came to power. Jews were required to wear a yellow Star of David and were segregated from the rest of the population.

Suuring and her husband were ordered to live with other Jews in a large hostel in the country where they remained till the day German troops arrived to transport everybody to concentration camps.

Fearing what could happen, Suuring and her husband escaped by crawling through a ditch to a neighbouring estate.

She adopted the gentile name of Molenaar and this was carefully typed on a dead boy's identity card. She also changed her name on her doctorate of chemistry from Amsterdam University so she could get a legitimate job in her area of expertise.

"Unfortunately these were so bad even a child could recognise them. They were never used."
Dora Suuring on a British airdrop of forged ID cards

She was duly hired to work in the laboratory at a baking powder factory. It was a useful place to be as she had access to the chemicals and equipment needed for her part in the art of forgery.

Her job was to carefully remove photos, writing and fingerprints from stolen or "lost" identity cards so that new identities could be made up.

Fingerprints were removed by carefully rubbing them out and shaving off loose fibres with a razor blade before a new fingerprint was put in its place. Acetone fumes were used to break down the glue used to stick down photos, a tricky process as any splashes of acetone would ruin the card.

Getting rid of the handwriting was relatively easy. Permanganate, hydrogen peroxide and vinegar and a neutralising agent did the trick.

It only worked for a while, until the Germans discovered chemical traces on tampered papers could be detected using infra-red light.

The Germans also began issuing lists of stolen card numbers. The problems this caused prompted the underground to ask the British to airdrop a supply of forged cards into Holland.

"Unfortunately these were so bad even a child could recognise them. They were never used," she says.

The next step was to get a Dutch printer to make cards. To simulate the watermark used on official papers an artist replicated the watermark on thin tissue paper and this was glued between two layers to make a realistic looking forgery.

This too worked for a while until the Germans discovered these fakes could be discovered by dipping them in water, where the layers of paper delaminated.

Suuring said the final ruse involved an audacious raid on the local identity card bureau. Three members of the underground, one of them a German Jew dressed in an Army officer's uniform, drove up to the office on a supposed spot inspection. They got away with a large stash of unused new cards.

Suuring remembers those years as exciting times in her life, all the more exhilarating for the fact that the war tore down all religious, class and social barriers as people from all walks of life depended on each other for survival.

She also remembers the tremendous relief of liberation day, May 4 , 1945 – the jubilation she felt and the wonderful feeling of freedom that night as she and a friend luxuriated in a café.

It was something she could never have safely done during the war for fear of being picked up and meeting the fate that so many others suffered in wartime Europe.

Dr Dora Suuring arrived in New Zealand from Holland in 1948. She joined the NZIC in the early 1950s, and became a Fellow in 1977 after having served on the Wellington branch committee, including one year as chairperson. She is still an active member.

Dora started work in New Zealand in 1951 as a science teacher at Chilton St James School, and taught science subjects in various capacities at several schools, before joining Teachers College in 1970. She has been involved in many activities relating to the teaching and assessment of science during her career and since her "retirement" in 1981.

The *Evening Post* published the above article and accompanying photograph in April 2001 as part of commemorations of Dutch Liberation Day. They are reproduced here with the permission of the *Evening Post* in recognition of Dora's contribution to New Zealand science through her career as an educator. Dora arrived in New Zealand with one baby, and now has two children, two grandchildren and two great grandchildren. But her career has benefited the lives of many, many more. It is interesting to note that the NZIC did not accept her initial membership applications – it is hoped that today's membership structure will offer more opportunities for enthusiastic chemists to promote science in our community.

NZ Science Scene

CEO Appointed For Waikato Innovation Park

Hamilton businessman John Birch has been appointed to head the Innovation Park planned to serve Hamilton and the Waikato.

His appointment is expected to accelerate the building of the facility. The Waikato Technology Foundation and the region's Economic Development Forum have joined forces to provide more impetus for the Innovation Park project and one of the first initiatives is the CEO appointment.

As CEO, John Birch will oversee the establishment process of the Innovation Park. This will initially involve working with members of the existing Waikato Technology Foundation and Economic Development Forum to form a new organisational structure within which the Innovation Park will operate.

This structure is expected to be in place by the end of August.

Funding for the yet to be named Innovation Park is currently being sought locally and from central government. It is also envisaged that as the development proceeds funding will also be gained from private sector investors.

As an organisation, the Economic Development Forum has been funded by Mighty River Power, On Energy, WEL Networks and Hamilton City Council. The EDF is made up of representatives from research and academic organisations as well as business and local government.

Chair of the Waikato Technology Foundation, Professor Bryan Gould, says the appointment of a CEO for the Innovation Park is a significant step forward. "We are expecting that with John Birch working on the project in a fulltime capacity we will have the resource to make the park happen much more quickly," says Professor Gould.

Mr Birch says his focus will be to have the Innovation Park grow on a commercial footing which can provide a return to investors, in addition to providing benefits to the wider community through greater economic development.

The multi-million dollar Innovation Park is planned for land formerly part of Ruakura which is adjacent to the University of Waikato.

John Birch was a founder of Hamilton based process engineering company McClunie Birch, the company that built the $120 million extension to the Te Rapa milk powder factory. He has recently sold his shareholding in McClunie Birch.

"Obviously I feel the Innovation Park is a tremendous opportunity for Hamilton and the Waikato region. The facility that is planned would be a huge boost for innovation particularly in the area of agricultural scientific research which has traditionally been a strength of this region," he says.

The Innovation Park will be a 20-hectare science and technology park and will provide a place for a world class 'life sciences' and ancillary disciplines based on projects and innovations from the University, Crown Research Institutes and businesses. It will comprise a number of different building types including: incubator facilities; multi-tenanted buildings; corporate offices; R & D facilities; warehouses and light manufacturing.

A New Extramural Paper 123.240 Business, Science And Society

A new paper designed to help you meet the challenges of the knowledge society in the 21st century will be offered extramurally by Massey University next year. This paper is suitable for teachers of science, technology, and social studies as well as business studies and science students, managers in a science-based business and anyone interested in the knowledge economy. The interface between science and society will be explored using examples and case studies. Industrial, professional and environmental topics will be discussed with an emphasis on strategic and policy issues relevant to New Zealand.

In it you will find out about:

- How science and technology works - the process.
- The future products of science.
- How science and technology interface with the business world.
- The people - the managers and the scientists.
- The impact of science on business, society and the environment.

The topics covered will be:

- Introduction to the Paper
- Process of Science
- New Materials: The Fruits of Science
- The Marriage Between Science and Business: The New Zealand Dairy Industry
- Capturing Scientific Innovation in Industry: Technologies of the Future
- Business, Science and Society: The Good and the Bad
- Energy and Society: Problems and Solutions

Assessment is by four assignments. Although a background in science is not assumed, this paper will be of value to both scientists and non-scientists alike.

For more information contact the Paper Coordinator Andrew Brodie (Email: A.Brodie@massey.ac.nz or Phone: 06 3569099 Ext. 3536) or check out the web page at: http://sciences.massey.ac.nz/papers/123.240 For an enrolment pack Ph 0800 MASSEY.

Characterisation Of Fats In Cookies Using Power Compensation DSC

W.J. Sichina, Marketing Manager, PerkinElmer Instruments

Introduction

Differential Scanning Calorimetry (DSC) is useful technique for the characterization of food products, including:

- the gelatinization and staling (retrogradation) behavior of starches
- polymorphism of fats such as cocoa butters and chocolate
- effects of moisture content or absorbed moisture
- ageing effects
- protein denaturation
- determination of fat content or solid fat index (SFI)

The processing and handling behaviour of food fats has been found to depend upon the solid-to-liquid fat ratio in the food sample. Many rheological or flow properties, and their resultant effect on the texture of the final product, stem from this fat ratio index.

The study of the fat content and the nature of the fats of foods is becoming increasingly more important due to health considerations, especially with regards to the level of solid fats, saturated fats and trans fats in food products. There is a variety of fats with different levels of solid fats available in food products. An example of this is the Oreo Cookie where there is the regular Oreo and the reduced fat version. There are also Oreo-like cookies with no solid, hydrogenated fats present.

The complete characterization of fats by DSC can become complex due to the nature of the fats contained in the food. This can be further complicated by the presence of polymorphic melting forms of the given fat. A polymorph is an unstable melting form and this can be controlled by processing. Different polymorphic forms are sometimes desired for obtaining the desired textural properties of the fat.

The successful analysis of fats in foods requires a DSC with high sensitivity and high resolution. The resolution performance aspect is important to be able to separate out the glass transition (Tg) and the different melting events associated with fats and possible polymorphic forms. The DSC with the best resolution and sensitivity performance available is the PYRIS Power Compensation DSC from PerkinElmer Instruments.

Power Compensation DSC

The ideal DSC for the characterization of foods and fats is the Power Compensation DSC. The very low mass furnaces provide low thermal inertia and the fastest response time of any DSC instrument on the market. This allows for the best peak definition and separation of overlapping peaks of any commercially available DSC. The Power Compensation DSC uses two independently controlled, ultra low mass furnaces (mass of 1 g) in the design of the DSC cell. The very low mass provides low thermal inertia and a very fast DSC response time, which is critical for high resolution.

In contrast, heat flux DSC devices, with their more massive furnace or those using a large silver block, have a more sluggish responsiveness. This translates to a higher inherent thermal inertia and a much slower DSC response time. The resolution from DSC instruments with a large mass furnace is much poorer than with the Power Compensation DSC. Some instrument companies attempt to correct the problems of the use a large silver block with DSC algorithms designed to account for the slower response time of the DSC cell. However, there are concerns with such treatments since this alters the actual heat flow results. The PYRIS Power Compensation DSC provides the true sample response based on actual DSC hardware rather than mathematical manipulation of results.

In this study, the fats associated with three different fillings of cookies were assessed:

- regular Oreo
- reduced fat Oreo
- Oreo-like cookie with no hydrogenated (solid) fats.

Experimental

The following experimental conditions were used to analyze the fillings of the three different cookies.

Experimental Conditions

Instrument	PYRIS Power Compensation DSC
Cooling	Intracooler II
Sample pan	Open aluminum pan
Sample mass	Approximately 11 mg
Temperature range	-60 °C to 100 °C
Heating rate	20 °C/min
Purge gas	nitrogen

The DSC was calibrated for temperature and enthalpic responses using high purity indium metal.

Results

Displayed in Figure 1 are the DSC results generated for the filling of the regular Oreo cookie. The plot shows the DSC heat flow as a function of sample temperature. The sample yields a complex DSC thermograph due to the nature of the fats and polymorphic forms associated with the as-received Oreo cookie filling. The fat undergoes melting beginning at -18.8 °C. A series of melting peaks at observed at -2.6 °C, 16.1 °C, 28.0 °C, 35.1 °C and 44.5 °C for the fats in the filling. The complex melting spectrum reflects the occurrence of polymorphic forms due to the particular processing conditions used to produce the Oreo filling. The total heat of melting of the cookie filling is found to be 28.2 J/g. The DSC results show that a significant amount of the fat in the Oreo cookie filling melts above room temperature and this behavior is due to the hydrogenated fats in the filling.

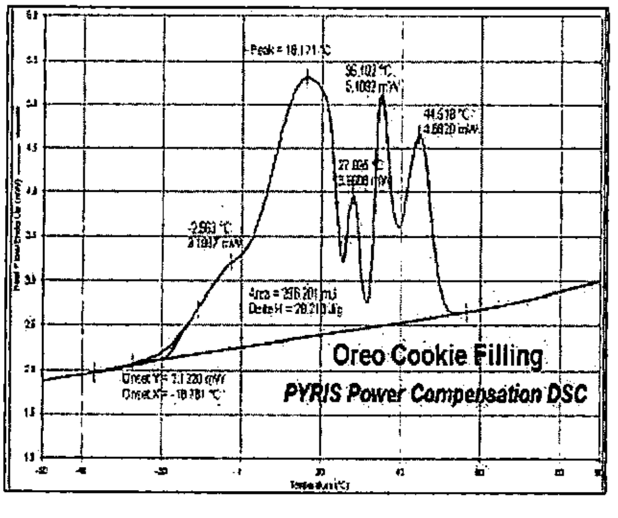


Figure 1: DSC results for regular Oreo cookie filling.

The high resolution response of the PYRIS Power Compensation DSC is necessary to be able to detect the various peaks associated with the polymorphic forms of the cookie filling, even at the fast heating rate of 20 °C/min.

Heat flux DSC instruments, especially those using a massive silver block, would tend to smear out the various transitions associated with the fats and polymorphic forms in the filling making the characterization less definitive and incomplete. With the PYRIS Power Compensation DSC, all of the important transitions, both large and small, are observed.

The regular Oreo cookie filling was cooled back to -60 °C and then reheated at 20 °C/min and the results of the reheat experiment are displayed in Figure 2. The filling now exhibits a very different thermal response and this reflects the differences due to thermal history. Melting, cooling and reheating produces a new morphology or structure in the fat. DSC is a valuable technique for studying the effects of thermal history on fats and their polymorphic forms.

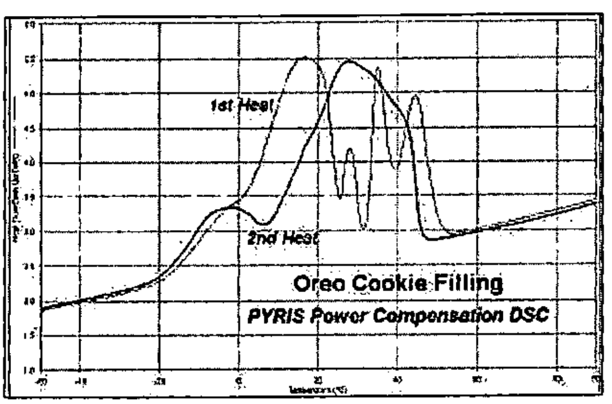


Figure 2: Comparison of first and second DSC heats for filling.

The Power Compensation DSC also provides excellent results during cooling experiments. Fats yield well-defined crystallization events during cooling and this information is valuable for characterization and process control purposes. Displayed in Figure 3 are the DSC results generated for the Oreo cookie filling by cooling from 100 to -60 °C at a rate of 20 °C/min. The crystallization of a fat component occurs sharply at 23 °C. The cooling data reflects two different crystallizable fats in the cookie filling.

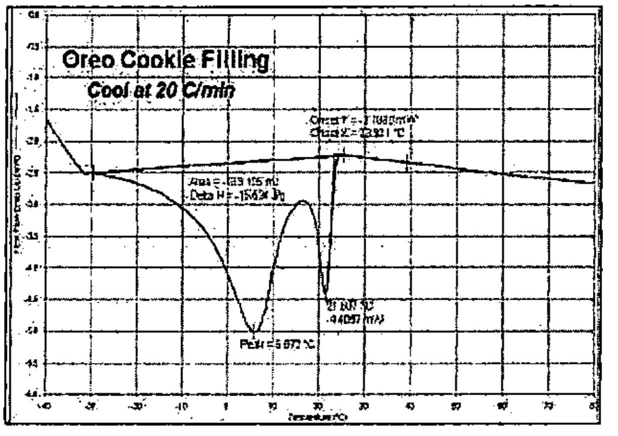


Figure 3: DSC cooling results for Oreo cookie filling.

The DSC results obtained for the reduced fat Oreo cookie filling are displayed in Figure 4. This filling undergoes multiple melting transitions at -4.1 °C, 12.0 °C and 38.8 °C. Although the reduced fat filling contains solid or hydrogenated fats, the amount of fat is reduced as is demonstrated by the lower values of the heats of melting. The first and second melting transition yield heats of melting of 4.6 and 4.3 J/g, respectively, for a total heat of 8.9 J/g. This is much lower than the value obtained for the regular Oreo cookie filling (28.2 J/g).

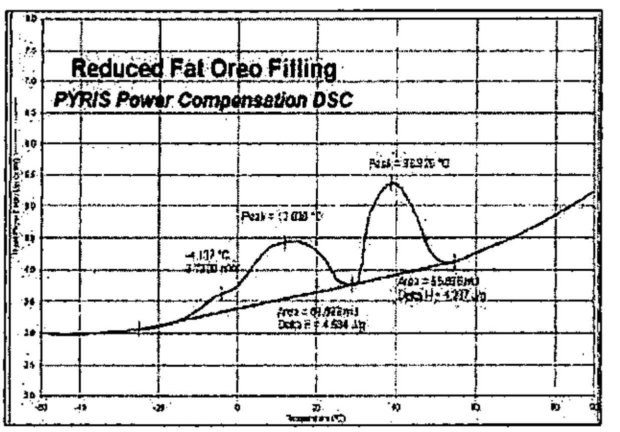


Figure 4: DSC results for reduced fat Oreo cookie filling.

The Oreo-like cookie contains a filling with no hydrogenated or solid fats and the DSC results for this sample are shown in Figure 5. The melting of the fat in this filling completely takes place below 0 °C with melting peaks occurring at -26.0 °C and -17.3 °C. The total heat of melting for the non-hydrogenated fat filling is 16.1 J/g.

Displayed in Figure 6 is a direct overlay of the DSC results obtained for the three different cookie fillings. The differences in the melting responses of the fats comprising the fillings are very evident from these results.

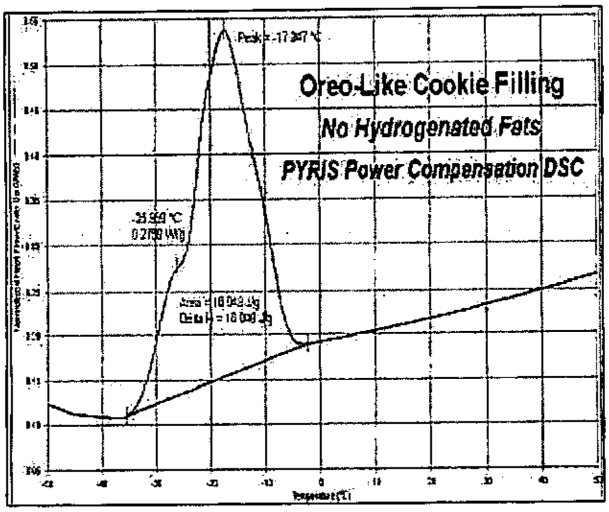


Figure 5: DSC results for Oreo-like cookie filling (no hydrogenated fats).

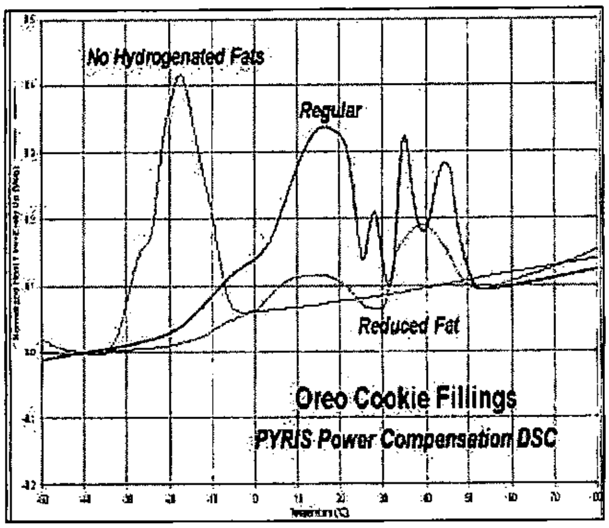


***Figure 6:** Overlay of DSC results for regular Oreo, reduced fat and non-hydrogenated fillings.*

Summary

The PYRIS Power Compensation DSC yields excellent result for foods including the fat nature and content. The fast responsiveness of the Power Compensation DSC provides the highest possible resolution and this is critical for characterizing the various polymorphic melting forms associated with fats in foods. Even at the fast heating rate of 20 °C/min, the Power Compensation DSC is able to provide high resolution to be able to detect the multiple melting peaks of the polymorphic forms for the as-received Oreo cookie filling. This data is important for the full characterization of the food fats, quality assurance, product uniformity and process control purposes.

For more information on the instrument or techniques described in this application note ...

Contact: Laurence Van Dam, NZ Scientific Ltd
P O Box 107-077 Airport Oaks, Phone: 0800 776767
Fax: 0800 776000, Email: perkin-elmer@clear.net.nz
Internet: www.perkinelmer.com

Editorial

The role of *Editor* of the Institute's *Journal* is one that I had not expected to become involved with – to contribute, yes, but to actually handle the work – **never!** And I suspect that this view is that of the majority of you, the members. So how is it that I have changed my mind - or had it changed for me as some might say? The answer is quite simple – the role of *Journal Editor* has been markedly changed so as to better fit the available time of otherwise fully committed employees. From henceforth the *Journal* will appear as a quarterly put together with NZIC material provided by each of the Branches in turn. The *Editor* (and whosoever wishes to assist) will attempt to supplement and balance this with other articles of general interest from outside the country, from visitors to the country, and from any of you that wish to contribute additionally and independently. But the single critial factor that persuaded me to take on another NZIC role is my firm belief that for many that are unable to attend Branch meetings and Institute conferences, the *Journal* **is** the Institute. My initiation to the task has been made simple - Professor Alan MacDiaramid's Nobel Prize acceptance lecture was recently published and then made available to us by the Nobel Foundation.

I have accepted this job on the clear understanding that I will not need to source the articles but concentrate my limited efforts on the actual role of editing the copy and balancing the various issues as best I can. If the allocated Branch is unable to provide the articles for their issue, then there is little chance of an issue and, as an obvious corrolary, *Chemistry in New Zealand* will need to hibernate again whilst simultaneously attempting to pacify its ever tolerant publisher.

I have every confidence that each and every member will wish to contribute to the success of *Chemistry in New Zealand* as a new quarterly. Inevitably with any new venture the incumbent wishes to improve and impress. And so it is with me. I hope to initiate an occasional series of **Updates** in which my various colleagues in academia will provide simply written short synopses of recent developments in a given topical area of chemistry. A set of **Snippets** will also serve to provide some (relatively) recent pieces of current work. Hopefully these will fit snugly with commuter travel on the bus or train – or during the commercial breaks in your favourite TV programme! Any successes that follow will reflect the efforts of the Branches in serving the *Journal* and the vision of Council in making the structural changes necessary rather than any contribution from me. Should you be seeking perfection in our offering then I must disappoint you as the only place I can ever find "perfection" is in a dictionary.

