chemistry in new zealand

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VOLUME 51 No. 2

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Front Cover Story

Digilab Fourier Transform Infrared Spectrometers provide an entirely new set of tools to the spectroscopist. Our Cover Story illustrates some of the advantages of FT-IR over dispersive IR systems and explains why Digilab have become market leaders in this technology.

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Editor: Bruce Graham, c/- Dept of Health, 2 Edenvale Rd, Mt Eden, Auckland.

Branch Editors:

Auckland: Dr Roger Whiting, Auckland Technical Institute, Private Bag, Auckland.
Waikato: Dr Max Sutton, Ruakura Soil and Plant Research Station, Private Bag, Hamilton.
Manawatu: Dr Cecil Johnson, Applied Biochemistry Division, Private Bag, Palmerston North.
Wellington: Dr Lawrence Porter, Chemistry Division, DSIR, Private Bag, Petone.
Canterbury: Dr Doug Rankin, Wool Research Organisation, Private Bag, Christchurch.
Otago: Dr Jim McQuillan, Chemistry Department, University of Otago, P.O. Box 56, Dunedin.

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NOTICES

Grades of Membership

At its meeting in February Council considered the proposal by the Auckland Branch that the three non-corporate grades of membership (Associate, Technician, and Graduate) be combined into one. Most of the branches had carried out surveys of their members, and in most cases these showed a significant level of support for the change. However it was clear that opinions on the matter were strongly divided, and Council was reluctant to put the matter to a vote because of the probable divisive nature of the outcome.

It was suggested that the most desirable approach was to promote further discussion amongst the membership until, hopefully, some degree of concensus was reached. This was agreed to, and the following course of action was proposed:

1. Two short articles presenting the case for and against the proposal will be published in the next issue of *Chemistry in New Zealand.*
2. Members are then encouraged to respond to these, in the form of *letters to the editor.* These should be kept to a maximum of 150 words, to ensure that as many contributions as possible can be published.
3. There should also be further opportunity for discussion of the matter at branch meetings, and also at the Institute AGM in August.
4. A referendum of all members will then be carried out towards the end of the year.

1987 Prizes and Awards

Members are reminded that entries close on 30 April 1987, for the ICI, and Shell Industrial and Applied Chemistry Prizes. Note that the scope of the latter prize has been extended to encompass "applied" as well as "industrial" chemistry. Also, the value of the award has been increased to $500.

The closing date for the Chemical Essay Prize is 30 June 1987. In an attempt to boost the number of entries for this prize it has been decided to specify the topic for each year, and give publicity to the competition by means of a poster. The theme for 1987 is "Chemistry in Society. Its past failures and successes against its role in the future".

Nominations of NZIC members for the 1988 NZIC-RACI Visiting Speaker Award should be sent to the Secretary General by 30 June 1987, through Branch Secretaries. Nominations should be accompanied by an appropriate curriculum vitae, a written assent to nomination and the periods in 1988 in which the nominee would be free to visit Australia.

B W Graham

EDITORIAL

Which Report?

So the Beattie Committee has duly presented its deliberations on science and technology in New Zealand. The release of the report just prior to Christmas by the Minister of Science and Technology can hardly be said to have grabbed the headlines. One wonders whose decision it was to release the report at such a "non-event" time of the year?

I have not yet seen the report. The review copy I had been hoping for did not eventuate. DSIR finances must be in an even more parlous state than we had thought!

I did not spend Christmas feeling totally neglected, however, as I had already received a copy of another report on the same subject, from the NRAC. This report of 150 or so pages was prepared by Dr E G Bollard, a former Director of DSIR's Division of Horticulture and Processing, and President of the Royal Society of New Zealand from 1981 to 1985. The research on which the report is based was originally undertaken for the New Zealand Planning Council, and publication of the report was funded by the NRAC. In the words of Alan Mackney in the Foreword:

It is not generally known that a substantial literature is now available on the role of S & T in modern economies. This report considers this international information and applies it to New Zealand's current circumstances, it seeks to identify the role S & T should take in future production, diversification, and resource management.

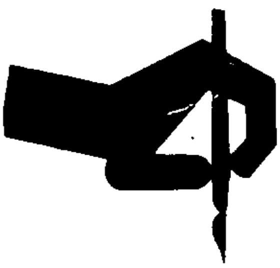
Further details about the report are given elsewhere on this page.