"Synthetic Metals": A Novel Role For Organic Polymers (Nobel Lecture) *

Alan G MacDiarmid

Department of Chemistry, University of Pennsylvania, Philadelphia, PA 19104-6323, USA

Fax : (+1) 215-898-8378, Email: macdiarm@sas.upenn.edu

Abstract:

Since the initial discovery in 1977, that polyacetylene $(CH)_x$, now commonly known as the prototype conducting polymer, could be p- or n-doped either chemically or electrochemically to the metallic state, the development of the field of conducting polymers has continued to accelerate at an unexpectedly rapid rate and a variety of other conducting polymers and their derivatives have been discovered. Other types of doping are also possible, such as "photo-doping" and "charge-injection doping" in which no counter dopant ion is involved. One exciting challenge is the development of low-cost disposable plastic/paper electronic devices. Conventional inorganic conductors, such as metals, and semiconductors, such as silicon, commonly require multiple etching and lithographic steps in fabricating them for use in electronic devices. The number of processing and etching steps involved limits the minimum price. On the other hand, conducting polymers combine many advantages of plastics, for example, flexibility and processing from solution, with the additional advantage of conductivity in the metallic or semiconducting regimes; however, the lack of simple methods to obtain inexpensive conductive polymer shapes/patterns limit many applications. Herein is described a novel, simple, and cheap method to prepare patterns of conducting polymers by a process which we term, "Line Patterning".

Introduction

An organic polymer that possesses the electrical, electronic, magnetic, and optical properties of a metal while retaining the mechanical properties, processibility, etc., commonly associated with a conventional polymer, is termed an "intrinsically conducting polymer" (ICP) more commonly known as a "synthetic metal". Its properties are intrinsic to a "doped" form of the polymer. This class of polymer is completely different from "conducting polymers" which are merely a physical mixture of a nonconductive polymer with a conducting material such as a metal or carbon powder distributed throughout the material.

The Concept of Doping

Conjugated organic polymers are either electrical insulators or semiconductors. Those that can have their conductivity increased by several orders of magnitude from the semiconductor regime are generally referred to as "electronic polymers" and have become of very great scientific and technological importance since 1990 because of their use in light emitting diodes [1]. The emeraldine base form of polyaniline and *trans*-$(CH)_x$ are shown in Figure 1 to illustrate the increases in electrical conductivity of many orders of magnitude which can be obtained by doping. The conductivity attainable by an electronic polymer has very recently been increased an infinite number of times by the discovery of superconductivity in regioregular poly(3-hexylthiophene) [2]. Although this phenomenon was present only in a very thin layer of the polymer in a Field Effect (FET) configuration at a very low temperature (*ca.* 2 K) it represents an historical quantum leap - superconductivity in an organic polymer!

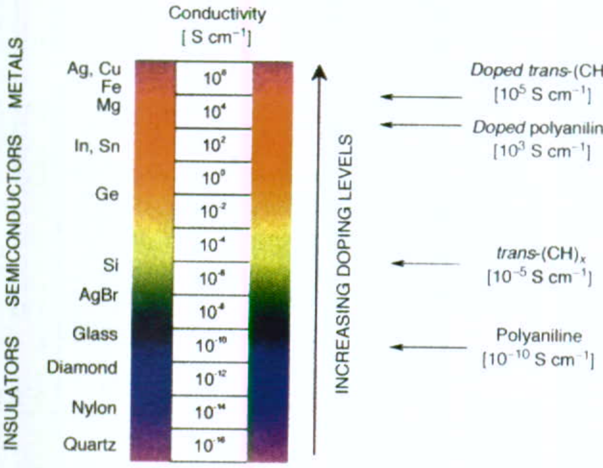


Figure 1. *Conductivity of electronic polymers. Conductivity increases with increased doping.*

Prior to the discovery of the novel protonic acid doping of polyaniline, during which the number of electrons associated with the polymer chain remain unchanged [3], the doping of all conducting polymers had previously been accomplished by redox doping. This involves the partial addition (reduction) or removal (oxidation) of electrons to or from the π system of the polymer backbone [4-6].

The concept of doping is the unique, central, underlying, and unifying theme which distinguishes conducting polymers from all other types of polymers [7]. During the doping process, an organic polymer, either an insulator or semiconductor having a small conductivity, typically in the range 10^{-10} to 10^{-5} S cm^{-1}, is converted into a polymer which is in the "metallic" conducting regime (*ca.* 1 to 10^4 S cm^{-1}). The controlled addition of known, usually small ($\leq 10\%$) non-stoichiometric quantities of chemical species results in *dramatic* changes in the electronic, electrical, magnetic, optical, and structural properties of the polymer.

Doping is reversible to produce the original polymer with little or no degradation of the polymer backbone. Both doping and undoping processes, involving dopant counterions which stabilize the doped state, may be carried out chemically or electrochemically [6]. Transitory doping by methods which introduce no dopant ions are also known [8].

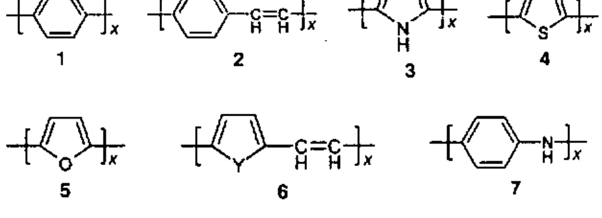
By controllably adjusting the doping level, a conductivity anywhere between that of the non-doped (insulating or semiconducting) and that of the fully doped (highly conducting) form of the polymer can be easily obtained. Conducting blends of a (doped) conducting polymer with a conventional polymer (insulator), whose conductivity can be adjusted by varying the relative proportions of each polymer, can be made [9]. This permits the optimization of the best properties of each type of polymer.

Since the initial discovery in 1977, that polyacetylene $(CH)_x$, now commonly known as the prototype conducting polymer, could be p- or n-doped either chemically or electrochemically to the metallic state [7,10,11], the development of the field of conducting polymers has continued to accelerate at an unexpectedly rapid rate and a variety of other conducting polymers and their derivatives have been discovered [5,6]. This rapid growth rate has been stimulated by the field's fundamental synthetic novelty and importance to a cross-disciplinary section of investigators—chemists, electrochemists, biochemists, experimental and theoretical physicists, and electronic and electrical engineers—and to important technological emerging applications of these materials.

In the "doped" state, the backbone of a conducting polymer consists of a delocalized π system. In the undoped state, the polymer may have a conjugated backbone such as in *trans*-$(CH)_x$ which is retained in a modified form after doping, or it may have a nonconjugated backbone, as in polyaniline (leucoemeraldine base form), which becomes truly conjugated only after p-doping, or a nonconjugated structure as in the emeraldine base form of polyaniline which becomes conjugated only after protonic acid doping.

Redox Doping

All conducting polymers (and most of their derivatives), e.g., poly-(*para*-phenylene) (**1**), poly(phenylenevinylene) (**2**), polypyrrole (**3**), polythiophene (**4**), polyfuran (**5**), poly(heteroaromatic vinylenes) (**6**; Y = NH, NR, S, or O); polyaniline (**7**), etc., undergo either p- and/or n-redox doping by chemical and/or electrochemical processes during which the number of electrons associated with the polymer backbone changes [5, 6]. Selected examples of the different types of doping are presented below.



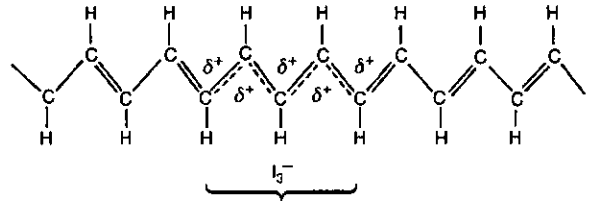
Chemical and Electrochemical p-Doping

p-Doping, that is, partial oxidation of the π backbone of an organic polymer, was first discovered by treating *trans*-$(CH)_x$ with an oxidizing agent such as iodine [7], [Eq. (1)]

$$trans\text{-}(CH)_x + 1.5(xy)I_2 \rightarrow [CH^{+y}(I_3)_y^-]_x \ (y \leq 0.07) \quad \ldots (1)$$

This process was accompanied by an increase in conductivity from *ca.* 10^{-5} S cm^{-1} to *ca.* 10^{3} S cm^{-1}. If the polymer is stretch-oriented five- to six-fold before doping, conductivities parallel to the direction of stretching up to around 10^5 S cm^{-1} can be obtained [5, 6].

Approximately 85% of the positive charge is delocalized over 15 CH units (depicted in Scheme 1 for simplicity over only five units) to give a positive soliton.



Scheme 1

p-Doping can also be accomplished by electrochemical anodic oxidation by immersing a *trans*-$(CH)_x$ film in, for example, a solution of $LiClO_4$ dissolved in propylene carbonate and attaching it to the positive terminal of a DC (direct current) power source, the negative terminal being attached to an electrode also immersed in the solution [10], [Eq. (2)].

$$trans\text{-}(CH)_x + (xy)(ClO_4)^- \rightarrow [CH^{+y}(ClO_4)_y^-]_x + (xy)e^- \ (y \leq 0.1) \quad \ldots\ldots (2)$$

Chemical and Electrochemical n-Doping

n-Doping, that is, partial reduction of the backbone π system of an organic polymer, was also discovered using *trans*-$(CH)_x$ by treating it with a reducing agent such as liquid sodium amalgam or preferably sodium naphthaline [7], [Eq. (3) (Nphth = naphthaline)].

$$trans\text{-}(CH)_x + (xy)Na^+(Nphth)^- \rightarrow [Na_y^+(CH)^{-y}]_x + Nphth \ (y \leq 0.1) \quad \ldots\ldots (3)$$

The antibonding π system is partially populated by this process which is accompanied by an increase in conductivity of about 10^3 S cm^{-1}.

n-Doping can also be carried out by electrochemical cathodic reduction [11] by immersing a *trans*-$(CH)_x$ film in, for example, a solution of LiClO, dissolved in tetrahydrofuran and attaching it to the negative terminal of a DC power source, the positive terminal being attached to an electrode also immersed in the solution [Eq. (4)].

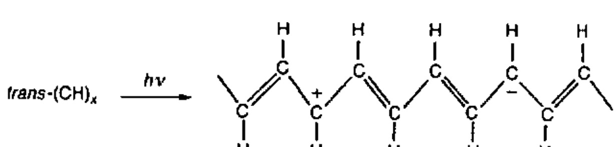
$$trans\text{-}(CH)_x + (xy)Li^+ + (xy)e^- \rightarrow [Li_y^+(CH)^{-y}]_x \ (y \leq 0.1) \quad \ldots\ldots (4)$$

In all chemical and electrochemical p- and n-doping processes discovered for $(CH)_x$ and for the analogous processes in other conducting polymers, counter "dopant" ions are introduced which stabilize the charge on the polymer backbone. In each case, spectroscopic signatures, for example, those of solitons, polarons, bipolarons, etc., are obtained characteristic of the given charged polymer. However, the doping phenomena concept extends considerably beyond that given above to "doping" processes where no counter dopant ion is involved, that is, to doping processes in which transitory "doped" species are produced, which have similar spectroscopic signatures to polymers containing dopant ions. This type of doping can provide information not obtainable by chemical or electrochemical doping. Examples of such types of redox doping which can be termed "photo-doping" and "charge-injection doping" are given below.

Doping Involving No Dopant Ions

Photo-Doping

When *trans*-$(CH)_x$ for example, is exposed to radiation of energy greater than its band gap, electrons are promoted across the gap and the polymer undergoes "photo-doping". Under appropriate experimental conditions, spectroscopic signatures characteristic of, for example, solitons can be observed [12] (Scheme 2). The positive and negative solitons are here illustrated diagrammatically for simplicity as residing only on one CH unit; they are actually delocalized over *ca.* 15 CH units. They disappear rapidly because of the recombination of electrons and holes when irradiation is discontinued. If a potential is applied during irradiation, then the electrons and holes separate and photoconductivity is observed.



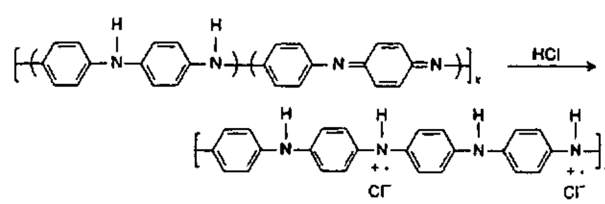
Scheme 2

Charge-Injection Doping

Charge-injection doping is most conveniently carried out using a metal/insulator/semiconductor (MIS) configuration involving a metal and a conducting polymer separated by a thin layer of a high dielectric strength insulator. It was this approach, which resulted in the observance of superconductivity in a polythiophene derivative, as described previously. Application of an appropriate potential across the structure can give rise, for example, to a surface charge layer, the "accumulation" layer which has been extensively investigated for conducting polymers [8, 13]. The resulting charges in the polymer, for example, $(CH)_x$ or poly(3-hexylthiophene), are present without any associated dopant ion. The spectroscopic properties of the charged species so formed can therefore be examined in the absence of dopant ion. Using this approach, spectroscopic studies of $(CH)_x$ show the signatures characteristic of solitons and the mid-gap absorption band observed in the chemically and electrochemically doped polymer. However, coulombic interaction between charge on the chain and dopant ion is a very strong interaction and one that can totally alter the energetics of the system.

Non-Redox Doping

This type of doping differs from redox doping described above in that the number of electrons associated with the polymer backbone does not change during the doping process. The energy levels are rearranged during doping. The emeraldine base form of polyaniline was the first example of the doping of an organic polymer to a highly conducting regime by a process of this type to produce an environmentally stable polysemiquinone radical cation. This was accomplished by treating emeraldine base with aqueous protonic acids (Scheme 3) and is accompanied by a nine to ten order of magnitude increase in conductivity (up to around 3 S cm^{-1}) to produce the protonated emeraldine base [14-16]. Protonic acid doping has subsequently been extended to systems such as poly(heteroaromatic vinylenes) [17].

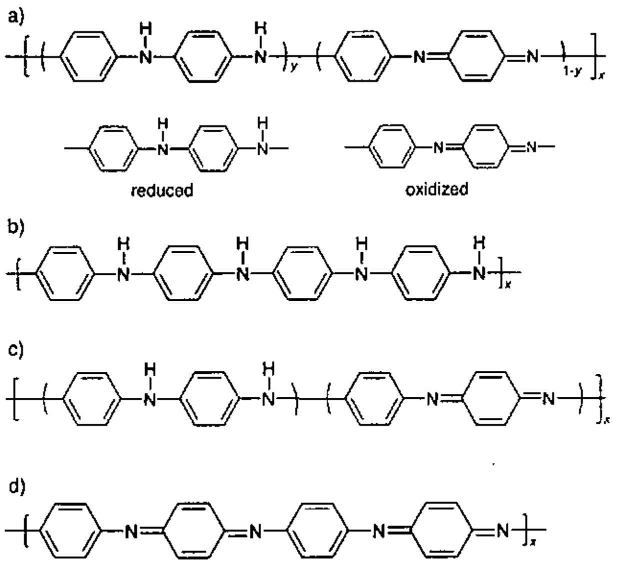


Scheme 3

The Polyanilines

The polyanilines refer to a very important class of electronic/conducting polymers. They can be considered as being derived from a polymer, the base form of which has the generalized composition given in Scheme 4a, and which consists of alternating reduced, and oxidized, repeat units (Scheme 4a) [3,14,15]. The *average* oxidation state can be varied continuously from y=1 to give the completely reduced polymer, to y=0.5 to give the "half-oxidized" polymer, to y=0 to give the completely oxidized polymer (Schemes 4b-d). The terms "leucoemeraldine", "emeraldine", and "pernigraniline" refer to the different oxidation states of the polymer where y=1, 0.5, and 0, respectively, either in the base form, for example, emeraldine base, or in the protonated salt form, for example, emeraldine hydrochloride [3,14,15]. In principle, the imine nitrogen atoms can be protonated in whole or in part to give the corresponding salts, the degree of protonation of the polymeric base depending on its oxidation state and on the pH of the aqueous acid. Complete protonation of the imine nitrogen atoms in emeraldine base by aqueous HCl, for example, results in the formation of a delocalized polysemiquinone radical cation [3,15,18] and is accompanied by an increase in conductivity of about 10^{10}.

The partly protonated emeraldine hydrochloride salt can be synthesized easily either by the chemical or electrochemical oxidative polymerization of aniline [3,14,15]. It can be deprotonated by aqueous ammonium hydroxide to give emeraldine base powder (a semiconductor).



Scheme 4. a) Generalized composition of polyanilines indicating the reduced and oxidized repeat units, b) completely reduced polymer, c) half-oxidized polymer, d) fully oxidized polymer.

Allowed Oxidation States

As can be seen from the generalized formula of polyaniline base (Scheme 4a), the polymer could, *in principle*, exist in a continuum of oxidation states ranging from the completely reduced material in the leucoemeraldine oxidation state, y=1 to the completely oxidized material in the pernigraniline oxidation state, y=0. However, we have shown [16] that at least in *N*-methyl-2-pyrrolidinone (NMP) solution in the range y=1 to y=0.5 (emeraldine oxidation state) only two chromophores are present, characteristic of y=1, and y=0.5 species and that all intermediate oxidation states consist, at the molecular level, only of *mixtures* of the chromophores characteristic of these two states.

Since most of the properties of polyaniline of interest are concerned with the solid state, we have carried out a series of studies in the solid state which show that the same phenomenon is true in the y=1 to y=0.5 oxidation-state range and in the y=0.5 to y=0 oxidation-state range. Within each of these ranges all intermediate oxidation states consist, at the molecular level, only of mixtures of the chromophores characteristic of the two states defining the beginning and end of each range [19, 20].

Doping

Polyaniline holds a special position amongst conducting polymers in that its most highly conducting doped form can be reached by two completely different processes—protonic acid doping and oxidative doping. Protonic acid doping of emeraldine base units with, for example 1 M aqueous HCl results in complete protonation of the imime nitrogen atoms to give the fully protonated emeraldine hydrochloride salt [14, 15].

As shown in Figure 2, protonation is accompanied by a 9 to 10 order of magnitude increase in conductivity reaching saturation in *ca.* 1 M aqueous HCl.

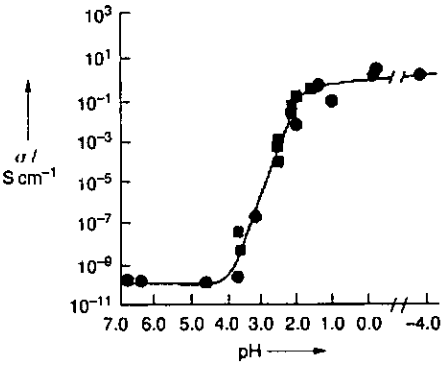
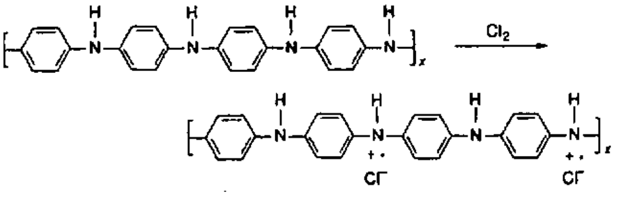


Figure 2. Conductivity of emeraldine base as a function of the pH of the HCl dopant solution as it undergoes protonic acid doping (● and ■ represent two independent series of experiments) see refs 14 and 15.

The same doped polymer can be obtained by chemical oxidation (p-doping) of leucoemeraldine base [3]. This actually involves the oxidation of the σ/π system rather than just the π system of the polymer as is usually the case in p-type doping. Its reaction with a solution of chlorine in carbon tetrachloride proceeds to give emeraldine hydrochloride (Scheme 5).



Scheme 5

Nanoelectronics

The basic purpose of this research is to blend the now well-established field of electronic/conducting polymers with the new, emerging field of nanoscience, by electrostatic fabrication ("electrospinning") to produce "nanoelectronics"—electronic junctions and devices significantly smaller than the diameter of a human hair (*ca.* 50,000 nm). It is commonly accepted that a nanomaterial is defined as one consisting of a substance or structure which exhibits at least one dimension of less than 100 nm (0.1 μm) [21].

Our objectives were: 1) to develop a method by which nanofibers (diameter <100 nm) of organic polymers could be controllably and reproducibly fabricated such that in one given preparation, all fibers would have a diameter <100 nm, *and* 2) to reproducibly and controllably fabricate, for the first time, nanofibers of electronic polymers (in their semiconducting and metallic regimes) *and/or* their blends in conventional organic polymers for the purpose of ascertaining their applicability in the fabrication of nanoelectronic devices.

We have made substantial progress in achieving these objectives by using a relatively little known, simple, convenient, and inexpensive "electrospinning" method [22-27]. We have previously reported [23] fabrication of the first conducting polymer fibers (diameter ≈950 nm to 2100 nm) of polyaniline doped with *rac*-camphorsulfonic acid

(PAn . HCSA) as a blend in poly(ethylene oxide) (PEO). We were surprised to find that an electronic polymer, such as polyaniline, which might have been expected to be more susceptible to degradation than most conventional organic polymers, survived, without observable chemical or physical change, following the 25,000 V electrospinning fabrication process in air at room temperature.

Electrospinning

The electrospinning technique involves a simple, rapid, inexpensive, electrostatic, nonmechanical method in which a polymer solution in a variety of different possible common solvents, including water, is placed in a hypodermic syringe or in a glass pipette, at a fixed distance (5-30 cm) from a metal cathode [24]. The positive (anode) terminal of a variable high voltage transformer is attached to the metal tip of the hypodermic syringe or to a wire inserted into the polymer solution in the glass pipette, the negative terminal being attached to the metal cathode. The tip of the syringe can be placed vertically over the cathode or at any other convenient angle to it. When the voltage applied between the anode and cathode reaches a critical value, *ca.* 14,000 V at a *ca.* 20 cm separation, the charge overcomes the surface tension of the deformed drop of the polymer solution on the tip of the syringe and a jet is produced. Since the polymer molecules all bear the same (positive) charge, they repel each other while travelling in air during a few milliseconds from the anode to cathode and become separated [25]. At the same time, evaporation of the solvent molecules occurs rapidly. Evaporation of solvent is also enhanced because the similarly charged (positive) solvent molecules repel each other. Under appropriate conditions, dry, meters-long fibers accumulate on the surface of the cathode resulting in a nonwoven mesh of nano- to micron-diameter fibers depending on experimental parameters (Figure 3).

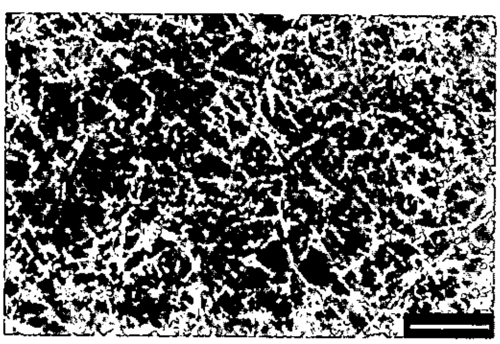


Figure 3. *50 wt% Nanofiber blend of PAn . HCSA fabricated from 2 wt% PAn . HCSA and 2 wt% PEO from chloroform solution at 25,000 V (anode/cathode separation, 25 cm). Scale bar: 100,000 nm.*

Nanofiber Fabrication

Since the submicron fibers (500-1600 nm) obtained in our initial work [23] were not classifiable as true "nanofibers", our immediate objective was to break the "nanotechnology barrier" and to consistently and reproducibly fabricate true nanofibers (diameter <100 nm) of an organic polymer. This was accomplished (see Figure 4) using an 8 wt% solution of polystyrene (M_w 212,400) in tetrahydrofuran at a potential of 20,000 V between the anode and cathode which were separated by 30 cm. The fibers were collected as a mat on an aluminum target and were found to have diameter characteristics: average: 43.1 nm, maximum: 55.0 nm, minimum: 26.9 nm. Other studies involving polystyrene gave fibers whose diameters were consistently <100 nm; average: 30.5 nm (maximum: 44.8 nm, minimum: 16.0 nm). It might also be noted that the 16 nm fiber is only around 30 polystyrene molecules wide. It is also of interest to note that a 16 nm fiber, such as the one mentioned above, lies well within the *ca.* 4-30 nm diameter range of multiwalled carbon nanotubes [26].

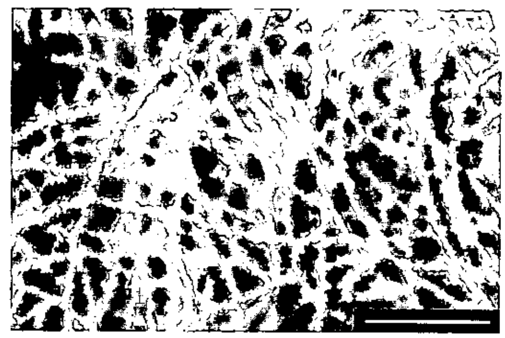


Figure 4. *Electrospun fibers of polystyrene (see text). Scale bar: 1000 nm. The extended length of the fibers is clearly visible.*

Electronic Polymer Fibers

By using a previously applied method for producing polyaniline fibers [27] we have prepared highly conducting sulfuric acid doped polyaniline fibers (diameters, average: 139 nm, maximum: 275 nm, minimum: 96 nm) by placing a *ca.* 20 wt% solution of polyaniline in 98% sulfuric acid in a glass pipette with the tip *ca.* 3 cm above the surface of a copper cathode immersed in pure water at 5000 V potential difference. The fibers collect in or on the surface of the water. The conductivity of a single fiber was *ca.* 0.1 S cm^{-1}, as expected since partial fiber dedoping occurred in the water cathode. The diameter and length of the fibers appear (Figure 5) to be sensitive to the nature of the polyaniline used. No great difficulty is foreseen in producing fibers <100 nm diameter.

Figure 5. *100% polyaniline fiber with an average diameter of 139 nm.*

It is relatively easy to prepare conducting blends of PAn . HCSA in a variety of different conventional polymers such as polyethylene oxide, polystyrene, polyacrylonitrile, etc. For example, *ca.* 20 wt% blends of PAn . HCSA in polystyrene (M_w 114,200) are obtained by electrospinning a chloroform solution; fiber diameter characteristics: average: 85.8 nm, maximum: 100.0 nm, minimum: 72.0 nm. These fibers are sufficiently electrically conductive that their scanning electron micrographs (SEMs) may be recorded without the necessity of applying a gold coating. Separate, individual nanofibers can be collected and examined if so desired. An appropriate substrate—glass slide, silicon wafer, or loop of copper wire, etc.—is held between the anode and cathode at a position close to the cathode for a few seconds to collect individual fibers (see Figure 6).

Figure 6. Polystyrene fibers collected on a bent copper wire (magnification 33 x) and subsequently coated with a thin layer of polypyrrole by in situ *deposition from aqueous solution. Scale bar: 1 mm.*

Current/voltage (*I/V*) curves are given in Figure 7 for a single 419 nm diameter fiber (Fiber 1) and for a *ca.* 600 nm diameter fiber (Fiber 2) of a blend of 50 wt% PAn . HCSA and poly(ethylene oxide) collected on a silicon wafer coated with a thin layer of SiO_2. Two gold electrodes separated by 60.3 μm are deposited on the fiber after its deposition on the substrate.

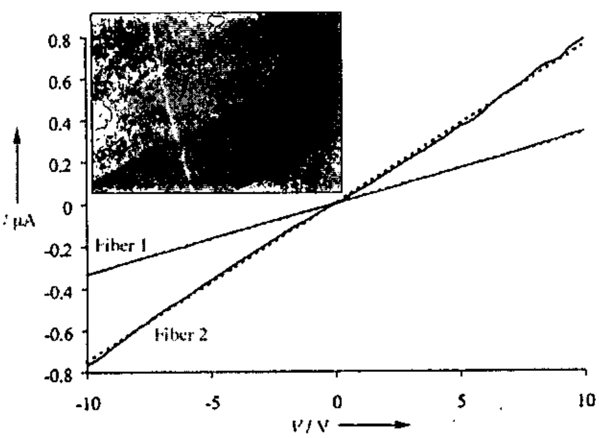


Figure 7. Current/voltage curves of 50 wt% PAn . HCSA/ PEO blend nanofiber (see text).

Nanofibers as Substrates

The large surface to volume ratio offered by nanofibers makes them excellent, potentially useful substrates for the fabrication of coaxial nanofibers consisting of superimposed layers of different materials. Catalysts and electronically active materials can be deposited on them by chemical, electrochemical, solvent, chemical vapour, or other means, for use in nanoelectronic junctions and devices.

We have found, for example, that polyacrylonitrile nanofibers can be easily and evenly coated with a 20-25 nm layer of conducting polypyrrole (Figure 8) by immersion in an aqueous solution of polymerizing polypyrrole [28]. Analogously, we have found that electroless deposition of metals can also be performed. Polyacrylonitrile fibers, for example, can be evenly coated with gold by electroless deposition [29].

Figure 8. Scanning electron micrograph of conducting polypyrrole-coated polyacrylonitrile nanofibers. Scale bar: 1000 nm.

Carbon Nanofibers

As reported polyacrylonitrile fibers may be thermally converted into carbon nanofibers with some shrinkage [30]. We have similarly converted polyacrylonitrile nanofibers into carbon nanofibers.

In summary, electronic polymers have been used for the past 20 years to produce rectifying diodes by Schottky and p/n junctions, transistors, light-emitting devices, photovoltaic cells, rechargeable batteries, etc. [1]. Now, the ability to fabricate nanofibers of electronic polymers which are only a few molecules thick suggests the emergence of a field of nanoelectronics whereby the electronic properties of such nanofibers can be exploited for technological purposes.

Line Patterning of Conducting Polymers [30]

One of the exciting challenges of the first part of this century will be the development of low-cost disposable plastic/paper electronic devices [31-33]. Conventional inorganic conductors, such as metals, and semiconductors, such as silicon, commonly require multiple etching and lithographic steps in fabricating them for use in electronic devices. The number of processing steps and chemical etching steps involved limit the minimum price and therefore their applicability in disposable electronics. On the other hand, conducting polymers combine many advantages of plastics, for example, flexibility and processing from solution, with the additional advantage of conductivity either in the metallic or semiconducting regimes; however, the lack of simple methods to obtain inexpensive conductive polymer shapes/patterns limit many applications. We here describe a novel, simple, and cheap method to prepare patterns of conducting polymers by a process which we term, "Line Patterning".

Line Patterning uses the difference in selected physical and/or chemical properties between a substrate and insulating lines which have been printed on it by a conventional copying or printing process towards a fluid (or vapour) to which they are both simultaneously exposed. The substrate and printed lines react differently or at different rates with the fluid (or vapour) to which they have been exposed. This results in a non-uniform deposition on the substrate as compared to the printed lines. If the fluid contains a conducting polymer, which remains as a film after evaporation of the solvent, a pattern of conducting polymer results. A pattern is first designed on a computer and is then printed on, for example, an overhead transparency using a standard, non-modified office laser printer.

The printed (insulating) lines can be easily removed, if necessary, in a few seconds by ultrasonic treatment in toluene, dissolving the printed lines and leaving a clean pattern of deposited material on the substrate whose shape was originally defined by the now nonexistent printed lines. Line Patterning has the following advantages: no photolithography is involved; no printing of conducting polymer is involved; it uses only, for example, a standard office laser printer, which is not modified in any way; commercially available flexible, transparent plastic or paper substrates can be used; solutions of commercially available conducting or nonconducting polymers can be used from which the polymers may be deposited on substrates, it is inexpensive; rapid development of customized patterns (within hours) from a computer designed pattern to product is routine.

We have exploited, for example, the observation that a commercial dispersion of poly-3,4-ethylenedioxythiophene (PEDOT, "Baytron P", Bayer Corp.) wets commercial plastic overhead transparency, but not the lines printed on it by a standard office laser printer. A coating of PEDOT can be applied by a roller and after evaporation of the solvent; the printed lines can be easily and cleanly removed by sonication, leaving only the conducting polymer on the transparency.

Two electrodes were prepared in this way, each containing 25 lines inch^{-1}. A drop of a standard commercial polymer dispersed liquid crystal (PDLC) display [34] mixture containing an optical adhesive and 15 μm spacer spheres was placed on the center of each electrode. The second electrode was placed on top at an angle of 90° to the first. This resulted in a (25 x 25), that is, 625 pixels (square-inch matrix)$^{-1}$ (Figure 9). Exposure to UV light for a few minutes resulted in polymerization of the mixture to bind the two electrodes together and to produce a free-standing working PDLC display device. When an electrode pattern of 100 lines inch^{-1} was used a working 10,000 pixel square-inch^{-1} display was produced.

We have devised a novel way of separating conducting polymer circuits from each other by making use of the height (*ca.* 4-5 μm) of the printed toner lines, made by using a standard office printer, above the substrate, for example, on an overhead transparency. This is illustrated (Figures 10 and 11) by a "push button" switch to open and close a simple electrical circuit. A combination of two patterned transparencies where the two adjacent conductive areas are electrically separated from each other by two *ca.* 4 - 5 mm nonconductive printed toner lines is obtained by placing the printed lines on top of each other as shown in Figures 11 and 12. Depression of the areas labelled "PRESS" causes the upper transparency to bend. This electrically connects the conducting PEDOT surfaces. When released, the transparency film returns back to its original position, thus breaking the electrical circuit.

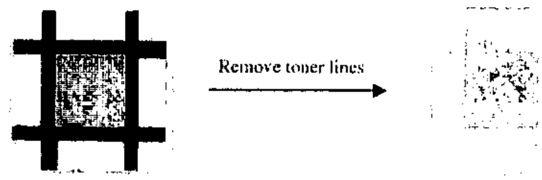


Figure 9. Fabrication of a 625 pixel PDLC display (see text).

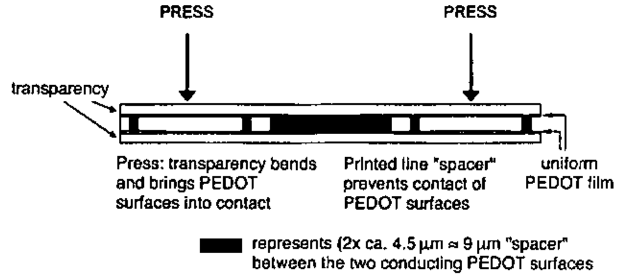


***Figure 10.** A simple electronic circuit ("push button" switch).*

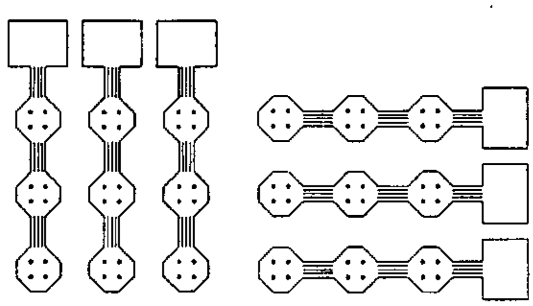


***Figure 11.** "Push button" switch.*

The two-dimensional conducting polymer circuits may be readily converted into three-dimensional circuits by two different methods as shown in Figure 12 simply by 1) stapling two two-dimensional circuits together using a common office stapler. The metal staple joins together electrically the conducting polymer areas on two different substrates *or* 2) making a pinhole through the sheets, as shown, before applying the PEDOT solution. Some of the solution enters the pinhole and joins together electrically the conducting surfaces on the two different circuits.

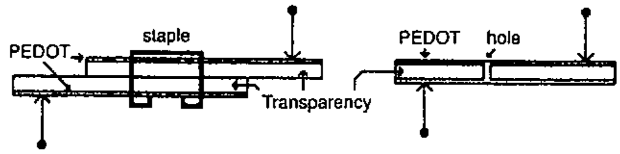


***Figure 12.** Three-dimensional connections; a) connected with staple, b) connected by a coated hole; • = connection to power supply.*

We have recently observed a curious field effect which thin films of PEDOT exhibit when exposed to a positive gate potential in an FET configuration as shown in Figure 13. A source/drain electrode and a gate electrode are prepared by Line Patterning and are covered by a thin layer of PEDOT as described above. A drop of the optical adhesive containing spacer spheres described above is placed on the source/drain electrode upon which the gate electrode is then placed at 90°. The two electrodes are manually squeezed together and the optical adhesive is polymerized by exposure to UV light as was done for the PDLC display described above. Several thousand of these interconnected transistor-type devices could be readily fabricated per square inch by the Line Patterning process, if it were considered desirable. The free-standing, flexible device shown in Figures 13 and 14 is produced.

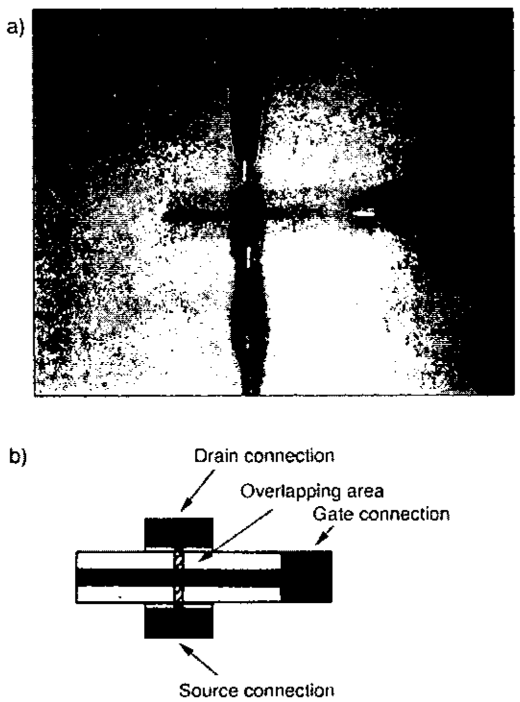


Figure 13. Field-effect doped "PEDOT". a) FET-type device, b) field-effect configuration.

Figure 14. FET-type device.

The device exhibits the same general reversible features commonly associated with a field effect transistor (FET) as shown in Figure 15. The doped "metallic" PEDOT film ($\sigma \approx 2$ S cm^{-1} at room temperature) would not be expected to show a change in conductivity by exposure to a field of this type under the configuration used. We believe this effect presents an entirely new method for ascertaining the nature of highly doped "metallic" conducting polymers.

It has frequently been postulated that a doped conducting polymer consists of metallic "islands" surrounded by lowly conducting "beaches" as shown in Figure 16. We postulate that in the effect we have observed only the lowly conducting "beaches" and not the metallic "islands" respond to the applied field. The application of an electric field changes the conductivity of the "beaches" and hence the extent of electrical percolation in the source/drain PEDOT electrode between the metallic "islands", hence changing the bulk conductivity of the material. The response time for our device is much slower than for a conventional field effect transistor. We therefore conjecture that the chief changes in conductivity are probably caused by slow diffusion of the dopant anions under influence of the applied field. On removal of the field the system reverts to its original state.

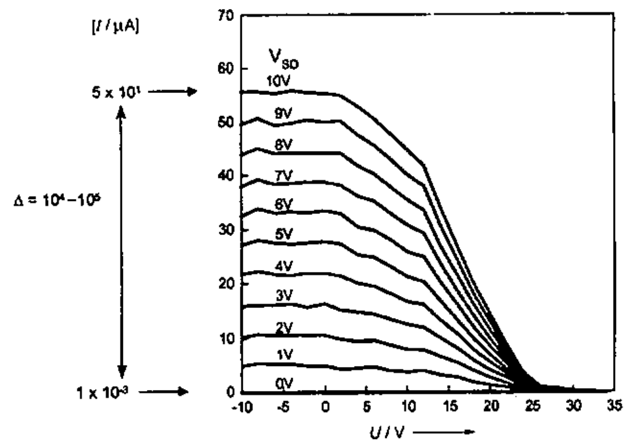


Figure 15. Field effect transistor characteristics.
I = source - drain current; U = gate voltage.

Preliminary studies show that the effect is also present in polyaniline; it may therefore possibly be found in many other conducting polymers and would thus represent a general phenomenon characteristic of all conducting polymers, at least within certain ranges of doping.

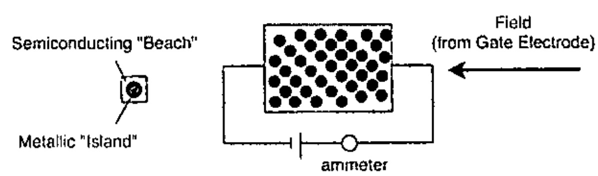


Figure 16. Percolation field effect in doped conducting polymers. Metallic "islands" separated by "beaches" of non- or lowly conducting (semiconducting) polymer. The field changes the conductivity of the semiconducting "beaches" but not that of the metallic "islands" - hence the field changes the extent of electrical percolation between the metallic "islands" - and therefore changes the bulk conductivity of the material.

Summary

- Polyacetylene, $(CH)_x$, the simplest organic polymer, can be reversibly doped to the metallic regime by partial oxidation or reduction either chemically or electrochemically.
- Polyaniline can be doped to the metallic regime by a simple acid/base protonation.
- A large number of electronic conductive polymers are

now known.

- A variety of technological applications of electronic conductive polymers, present and projected, are apparent.

This Nobel Prize has world-wide implications since it shows the ever-increasing importance of interdisciplinary research - in this case collaborative research between a polymer chemist, Hideki Shirakawa [35], Alan Heeger [36], a physicist, and myself, an organometallic chemist. Each of us had the task of learning the specialised scientific language of the other in order to collectively focus on one specific scientific challenge, an example of where 1 + 1 + 1 is more than 3!

The prize is also recognition of the good fortune that Alan, Hideki, and I had in having each other as such excellent colleagues and also in having such creative colleagues in each of our respective individual research groups - the work stemming from a research group cannot be better than the persons carrying it out. The prize is a recognition of them and their work and also the work of countless others world-wide during the past 23 years who put the "flesh on the skeleton work" carried out by us in the 1970s at Penn (University of Pennsylvania). If it were not for them there would be no prize today in the field.

Research in an experimental science (and also in many other fields) cannot be accomplished without financial support for stipends, apparatus, supplies and the like. A funding organization and project officers within such an organization have tremendous control over the future of science and technology in any given country. In this respect Dr. Kenneth J. Wynne, my contracting officer at the US Office of Naval Research for many years, before his recent retirement, had the scientific intuition and foresight to fund our first work on conducting polymers - the first funding of work of this type anywhere in the world. He funded it because of its scientific interest. The fact that it now has great technological potential was not a consideration at that time.

"Of what use is a beautiful poem"? It gives intellectual stimulation and enjoyment. Similarly with research. If it has some practical use, that is merely "icing on the cake!"

Early studies: Polyacetylene, $(CH)_x$: Alan J. Heeger [36] (formerly, Physics Department, University of Pennsylvania), Hideki Shirakawa [35] (Tsukuba University), and many undergraduate, graduate students, and post-doctoral fellows. Financial support: Principally, US Office of Naval Research (Dr. K. J. Wynne, Program Manager); University of Pennsylvania Materials Science Laboratory.

Polyaniline: Arthur J. Epstein (Physics Dept., Ohio State University) and many undergraduate students, graduate students, and post-doctoral fellows. Financial support: Principally, US Office of Naval Research (Dr. K. J. Wynne, Program Manager); University of Pennsylvania Materials Science Laboratory.

Recent Studies: Nanofibers ("Electrospinning"): I. D. Norris, J. Gao, F. K. Ko, W. E. Jones, Jr., A. T. Johnson, Jr. Financial support: US Office of Naval Research (Dr. K. J. Wynne, Program Manager); Army Research Office - MURI.

Line Patterning: D. Hohnholz, H. Okuzaki. Financial support: Subcontract, Kent Displays, Inc. (ONR-SBIR Program); US Office of Naval Research (Dr. K. J. Wynne, Program Manager); Fellowship from Ministry of Education, Science, Culture and Sports, Japan.

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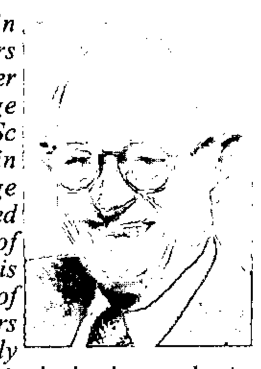
About the Author



Alan MacDiarmid was born in Masterton, New Zealand 74 years ago and after obtaining his higher education at Victoria College University of New Zealand (MSc 1950), University of Wisconsin (PhD 1953), and Cambridge University (PhD 1955), he joined the faculty of the University of Pennsylvania in 1955, where he is currently Blanchard Professor of Chemistry. During the past 24 years he has been involved exclusively with conducting polymers, particularly the synthesis, chemistry, doping, electrochemistry, conductivity, magnetic and optical properties, and processing of polyacetylene and polyaniline. He is the author/co-author of approximately 600 research papers and 20 patents. He is the recipient of numerous awards and honorary degrees both nationally and internationally. In 1973, he began research on $(SN)_x$ *an unusual polymeric material with metallic conductivity. His interest in organic conducting polymers began in 1975 when he was introduced to a new form of polyacetylene by Dr. Hideki Shirakawa at the Tokyo Institute of Technology. The ensuing collaboration between MacDiarmid, Shirakawa, and Alan Heeger (then at the Department of Physics at the University of Pennsylvania) led to the historic discovery of metallic conductivity in an organic polymer, and the award of the Nobel Prize for Chemisty. 2000.*

NEWS

NZIC Council

President Leon Phillips recently had a from visit Paul H.L.Walter, former President (1998) and currently roving ambassador for the American Chemical Society, plus two of the ACS staff in Washington, Nancy Gray and Denise Creech, who are Director of the Membership Division and Assistant Director, Membership Programs, respectively.