For those of you who just can't have enough on the subject (S & T that is) we have also been fortunate in obtaining the text of an address made by Charles Martin to the Canterbury Branch late last year. This is reproduced in full in this issue and I would recommend it for its forthright and somewhat "different" approach to the subject. We also have a short piece from Ian Devereux — mainly on "The Institute" — but also touching briefly on the funding of S & T.

Judging from newspaper reports, most people involved with science and technology in New Zealand will probably be quite happy with the findings of the Beattie Committee. Given the "political" response to it, however, many people must be wondering whether any of the recommendations will actually be taken note of and acted upon. Should we be leaving it at that though? Shouldn't the Institute and every other scientific body in the country be calling for action now? The boat racing is over and the cricket tour hasn't quite got under way, so there must be a few politicians around who might listen.

I fear that our leaders are being much too meek.

Bruce Graham



LETTER TO THE EDITOR

Recruitment — Denis Hogan replies

Sir — In his editorial on recruitment in the October issue, Lester Stonyer argues that many young chemists will not join the Institute because we cannot answer their question "What is in it for me?" He concludes that if we could answer that question we would have no recruitment problem. In between these statements he severely criticises the Institute for its present management. It is not so easy to keep a reply sufficiently concise for the letters column but I will try.

1. Of course Council tends to comprise successful people. What else would be expected? This does not mean that the less successful, however that vague description is defined, are not welcome and have no place in the Institute. Surely most of us are "hard-working chemists who have not got to the top of the tree".

2. There is no difficulty persuading Council that a lot of "excellent, diligent, highly contributing people in industry are worthy of membership". Many of them are already members — our rules are demonstrably flexible in this regard. This paragraph begs the question of the relationship between academic qualifications and grades of membership which I suspect underlies Lester's thoughts. This is a highly complex and emotional issue which cannot be sensibly discussed in a sentence. There will no doubt be further opportunity for such discussion.

3. There will be many definitions of the REAL objective of the Institute — it depends on which barrow is being pushed. For me it is to provide a forum where the practitioners of chemistry can discuss their discipline, exchange ideas etc. Lester is not specific about which details we worry about [except for grades of membership see (2)] but if the detail is not attended to and the rules not observed, the end result is chaos.

4. There is constant encouragement to branches, subcommittees, specialist groups etc, to make public comment. There are no barriers other than modesty and inertia preventing public debate on matters chemical. It is, however, not easy to achieve the desired effect.

5. Far from being outmoded, the Institute's management structure is very flexible. Problems are usually due to human fallibility rather than the structure. Matters can be actioned quickly if there is a perceived need.

6. Not many members will have been to an Institute meeting, futile or otherwise, to debate whether we are a professional body or a learned society. We are, of course, both. For struggling young chemists with the problems Lester describes, help is available if they care to seek it. There is nothing in the Institute's structure or management that prevents them from seeking help from their chemical colleagues. Any branch would welcome such approaches and if the result was an application for membership that would be the branch's reward.

7. Finally, it is more important, and we will be more successful, if we offer a wide range of activities in chemistry and show by what we do rather than what we say that we are a live body. We are — many examples can be given from Chem NZ to chromatography courses. If the potential applicants cannot themselves answer the question "What is in it for me?" by realising that they will become members of the broad chemical community and thereby further their interest in their chosen discipline, then no amount of special pleading on our part will bring them in.

Noone and no organisation is perfect, but I contend that NZIC has a basically good and flexible structure, that it is working very actively for chemistry and that it is achieving more than its critics concede. A blind rush to increase membership for the sake of being bigger without considering the consequences is not what we need. The key to the Institute's health is, as it always has been, the ideas and the energy of its members whose common bond is an interest in the practice of chemistry.

Denis Hogan
Registrar

BOOK REVIEW

Science & Technology in New Zealand: Opportunity for the Future

E G Bollard

Available from National Research Advisory Council, P. O. Box 12240, Wellington (price $15.00, post free)

This report aims to provide information on the applications of science and technology in New Zealand, for both the scientist and non-scientist. By drawing on local and overseas information it describes the nature of S & T and its role in the innovative process; the methods available for evaluating the effectiveness of S & T funding; and also the social implications of the development of S & T. Throughout the report emphasis is placed on the importance to development in New Zealand of an S & T policy appropriate to our particular circumstances.

The report is divided into three parts : Science and technology in modern economies, the practice of science and technology, and Science and Technology in New Zealand. Within these, subjects touched on include the nature of research and development and science and technology, evaluation of r & d, employment issues, r & d in small firms, the importance of basic research, science and society, and the role of government. Information is presented on the status of and support for r & d and S & T in the OECD countries, US, UK, and Australia. One obvious omission is Japan, a shortcoming that the author acknowledges. The final part of the report considers the past development of New Zealand and its relationship to S & T, the present situation with regard to support for r & d, and prospects for the future.

Because of the timing of its release this report will probably be somewhat overshadowed by the report of the Beattie committee. However, because of the depth of coverage of the current literature on the role of S&T in world economies it must surely rank as essential reading for those concerned about the current funding situation in this country.

B.W.G.

NITROGEN CERAMICS: A CHALLENGE FOR THE CHEMIST

D. S. Perera
Chemistry Division, DSIR, Petone

Dan Perera is a Research Scientist in the Solid State Chemistry Section of the Chemistry Division, DSIR, at Gracefield. He holds a BSc in Ceramics Technology from University of Sheffield and a PhD (Engineering Materials) from University of Newcastle Upon Tyne. He has been working in the field of Ceramics Technology for 19 years. His current research interests are in refractories and nitrogen ceramics.

INTRODUCTION

Nitrogen ceramics play a prominent role in the field of high-tech ceramics. High-tech ceramics is also kown by other names such as "special ceramics", "engineering ceramics", "fine ceramics", "high-performance ceramics" and "advanced ceramics". The field of high-tech ceramics is broad and the technology is still being developed. There is scope for smaller innovative companies in this business; many have already started and are growing. The 1980 world market is estimated as \$(US)4.1 billion and by 1995 it is expected to gross to \$(US)17 billion.[1]

Most of the metal oxides, carbides and nitrides have been contenders as high-tech ceramics. The main candidate materials for this type of ceramics have been silicon carbide, silicon nitride and partially stabilised zirconia. This article will concentrate on silicon nitride and related nitrogen ceramics, with the emphasis on chemistry.

SILICON NITRIDE

Silicon nitride exists in two crystallographic forms, alpha and beta. Of these, α - Si_3N_4 is produced by nitriding silicon at 1200-1300°C, and β-Si_3N_4 by nitriding above 1450°C:

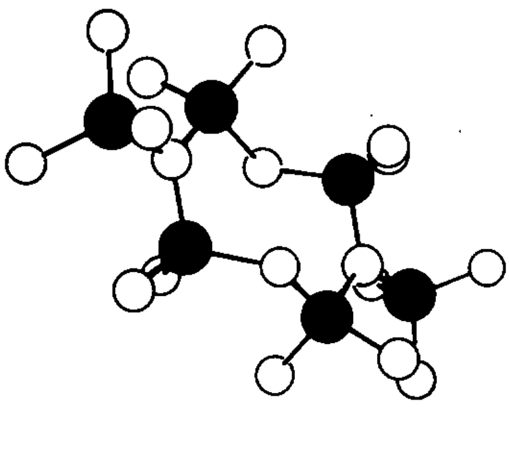
$$3Si\ (s) + 2N_2\ (g) \rightarrow Si_3N_4\ (\alpha)$$

1300-1350°C : $\Delta G° = -1167 + 0.594T$ KJ mol^{-1} (Ref. 2)

$$3Si\ (s) + 2N_2\ (g) \quad Si_3N_4\ \beta)$$

1400°C : $\Delta G° = -925.2 + 0.450T$ KJ mol^{-1} (Ref. 2)

Figure 1 The crystal structure of β-silicon nitride (open circles: nitrogen)