The ACS is currently running a pilot program of joint membership with five other chemical societies in Chile, Japan, Canada, Taiwan and Mexico. The system is that a member of one society gets a 20% discount on membership dues in the other. Since ACS membership costs around $US130 annually, I think this is a great idea. Once the pilot program is over and has proven successful, the ACS will change their by-laws and we too will be able to take part if we want to. Council will keep you informed of progress.

Annual General Meeting

The Annual General Meeting of the New Zealand Institute of Chemistry will be held during the Molecules for Life Conference at the War Memorial Centre, Napier, 4-7 December 2001. The time and date of the meeting will be advised to branches and posted on the web page at a later date.

Nominations For Offices

Nominations are called for the offices of President, First Vice-President, Second Vice-President, Honorary General Secretary and Honorary Treasurer.

Nominations can be made by Branches, or by any six members, and should reach the Honorary General Secretary by November 30, 2001.

The address for nominations is:
Secretary@nzic.org.nz
or FREEPOST 96
New Zealand Institute of Chemistry
P O Box 39283 Howick
Auckland 1730
New Zealand

The First Vice-President is automatically nominated for the position of President.

The Second Vice-President is automatically nominated for the office of First Vice-President.

Missing Members

We have lost contact with the following people, if you know their whereabouts please contact the NZIC Office at nzicoffice@nzic.org.nz.

Auckland Branch:
Dr G D Beresford, ESR Ltd, Auckland
Mr I R Clark, NZ Refining Company Ltd, Whangarei
Mrs L Clark
Dr R A F Couch, Auckland Hospital
Mr A C Eaton
Miss D Emery
Mr S A Jordan, Chemical Specialties Ltd
Y H M Lai
Mr J G McCort
S K Peterson
Mr R P Sharma, Manukau Consultants Limited
Mr D J Shaw
J K O Ting
Dr D C Ware, University of Auckland
Mr M Q Xu, Firth Industries Dricon Division, Auckland

Waikato Branch:
T Adams, Hamilton
Mr W Campbell, Opotiki
Mr R Clark, Tauranga
Professor R M Daniel, University of Waikato
Dr R M Haselmore, R J Hill Laboratories Ltd, Hamilton
S S Hoque, Hamilton
Mr F W King, Tauranga
Q Li, Hamilton
Dr K J McNaught, Hamilton
Mrs C M Menzies, Hamilton
Mr A Rahman, Hamilton
M Senanayake, Hamilton
Miss T M Stewart, Hamilton
Dr J M Thorp, Thames

Manawatu Branch:
Mr W Campbell, Massey University

Wellington Branch:
Mr G Stevenson, Wellington

Canterbury Branch:
Mr K R Ashby
Mr I J Beaton, Dunlop Industrial, Christchurch
Mr G J Day, Christchurch
B May, Christchurch
Mr J M Murphy, Christchurch
Ms R Officer, Christchurch
A Rea, Christchurch
Dr M J Rosser, Christchurch
Mr S Telfer, University of Canterbury

Otago Branch:
Ms A Barlow, Dunedin
W Carseldine, Dunedin
Mr D G Bokern, University of Otago
Mr M Polson, University of Otago
Ms J M Turnbull, University of Otago

Overseas:
Dr M F Mahoney, Padres Maristas, Brazil
Professor H Bloom, Australia
Mr M J Ellwood, Australia
Mr P L Charlton, Fiji
Dr A L Johnson, USA
Dr M J B Moore, USA

Chemical Education Trust

Distribution of Funds

The annual allocation by the Chemical Education Trust has seen grants totalling $2600 distributed to four high schools. **Freyberg High** (Mr Craig Steed, HOD Science), **Taradale High**, (Mr Martyn Williams HOD Chemistry), **Wanganui High** (Mr Ian Thomas, HOD Chemistry), and **Westland High** (Mr Paul Hewson, HOD Science) were selected as recipients of the 2001 grants. Equipment ranging from a pH meter, a pH probe to go with existing computer set-up, a light sensor and temperature sensors (also to interface with an existing computer) as well as relevant computer software packages were among the requests received.

Ed.

NZIC Branch News

AUCKLAND

The University of Auckland held its annual "Courses and Careers Day" on Saturday, 1 September 2001. The Chemistry Department organised a number of exhibits based on the four themes: synthesis; isolation; measurement; and modelling. There were also displays from the Forensic and Food Sciences Section.

There have been two separate visits by Nobel Prize Winners to the University of Auckland. **Professor Alan MacDiarmid** visited in July and spoke at a well-attended public seminar on 2 July. The seminar was jointly hosted by The Faculty of Science (University of Auckland) and The Auckland Branch of The Royal Society of New Zealand. Professor MacDiarmid also participated in the "Bump into Science" day where he took part in a Question and Answer session for school students. **Professor Yuan Tseh Lee** (Academia Sinica, Taiwan) also visited and presented a public seminar on July 31 at the University's Conference Centre entitled "Recent Advances in Chemical Reaction Dynamics" Professor Lee shared the 1986 Nobel Prize in Chemistry with Professors Herschbach and Polanyi for their studies in molecular dynamics. The continuing focus of Professor Lee's research has been to elucidate detailed dynamics of simple elementary reactions and photochemical processes that play important roles in macroscopic systems.

The "Bump into Science" day was held in July as part of the Auckland Festival of Science and Technology. The Festival, hosted by the University of Auckland's Faculty of Science attracted approximately 3000 people of all ages. The Festival involved a range of companies, tertiary institutions and museums. The Chemistry Department ran a number of displays as well as their famous "chemistry magic shows".

Inaugural lectures for the recently appointed **Professors Clark and Schwerdtfeger** are scheduled for October at The University of Auckland Conference Centre, 22 Symonds Street:

- **Professor Peter Schwerdtfeger**, 3 October 2001, 1-2 pm "Small effects, large consequences: from relativity to electroweak interactions"; and
- **Professor George Clark**, 10 October 2001, 1-2 pm "Serendipity and the research scientist: a chemist's perspective".

The "Auckland Chemistry Scholar of the Year Competition", was held on 29 August and involved seventh form students from a number of local area high schools. The programme included a written exam, two practical laboratory sessions and a lecture. At the end of the day, a mastermind-type quiz produced the winner from the top four students.

The top Auckland secondary school chemistry scholar for 2001 is **Jack Chen** from **Auckland Grammar School.** There were three runners-up; **Joshua Agnew (Westlake Boys High School), Jason Du (Takapuna Grammar School)** and **Michael Brown (Rangitoto College)**. The four chemistry top guns fought off strong opposition from a field of 73 seventh formers from 28 schools throughout the region to claim their places. Auckland Branch Chair **Gordon Rewcastle** presented their prizes. Jack's success follows earlier chemistry achievements including representing New Zealand at the International Chemistry Olympiad, which was held in India in July.

Above: *Jack Chen with his "Auckland Chemistry Scholar of the Year" prizes.*

The competition is now in its 20th year and is sponsored jointly by the Auckland Branch of the NZIC and the University of Auckland Chemistry Department. Organiser **Dr Bridget Sykes**, a senior tutor in Chemistry, was thrilled at the turnout for the competition when the seventh formers swapped their class-rooms for a day at university. "We usually have about 60 contestants, but this year, entries were up, and our laboratories were operating at full capacity. The calibre of contestants was high, and competition very hot." Thanks go to **John Packer, Douglas Russell, Bridget Sykes** and all the other staff members who gave up their time to participate in this successful event.

Members of the Auckland Branch visited the Auckland Cancer Society Research Centre and the Division of Pharmacy at the Auckland Medical School on 26th July. The evening included talks by **Professor Bill Denny** on the anti-cancer research conducted at the Cancer Centre, and by **Professor John Shaw** who spoke about the new Bachelor of Pharmacy degree course. The talks were followed by tours of the two facilities.

The winner of the Department of Chemistry, Chocolate Competition was **Dr. Bianca Kuipers.** Her winning entry was a delicious chocolate cheesecake. Special congratulations to **Anna Yee**, a member of the Auckland Branch Committee, who came third equal with a stunning chocolate caramel slice.

CANTERBURY

Since the last issue of *Chemistry in New Zealand*, a number of interesting events have occurred. In July, the **ChemED 2001** conference was held at the University of Canterbury. This was an extremely successful event and **Richard Rendle** and the organising committee should be commended for all their hard work in preparing the conference.

In August, there were two Branch lectures. **Nigel Perry** (Plant Extracts Research Unit (PERU),Otago) gave a well attended talk that provided an overview of the work he and his group have been doing on the isolation of novel compounds from some of New Zealand's more unusual plant species.

Richard Hartel (Wisconsin-Madison) spoke to a joint NZIC/New Zealand Institute of Food Science and Technology (NZIFST) audience on research he has been doing over the last eleven years in chocolate and ice cream. Richard detoured to Christchurch on his way from Wisconsin to the NZIFST conference in Dunedin. There was a good turnout from members from both the NZIC and the NZIFST and a few guests as well.

The Branch awarded two prizes in the Canterbury-Westland Science Fair this year. The quality of the entrants was very high and the awards were for the "Best Exhibits Illustrating An Understanding of Chemistry". These prizes were a copy of "NZ Is Different" and a cash prize. Many thanks go to **Martin Lee** and **Rebecca Hurrell** who acted as our judges.

The Chemistry Ball was held in late August. This is a popular event amongst University of Canterbury students and this year it was held at Addington Raceway.

The Science Outreach programme, based in the Department of Chemistry at Canterbury, continues to go from strength to strength. It is expected that more than 300 talks will have been given during the year. If you would like to know more details about this programme, please contact **Rebecca Hurrell** on email: (r.hurrell@chem.canterbury.ac.nz) or check out the web page: www.chem.canterbury.ac.nz

Future events include the Presidential Address, a student BBQ, and a wine tasting.

MANAWATU

Each year the branch runs a *Careers in Chemistry* lunch function for university students. This year the speakers at the July meeting were **Emma Jolley** (Chemist, New Zealand Pharmaceuticals Ltd), **Craig Steed** (Teacher, Freyberg High School), **Nick Robinson** (Research Chemist, New Zealand Dairy Research Institute) and **Darren Englebretsen** (Wellcome Research Fellow, Massey University). All spoke positively about their jobs and students asked lots of questions. One of the speakers said that he wished he had taken more notice of physical chemistry when he was a student which was music to the physical chemists' ears! At the meeting the 2000 NZIC prizes were presented to **Alexander Park** and **Jasmine Jury** (top students in third year chemistry at Massey University), **Vikki Weake** (top student in third year biochemistry at Massey University) and **Debra Hall** (top student in level 6 environmental chemistry at UCOL).

NZIC President, **Leon Phillips**, visited the branch on 19 June and gave a talk on his research entitled "What is actually going on at the surface of a liquid?" This was followed by a very pleasant meal at Wharerata, the Massey University staff club. The scientific highlight of the Branch's year must surely be the visit of the 2000 chemistry Nobel Prize winner, **Alan MacDiarmid**, in July. About 250 attended his scientific lecture at Massey University and in excess of 450 attended the public lecture. While at Massey University, Alan opened the new *Nanomaterials Research Centre* which is headed by **David Officer** (see elsewhere in this issue for a fuller story).

Future meetings of the Branch are on 10 October when **David Officer** will give a lecture on "Nanomaterials" and the branch AGM is on 30 October when **Richard Haverkamp** will give his Chairman's address.

Merck New Zealand Limited

Barry Scott reports that as from the beginning of this year BDH Chemicals New Zealand Ltd. has changed its name to Merck New Zealand Limited. This brings them into line with the parent company: Merck KGaA, Darmstadt, Germany. Apart from new stationery and a new coat of paint, it is business as usual with BDH chemicals still their major product line. But look out for more Merck products. This year they have refurbished the offices for the first time since the building was built in *ca.* 1975! Currently they are upgrading to a new, faster, better computer system.

Massey University

Recent visitors to Massey University have included **Professor Heinrich Lang** (Chemnitz University of Technology) who spoke about his very interesting research in a talk entitled "Carbosiloxane Dendrimers" and **Professor Sir Tom Blundell** (Department of Biochemistry, University of Cambridge) whose seminar, "Genome Sequences, Protein Structures and Drug Discovery", was a fascinating *tour de force.*

The 10[th] Annual Massey – Victoria Chemistry Graduate Student Seminar Day was held on 4 September at Massey University. This year's meeting was organised by graduate students, **Nandana Ariyaratne** and **Laine Cousins**, and a number of very good papers were presented by the students.

Richard Haverkamp (Branch Chairman) is away during September/October for 6 weeks at SINTEF in Trondheim, Norway, investigating anodic processes in aluminium smelting. During this time he will present a paper to the 11[th] International Aluminium Symposium which is to be held on a cruise ship travelling between Trondheim and Bergen! He will also visit the Singapore Polytechnic to help establish the collaborative programme with Massey University.

In June, **Carol Taylor** travelled to the USA for 3 weeks. The focus of her trip was the 37[th] National ACS Organic Symposium. This biennial conference captures the state-of-the-art of organic chemistry, giving an overview of the field. There were 13 lectures, of which the following were personal highlights:

· *Carolyn R. Bertozzi:* Metabolic Cell Surface Engineering
· *Alois Fürstner:* Alkyne Metathesis: A Complementary and Competitive Tool
· *Carl R. Johnston:* Using Nature's Catalysts: The Chemoenzymatic Synthesis of Bioactive Molecules
· *Manfred T. Reetz:* Evolution in the Test Tube as a Means to Create Enantioselective Enzymes.

For some years, Carol has been working on the synthesis of peptides related to the adhesive protein of the edible blue mussel, *Mytilus edulis*. During this trip she also visited the lab of Professor Herb Waite at the Marine Science Institute of the University of California—Santa Barbara. Professor Waite first isolated the adhesive protein in the early 1980s and is a leader in the field. During the first week of September, Carol will be in Australia where she will give a plenary lecture at the *Southern Highlands Conference on Heterocyclic Chemistry*. This annual meeting is held at Milton Park, Bowral (NSW). The conference topic is interpreted in the widest sense to include natural products and covering synthetic, organometallic, pharmacological, stereochemical and commercial aspects. Carol's talk is entitled, "Hydroxyproline: Molecular Hinge and Fine-Tuning Device." She will also visit the University of Sydney on Thursday, September 6th. It will be a good chance to catch up with Australian colleagues.

The Wellcome Trust has awarded **Darren Englebretsen** a supplementary grant of $84,000 for purchase of two freeze-driers. The larger corrosion-resistant system will be used for corrosive (TFA) and noxious smelling (thiol!) solutions containing newly cleaved synthetic peptides. The smaller system will be dedicated to valuable, purified synthetic insulin-derived peptides.

David Parry is co-organiser of the 3[rd] Workshop on "Coiled-Coils, Collagen and Co-Proteins". This is to be held 16-22 September in Alpbach (Austria). The Workshop occurs on a four year cycle and is concerned with the structure and function of a wide variety of fibrous proteins and their assembly partners. The organisation of the meeting is unusual in that only one or two lead speakers per theme are organised. Offers to speak are made to the Session Chair on arrival at Alpbach and this ensures that only the most topical papers are accepted. There is to be a Special Edition of the *Journal of Structural Biology* devoted to the subject material edited by **David Parry** and **John Squire**. Prior to the meeting David will be spending a week at the Biozentrum in Basel, Switzerland, working with **Sergei Strelkov** and **Ueli Aebi** on intermediate filaments, and with **Juergen Engel** on other coiled-coil proteins.

Gavin Hedwig has returned from a short visit to the University of Lethbridge, Alberta, where he continued with his research project on "the thermodynamic properties of protein model compounds" in collaboration with **Dr. Andrew Hakin**, of the Department of Chemistry and Biochemistry.

Tony Wright, **Paul Buckley** and **Judy Edwards** have been awarded a grant of $7,500, for the project "Visual Learning Objects for Flexible Learning" from the Massey University Fund for Innovation and Excellence in Teaching. This is to develop digital video resources for chemistry papers and will cover the purchase of a video camera that will be available for use in demonstrations, as well as for recording video clips for laboratories, of industrial visits, and guest lectures. One of the aims of the grant is to start building an image and video clip database for use in web-base teaching. **Tony Wright** was also Chief Judge of the Manawatu Science Fair and conscripted many of the chemists in the area to assist with judging that took place on August 31.

Tony Burrell has been appointed an Honorary Research Fellow of Massey University. He has moved to the Los Alamos National Laboratory, USA, but he will maintain a connection with Massey University as a member of the Nanomaterials Research Centre.

OTAGO

Professor Barrie Peake returned to the Chemistry Department at the end of June following a sabbatical year which he spent in the Chemistry Department at the University of North Carolina, USA - undertaking research on rain chemistry - and then at the Cawthron Institute in Nelson for algal toxin research. On the way back to New Zealand he attended the Pacifichem 2000 conference in Hawaii where he co-chaired a symposium on aquatic photochemistry and presented a paper on hydrogen peroxide levels in southern New Zealand aquatic environments.

The **Robinson/ Simpson** group is highly emitting at the moment! They have synthesised a number of highly emitting ferrocene fluorophores, some of which will be tested for brain cell staining. **Eva Murray** is wrapping up her Honours project and begins work with MFAT in November. **John McAdam** is away for ten weeks as part of the EU collaboration with **Professor Tony Manning** in Dublin. Tony will be returning to Otago for the January to March period next year. His work involves even-chain thiophene metal complexes. **Professor Brian Robinson** will be visiting Toronto and Brown Universities in September/October; while in Brown he will continue the ESR collaboration with **Professor Phil Rieger**.

The Otago Branch was one of the sponsors of the Senior Schools Science Quiz, held on August 27th. This is a nationwide quiz for school pupils in years 11-13 that consists of 45 multiple choice questions to be completed in 50 minutes.

Dunedin was fortunate to have a visit from **"Dr Bunhead"** (otherwise known as **Tom Pringle**) as part of the Science Festival in July. His shows (one for kids, and a slightly "naughty" one for adults) were performed in front of packed houses, and consisted of a variety of chemistry demonstrations interspersed with some very funny chatter.

WAIKATO

The annual Waikato Branch Analytical Chemistry Competition was held at the University of Waikato Chemistry Department on Thursday 19th June. Invitations to schools in the Waikato/Bay of Plenty region to send teams of four students resulted in 25 teams this year, with students coming from as far afield as Gisborne. This year the task was to analyse a lead salt by both a gravimetric procedure and by a back-titration method—quite a demanding task in the time available. Some excellent results were achieved and most of the students presented reports that would rank alongside those expected of a good first-year university student. Judging was difficult, and the following prizes were awarded:

· 1st Prize to **Te Aroha College (John Stowers, Ryan Spooner, Cameron Keepa** and **Richelle Gwynne)**
· 2nd Prize to **Hillcrest High School (Sheela Upreti, Rita Upreti, Blake Watkins** and **Stephen Kendrick)**
· 3rd Prize to **Waikato Diocesan School (Rebecca Burns, Catherine Empson, Anna Denby** and **Nerissa Harrison)**
· 4th Prize **Tauranga Girls College (Stacey Enright, Sarah Buchanan, Lizzie Smith** and **Rachel Hayden)**.

We thank the numerous people who contributed to the success of the event: **Annie Barker** in particular for setting up the laboratories, assisted by **Natalie Curnow** and **Amu Upreti; Michele Prinsep** and **Natalie Curnow** for participation and prize certificates; **Lyndsay Main, Michele Prinsep** and **Peter Morris** for supervising the laboratories; **Tui Doak** and **Bryant Halls** for excellent lunches. All-important financial support from **Hill Laboratories** for generously sponsoring the prizes, the **NZIC Waikato Branch** for funding the lunches, and the **Chemistry Department, University of Waikato** for facilities and staff time is acknowledged with thanks.

Above and below: Students at the waikato Branch Anuual Chemistry Competition and the University of Waikato Chemistry Department.

Overall the competition enabled keen 7th form chemistry students to spend a day in the university laboratories and mix with peers from other schools. It also provided an opportunity for the teachers accompanying the students to meet each other and with the university chemists.

University news centres on MSc and PhD completions, and graduates returning to New Zealand after work or fellowships overseas. **Merilyn Manley-Harris** and **Ian Suckling's** student, **Subathira Sivakumaran** (M.Phil - Development of a Method toMeasure Lignin Redeposition During Kraft Pulping) has left Forest Research Institute and gone to Palmerston North where her husband has relocated. **Rebecca Fitzgerald** (MSc: Laundering Protocols for Pesticide Contaminated Overalls) was on a GRIF project with Dow Agrosciences (supervisor **Paul Sinkovich**) and is now working at Hill Laboratories Ltd in Hamilton.

Natalia Panova is on the verge of finalising her PhD on calcium phosphate precipitation from Whey permeate which has been carried out on a three year TIF fellowship in collaboration with Kiwi Cooperative Dairies (now part of Fonterra) and NZDRI. **Qiang Li** who carried out a spectroelectrochemical study on nickel corrosion in thiocyanate solutions found a technician's position in Melbourne after a long and unsuccessful search for work in New Zealand. **Tristan Speak** has extended some of **Natalia Panova's** work on precipitation of calcium phosphate from whey permeates and is starting to write up his MSc (Tech) thesis and will submit probably in December. **Carol Morrison** is still working at her project concerned with processing of a denatured protein by-product in collaboration with the Speciality Ingredients Group in Hautapu. **Kavitha Babu** is currently synthesising gold sols as part of her MSc project.

Other past graduates include **Glenn Johnson** [MSc (Tech), 1998] moved to the UK and worked at Cambridge Display Technologies in the new exciting area of light emitting plastics. **Qiang Li** (completed in 2001) and **Martin Kear** (1998) (pH-stat dissolution studies of phosphate rock from fertilisers) continue to work at AgResearch in Soil Fertility Services. **David Foster** who studied processing of New Zealand mammalian bone is currently pursuing a protein and NMR-based PhD with **Conan Fee, Alistair Wilkins** and **Michael Mucalo** in a MAPE/Chemistry collaboration.

Craig Bullen, who completed 1998, is pursuing a PhD at the University of Melbourne with **Paul Mulvaney** in quantum dot research that is closely allied to his MSc thesis on precious metal hydrosols. **Andew (Buck) Rogers** (PhD, Otago), who was a New Zealand Dairy Board Postdoctoral Fellow with **Michael Mucalo** working on the calcium phosphate precipitation from whey project, took a permanent position as senior research scientist at NZDRI in Palmerston North (in 1999).