There are two methods of fabrication, which give reaction-bonded silicon nitride (RBSN) and hot-pressed silicon nitride (HPSN). In reaction bonding, the required shape is first of all made from compacted silicon powder which is then nitrided in molecular nitrogen at 1400°C to give a product of mixed α and β silicon nitrides with about 20% porosity.[3] The original dimensions of the silicon compact remain virtually unchanged during nitriding and therefore complex shapes can be made. The other method is to hot-press (apply a pressure while heating) α-Si_3N_4 with a suitable additive (e.g. MgO, Y_2O_3) at 1700-1800°C, to give a high-strength maximum density β-silicon nitride. Both methods have disadvantages in that hot-pressing is limited to simple shapes and reaction-bonding gives porous products which makes them weak. Several other routes for producing α or β silicon nitride have been recorded in the literature:[4]

1. By combined reduction and nitridation of silica
   $$3\,SiO_3 + 6C + 2N_2 \longrightarrow Si_3N_4 + 6CO$$
   (may also be carried out in NH_3, which is thought to be more reactive).
   The reaction takes place via a gaseous phase
   $$SiO_2\ (s) + C(s) \longrightarrow SiO\ (g) + CO(g)$$
   $$3\,SiO(g) + 2N_2\ (g) \longrightarrow Si_3N_4\ (s) + \tfrac{3}{2}O_2\ (g)$$
2. By thermal decomposition of silicon imide or amide
   $$3Si(NH)_2 \rightarrow Si_3N_4 + 2NH_3 \quad \text{or}$$
   $$3Si(NH_2)_4 \rightarrow Si_4N_4 + 8NH_3$$
3. By vapour phase reaction
   $$3SiCl_4 + 16NH_3 \longrightarrow Si_3N_4 + 12NH_4Cl$$

Reaction 1 is important from an economic point of view as silica is cheaper and more abundant than silicon, and carbon is also relatively cheap.

Si-Al-O-N System

In 1972 it was found possible to replace silicon with aluminium and at the same time nitrogen with oxygen in silicon nitride without a change of structure.[5,6] This opened up a wide field of chemistry based on the Si-Al-O-N system, and the acronym "sialon" has been given to phases formed in this system. Currently these materials are marketed by Lucas Cookson Syalon Ltd in England under the trade name Syalon.[7] The Si-Al-O-N system has been extended by incorporating other metal and non-metal atoms, and all these systems are referred to as oxynitrides. Nearly all the nitrogen analogues of silicates have been produced (except the clay mineral types), and also nitrogen glasses.

The β-Si_3N_4 structure is built up of SiN_4 tetrahedra joined in a three-dimensional network by sharing corners; each nitrogen corner is common to three tetrahedra (see Figure 1). The unit-cell contents of β-Si_3N_4 are Si_6N_8. With the partial replacement of Si^{4+} by Al^{3+} and N^{3-} by O^{2-}, in β-Si_3N_4, the

Table 1. Comparison of the Physical Properties of Nitrogen Ceramics with other materials

Property	HPSN	β'-Sialon	SiC	PSZ	Al_2O_3	Porcelain	Steel
Young's Modulus, GPa	300	300	350	400	160	70	224
Flexural strength,							
Mpa 20°C	820	800	650	700	410	70	400
1200°C	400-760	700	580	370†			
1400°C	480	580	510				
Fracture toughness MPam ½	4-6	5	5-6	14	5	1-2	150
Density g cm^{-3}	3.2	3.2	3.2	5.5	3.7-3.9	2.4	8.0
Melting point (or dissociation temperature *)°C	1900*	1900*	2600*	2690	2050	~1400	~ 1430
Linear thermal expansion coefficient, x 10^{-6} °C^{-1}	3.0	3.2	4.5	12.0	8.8	6.0	10-12
Thermal conductivity, W m^{-1} °C^{-1}	35	20-25	87	1.8	30	2.1	25

† 800°C

Key: HPSN: Hot-pressed silicon nitride

PZS: Partially stabilized zirconia.

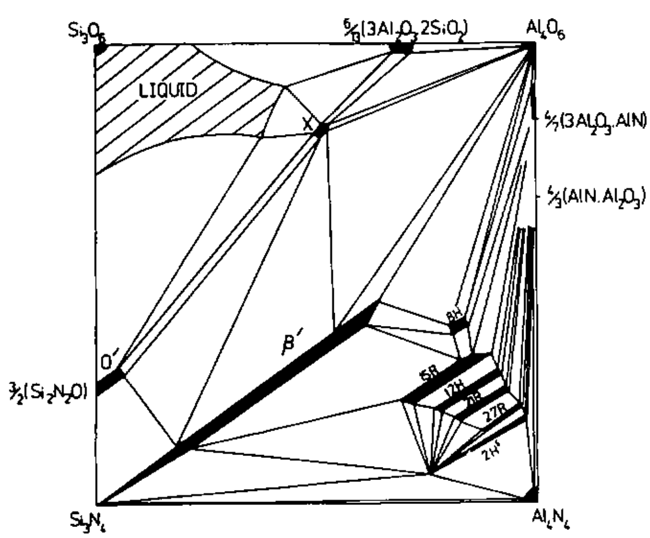
Note: The above values are listed to show the order of magnitude. They vary depending on the fabrication method, purity and method of testing.

structure is not altered, but the unit-cell dimensions increase with increasing substitution. Hence the structure derived from β-Si_3N_4 is given the symbol β' and may be represented by $Si_{6-z}Al_zO_zN_{8-z}$ (z = o is β-Si_3N_4). The homogeneity range of β'-sialon at 1760°C extends up to z = 4.2.[8]

The Si-Al-O-N system being a four component system could be represented by a regular tetrahedron, where each of the vertices represent one atom of the respective elements. However, for convenience it can be represented by a square (Figure 2) where the bottom left hand corner represents 1 mole of Si_3N_4 and the other three isomers represent Al_4N_4, Al_4O_6 and Si_3O_6 (for a detailed discussion refer to Jack[9]). In this system the concentrations are expressed in equivalents and any point in the square is a combination of 12 positive and 12 negative valencies. Here it is assumed that the elements Si, Al, O and N exist in their normal valence state. In going from the left-hand to the right-hand side of the diagram, $3Si^{4+}$ is gradually replaced by $4Al^{3+}$; and from bottom to top, $4N^{3-}$ is replaced by 6 O^{2-}.

The behaviour diagram shows the homogeneity range for various phases in thick black lines (Figure 2). The only phase that has been extensively investigated is the β'-sialon. Some of its properties are compared with other ceramics in Table 1. Silicon nitride and β'-sialon have good thermal shock resistance, i.e. can be rapidly cooled from a high temperature to room temperature or vice versa without fracturing, due mainly to the low thermal expansion coefficients. Low densities and high elastic modulii make these materials more attractive than metals (cf steel Table 1) because of their high usable strength to weight ratio. The low densities result from the atoms having low atomic weights and small co-ordination numbers, implying covalent bonding. High interatomic bond strengths confer high decomposition temperatures and high elastic modulii.

Figure 2 The Si-Al-O-N behaviour diagram at 1700°C (from ref. 9)



Sialon Phases

In the behaviour diagram (Figure 2) the phase designated by X has a variable composition close to $Si_4Al_4O_{11}N_2$ [10] and its structure is still debatable. O' represents the solid solution field of silicon oxynitride (Si_2N_2O) with alumina.

The other phases 8H, 15R, 12H, 21R, 27R and $2H^{\delta}$ are aluminium nitride-type polymorphs. Aluminium nitride itself has a wurtzite-type structure (Figure 3), where the nitrogen atoms are in a hexagonal close-packed arrangement with aluminium atoms. The aluminium atoms also form a hexagonal close-packed arrangement and occupy half of the tetrahedral interstices of the nitrogen-atom packing. The two kinds of atoms are in equivalent positions and the stacking sequence of each kind of atom, Al or N is ABABAB . . . . The aluminium nitride polytypes are related to AlN structure, but the metal(M) : non-metal(X) atoms vary. All the hexagonal polytypes are designated by letter H (after Ramsdell[11]) and the rhombohedral polytypes by R. The M:X ratio is 1:1 for AlN (designated as 2H) and it forms the end-member of this series. The other polytypes have M:X ratios of 4:5(8H), 5:6(15R), 6:7(12H), 7:8(21R) and 9:10(27R). The $2H^{\delta}$ has a slightly expanded c dimension compared to aluminium nitride. The stacking sequence of the 15R and 12H structures are shown in Figure 4. The crystal structures of these polytypes are discussed in detail by Thompson.[12] Although some work has been carried out on sialon polytypes,[13,14] their potential as semi-conductors because of their unique-crystal structure has not been explored.