Bill Henderson's PhD students also have moved on. **Lea Bonnington** (analysis of organosilicone surfactants and their degradation products – jointly with **John Zabkiewicz** at Forest Research Institute), is currently travelling throughout Japan, China, etc., en route to a postdoctoral position in Spain. **Steve Alley** worked on novel ferrocenyl compounds and having completed his study is now in Dublin teaching rugby, and maybe plans to do a postdoctoral there too.

Dr Meto Leach (PhD 1998) returned to the Chemistry Department at the University of Waikato last year. Meto is researching in natural products chemistry and recently gained a $960,000 research contract from FoRST to look into consolidating traditional Maori medicine and developing it for the benefit of all New Zealanders. This exciting study is the first of rongoa Maori, traditional Maori practices of medicine and healing and is established against the background of rapidly growing international interest in traditional models of health, wellness and healing. As Meto sees it, there is an urgent need for such research given the alarming disparity in health between Maori and non-Maori.

WELLINGTON

The month of July was significant for science in New Zealand, and in Wellington in particular, with the visit of Victoria University alumnus and **Nobel Laureate Professor Alan MacDiarmid.** His first engagement was the presentation of an Scince & Technology Research Medal to **Dr Graham Gainsford** at the Gracefield IRL campus. In the afternoon he opened and hosted a research symposium on New Materials at Victoria University of Wellington (VUW) sponsored by the School of Chemical and Physical Sciences. He opening remarks outlined his work on conducting polymers and the recognition that it has subsequently brought. This was followed by short presentations covering on-going work at VUW and IRL on conducting polymers and carbon nanotubes (**Kaiser, Spencer, Edgar and Liu**), and then the electronic nose (**Partridge**). The second session opened with **Professor Gordon Wallace** (University of Wollongong and a collaborator with MacDiarmid) giving an enlightening discourse on conducting polymers providing bio-communication for the molecular-to-whole body level. Electronic and optoelectronic materials were discussed by the IRL-VUW team of **Trodahl, McIvor and Pantoja,** and the symposium concluded with a presentation by **Professor Paul Callaghan FRS** (Rheo-NMR of Soft Materials) who has very recently moved from Massey University and taken up the **MacDiarmid Chair of Physical Sciences** at VUW. A special feature of the symposium was the targeting of presentations to a level understandable by year 13 school pupils. Invitations to senior pupils interested in a science career had been issued and pupils (and a teacher) from schools as far away as Palmerston North attended.

After his tour of the other main New Zealand centres Professor MacDiarmid returned to Wellington on July 4 when he was presented with the **RSNZ Rutherford Medal** by the Governor General in the presence of a large audience at Government House. His public lecture the same evening, linked by television to an audience in Rotorua, charmed the packed Town Hall; there can be no doubt that as an ambassador for science and for New Zealand Professor MacDiarmid serves us exceptionally well.

Above: *Professor MacDiarmid (right) at his town hall lecture with Victoria University of Wellington Dean of Science Professor Peter Englert (left) and Wellington mayor Mark Blumskey.*

The Wellington Branch Mellor Lecture attracted a good audience despite the necessity of holding it on the last Friday evening of June. **Professor Terry Collins** is a gifted speaker and his work designing and utilising biodegradable catalysts for remediation work was appreciated by all that attended.

Above: Professor MacDiarmid addressing students on the VUW Marae.

A Friday evening was also the time selected for chemistry teachers to have an updating and laboratory experience at VUW. This was under the auspices of Branch Chairman **Professor John Spencer** and his team. The 25 attendees, some from the Wairarapa, appeared to enjoy the presentations by **Dr Ashton Partridge** of IRL and PhD students **John Ryan** and **Michael Richardson**. Following light refreshments the group tested a selection of demonstrations suitable for use at 'open days'.

The August meeting was addressed by **Dr Alan Limmer** of Stonecroft Wines (Hawkes Bay) whose title, "An errant chemist rambling through wine making" hardly did justice to his interesting and well constructed presentation on the chemical aspects of wine making. Alan has a PhD in chemistry and managed a private laboratory for some years before planting a vineyard and moving into full-time wine making in 1990. His belief that most of the New Zealand Bursary chemistry syllabus could (and should?) be taught with examples from wine chemistry encouraged a number of secondary school teachers to attend - and he provided plenty of examples of basic chemistry to prove the point! Of course, listening to a lecture on wine stimulates the palate and the meeting concluded with a tasting of Stonecroft wines, but not before the audience had participated in several taste experiments to illustrate the benefits of fining and the effect of copper sulfate on wine.

BRANZ

Scientists **Chris Kane** and **Dr Victoria Braham** have continued their efforts in assisting ASEAN nations with developing their competence in managing corrosion problems in their infrastructure. Victoria had a fascinating visit to Myanmar (formerly Burma), to advise on maintenance management systems in power stations, and also presented a seminar series on 'corrosion control and prevention in industry' to an audience of some 50 people. Then she assisted with analysis of corrosion problems on an underground water pipeline in Brunei.

Dr Mark Jones has joined BRANZ to replace **Stephanie Callaghan** in leading research work on polymer performance. Two main projects are in progress. The first is a pilot trial of exposures of panels which, it is hoped, can be developed into a national mapping project for polymer weathering indices. The second is continuing BRANZ contribution to a long-running RILEM project that compares the performance of joint sealants in New Zealand, Australia, Canada, Singapore, USA and UK.

Dr Stephen Roe has been examining the properties of building wraps – the layer of treated black paper, or other membrane material, that is applied outside the studs on framed structures – as a means of controlling air and moisture movement through the wall. He has addressed some interesting questions relating to the chemical and physical properties of this material that include issues of degradation rates, bursting strengths, and the effects of surfactants on water permeation rates through them.

Cawthron Institute

The Cawthron Institute in Nelson has grown rapidly in the past 18 months. CEO **Graeme Robertson** reports current staffing at 130, up by nearly 50% from 18 months ago. The aquaculture, biosecurity, coastal and freshwater divisions are all expanding. This reflects the increased opportunities for research in these areas and the effectiveness of Cawthron as a small, but focussed, multi-disciplinary institute.

The Laboratory division is also robust with a new Biotoxins section based on major investments in capital. Laboratory Manager **Lorraine MacIntosh** will be leaving in September to pursue personal goals in Spain. However, chemistry at Cawthron is alive and kicking with the following initiatives underway:

· The new Biotoxins Section, headed by **Paul McNabb** (ex-Wallaceville), has captured over 90% of the market for monitoring of shellfish for marine biotoxins. This encompasses both recreational/traditional marine food resources for the Ministry of Health and the burgeoning commercial seafood industries (cultivated mussels are as valuable to Marlborough as its highly touted wine industry!). The Section is developing new methods based on LC-MS to supplant current bioassay techniques and provide more precise, rapid and meaningful test results. The Micromass Ultima triple-quadrupole LC-MS is an ideal instrument for this work. **Patrick Holland** (current NZIC 1st-Vice-President) has joined the section from HortResearch to assist with the method development, validation and QA/QC.

· The LC-MS has already provided strong spin-offs to research by uncovering new toxins and metabolites and revealing the complexities of major phytoplankton blooms where several species can lead to a cocktail of toxins. **Lincoln Mackenzie** is currently in Ireland for six months pursuing research links into the biology of bloom events, the production of toxins, and their accumulation and depuration by shellfish.

Other research areas with chemical/biochemical emphasis are novel enzyme assays by **Doug Mountfort** which resulted in success in a recent FRST NERF tender with Lincoln Ventures for the development of biosensors. Postdoctoral Fellow **Jenny Smith** is working with Doug and **Lesley Rhodes** on sulfated polysaccharides from seaweeds, and chemical aspects will receive a boost from visiting scientist **Ruth Falshaw** from IRL.

The Water and Environmental Services from Cawthron are set to be enhanced by the recent installation of a PerkinElmer Optima 4300DV ICP-OE spectrometer. **Geoff Miles** is responsible for the commissioning of the instrument and the development of test methods tailored to client requirements. A five day national training course run by PerkinElmer on ICP has just been completed at Cawthron based around the new instrument.

Associated with the enhanced and expanded laboratory services is the replacement of the Metrix LIMS system by the new Labware System V4.0. This Windows compliant programme will result in more direct electronic collection of data from instruments and in the transmission of reports to clients via the Internet. **Carol Hulse** has responsibility for the complex task of managing the interfacing.

The Food Chemistry Section under **David White** is also looking at upgrades of equipment to increase the role of instrumental analysis in the wide range of testing that they carry out for food industries. The chemical tests for the new olive oil industry were recently complemented by sensory tests when David served as a judge in national olive oil competition.

Patrick Holland took time out from the busy developments on the LC-MS to attend the IUPAC General Assembly and Congress in Brisbane at the end of June. As Secretary to the Division of Chemistry & the Environment, he facilitated and documented the changes occurring within IUPAC as the old Commission structure is replaced with a more project driven one. These changes should see more opportunities for New Zealand chemists to become involved in international collaborative projects.

Industrial Research Ltd

Dr Mark Waterland (Otago Graduate) joined the Applied Inorganic Chemistry team to work with **Dr Tim Kemmitt** in late August. Mark has come from USA postdoctoral positions at Rochester and Kansas State Universities in the USA. **Drs. Neil Milestone** and **Steve Bagshaw** attended the 13th International Zeolite Conference in Montpelier, France. Neil also visited a series of Japanese laboratories en route to this meeting to maintain the collaborative links. **Dr Cees Lensink** attended the 12th European Symposium on Organic Chemistry in Groningen, The Netherlands, where a part of the conference was devoted to asymmetric catalysis. **Dr Graeme Gainsford** presented a lecture on "Hydrogen Bonding: some novel examples" at the Crystal 22 (SCANZ) meeting at Couran Cove, South Stradbroke Island, Queensland, Australia.

Industrial Research Limited has just completed a management restructure in which **Dr Sunil Vather** has been appointed to the position of Manager, Research and Development.

Victoria University

Professor Paul Callaghan joined the School of Chemical & Physical Sciences initially as a Professor of Physics but subsequently has been appointed as inaugural MacDiarmid Professor of Physical Sciences. He and his research group moved from Massey University and established themselves in Wellington in July. **Dr Jim Johnstone** (Head of School) has had a five week period of leave in the UK and USA to progress the further development and commercial applications testing of the novel silica-based materials he and his research group are developing under a NERF contract. These materials have high surface areas and surface chemical reactivity, high oil absorption capacities, excellent whiteness and light scattering properties. There is a keen industrial interest to incorporate them into paper to improve optical and print quality, thereby providing the paper with a competitive market edge. Whilst in the UK he continued his collaborative work with **Professor Nicholas Wiseman** (UMIST) and various paper companies interested in using the silica material, and a chemical manufacturer who is interested in producing it. The material is currently undergoing applications testing and evaluation for possible commercialisation. Following this, he travelled to the USA where he met and worked with the large paint manufacturing company Sherwin Williams, and with a catalyst manufacturing company. Under the NERF contract, he and his research group have also been developing silica-based materials with anti-corrosive and anti-microbial properties for incorporation into paint, as well as catalyts for the fine chemicals industry. During his visit he discussed the results of the collaborative applications testing programme with Sherwin Williams and also the interest in the catalysts.

Dr Peter Northcote, PhD student **Rob Keyzers** and MSc candidate and IRL employee **Greta Mores** attended the 10th International Symposium of Marine Natural Products in Nago, Okiawa (Japan) in late June. Peter was one of the plenary lecturers and the two students presented their work in the poster sessions. **Professor Brian Halton** attended the Tenth International Symposium on Novel Aromatics (ISNA-10) held at The University of California—San Diego campus in La Jolla, California, where he presented the results of work on one of the missing benzyne isomers, triafulvalene. As a member and secretary of the Nozoe International Committee he chaired the Second Nozoe Memorial Lecture – ISNA's premier named lecture – given by **Professor Dr Klaus Muellen,** Director of the Max Planc Institute for Polymer Research in Mainz Germany. Professor Halton spent a very enjoyable period of sabbatical leave in the Institute several years ago. **Dr James Wright** (University of Auckland) also attended and provided an invited lecture on the work (with Professor Warren Roper) on osmabenzenes. **Professor Chris Hunter** (formerly a lecturer at the University of Otago and now Professor of Chemistry at Sheffield University) was another plenary lecturer. The next meeting in the series is scheduled for 2004 and will be held in the Netherlands. **Dr Lyndon West** gained his PhD from Victoria University in May and took up a postdoctoral appointment with Professor John Faulkner (a visitor to New Zealand several years ago) at the Scripps Marine Institute in La Jolla, California. Obviously the opportunity to renew his interaction with Professor Halton over a pleasant lunch by the ocean was taken - but only after the conference had ended!

Chemistry In The Manawatu

Complied By Andrew Brodie
Chemistry – Institute of Fundamental Sciences, Massey University
Private Bag 11-222, Palmerston North

Palmerston North has one of the largest concentrations of chemical-based activity in New Zealand. Not only is there Massey University with strong chemistry and biochemistry groups, but Crown Research Institutes (Landcare, HortResearch, Crop and Food, AgResearch), the New Zealand Dairy Research Institute, the New Zealand Leather and Shoe Research Association, and New Zealand Pharmaceuticals Limited all have laboratories in the area.

Two of the organizations (Massey University and the New Zealand Dairy Research Institute) are celebrating their seventy-fifth anniversaries next year. Massey University has compiled a list of all its known chemistry graduates and soon Professor Andrew Brodie will be contacting these people. However, a lot of addresses are clearly outdated. Should you be a Massey chemistry graduate that has not been contacted by the time you receive this issue of *Chemistry in New Zealand*, please e-mail Professor Brodie (A.Brodie@massey.ac.nz) so he can add or record your correct details. A celebration is being planned for next year to bring together as many as possible of the graduates.

This article highlights some of the activities of these various organizations as a prelude to the December 2001 NZIC conference that is being organised by the Manawatu Branch.

Massey University

$6 Million Chemistry Investment

The $6 million refurbishment of Science Tower A at the Palmerston North campus was officially opened by the Vice-Chancellor, Professor James McWha, in March. Upgrade work began on the 35-year-old building in early 2000 and was completed in time for this year's chemistry students intake.

Head of the Institute of Fundamental Sciences, Professor David Parry, says it was a large investment and is part of the University's desire to provide quality facilities for its students and state-of-the-art research laboratories for staff and postgraduates. The investment is also testament to Massey's commitment to the basic sciences. The calibre of chemistry research being undertaken at the University is borne out by the level of research funding that it has attracted – external research funding for chemistry increased by 38 percent last year, he says, and this follows on from substantial increases in each of the previous two years. "These facilities are among the best in New Zealand. We can now be proud that our laboratories match the quality of our teaching, and provide the platform for our continued internationally-recognised success in the research field."

Nobel Laureate Opens Nanomaterials Centre

(MU photos 1 and 2 to be inserted into this section)

"Massey University's new Nanomaterials Research Centre puts the University and New Zealand at the cutting edge of research in this area", said Nobel Laureate Professor Alan MacDiarmid when opening the new centre, in the Institute of Fundamental Sciences. He won the Nobel Prize for Chemistry last year, and several of Massey's scientists described meeting Professor MacDiarmid and discussing chemistry with him as a career highlight. "This is extremely timely," he said, of the research centre opening. "The American government, under former President Bill Clinton, invested US$470 million in nanoscience and technology. A big new research institute has just been opened in Texas and another one in China. "Massey's move to establish a research centre now shows you are at the very, very cutting edge of what is going on worldwide."

Above: *Nobel prize winner Professor Alan MacDiarmid, Massey University Vice-Chancellor Professor James McWha, Director of the Nanomaterials Research Centre Associate Professor David Officer and College of Sciences Pro Vice-Chancellor Professor Robert Anderson toasting the new research centre.*

Above: *Massey University graduate students talking to Alan MacDiarmid.*

Nanoscience is the study of materials at one step above molecular level – if molecules are the 'building blocks', then nanotechnology is the 'brick wall' they make up. Around the world, nano research is investigating ideas such as tiny bloodstream motors that help clean and repair arteries, and other machines that can work inside a human cell.

Associate Professor David Officer leads the Nanomaterials Research Centre at Massey. Associate Professor Officer, with Professor Tony Burrell, has research links with Professor MacDiarmid. Massey's research concerns conducting polymers, and the centre is investigating solar energy capture and storage using these materials. Professor MacDiarmid, who is at the University of Pennsylvania, is also chairman of the Millennium Solar Project's international advisory board and known as the 'father' of conducting polymers.

Vice-Chancellor, Professor James McWha said Massey was honoured to host Professor MacDiarmid and was especially pleased postgraduate students had the opportunity to discuss their work with him.

Professor MacDiarmid gave a special guest lecture at Massey during his visit to Palmerston North, well attended by scientists, engineers and students. He met about 20 of Massey's chemistry and technology post-graduate students over afternoon tea and was keenly interested in their research.

Professor MacDiarmid also spoke to a capacity crowd at a public lecture. Professor of Chemistry Andrew Brodie said about 450 people packed the College of Education's auditorium. At the end of his lecture he made the Nobel Medal available for inspection and holding. Professor Brodie said. "You should have seen the expression on the faces, young and old alike, as they did so. "I will remember his entire visit as one of the highlights of my time at Massey."

Chemistry Quiz on the Nobel Prize

Seven Manawatu secondary school science students received prizes to celebrate Professor Alan MacDiarmid's visit. Institute of Fundamental Sciences lecturer Tony Wright designed a quiz for secondary science students, based on Professor MacDiarmid's Nobel Prize last year.

The prizes were in two groups - two of $100 for students who attended Professor MacDiarmid's public lecture and other prizes of $50 and $25 for students who could not attend the lecture. The winners were Anna Russ (Freyberg High School) and Shah Mohammed (Awatapu College) ($100 prizes), Gareth Lamb and Robert Marshall (Palmerston North Boys High School) and Euan Brouwers (Francis Douglas Memorial College), ($50 prizes), and Chris Anderson and Elliot Benge (Rangitikei College) ($25 prizes).

The Manawatu Branch of the New Zealand Institute of Chemistry donated the prize money. The quiz may be viewed on the Institute of Fundamental Sciences' home page at: http://ifs.massey.ac.nz/ then click on Nobel Prize Quiz.

New Zealand Dairy Research Institute

NZIC Fellow Honoured for Making More from Milk

A New Zealand Dairy Research Institute scientist who has spent 30 years helping turn milk into a myriad of traditional and revolutionary products has received a prestigious award from the Royal Society of New Zealand. Dr. Lawrie Creamer, Principal Research Scientist in the Food Science Section, was awarded the R. J. Scott Medal in Engineering Sciences associated with biological, food, natural products processing, and medical technologies. It was one of nine awards recognising excellence in research announced by the Royal Society.

Dr. Creamer has been at the forefront of dairy research since joining the staff of the New Zealand Dairy Research Institute in 1963. The range of his basic, applied and strategic research has been unusually wide, and has contributed substantially to the growth of the dairy industry's exporting efforts.

His work has enabled many improvements in the manufacture of traditional dairy products such as cheese and milk powders. Together with others, Dr. Creamer defined the compositional parameters for high quality cheddar cheese and showed how they could be controlled during cheese making. His recent study of the movement of water within young cheese raised considerable international interest and earned him an award at the 1998 International Dairy Federation Congress in Denmark. Meanwhile, his understanding of protein interactions when milk is heated has been enormously helpful to manufacturers of UHT milk, sterile concentrated milks, and milk powders.

At a time when the dairy industry's survival depended on the expansion and diversification of markets and products, Dr. Creamer's work has also supported the development of new products - such as milk proteins capable of providing texture and functionality in a wide range of sophisticated foods. He was one of the pioneers behind the development of industrial applications for casein that include paper coatings, and he collaborated on important work into whey proteins and isolates.

The originality of his findings and his ability to throw new light on old problems have earned Dr. Creamer an international reputation. Researchers from around the world regularly visit the NZDRI to work with him; he has been honoured with a major award from the American Dairy Science Association; and was the first person from outside North America to be invited onto the editorial board of the leading US publication in the field, the *Journal of Dairy Science*.

The Royal Society medal recognises Dr. Creamer's success in solving longstanding problems in dairy-based food manufacture by using state-of-the-art techniques and a creative approach. In doing so, he has given the burgeoning field of Food Science a strong platform of sound scientific principles from which traditional manufacturing processes have been advanced and new products developed.

AgResearch

Dairy Cows, Methane and Greenhouse Gases

Greenhouse gases are being blamed for increasingly unpredictable weather patterns, in New Zealand and globally. Garry Waghorn and Harry Clark of AgResearch Grasslands say that our humble sheep and cows have to shoulder their share of the responsibility. Greenhouse gases include carbon dioxide (CO_2) that comes from the burning of coal and oil, methane from ruminants, swamps and rice paddies, and nitrous oxide (N_2O) from nitrogen fertiliser, urine patches and rotting vegetation.

Are all these greenhouse gases equal? No! In fact one kilogram of methane has over 20 times the global warming potential of one kilogram of CO_2, and N_2O is nearly 300 times as effective as carbon dioxide.

So this is where our farms come in.

New Zealand emissions (expressed as carbon dioxide equivalents) are about 74 million tons per annum—almost 20 tons for each human. Although nitrous oxide emissions are small (one to two kilograms per hectare per year), their potency means that they account for about 16% of New Zealand's greenhouse emissions. Carbon dioxide emissions are 38%, while methane contributes about 44% of our emissions.

The high contribution made by methane is unusual by world standards and is due to the large numbers of dairy cows, beef cattle, sheep and other ruminants relative to our small human population.

Greenhouse gas production affects us all because New Zealand is committed to the ratification of the Kyoto Protocol. This means that there are likely to be financial penalties if emissions exceed those for 1990. If agricultural production increases, so too will our emissions because of the methane and nitrous oxide produced by our ruminants. Clearly, farms make a big contribution and so farmers need to be aware of greenhouse gas emissions and the potential financial consequences ("carbon taxes") involved.

Scientists at institutes like AgResearch, NIWA, and Landcare have made good progress in defining greenhouse gas production from ruminants to create an accurate inventory, and they are developing methods to reduce or mitigate these emissions. Current research is focusing on ways to minimise energy losses to methane. Some of the research carried out by scientists has involved 24-hour sampling of respired gas from cattle and sheep grazing pastures in order to measure just how much methane is produced each day.

Methane is a major research target because its production can be lowered by several routes without compromising animal production and profitability. However, it cannot be eliminated in the short or medium term. It has to be remembered methanogenic rumen microbes are an essential component of fibre digestion, which is the basis of ruminant production from grazed pastures. It is unlikely, therefore, that a simple solution will be found to achieve a large reduction in methane emissions from ruminants.