Some of the metal-sialon systems which have been reported in the literature include Li,[8] Be,[15] Mg,[8,16,17] Ca,[18] Sc,[19] Ga,[20] Y,[8,] Zr,[14] Ce,[14] Nd[18] and Dy[21]. Most of the studies were limited to phase relationships in those systems or in trying to understand the role played by the vitreous phases in sintering β'-sialon.

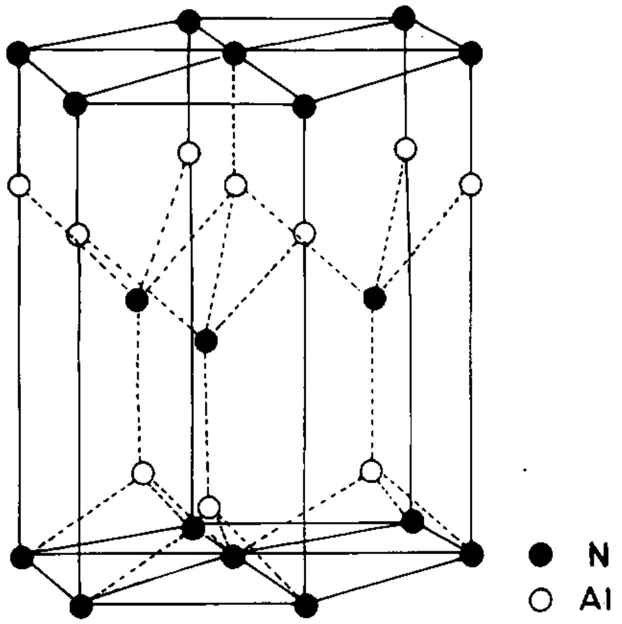


Figure 3 The crystal structure of aluminium nitride

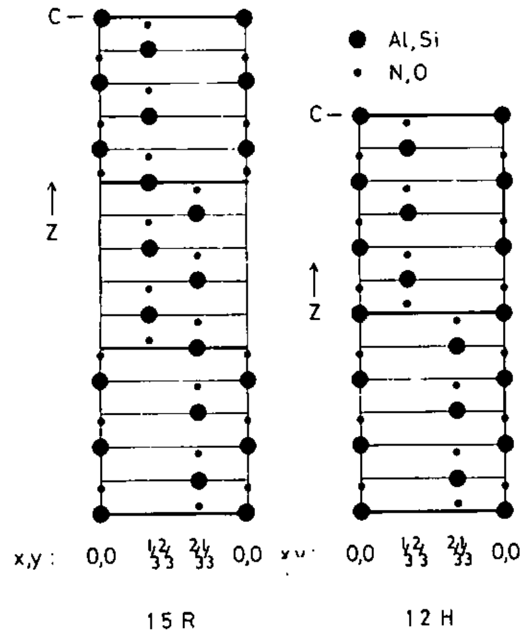


Figure 4 Projections of the 15R and 12H structures on the (110) plane (from ref. 8).

Sialon systems incorporating C have also been investigated.[22] Extending the system with B is another possibility, because boron nitride itself is a useful ceramic.

Limited work carried out on nitrogen glasses shows them to have superior properties to oxide glasses. The viscosity,[18] hardness,[23] refractive index,[18] dielectric constant,[24] electrical conductivity,[24] infra-red transmission,[18] and density[25] of glasses containing nitrogen are increased and the coefficient of expansion is decreased.[25] Oxynitride glass-ceramics are self-nucleating.[26]

Preparation of β'-Sialon

β'-sialon can be prepared by several routes, each giving a product of different purity and properties. The most important are:

1. Hot-pressing or reaction sintering powders of different combinations of α-Si_3N_4, Si_2N_2O, SiO_2, Al_2O_3, and AlN at 1650–1800°C.
2. Nitridation of naturally occurring silica and aluminium powders in N_2.[27] This proceeds via the reactions:

$$3Si_2 + 4Al \rightarrow 3Si + 2Al_2O_3 \quad (790°C)$$
$$2Al + N_2 \rightarrow 2AlN \quad (920\text{–}1300°C)$$
$$3Si + 2N_2 \rightarrow Si_3N_4 \quad (\sim 1400°C)$$