Methane is expelled in the breath of ruminants and is a by-product of the fermentation of feed in the rumen. The rumen is the main stomach and in a cow it contains about 80 kg of fermenting feed that is broken down by large numbers of bacteria, protozoa and fungi. There are more than a billion bacteria in each millilitre of rumen contents, many of which digest fibre to provide energy for ruminants. The main products of fibre digestion include acetic acid (vinegar), which is used by the ruminants for energy, and hydrogen, which must be removed to allow digestion to continue. Methanogenic microbes grow by capturing hydrogen and producing methane.

Methane production has another disadvantage for farmers in that it is wasted energy that is lost to the animal. Typically 5–6% of gross energy, or 9-10% of Metabolisable Energy (ME), is lost as methane. This is significant, and especially if the energy could be diverted to production.

One way of looking at how much energy is lost as methane from New Zealand ruminants is on a weight basis. For example, in a dairy cow it varies between 150 and 350 grams per day, depending upon feed intake. The average New Zealand dairy cow produces about 90 kilograms of methane per year, and this is equivalent in energy to about 120 litres of gasoline. For a 200 cow dairy herd the "petrol equivalents" are 24,000 litres per annum, enabling a reasonable sized vehicle to be driven 200,000 kilometres!

While there are no easy solutions to reducing the amount of energy lost as methane, improvements are possible despite some recent claims. For example, if methane production is expressed per unit of milk solids, then high producing cows will have a lower yield of methane than low producing cows. This is because the feed required to maintain the cow is spread over a larger output, and because high feed intakes tend to reduce the methane yield per unit of food eaten. Alternatively, a low fibre, high concentrate diet will reduce the methane yield per unit of dry matter intake because the rumen microbes generate less hydrogen when digesting starchy concentrate diets.

AgResearch Grasslands microbiologists are able to identify the principal microbes for methane production in the rumen. In turn, this will help researchers manipulate the methanogens to reduce methane emissions from ruminants. Other research is being carried out at AgResearch and Dexcel to evaluate grasses, legumes, and silages fed to cows to understand their contribution to methane production. High quality forages, especially those containing condensed tannins, may reduce methane by 15-20% relative to production from pasture. Low quality forages will increase methane production.

Recent suggestions that a newly developed probiotic should increase animal performance and reduce methane production has not been supported with any evidence from trials in New Zealand or overseas. Another development from the CSIRO in Australia is a vaccine which is claimed to reduce methane production, but again, despite the publicity, there has been no evidence published in the scientific literature of reduced methane production from animals. This is not to suggest that these approaches will not work, but that rigorous testing will be needed before any products can validly claim to solve the methane problem.

An understanding of nutrition by farmers will improve profit and productivity in New Zealand as well as lowering greenhouse gas production overall.

LandCare Research

Eroding Uncertainty in New Zealand's Greenhouse Gas Emissions

When people think of greenhouse gas emissions, they generally think of air pollution from burning fossil fuels and, in New Zealand's case, methane emitted by cows and sheep. Few suspect that soil—or the loss of it through erosion¾may also significantly affect our national carbon stocks and net greenhouse gas emissions. Landcare Research is leading a project to produce a national erosion-related carbon budget, to show how much carbon is lost from eroded soil, and released from soil into the atmosphere.

Soil acts as a sink for atmospheric carbon dioxide (CO_2), trapping and storing large quantities of carbon from plant photosynthesis as forest litter and soil organic matter. When hillslope soils erode, this soil carbon is lost in sediment that is washed into rivers and deposited on to floodplains, or carried out to sea. New Zealand has a relatively high rate of carbon loss from erosion compared to many Western countries. This loss of soil reduces the nation's ability to absorb rising levels of atmospheric CO_2.

Above: Scientists from a range of organisations and countries unite to address New Zealand's erosion-linked greenhouse gas issues. Among them are: Dr. David Giltrap, Dr. Aleksey Sidorchuk (Landcare Research), Hannah Brackley (Landcare Research), Dr. Rob Davies-Colley (NIWA), Programme leader, Dr. Noel Trustrum (Landcare Research), Dr. Troy Baisden, (Landcare Research), Dr. Murray Hicks (NIWA), Dr. Nick Preston (Landcare Research), and Science leader Dr. Kevin Tate (Landcare Research).

Landcare Research scientists, along with Drs. Murray Hicks and Rob Davies-Colley from NIWA and private consultant Dr. David Giltrap, have gathered to set their course for a two-year project to find out the details of these erosion-linked carbon losses. The project has an international flavour, with four new staff joining Landcare Research from the USA, Germany and Russia, to share their skills and experience from the Northern Hemisphere. These people, and PhD student Hannah Brackley, will combine their expertise on soil, riverine, and marine processes to chart what happens to carbon as soil is transported from land to the sea.

Understanding the processes that convert soil carbon into atmospheric CO_2 and finding out just how much carbon is released from the soil into the atmosphere is an important aspect of the research, both globally and nationally. "The current New Zealand data related to carbon losses from erosion is very patchy" says programme leader, Dr. Noel Trustrum of Palmerston North's Landcare Research. "Not only do we need to know how much carbon goes into the atmosphere, but also how much is associated with stripped soil, so we can estimate New Zealand's ability to recover from the effects of global warming."

"Soil loss through erosion begins an insidious cycle" says Dr. Trustrum. "Because erosion has removed much of the soil, vegetation takes longer to grow. Therefore, not as much carbon dioxide is taken out of the atmosphere and not as much carbon is sequestered back into the soil".

"We have already produced a preliminary carbon budget for the Waipaoa Basin north of Gisborne. This area has gained attention from scientists around the world because of its very high erosion rate. From this we completed New Zealand's first national scale estimate of the potential loss of carbon by soil erosion. Although these preliminary estimates have a very large uncertainty, they suggest losses that might almost equal the carbon sequestered annually by New Zealand's plantation forests. We now intend to reduce this uncertainty by at least 50%, and to develop a predictive understanding of the impacts of changing land use and climate variability on carbon transfer, both for individual catchments, and for the whole country".

"Areas that are likely to contribute the most to carbon losses, especially areas where there have been human-induced land use changes such as agricultural and forestry practices, will certainly include the east coasts of the North and South Islands, and parts of Northland" says Dr. Trustrum.

Dr. Trustrum says the project is likely to reveal some surprising facts about erosion-carbon links. "For example, in the Waipaoa basin, sheet erosion (where the topsoil is washed away by rainwater) accounts for only about 10% of the soil eroded. But it can account for about 40% of the carbon that is lost. On the other hand, more than half the soil, but less than 20% of the carbon, is lost through landslides and deep gullies".

Landcare Research science leader Dr. Kevin Tate of Palmerston North says the emphasis of the research is to find ways to mitigate CO_2 emissions. "The gradual warming of the earth's temperature is, and will remain, an internationally recognised problem" he says. "Under the terms of the Kyoto Protocol, soil can be recognised as an atmospheric carbon sink, but only if the carbon recovery is human-induced, and verifiable through scientific evidence. Therefore, carbon sinks may become a marketable commodity if countries are permitted to use them to meet their international obligations".

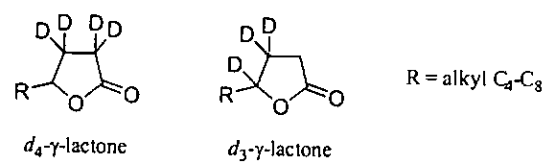
"Whatever the future of the Kyoto Protocol—the United States has recently rejected it—New Zealand and many other countries will continue in attempts to mitigate their greenhouse gas outputs".

HortResearch

First Class Honours for HortResearch Scholar

HortResearch Scholar Jo-Anna Hislop has recently completed her MSc at Massey University and has been awarded first class honours. Jo's project involved a new synthesis of deuterated γ-lactones (Scheme 1). These flavour compounds occur in many food types where, characteristically, they impart a pleasant peachy-coconut aroma. Their presence is therefore closely related to food quality and consumer acceptance. Jo synthesised these important materials for use as internal standards in the highly sensitive measurement technique known to analytical chemists as *S*table *I*sotope *D*ilution *A*ssaying (SIDA). SIDA makes possible the accurate measurement of γ-lactones at part per billion (ppb) levels in many types of food.

Jo started at HortResearch, Palmerston North as a summer student over the 1998-1999 summer period working with HortResearch chemist, Simon Fielder. From there, she accepted a HortResearch scholarship for a chemistry MSc programme at the Institute of Fundamental Sciences, Massey University. Associate Professor Dave Harding was Jo's academic supervisor.



Scheme 1.

Jo developed two synthetic approaches to deuterated γ-lactones. The first produced lactones containing four deuterium atoms (d_4-γ-lactones) and the second gave lactones with three (d_3-γ-lactones). Both synthetic methods are novel with the later proving significant value as a source of labelled standards for SIDA (Scheme 2). Specifically, the d_3-synthesis placed the deuterium label at a position in the lactone ring that is retained in the base (most abundant) peak upon fragmentation in electron impact mass spectrometry (EI-MS) conditions. This was designed to give maximum sensitivity using *S*elected *I*on *M*onitoring (SIM), allowing for lower detection/quantification levels to be achieved. Furthermore, the label was placed synthetically at a position remote from the carbonyl group of the lactone to eliminate unwanted exchange phenomena, which could, in principal, compromise the integrity of the label. There is evidence to suggest that d_3-lactones have significant advantages over their d_4-analogues under GC conditions where a γ-carbonyl label appears to undergo exchange in the injection port.

No previous synthesis of deuterated γ-lactones aimed specifically as SIDA standards have been reported and Jo's innovations have also been used to prepare unlabelled γ-lactones. Interest in these materials as potential antifungal agents is growing as they can be prepared efficiently in one step from readily available starting materials.

Crop & Food Research

Cleaning Up for Hydroponic Boom

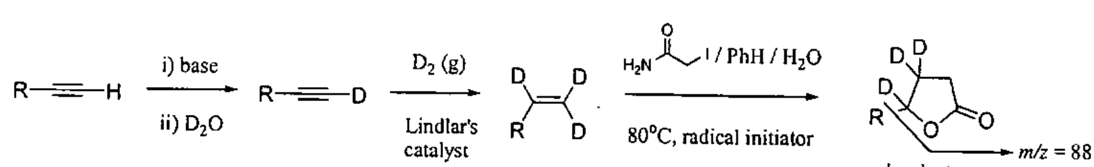
A hygiene aid that controls root disease and has increased lettuce growth by over 10% is being investigated by Crop & Food Research scientists in Palmerston North. Taranaki hydroponics grower, Russell Jordan of Jordan Nursery, came to Crop & Food Research to develop a sanitiser for controlling a devastating root disease that can wipe out an entire lettuce crop.

With funding assistance from Technology New Zealand's Technology for Business Growth programme, Hari Krishna and Ross Lill at Palmerston North's Crop & Food Research laboratories formulated a sanitiser which, when used in hydroponically grown lettuces, controlled root disease and increased plant growth by more than 10%. The sanitiser uses food-approved ingredients and contains no chemical pesticides.

"We're still not sure what's causing the growth promotant effect but we are investigating this," Dr. Krishna says. "We are also looking at the effectiveness of the sanitiser with other hydroponically-grown crops including tomatoes, capsicums and cucumbers." There is good potential for the sanitiser in hydroponics crops, he says. Similar research has recently been reported in the United States. However, more testing is needed to explore all the possibilities.

Acknowledgements

This article has been compiled by Professor Andrew Brodie (Massey University) using information from Massey University, New Zealand Dairy Research Institute, HortResearch, Landcare Research, AgResearch and Crop & Food Research. The use of this material is gratefully acknowledged.



Scheme 2.

The Extraction Of Gold From Plants And Its Applications To Phytomining

A. E. Lamb,[a] C. W. N. Anderson[b] and R. G. Haverkamp[a]

[a]*Institute of Technology & Engineering, Massey University, Palmerston North, and* [b]*Institute of Natural Resources, Massey University, Palmerstion North*

Abstract:

Phytomining is the use of hyperaccumulating plants to extract a metal from soil with recovery of the metal from the biomass to return an economic profit. This work looks at the possible methods for recovering gold from plant material, including chemical reduction with and without solvent extraction, thermal reduction and copper electrodeposition. Some progress was made with ascorbic acid as the chemical reductant. A solid phase was produced at the liquid-liquid interface after solvent extraction. The deposition reaction reduced the gold concentration in methyl isobutyl ketone (MIBK) to less than 2 ppm, equating to 85% recovery, in 3.5 hours. Copper electrodeposition also gave some promising results. However, both, require much more work before they are viable for scale-up.

Keywords: Phytomining, gold extraction, biomass.

Introduction

It has been recognised for some years that some plants can accumulate metals from the soil in which they are grown. It is also known that a smaller number of plants can accumulate a given metal to a concentration very much higher than the substrate concentration.

Plants that can accumulate a metal to 1000 times the highest concentration found in 'normal' accumulator plants are termed *'hyperaccumulators'*, and can be used to extract metals from soils [1]. This has found application in two main areas.

The first of these is *phytoremediation*, where hyperaccumulators are used to 'clean up' soils of metal pollutants such as lead or cadmium *in situ* [2]. The second is phytomining, the extraction of metals from soils or ores for recovery and sale, for example nickel or gold.

The phytomining of gold has several hurdles in its path to commercial viability. The first is a lack of plants that would naturally hyperaccumulate gold. This is because gold is insoluble in soil solutions and therefore unavailable for uptake by plants. The addition of chelating agents such as thiocyanate to the soil to complex and solubilise gold has overcome this problem [3]. The approach used was based on the concept of 'induced hyperaccumulation' for lead [4].

The second hurdle is taking hyperaccumulation results obtained in the laboratory and extending them to the field, something that has proven not to be easy [5]. The final problem is extracting the gold economically from the plant material.

So far work carried out in this laboratory to extract gold has used the following extraction method. The plant material is ashed and dissolved in 2 M HCl, followed by solvent extraction of the gold into methyl isobutyl ketone (MIBK). Addition of the reducing agent sodium borohydride to the organic layer causes a black precipitate to form at the boundary between the layers. Heating the precipitate at 800 °C causes metallic gold to form.

This method presents several problems for scale-up. The highly reactive reducing agent produces gas upon reaction and quite possibly degrades the solvent. Solvent use gives high cost and environmental restrictions. Separation of the precipitate from the boundary layer is difficult. The use of both a reducing agent and thermal reduction requires two process steps.

The project described in this paper seeks to address these problems and make some inroads into providing a cost-effective method of extracting the gold on an industrial scale. Solvent extraction, copper electrodeposition and thermal reduction methods were investigated.

Materials and Methods

Standards

A 1000 mg/kg gold standard was prepared by dissolving a known amount of 22 carat gold in aqua regia and making the solution up to volume with 2 M HCl. Once the solution cooled the silver precipitated and the supernatant was decanted, removing the silver.

Ascorbic acid and sodium borohydride solutions were made up to approximately 2 wt % through dissolution in distilled water.

Ashing

All ashing was done at 550 °C in borosilicate test tubes for between 15 and 20 hours.

Solvent Extraction

The distribution ratio of gold between MIBK and water is such (~10^6) that shaking the two phases for 5 minutes in a separating funnel was used for quantitative extraction. A ratio of 1 mL MIBK per 10 mL aqueous phase was employed.

Ascorbic Acid Reduction of Gold

A gold loaded MIBK layer was contacted with an equal volume of ascorbic acid solution. This was carried out in a plastic sample container to avoid the precipitate plating onto the side of the vessel as it did with glass. A reflux condenser was fitted and the container held in a water bath at 50 °C.

Thermal Reduction of Gold

Spectroscopy grade graphite was used where a carbothermal reduction was carried out. All thermal reductions were done in crucibles at 800 °C.

Copper Electrodeposition

Five strips of copper were obtained and cleaned with 2 M HCl and weighed. These were placed in the solutions described below.

1 25 mL 2 M HCl
2 25 mL of a 2 M HCl solution containing 80 mg Au/L.
3 25 mL of a 2 M HCl solution containing 80 mg Au/L and 80 mg ferrous ions per litre (added as ferrous chloride).

After 5 hours the first three solutions were inspected. The copper strip from each was dried and reweighed and in the case of the HCl replaced in the solution. 1 mL aliquots of the solution from solutions 2 and 3 were taken and made up to 50 mL with distilled water in a volumetric flask for analysis by atomic absorption (AA) spectroscopy. The remaining solution was filtered through Whatman 42 filter paper and ashed.

Plant Preparation

Plant material was prepared for extraction by ashing and dissolving in hot 2 M HCl.

Analysis

After dilution (if necessary) the solutions were analysed using a graphite furnace AAS and the concentration of the gold in the original sample determined.

Results and Discussion

Solvent Extraction and Chemical Reduction

A chemical reductant that did not have the difficulties associated with borohydride, as discussed above, was required. Ascorbic acid was decided upon as an alternative reducing agent.

The high distribution ratio of MIBK for gold was confirmed in the literature [6, 7], and no other candidate was found with sufficient distribution ratio, availability and relative non-toxicity [8], therefore MIBK was retained as the solvent.

Initially excess ascorbic acid solution was added to an artificial gold-bearing aqueous phase. Although the gold did precipitate, it was soon apparent that this approach was not feasible as the actual solution that would be obtained from the plant material was too dilute in gold, and ascorbic acid would also reduce iron and copper that would be present in solution.

Instead, in qualitative experiments, artificial aqueous solutions containing 2 mg Au were extracted into MIBK and the organic phase contacted with ascorbic acid solution and heated to 50 °C for three hours. A black precipitate could be seen to form at the interface. When heated to 550 °C metallic gold formed. Circumstantially, the evidence points to the black precipitate as being finely divided gold – there are no other metal species present and ascorbic acid solution contacted with pure MIBK for the same length of time did not form a precipitate. However there is no direct proof to support this as of yet.

The following method was used to produce gold from the plant material that was available. Dried plant material (30 g), with a gold content of 30 mg/kg dry plant material, was ashed and dissolved in 300 mL HCl. The aqueous phase was extracted into 50 mL MIBK and contacted with an equal volume of ascorbic acid solution. The concentration of gold in the organic phase was monitored over time in order to get an indication of the reaction rate (Figure 1).

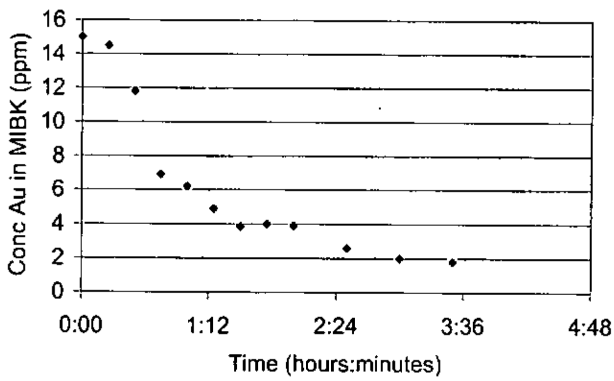


***Figure 1:** Concentration of gold in MIBK during chemical reduction.*

The concentration of gold decreased most rapidly within the first 1½ hr and then leveled off. The advantage of leaving the solution longer than four hours is marginal, especially if it is considered that in the industrial process the solvent will be recycled.

After 3½ hours the solution was filtered and the paper and precipitate ashed. Metallic gold residue resulted. No attempt was made to measure quantitatively the amount of gold precipitate.

Further work needs to be carried out in this area, firstly to determine that the precipitate is gold, and secondly to improve the quality of the precipitate. It has been reported that the same type of reduction using oxalic acid in an agitated vessel produces a sand like precipitate which settles and is easily recovered by filtration [9]. This is much more desirable than the very fine precipitate that accumulates at the interface which was obtained in these experiments.

Although this reaction is a slow one, the nature of the mining method means that any processing step be a batch one.

Thermal Reduction

Two types of reductions were carried out, in the absence and presence of carbon from the MIBK layer. Both of these reductions gave a metallic gold residue but they also indicated that some gold was being lost in the process (Table 1).

Table 1. *Gold recovery for thermal reduction.*

Reactants	Au Added (mg)	Au Recovered (mg)
MIBK + C	2.00	1.59
MIBK	2.00	1.34
Water	2.00	1.63

More trials need to be carried out to determine the optimum temperature to reduce the gold in order to minimise losses.

Copper Electrodeposition

Copper will cement gold from solution as it is higher in the electrochemical series, but will not cement iron or any other metal species likely to be present in the plant ash. An experiment was carried out to determine whether copper electrodeposition was feasible from the acid solution (Table 2).

Table 2. *Results of copper electrodeposition.*

Reactants	Cu Weight Loss (mmol)	Au Deposited (mmol)	Au in Solution (mmol)
HCl	0.019	-	-
HCl/Au	0.031	0.007	0.003
HCl/Au/Fe	0.031	0.005	0.003

This shows that after five hours the electrodeposition reaction was not complete and the copper was dissolving in the 2 M HCl. A possible solution to this is to neutralise the acid prior to electrodeposition, provided this does not affect the gold in solution.

Applications to Phytomining

The aim of this work was to go some of the way towards establishing a cost-effective method for gold extraction to be used in the phytomining process.

A solvent extraction and chemical reduction method using MIBK and ascorbic acid has emerged as a possibility, as has electrodeposition by copper. Both of these require much more testing to be done before they could even be considered for scale up.

A rough costing was done on a projected solvent extraction plant which indicated that the raw plant material would have to contain 70 mg/kg gold to break even, something which has not yet been achieved in field trials.
Thermal reduction from MIBK is less likely to be economic as a large effort would have to be made to recover the solvent, as well as the possibility of losing gold at the high temperatures used.

CONCLUSIONS

Ascorbic acid will precipitate a fine black solid at the interface of the gold bearing MIBK layer and an aqueous ascorbic acid layer. The precipitate yields metallic gold upon heating to 550 °C. Use of a solvent extraction process with ascorbic acid as the reducing agent may be a possibility for recovering the gold in phytomining process but further work needs to be carried out on several points. Copper electrodeposition of the gold from a 2 M HCl solution is impractical due to the copper dissolving in the acid. Further work could determine if prior neutralisation of the acid would render the process feasible.

Thermal reduction of the gold loaded MIBK layer in both the presence and absence of carbon did decompose the gold complex to metallic gold but some gold was lost at the temperature used (800 °C).

Overall, some progress has been made in determining a method for the extraction of gold from the plant material. Ascorbic acid is a much more benign reducing agent than borohydride for a solvent extraction process, and a electrodeposition process would require very little in the way of chemicals or running costs.

Acknowledgements
Many thanks to the late Professor Robert Brooks, without whom this work would not have been possible.

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The Induced Accumulation Of Gold In The Plants *Brassica juncea*, *Berkheya coddii* And Chicory

A.E. Lamb,[a] C. W. N. Anderson[b] and R. G. Haverkamp[a]
[a]*Institute of Technology & Engineering, Massey University, Palmerston North and* [b]*Institute of Natural Resources, Massey University, Palmerstion North*

Abstract:
In this study the growth substrate of the plants Brassica juncea, Berkheya coddii and chicory were amended with thiocyanate and cyanide solutions to induce uptake and the gold concentrations in the different organs determined. Both species showed maximum uptake with cyanide amendment although thiocyanate also induced hyperaccumulation. Gold concentrations ranged from negligible in the leaves of B. coddii amended with thiocyanate, to 326 mg Au/kg dried biomass in the leaves of B. juncea amended with cyanide. The chemical additives KI, KBr, NaS_2O_3, were also used with the B. juncea and chicory. The results showed varying degrees of hyperaccumulation with all chemical treatments. Cyanide again gave the best results with 164 mg Au/kg dried biomass measured in the chicory plant. NaS_2O_3, KI and NaSCN gave maximum results of 51, 41, and 31 mg Au/kg dried biomass respectively. This technology has potential application in the economic recovery of metals.
Keywords: hyperaccumulation, gold, phytoremediation.

Introduction

The field of metal accumulation and hyperaccumulation by plants is a young one and the specific area of gold hyperaccumulation barely nascent. Currently, the main interest in metal accumulators lies in the field of phytoremediation where plants are used to 'clean up' metal contaminants from the soil.

However, for some metals it is possible that hyperaccumulation could be an economic means of mining the metal (phytomining), either because they are accumulated in very large amounts in certain plants or because they are highly valuable.

The term hyperaccumulation has come to represent a value 1000 times the highest found in non-accumulating plants. For gold this defines a threshold at 1 mg/kg [1]. By 1997 plants had been discovered that will hyperaccumulate Cd, Co, Cu, Mn, Ni, Se, Tl, and Zn [2]. The number of Ni hyperaccumulating plants stands at 317, by far the largest number found for a given metal.

There have been no discoveries to date of plants that will naturally hyperaccumulate gold. This can be accredited to the fact that gold exists as an insoluble species in soil solution and is, therefore, unavailable for plant uptake.

Shacklette *et al.* [3] were the first to investigate the hydroponic uptake of gold by plants, in particular in *Impatiens holstii* and *Impatiens balsamina*. Gold cyanide, bromide, iodide, thiocyanate, and thiosulfate solutions were trialled and all of the plants exhibited accumulation of gold to some extent. Plants could therefore accumulate gold if a soluble species were available. The next step was to solubilise metals in the soil solution.

This idea of solubilising an intractable species by introducing a chemical agent to the soil found its main application in the area of phytoremediation of such insoluble pollutants as lead [4, 5, 6]. Several articles have since been published which detail experiments showing that plants can be induced to accumulate or even hyperaccumulate gold with the addition of sodium thiocyanate solution to the substrate [1, 7, 8, 9].

The objective of this study was to further investigate the effect of chemical addition to gold bearing soils on the uptake of gold by plants. The effect of thiocyanate on uptake by *Brassica juncea*, *Berkheya coddii* and chicory was determined. Also the effect of iodide, bromide, cyanide, thiocyanate and thiosulfate was investigated for *B. juncea* and chicory.

Materials and Methods

<u>*Soil and Chemical Preparation*</u>

Artificial gold-bearing soil was prepared by dripping a 1000 µg/mL gold chloride solution onto silica sand sieved to <200 µm. The sand was then dried and diluted with fresh river sand to give a 5 µg/g (5 ppm) substrate.

The chemical solutions used were prepared from laboratory grade reagents by dissolving the appropriate amount in tap water. The chemicals used were NaSCN, KCN, KI, KBr, $(NH_4)_2S_2O_2$.

<u>*Plant Trials*</u>

In each experiment, seedlings of the plant used were transferred to pots containing artificial substrate and allowed to grow for 4-6 weeks. At this point the soils were amended with controlled amounts of the solubilising agents and the plants left for another week, upon which time they were harvested.

B. Juncea *with NaSCN and KCN*

Nine *B. juncea* plants were grown. Their soil was amended with 0.5 g/kg substrate and 1.0 g/kg substrate thiocyanate, with four replicates in each set. One was treated with 1.0 g/kg potassium cyanide. Each plant was separated into leaves, stems and roots for separate analysis.

B.Coddii *with NaSCN or KCN*

Five *B. coddii* specimens were grown. The soil was amended with 0.5 g/kg substrate and 1.0 g/kg substrate sodium thiocyanate with two replicates in each set and one with 1.0 g/kg substrate cyanide. Each plant was separated into leaves, stems and roots for separate analysis.

B. Juncea *and Chicory with $(NH_4)_2S_2O_2$, KBr, KI, KCN, or NaSCN*

This treatment was carried out on both *B. juncea* and chicory. The plants were treated with bromide, iodide, cyanide, thiocyanate, and thiosulfate, with four replicates in each set for *B. juncea*. There was one chicory plant in each set excepting thiocyanate for which there were four. For both species there was one control.

Analysis

Each sample was dried, ground, then a portion ashed at 550 °C for analysis. The ashed sample was then dissolved in hot 2 M HCl. This solution was then extracted quantitatively into methyl isobutyl ketone (MIBK) by shaking for 5 minutes. After dilution with MIBK (if necessary) the organic layer was analysed using Graphite Furnace Atomic Absorption Spectroscopy (GFAAS) and the concentration of the gold in the original sample determined.

Results and Discussion

B. Juncea *with NaSCN and KCN*

The concentration of gold in the thiocyanate treated plants increases from leaves to stems to roots (Table 1). It can also be seen that for the plant treated with cyanide the reverse is true, with the highest concentration in the leaves. In all cases the concentrations in the plant overall are well above the 1.0 mg/kg threshold for hyperaccumulation.

***Table 1:** Average gold concentration in B. juncea amended with thiocyanate (for 1.0 and 0.5 g SCN^-/kg dried biomass)*

	Gold uptake by plant (mg Au/kg dried biomass)		
Plant Organ	CN^-	SCN^-	
	1.0 g/kg	1.0 g/kg	0.5 g/kg
Leaves	326	15	4
Stems	46	62	9
Roots	88	172	36

The plants amended with 0.5 g/kg substrate thiocyanate had a much lower gold concentration in all organs but hyperaccumulation still occurred.

B. Coddii *with NaSCN or KCN*

The concentration of gold in *B. coddii* was found to be highest in the roots of the SCN^- amended plants and in the leaves of the CN^- amended plant. And again a higher SCN^- loading gives better uptake, although in both cases only the roots showed significant accumulations of gold (Table 2).

***Table 2:** Gold uptake by B.coddii treated with thiocyanate (for 1.0 and 0.5 g SCN/kg dried biomass).*

	Gold uptake by plant (mg Au/kg dried biomass)		
Plant Organ	CN^-	SCN^-	
	1.0 g/kg	1.0 g/kg	0.5g/kg
Leaves	97	0.31	<0.01
Stems	94	<0.01	<0.01
Roots	36	49	31

B. Juncea *and Chicory with KBr, KI, KCN, or NaSCN*

B. juncea showed increasing hyperaccumulation in the order KBr < NaSCN < KI ≈ $(NH_4)S_2O_3$ < KCN, and it can be seen that chicory followed much the same trend (Table 3). In this third series of experiments the leaves of *B. juncea* did not exhibit a higher concentration than in the roots for the cyanide-amended plant as was seen in the other trial. This is surprising as in other recent work not reported here we have found with cyanide the leaves tend to have the highest concentrations of gold.

***Table 3:** Average gold uptake with varying chemical treatments*

Chemical Additive (0.5 mg/kg growth substrate)	Gold uptake by plant (mg Au/kg dried biomass)		
	B. juncea		Chicory
	Leaves	Roots	Whole Plant
KBr	5	7	17
NaSCN	4	24	31
KI	14	38	41
$(NH_4)_2S_2O_3$	15	22	52
KCN	16	76	164
Control	-	3	7

The high values for the controls are likely a combination of some contamination and the analytical uncertainty.

DISCUSSION

The plants grown in growth substrate amended with solubilisers, other than cyanide, all showed the same trend of the highest gold concentration in the roots, with lower concentrations in the stems and leaves.

A comparison between trials gives an idea of the reproducibility of the results. The gold uptake for a thiocyanate loading of 0.5 g/kg substrate were 4 and 36 mg Au/kg dried biomass for the leaves and roots respectively for the first trial (Table 1). For the same thiocyanate loading in the second trial loadings of 24 mg Au/kg dried biomass for the leaves and roots were obtained (Table 2). Given the variability of the growing conditions that the plants experienced, these are very close results. More work needs to be done on establishing standard conditions for plant growth.

Thiocyanate amendment resulted in hyperaccumulation in both *B. juncea* and *B. coddii*. Substrate amendment at a rate of 1.0 g NaSCN/kg growth substrate gave higher values of gold hyperaccumulation than at levels of 0.5 g NaSCN/kg.

As well as thiocyanate, all of the other chemicals trialed resulted in hyperaccumulation of gold. KBr induced the least hyperaccumulation with a maximum value of 17 mg Au/kg dried biomass recorded for the chicory plant, while NaSCN, KI, and $(NH_4)_2S_2O_2$ gave maximum values of 31, 41, and 52 mg Au/kg dried biomass respectively in chicory (Table 3).

KCN gave the highest levels of hyperaccumulation in all of the trials. However, its use as a soil additive is unlikely to be acceptable due to its toxicity.

Thiosulfate gave good accumulation in both *B. juncea* and chicory. While thiosulfate has been used in limited trials elsewhere, it does not often give as good results as thiocyanate, and it has been proposed that the ability of thiosulfate and thiocyanate to solubilise gold is pH dependent [10]. It has been suggested that the ability of some plants to exude acid from root hairs may have an effect on soil pH adjacent to the roots and therefore affect gold uptake [9]. Thiocyanate species are thought to exist in acidic soil conditions [11] and thiosulfate in basic conditions [12]. This could explain why thiosulfate gave better uptake in chicory and slightly worse uptake in *B. juncea* that thiocyanate. In further trials the pH of the artificial substrate should be measured.

Since the pH of the soil has an effect on gold solubility and mobility, it is also possible that the internal pH of the plant has an effect on the transport of gold within the plant. Plants grown in cyanide-amended soils had a much higher gold concentration in the stems and leaves indicating that gold was translocated to a much larger extent. This enhanced mobility, over that occurring with soils amended with other solubilisers, could be due to a favourable internal pH promoting soluble cyanide-gold complexes.

CONCLUSIONS

B. juncea and *B. coddii* are both capable of hyperaccumulating gold when sodium thiocyanate solution is added to artificial substrate.

B. juncea and chicory are both capable of hyperaccumulating gold when either iodide, bromide, cyanide, thiocyanate or thiosulfate solutions are added to artificial gold substrates.

Cyanide addition may induce higher gold concentrations in the leaves and stems of *B. juncea* and *B. coddii* than in the roots in some cases. For all cases of thiocyanate addition the root concentrations were higher. This difference in translocation ability between cyanide and thiocyanate may be due to the effects of the plant's internal pH on the complexes formed.

Thiosulfate was better at inducing hyperaccumulation in chicory than in *B. juncea*. Some plants are able to decrease soil pH in the area adjacent to their roots, making the conditions more favourable for thiocyanate and this may explain the difference in hyperaccumulation.

Acknowledgements
Many thanks to the late Professor Robert Brooks, without whom this work would not have been possible.

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Students' Perceptions And Learning Experiences Of Tertiary Level Chemistry

*Jacinta Dalgety**

Department of Chemistry, School of Science & Technology, The University of Waikato, Private Bag 3105, Hamilton, New Zealand

Introduction

New Zealand tertiary science and chemistry departments, as in most countries, experienced a growth in rolls during the 1980s and early 1990s. However, the late 1990s has seen retraction in science enrolments as students seek education in disciplines such as law and management that are perceived to provide better or more lucrative employment opportunities [1]. A significant component of tertiary education funding is directly related to enrolments and so low enrolments impact significantly on the finances of a chemistry department. Additionally, it is common for only a small proportion of students to continue into advanced studies in a specific subject area like chemistry after completing the introductory courses. This represents a significant problem in terms of funding because a subject area typically receives increasingly greater funding for second, third, and fourth year, and postgraduate students. Therefore, in order for New Zealand university chemistry departments to remain financially sustainable, there is a critical need for first year introductory courses, and indeed subsequent courses, to appeal to students and to inspire them to continue in the discipline. Yet anecdotal evidence suggests that the learning experiences the students are exposed to in introductory chemistry are having the opposite effect and in some cases intending majors fail to enrol in further chemistry courses. Herein is reported a study that investigates the learning experiences of chemistry students in their first semester of tertiary chemistry education, and how their learning experiences influence their attitude toward enrolling in subsequent chemistry courses.

There is an emerging body of literature concerned with the manner in which university curricula are taught [2]. In particular, the lecture environment has undergone much scrutiny in an effort to understand the effectiveness of traditional teaching styles [3]. Previous studies revealed that students found listening to lecturers and taking notes at the same time difficult, thus preferring handout notes because these enable them to focus on what the lecturer is saying [4, 5]. Other studies have suggested that lecture material which uses illustrative examples of chemistry in *real life* contexts is of more educational value to tertiary level students than the traditional *textbook* based examples [6, 7]. Practical classes have also been investigated but the focus has been mainly on curriculum rather than the students' perceptions of the classes; the majority of the studies find that the experiments follow a cookbook style of instruction [3, 8]. Despite the large amount of literature on learning experiences, there has been little interest in understanding why students drop out of science disciplines at tertiary level, with the majority of the research into students' science educational choices situated in secondary school [9, 10]. There is, however, a significant body of research on the aspects of tertiary learning culture that leads first year students to drop out of university study entirely and this cites factors such as financial difficulties and apprehensiveness about the tertiary style of learning [11, 12].

Methodology and Research Objectives

The purpose of the present study was to investigate the perceptions of first year chemistry students to a semester of tertiary level chemistry. The inquiry aimed to understand the first year chemistry learning experiences of undergraduate science and technology students as well as to investigate the effect of first year chemistry learning experiences on students' attitudes toward enrolling in subsequent chemistry courses.

Participants were interviewed twice, at the beginning of the year and the end of their first semester. Anticipated learning experiences were investigated by asking the students what aspects of their first semester chemistry course that they thought they would enjoy and what aspects they thought they would not enjoy. At this stage the students were also asked their intentions regarding the amount of chemistry study they intended to include in their degree and what factors influenced their decision to enrol in the first semester chemistry course. At the end of the semester the students were asked what they thought about each of the three learning environments, lectures, tutorials, and practical classes, and whether they were intending to enrol for any further chemistry courses, together with the factors that influenced their decision.

Interviews were conducted with fourteen students from a New Zealand university (age range: 17-30 years). All participants were enrolled in at least one chemistry paper during their first semester of university study. Five of the students identified themselves as chemistry majors while the remaining nine participants were enrolled either in another science or technology major (including biological sciences, earth sciences, materials and process engineering, and computer science) or in a cross-science disciplinary programme, e.g. animal behaviour, marine science, biochemistry. The gender balance was even, but the ethnicity distribution reflected the high percentage of New Zealand European students enrolled in science at the participating university. One participant was of Maori descent. All but one participant, a mature student, had recently completed the New Zealand Bursaries Chemistry Examination and achieved a passing grade.

**Telephone: (+64)-7-8384466 extn 8925; Fax: (+64)-7-8384218; Email: jad1@waikato.ac.nz*

The first year chemistry course that the majority of the students were enrolled in is a recommended course for both chemistry majors and non-majors and is a pre-requisite for all second year chemistry courses. The course consists of 36 lectures, 12 laboratories and 12 tutorials, with attendance at the laboratory classes being compulsory. The course covers two main topics, taught by different academic staff members, namely basic chemical concepts (including chemical equations, equilibria and solution chemistry) and inorganic bonding (including the structure of the atom, trends in the periodic table, and valence bond theory). The laboratory component consists of practical experiments that complement the lecture course and teach basic chemistry techniques including volumetric analysis and redox chemistry. The tutorials had no strict format, but often covered the tutorial sheets, laboratory write-ups, two topic tests and a final exam that contributes 67% of the final grade.

Two of the students involved in the study had achieved high passes in their New Zealand Bursaries Chemistry Examination and were granted direct entry into a second year analytical chemistry course. This consisted of a lecture programme on the theoretical concepts behind analytical chemistry instrumentation and a laboratory course giving the students experience in using such instruments. This course is entirely internally assessed with the laboratory write-up contributing 50% of the final grade. All direct entry students attended a tutorial once a week in which material covered in the first year course but not covered in their secondary school training, was taught. The students were not assessed on this material.

First, the students' perception of their learning experiences from the three learning environments, namely practicals, lectures and tutorials, is presented. Following this, the students' attitude toward chemistry and how their tertiary learning experiences have impacted upon this is outlined. Finally, the influence that these learning experiences have had on their attitude toward enrolling in subsequent chemistry papers is discussed. Quotations have been lightly edited to improve readability.

Research Findings

At the start of the year the students were slightly apprehensive about their first semester of tertiary chemistry. Although most were looking forward to the practical classes—anticipating the prospect of undertaking some "hands on" chemistry and the opportunity to "watch the reactions happening and see it for yourself"—many were concerned about the academic requirements of the lecture course. The non-majors in particular had a variety of concerns about what they were required to do as part of the course. These included "assignments", "studying the books", "trying to sit down and study and trying to remember it all", "sitting through the lectures and understanding them", and "mathematical parts, working out the equations." Some of the students thought they would benefit from learning some of the basic concepts of chemistry, including extension on their previous studies, whereas others thought they would like learning about some of the new concepts including atomic structure.

At the end of their first semester of tertiary level chemistry study the students had developed a clear idea of the learning experiences that contributed to their understanding and interest in chemistry and those that did not. The students had mixed reactions to their practical learning experiences. Overall the students felt the practicals were the most enjoyable part of their learning experiences, again specifically mentioning the "hands-on" approach as being a positive experience. Also, of the non-majors, the three technology students considered that the laboratory classes achieved their objective of teaching them basic chemistry laboratory skills. However, many of the students did not like the large emphasis on titration-based experiments, and the precision required in measuring burette readings. A student, who identified himself at the beginning of the year as being an intending chemistry major but at the end of the semester decided not to take any further chemistry papers, said he did not like: "Titration's. Fun, fun. Standardisation, things like that... I don't like having to do it so accurately, that you have to get it within 0.04 of a mL, you have to get three like that, I mean I usually get it, but I don't like the repetitiveness."

It was interesting to note that the overall opinion of the practical classes was influenced by the level of attention they received from the teaching staff. Students who had a negative perception of the teaching staff had negative experiences, whereas those who had a positive perception had positive experiences. The two students involved in the second year analytical course had more positive practical learning experiences. They found the laboratory course fun and more of what they anticipated chemistry would be like, with one student noting they "had a perception of what chemistry jobs would be like and the analytical course was like that".

The students learning experiences in the lectures were largely influenced by the teaching styles. The large majority of the students were positive about lectures where the material was presented in a manner that encouraged them to listen. As such, they preferred lectures where they had to write some notes because they "absorbed more of what was going on." They did not like it when the notes were all handed out at the beginning of the lecture because there was little incentive to concentrate during the lecture classes, which they then suggested made studying the material very difficult. "When you are just sitting there and you've got all the notes in front of you and the lecturer is talking you go off on tangents. I personally respond better to having to write some of the notes. I am going to have to do a lot of revision to remember what happened in the lectures where we didn't write any notes."

However, two students, who were more confident about their ability in chemistry, liked lectures when they had all the notes in front of them. They thought this gave them an opportunity to listen to the lecture, without having to worry about what material they needed for the exam. The students also mentioned that they liked it when the lecturers used analogies of real-life examples because it made it easier to understand. However, some students found the translation of abstract concepts to practical examples difficult. It is interesting to note that the two direct entry students thought the lecture course to be uninteresting and were anticipating returning to the traditional first year chemistry papers in the second semester and to learning more of what they described as "more normal chemistry."

Despite attendance not being compulsory, most of the students attended their tutorials, and they were very positive about their tutorial experiences because it gave them an opportunity to ask questions and get help with their revision. The lecture experiences of the direct entry students were reiterated in their attitudes toward their tutorial classes, in which they enjoyed the opportunity to learn "more like stuff from school".

The students' attitude toward enrolling in chemistry had decreased after their first semester of tertiary chemistry study. At the start of the year the non-majors generally believed that studying chemistry would help them understand other science disciplines. They saw chemistry study as being a valuable part of their degree and many mentioned they had enjoyed chemistry at secondary school. However, at the end of the semester much of their enthusiasm had diminished with many no longer considering studying chemistry beyond their first year. Likewise, the students who identified themselves to be chemistry majors at the start of the year showed decreased eagerness for their chosen subject, although only one was no longer considering undertaking a chemistry major. Contributing factors to this decreased attitude included disliking some parts of the course. However, the chemistry majors chose to continue studying chemistry primarily because they were unwilling to change their plans based upon some negative experiences. For example, a chemistry major said that she would take further chemistry papers because "I always planned to and I am still planning on taking chemistry as my major. This semester I haven't liked everything, but I did like certain aspects of the course and I do think I will like organic chemistry."

Conclusions and Implications for Teaching Practice

Case studies give excellent insights to specific situations, but extrapolating conclusions beyond that situation must be done with caution. This is not to say that the results from this research do not apply to other institutions, but it is up to the reader to ascertain which are significant in their own institution. Nonetheless, the results can be used to give pause to some of the issues regarding introductory tertiary chemistry courses. The results suggest it is important to capture students' interest in chemistry and allay their apprehensions. Students come to tertiary chemistry study anxious but enthusiastic, and are leaving their first semester courses disillusioned. Specific learning experiences that contribute to this include a decrease in interest in laboratory classes. These may addressed by making laboratory classes more interesting, perhaps by working within the context of students experiences, for example using laboratories to not only teach practical skills but also to investigate the 'real world' of students. Lecturing styles that allow students to disengage from the class can make it harder for them to pass the courses long term. Therefore, lecturers need to encourage student engagement in the lecture so that lectures are not perceived as a venue for merely gathering material, but a place to learn. Giving students tasks to complete in lectures and using analogies that are appropriate and capture their interests could achieve this. Tutorials, the learning environment that is so often undervalued, need to be given more attention, because students who attend them see them as helpful in contributing to their understanding of chemistry. These results should also be seen as encouraging—if students' are coming to tertiary study enthusiastic about learning chemistry we have the chance to entice more students into advanced tertiary chemistry study. Introductory chemistry courses need to be no longer treated as service courses, but as opportunities to encourage students into our dynamic and exciting discipline.