   The reaction is incomplete at 1400°C. But by hot-pressing the products a dense β'-sialon and a 15R sialon phase were obtained.[27]
3. Nitridation of kaolinite and carbon black in N_2 at 1400-1600°C.[28,29]

$$[Al_2O_3.2SiO_2.2H_2O] + +15C + 5N_2 \rightarrow 2Si_3Al_3O_3N_5 + 15CO + 6H_2O$$

4. Nitridation of kaolinite in NH_3 [30]

$$Al_2O_3.2SiO_2.2H_2O + NH_3 \xrightarrow{1400°C \quad 24H} Si_{6-z}Al_zO_zN_{8-z} + AlN + H_2O$$

   β'-sialon is obtained by dissolving out the AlN in weak sodium hydroxide solution.

The advantages of sialons over silicon nitride are that (1) they can be produced using a variety of natural raw materials; (2) the initial glass phase formed can be incorporated into the structure, thereby not weakening the material at high temperature; (3) small impurities can be incorporated into the β'-sialon structure; (4) materials can be "tailor" made.

Future Trends

Current and potential uses for silicon nitride and sialons are listed in Table 2. Increasingly more uses are being found for these materials as they can be "tailor" made. Some of these materials can be made from New Zealand minerals such as geothermal silica and halloysite clay.[33] The potential for the development of new value-added materials from inexpensive raw materials is excellent. It has been shown that β'-sialon in contact with molten metals such as aluminium is impervious to attack.[34] This is an area where some of these materials could be evaluated for refractory applications. Because of the unique crystal structures of "polytype" sialons their possibilities for electronic applications such as semiconductors seem promising.

Metal-Si-Al-O-N systems cover a very wide range of chemistry and any accommodation with C and B would be almost limitless. Only a very small field has been investigated so far. The scope for research in this field is wide, not only for ceramists and chemists but also for other disciplines.

Table 2. Applications for Silicon Nitride and Sialons [7, 31, 32]

Thermocouple sheaths
Flow control valves and metering devices
Pump components
Furnace coupling tubes
Porous membranes
Spray nozzles
For welding and metal joining
Crucibles and supports for molten precious metals
Kiln furniture
High temperature electrical insulations
Dental ceramics
Bone implants
Shaft seals and bearings for sea water pumps
Dies for extrusion and wire drawing
Ball bearings and races
Cutting tool tips
Pistons for diesel engines
Armour plating
Solid electrolytes
Refractories
Catalysts
Crucibles to hold molten silica for solar cells

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Science and Technology Through the 1990s

Charles G Martin Consulting Engineer, Christchurch

The following article is the text of an address given by Mr Martin to a meeting of the Canterbury Branch, towards the end of last year.

I became a member of this Institute 37 years ago, and in those early years I was active in the affairs of Wellington branch. Then, in 1956, I joined the Institution of Professional Engineers. Since then my contribution has been limited to paying my subscription and, now that you have made me a life member, I don't even have to pay that.

However, the prodigal son has returned; I have partaken of the fatted calf (or something); and all I now ask is that you do not exercise your traditional right to run and fall upon my neck.

Science and Technology

You have asked me to talk about science and technology, so I shall begin by defining my subject.

My definitions will generally follow those proposed by Professor Jacob Schmookler in his book *Invention and Economic Growth* (Harvard University Press, 1966).

"Science", then, is the study of how and of what the world is made. "Technology" is the art of manipulating the world for the purposes of mankind. Each of these terms also has a secondary meaning, denoting the body of knowledge relevant to these two activities.

The activities which produce these bodies of knowledge are research, invention and development. A popular and widely accepted definition of research is that it is a system for providing a comfortable living for cultured gentlemen. No scientist should accept this, because there are obvious contrary instances. For example, we all know that some of the people concerned are not cultured; some are not gentlemen; and some are neither. And, in some cases, the living provided could not be described as "comfortable" because it is manifestly luxurious.

Schmookler, however, defined "research" as "a relatively systematic quest for new knowledge about a class of phenomena". Research may yield new knowledge in science, or new knowledge about technology.