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Patent Proze

by Jane Calvert and Greg Lynch

Natural products and patents - what is the fuss about?

In recent times, and particularly during the Royal Commission of Inquiry into Genetic Modification, many have voiced reservations about the patenting of life forms and natural products. These reservations have tended to be based on concerns surrounding whether ownership or control of naturally occurring substances by way of a patent should be allowed.

It is timely to revisit the extent to which one can obtain patent protection for naturally occurring entities and to address some of these reservations.

Naturally occurring novel products of organisms and biological compounds including DNA fragments or sequences that have been isolated, or cultured to a particular degree of purity and that have been found to be useful for some purpose are patentable. This means that a patent application cannot be based simply on the discovery of a naturally occurring substance. Some underlying utility or purpose must also be determined. Novel processes for isolating or purifying compounds or DNA sequences from their natural environments are also patentable, as well as a genetically modified product such as an animal or plant. However, any resulting patent protection for these naturally occurring substances does not extend to provide any rights to these products when simply found in their naturally occurring state or environment. New Zealand's Patents Act specifies that:

"where a [patent] specification claims a new substance the claims shall be construed as not extending to that substance when found in nature."

How the system works in practice can be exemplified by considering the developments that led Bristol Myers Squibb to seek patent protection for paclitaxel or Taxol®, a natural product from the Pacific yew tree (*Taxus brevifolia*). Although this compound was discovered in 1962, it was five years later before the active compound was isolated from the bark of the yew tree. The useful anti-cancer properties were then identified. It was the isolation and research that led to the finding that paclitaxel had anti-cancer properties that amounted to the invention. The discovery of the compound in 1962 alone was not sufficient to amount to an invention. Patent applications were subsequently filed for the compound paclitaxel. However, the resulting patents did not extend to give Bristol Myers Squibb commercially exclusive rights in every Pacific yew tree in existence.

The reservations about the legitimacy of "owning" and being involved commercially with naturally occurring substances need to be put into context. The protection of life forms has been known in New Zealand since farming practice was established. Society accepts that farmers have rights to own, trade and protect their livestock or crops for commercial gain. In fact, some aspects of a farming based ownership can be more extensive than a patent right, which suggests to us that these patent/ownership reservations are based on a misunderstanding of the patent system as a whole. A patent right, while providing a commercially exclusive right to use an invention, does not last indefinitely. A trade secret on the other hand may afford protection indefinitely, if not disclosed to the public. The right granted by a patent is essentially a reward for the inventive effort involved in developing an invention, which is given in exchange for a full disclosure of the invention to the public. A patent right is no guarantee that commercial returns for the invention will be made by the patentee. Any patent right is always open to challenge during its lifetime, for example if the scope of the patent is too wide, or if any other contestable ground is argued successfully.

There are inherent commercial risks in the patent system and there is nothing absolute about the rights granted by a patent. It is incorrect to say that an individual or corporation has absolute ownership rights to a naturally occurring substance by way of patent rights.

This column deals with this topic in brief. If you have any questions please direct these to:

Patent Proze, P O Box 852 Wellington
or E-mail@bsw.com

Jane Calvert

Jane Calvert and Greg Lynch are both patent attorneys and solicitors at Baldwin Shelston Waters, where they specialise in chemistry and biotechnology patents. Jane joined BSW after completing a PhD in chemistry at the University of Canterbury in 1994. Greg also joined BSW in 1994 after three years research at Industrial Research Limited in Wellington. Following completion of a PhD in chemistry at the University of Otago in 1989, he spent two years as a post-doctoral researcher at Oxford University.

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Email: sales@shimadzu.co.nz
circle number 26 on the reader reply card

MULTITRATOR MULTI-MODE TITRATION SYSTEMS

The Multitrator concept
The Multitrator multi-mode titration system is essentially a "virtual instrument", where every aspect of the titration process is under the control of powerful Windows-based software. A central control module receives and transmits signals from the sensors and the computer, enabling the control of burettes, sample changers and other peripheral devices.

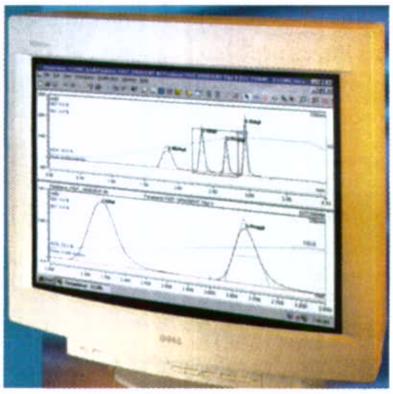
Solve titration problems
Only Multitrator offers thermometric, potentiometric, photometric and conductometric titrations in its basic configuration. Thermometric titrimetry (where endpoints are located by the rate of change of temperature) is an extraordinarily versatile technique, where acid/base, redox, EDTA, chloride, sulfate, phosphate and moisture determinations can be determined with the same simple thermometric probe. Aqueous and non-aqueous titrations may be performed with equal facility. To assist in the problem solving process, up to 3 different sensors can be multiplexed for simultaneous titrations.

Improved process and quality control means saving your company money
Multitrator employs state-of-the-art algorithms for optimal signal conditioning and accurate endpoint location. This leads to highly precise results over a broad range of techniques (typically 0.1%RSD or lower), permitting tighter control over process and quality parameters. The consequences can be better utilisation of resources and reduced product re-work.

Contact: GBC Scientific NZ
P O Box 68-330 Newton, Auckland
Free Phone/Fax: 0800 428428
Email: dpayne@xtra.co.nz
circle number 27 on the reader reply card

NEW CHROMATOGRAPHY INFORMATION MANAGEMENT SYSTEM FROM DIONEX

Ai Scientific announces the release of Dionex's Chromeleon 6, a chromatography information management system that provides control of chromatography instrumentation and the chromatography data from HPLC, GC and other techniques. The system combines both power and flexibility into a single software package offering laboratories a highly flexible and adaptable software package that can accommodate changing laboratory needs. The flexible client/server architecture allows users to deploy the product to suit the working environment. Operate as a single workstation or in a networking environment to support multiple users and multiple instruments, Chromeleon provides device control drivers for bi-directional control of instrument operation on a variety of chromatographs. Over 140 different instruments and devices are supported. The system features a user-friendly interface, and built-in databases maintain all chromatography results and provide fast, easy access using database queries. Additionally, the product offers a report generator, system security, electronic signature and signoff features, and graphic editing features, among other features.



Contact: Ai Scientific New Zealand
Phone: 0800 08 60 60, Email: aimail@aiscientific.com
Internet: www.aiscientific.com
circle number 28 on the reader reply card

TOC/TN ANALYZERS FEATURE CHOICE OF POWERFUL OXIDATION METHODS

Shimadzu has introduced the new TOC Visionary Series which includes seven different models for measuring total organic carbon (TOC) and total nitrogen (TN).

TOC-V, the Visionary Series offers a choice of either combustion or unique heated-UV-persulfate oxidation methods – a Shimadzu exclusive. Each unit can be operated stand-alone or PC controlled.

The TOC Visionary Series offers a number of productivity enhancing as well as cost reduction features and options. TOC-V systems enable automatic multi-point calibration from a single standard and an external sparge option can double sample throughput. The total nitrogen option permits simultaneous TOC and TN measurements and an optional air purifier can eliminate the need for costly and dangerous purified gases. A septum piercing autosampler accepts three vial sizes to easily adapt to different analytical requirements.

Contact: Shimadzu Scientific Instruments
Phone: 0800 12SHIM (0800 12 7446), Fax: (09) 836 7757
Email: sales@shimadzu.co.nz
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ANTON PAAR'S NEW DIGITAL VISCOMETERS

With an eye on current market demands, Anton Paar is proud to present a new range of viscometers. Viscosity measurements are not only required in research and development laboratories, they are also progressively important in industrial quality control. In this field there is a demand for simple, reliable instruments which produce automatic readings. The new DV instruments fulfill these requirements. They are extremely versatile, robust and easy to use. The DV viscometers operate by measuring the resistance of a spindle rotating in the sample. The flow viscosity is then calculated automatically from this torque measurement, the spindle geometry and the speed. The included series of spindles enables a wide range of viscosity measurements. The measuring method and the standard spindles conform to ISO standards 2555 and 1652.

With all these features, the DV series represents unrivalled value for money and is a sound investment for any user. Basic features of the entire series are:

- Easy to operate user interface
- Choose from 8 predefined languages
- Direct readout of all parameters and results
- Auto-Test function at start up
- Controlled speed changes prevent damage to the spindle
- Sound alarm when the recommended measuring range is exceeded.

Contact: MEP Instruments Ltd
Phone: (09) 366 1236, Fax: (09) 366 1235
Email: info@mep-instruments.co.nz
circle number 30 on the reader reply card

Exciting Range of Visiting Speakers

The Manawatu Branch of NZIC has a reputation for organizing great conferences and this year's one promises to be no exception. The theme of the meeting is "Molecules for Life" although the specialist groups are also organizing strong programmes covering a wide range of topics and, as well, a Nanomaterials Symposium is being run in parallel with the conference. It was a bit of a gamble going to Napier but registrations look as if they will hit the 300 mark. Although registrations needed to be sent by 31 August 2001 to avoid a late fee it is still possible to register. For further information see the website at http://www.hortresearch.co.nz/nzic.

Some important conference sponsorships have been negotiated.

Baldwin Shelston Waters have become Gold sponsors of the conference. This involves a very substantial sponsorship. Baldwin Shelston Waters is a multi-disciplinary intellectual property practice based in Australia and New Zealand. Further information can be found at: www.bsw.com Baldwin Shelston Waters are also supporting the "Publish and Perish" session at the conference.

HortResearch have become Silver sponsors of the conference. They are also hosting this website for us. For more information see www.hortresearch.co.nz

Industrial Research Limited, www.irl.cri.nz, are sponsoring two speakers to the conference: Professor Arnold Demain will present the Biotechnology: Fermentation Plenary, and Professor Barbara Imperiali will present the Glycotechnology Plenary.

Crop and Food Research, www.crop.cri.nz, is sponsoring Professor Ron Quinn to the conference. He will present the Natural Products Plenary.

Other sponsorships are currently under negotiation. The conference organisers and NZIC are very grateful for the support of all sponsors.

The plenary speakers are:

Professor Terry Collins, Carnegie Mellon University, Pittsburgh, USA
In his lecture, *Sustainability Science and the Economy of the Future*, Terry will stand back from his chemistry and explore the underlying issues raised in adopting a "green" approach to the practice and application of science. Terry hails from New Zealand and is the Director of the Institute for Green Oxidation Chemistry at Carnegie Mellon University in Pittsburgh, where he is Professor of Inorganic Chemistry.

Dr. Roy Tasker, University of Western Sydney, Australia
A quiet revolution is occurring in the way we learn in the molecular sciences. Roy Tasker is at the forefront of the revolution, developing multimedia resources that are being distributed worldwide by the major publishing houses. His talk, *Research into Practice: Exploiting the Learning Potential of the New Technologies*, will give insights into the ways these new technologies can enrich the learning experience as well as introducing the research background that underlies his work and glimpses into the future.

Professor Arnold Demain, MIT, USA
Arnold Demain, who is a Professor of Industrial Microbiology, has been in the forefront of biotechnology for more than 40 years. He is best known for his research in the elucidation and regulation of the biosynthetic pathways leading to penicillins and cephalosporins. His interests include microbiology, biochemistry and genetics of industrial microorganisms, and aspects of microbial biosynthesis, e.g. elucidation of pathways and improvement in the quantitative aspects of these pathways. His ability to integrate basic studies and industrial applications is his greatest strength. He has won many awards for his research.

Dr. Ron Quinn, AstraZeneca, Australia
Ron Quinn has broad research interests in natural product chemistry, receptor-ligand interactions, cellular signalling systems and computer-assisted drug design. On 11 June 1993, a joint venture agreement was signed between Griffith

University and Astra Pharmaceuticals Pty. Ltd., Sydney, Australia, a subsidiary of Astra AB of Sweden. Astra AB merged with pharmaceutical giant Zeneca in 1999 to form AstraZeneca. This joint venture is today known as AstraZeneca R&D Griffith University. As part of its expanding research and development activities in Australia, Astra Pharmaceuticals agreed to invest in the joint venture project to screen natural products from Queensland's reefs and rainforests to discover potential new pharmaceutical agents. They are identified by High Throughput Screening technology and advanced systems for chemical isolation and structure identification. The development of pharmaceuticals from natural product drug discovery at AstraZeneca R&D Griffith University is carried out in collaboration with AstraZeneca's research laboratories around the world.

Professor Chris Sander, MIT, USA
Chris Sander's research has been at the forefront of protein structure analysis, protein fold recognition and structure prediction for nearly two decades. He and colleagues have pioneered methods to recognize protein folds based on alignments of distance matrices. They have greatly improved secondary structure predictions by using information present in multiple sequence alignments of protein families in conjunction with neural network models, and more recently have focused on delineating the number of unique protein folds that will be discovered in the human genome.

Professor Ian Wilson, Scripps Research Institute, La Jolla, USA
Ian Wilson's research group at the Scripps Institute in California is primarily interested in determining structures of proteins involved in the immune response. His best known work is the structural elucidation of Class I MHC molecules bound to target peptides and the T-cell receptor. His group is also interested in antibody structure and the role of glycans in immune protein struture and function.

Professor Barbara Imperiali, MIT, USA
Barbara Imperiali graduated with a PhD in organic synthetic chemistry from MIT in 1983. She was appointed to Carengie Mellon University in 1986, before taking up a position at the California Institute of Technology in 1989. In 1999 she returned to MIT as a Professor of Chemistry. Professor Imperiali's group is particularly interested in the central processes of protein glycosylation and the biosynthesis of glycoprotein conjugates, research that transcends the boundaries between chemistry and biology. One of the transformations that has been studied in depth is *N*-linked glycosylation of asparagine mediated by Oligosaccharyl Transferase (OT). This important reaction is responsible for modifications to protein molecules that profoundly affect protein folding, protein function, and protein-protein interactions.

Other overseas speakers attending the conference include:

Dr. Mike Ward, Bristol University, UK: "Self-assembly in coordination chemistry: anion-templated assembly of supramolecular cages".

Professor Annie Powell, Karlsruhe University, Germany: "Well defined polymetal-oxo cluster aggregates as building blocks for supramolecular arrays".

Professor Keith Murray, Monash University, Australia: "Molecular magnetism: from large manganese clusters to extended metal dicyanamide frameworks".

Chemical Education Special Interest Group - A Reawakening

The NZIC special interest group in chemical education has not been active for a number of years. However, comments from a range of people both here and in Australia imply that a reawakening of the group might be successful.

An advantage of using the existing group is that membership of the NZIC special interest groups is not limited to NZIC members and so members of the NZASE could be welcomed.

One proposal is that the NZIC Conference in Napier in December could provide the venue for such a meeting, especially as there is a chemical education theme and plenary speaker, Roy Tasker.

A first step, however, is to gather expressions of interest. Readers who would consider joining such a group, are asked to email Tony Wright (awright@massey.ac.nz) who will collect the opinions and arrange the next step.

Across the Tasman, the RACI Chemical Education group has been increasing in strength in recent years and *The Australian Journal of Education in Chemistry* was relaunched at the IUPAC World Congress of Chemistry in Brisbane in July. David Treagust, Mauro Mocerino and Bob Bucat from Western Australia have taken up the editorship. The new version will contain a mix of referred and more casual contributions.

A second item of news is that there will be a chemical education conference in Melbourne at the end of November 2002. Preliminary details are available at the website: http://www.deakin.edu.au/fac_st/bcs/RACI_ChemEd/conf/conf.html

18-12 October 2001
International Workshop On Fire Blight
Venue: Napier, New Zealand
Contact: Joel L Vanneste, HortResearch
Private Bag 3123, Hamilton, New Zealand

17-18 October 2001
Food Safety - Protecting Consumers and New Zealand's International Trade
Venue: Heritage Hotel, Auckland, New Zealand
Contact: Selena Henry
MAF Food Assurance Authority
P O Box 2526 Wellington
Fax: (+64-4)-4744240
Website: www.maf.govt.nz/food

17-18 October 2001
Quarantine And Market Access Conference 2001
Venue: Hyatt Hotel, Canberra, Australia
Contact: Consec - Conference Management
P O Box 3127, Belconnen Delivery Centre
ACT 2167, Australia
Email: qmac@consec.com.au
Website: www.affa.gov.au/qmac

29 October 2001
Measuring Up - A Symposium On Calcium's Contribution To Bone Health
Venue: Carlton Hotel, Auckland, New Zealand
Contact: Andrea Patterson
New Zealand Milk
Tel: (+64-4)-4628062
Email: dairyhealth@newzealandmilk.com
Website: www.newzealandmilk.com

30-31 October 2001
Agrobusiness Congress
Venue: Christchurch, New Zealand
Contact: Jan Latham
Email: lathamj@lincoln.ac.nz

30 October-1 November 2001
Fresh Perspectives On Bioactive Dairy Foods - Opportunities And Challenges For Health, Marketing and Technology
Venue: Carlton Hotel, Auckland, New Zealand
Contact: Andrea Patterson
New Zealand Milk
Tel: (+64-4)-4628062
Email: dairyhealth@newzealandmilk.com
Website: www.newzealandmilk.com

1-2 November 2001
Foods For Well-Being: Building Stronger Health Values
Venue: William Angliss Institute, Melbourne, Australia
Contact: Lynette Parker
Crop & Food Research
Private Bag 4704 Christchurch
Tel: (+64-3)-3266401 extn 3534
Email: parkerl@crop.cri.nz
Website: www.crop.cri.nz/whats_on/food-health-conf/

8 November 2001
Functional Foods: Science To Marketplace
Venue: Auckland, New Zealand
Contact: Professor Lynette Ferguson
University of Auckland
Tel: (+64-9)-3737599 ext. 6732
Email: l.ferguson@auckland.ac.nz
Website: www.cce.auckland.ac.nz/ffood/

10 November 2001
New Zealand HiTech Awards Presentation
Venue: Te Papa, Wellington, New Zealand
Contact: Rebecca Douglas-Clifford
Project Manager, HiTech Awards 2001
Tel: (+64-25)-321515
Email: rdc@xtra.co.z
Website: www.hitech.org.nz

30 October-2 November 2001
CIA 2001. Comprising CHEMASIA 2001, INSTRUMENT ASIA 2001, ANALABASIA 2001
Venue: Singapore

18-21 November 2001
Corrosion & Prevention 2001 - Durability Of Materials
Venue: Conventions on King, Newcastle
New South Wales, Australia
Contact: Sally Nugent
P O Box 634, Brentford Square
VIC 3131, Australia
Tel: (+61-3)-98740800
Fax: (+61-3)-98744800
Website: www.corrprev.org.au

December 2001
675th Biochemical Society Meeting
Venue: Warwick, England, UK
Contact: The Meetings Office
The Biochemical Society
59 Portland Place, London W1B 1QW
England, UK
Fax: (+44-20)-76377626
Email: meetings@biochemistry.org
Website: http//:www.biochemistry.org

4-7 December 2001
"Molecules For Life" 2001 NZIC, NZSBMB, NZBA Conference
Venue: War Memorial Centre, Napier, New Zealand
Contact: Stan Moore
Massey University
Email: s.moore@massey.ac.nz
Website: http//:hort.cri.nz/nzic

27 January - 1 February 2002
The Dynamics of Ribosome Structure and Function - Triennial International Ribosome Conference
Venue: Rydges Hotel, Queenstown, New Zealand
Contact: Billie Masters
516 George Street, Dunedin, New Zealand
Tel:(+64-3)-4777754
Fax: (+64-3)-4777757
Email: billie@jsmasters.co.nz
Website: http://biochem.otago.ac.nz/ribocon/

30 June - 5 July 2002
18th International Cancer Congress
Venue: Oslo, Norway
Contact: Congress Secretariat, Congrex Switzerland
SA, 3, rue du Conseil-General
1205 Geneva, Switzerland
Fax: (+41-22)-8091874

24-27 September 2002
3rd World Congress On Emulsions
Venue: Lyon, France
Contact: CME
50 Place Marcel Pagnol
92100 Boulogne-Billancourt, France
Tel: (+33-1-)-47617689
Fax: (+33-1-)-47617465
Email: alain.lecoroller@wanadoo.fr
Website: www.cme-emulsion.com

14-17 July 2002
ICOS-14 14th International Conference on Organic Synthesis
Venue: Christchurch, New Zealand
Contact: Professor Margaret Brimble
Department of Chemistry
University of Auckland
Private Bag 91029, Auckland, New Zealand
Tel: (+64-9-)-3737599 ext. 8259
Fax: (+64-9-)-3737422
Email: am.brimble@auckland.ac.nz
Website: www.conference.canterbury.ac.nz/icos14

21-25 July 2002
INTERACT 2000 Conference
Venue: Sydney, Australia
Contact: Jane Yeaman
Tulips Meeting Management
P O Box 116 Salamander Bay
NSW 2317, Australia
Tel: (+61-2-)-49842554
Fax: (+61-2-)-49842755
Email: interact@pco.com.au
Website: www.pco.com.au/interact2002

20-25 October 2002
28th Meeting of the Federation of European Biochemical Societies; Jerusalem
Venue: Israel
Contact: Conference Secretariat
28th International Conference
P O Box 50006, Tel Aviv 61500, Israel
Website: www.kenes.com/febs

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- RESEARCH/ ☐
- DEVELOPMENTPRODUCTION ☐
- QA/QC ☐
- TEACHING ☐
- PURCHASING ☐
- CONSULTING/ADVISORY ☐
- OTHER (please specify) ☐

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- UV/VISIBLE SPECTROSCOPY ☐
- AA SPECTROSCOPY ☐
- NMR ☐
- THERMAL ANALYSIS ☐
- MICROSCOPY ☐
- pH/ELECTROCHEMISTRY ☐
- CENTRIFUGES ☐
- XRF or XRD ☐
- HPLC/LC ☐
- FLUORESCENCE SPECTROSCOPY ☐
- ICP, ICP-MS ☐
- POLYMERASE CHAIN REACTION ☐
- FTIR/IR SPECTROSCOPY ☐
- ELEMENTAL ANALYSIS ☐
- PARTICLE SIZE ANALYSIS ☐
- MASS SPECTROSCOPY ☐
- OTHER (please specify) ☐

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