Schmookler defined "inventive activity" as "work specifically directed towards the formulation of the essential properties of a novel product or process", and "development" as "the improvement of an invention after it has been proven to be basically sound". Note that inventive activity is often so intertwined with research and development that a scientist might have trouble deciding which function was being performed at a given moment. For example, while studying a given phenomenon, he or she may begin to think about a possible industrial application. At this point we may say that inventive activity has commenced. The scientist may then attempt to create this potential application on a laboratory scale. If it is then found that the application does not work as expected, the scientist may return to do some more research (thereby temporarily terminating the inventive activity). Later, armed with a better understanding, the scientist may return to inventive activity and try again. While these shifts in role may be difficult to keep track of as a practical matter, the roles are clearly different. Understanding a phenomenon is one thing —creating an industrial product or process based on that understanding is quite another.

Development, which is a post-invention activity, produces a class of innovations that Schmookler called "sub-inventions". These are "obvious" changes in a product or process, resulting from relatively straightforward applications of scientific or engineering knowledge or from acts of skill by workers, supervisors, users, etc.

Invention vs Research

The new knowledge produced by research only affects the world when it is put to use by invention. The common belief that invention follows research in a cause-and-effect relationship is false, for two reasons. First, it misrepresents the relationship between science and technology. Science arose out of technology, not technology out of science, and only in restricted areas has science advanced far enough to repay its debts. Secondly, the factual evidence does not support the view that new knowledge leads to invention. Every study on the matter has shown that inventions nearly always arise because of "demand-pull", not because of "knowledge-push".

Research adds to the store of generalised knowledge. From time to time some of this knowledge may be used in formulating an invention; but rarely, if ever, is there a cause-and-effect relationship between the research that produced the knowledge and the invention that used it.

Schmookler searched the literature covering a period of 100 years for correlations between scientific discoveries and successful inventions applicable to four typical industries. In his own words:

"Despite the popularity of the idea that scientific discoveries or major inventions typically provide the stimulus for inventions, the historical record of important inventions in petroleum refining, papermaking, railroading, and farming revealed not a single unambiguous instance in which either discoveries or inventions played the role hypothesised. Instead, in hundreds of cases, the stimulus was the recognition of a costly programme to be overcome or a potentially profitable opportunity to be seized; in short, a technical problem evaluated in economic terms."

Another investigation, by Jewkes, Sawers and Stillerman (*The Sources of Invention*, 2nd edition, Macmillan, London, 1969) has this to say:

"It is not known whether there is any necessary connection between the growth of scientific knowledge and the growth of technology or, if there is a connection, what are its laws. If science and technology have different motives for and criteria of success, it is a rash assumption that one immediately and proportionately stimulates the other . . . even where scientific advance has ultimately contributed to technology, the lag has been so great that it automatically rules out the possibility either of prediction or of calculated investment to produce

results. . . . Any community therefore which deliberately invests in pure science as a way of producing returns in technology and invention is not merely setting out on a course which threatens the ultimate values of science itself, but is also engaged in a blind gamble."

It is characteristic of the flood of published scientific knowledge that much of it will never have any effect on society. Even the very blunt tool of citation analysis shows that a great deal of the current literature is trivial, and it is not difficult, in one's own specialist field, to find papers that are simply wrong.

These are not arguments against the free publication of scientific results; but they are certainly relevant to arguments about the economic value of research as here defined, and about the justification for funding of research from the public purse.

However, there is another argument for the public funding of "pure" (ie undirected) research. Scientific research is a creative cultural activity, like poetry, music or art, and this is ample justification for its support by society. But there is no obvious reason why this support should be on a scale which differs greatly from that granted to art, poetry or music, or to research in history or to any other creative cultural activity that is considered by society to be worth paying for.

It is sometimes argued that undirected research in the universities should be supported because university staff should do this kind of research in order to be adequate teachers. This is a matter upon which there seems to be little factual evidence. It would be interesting to find out whether an academic who engages in goal-oriented research — i.e. inventive activity and/or development — is at an advantage or a disadvantage in his or her career compared with one who practises "pure" — i.e. open-ended or undirected — research.

My personal view is that the universities are the proper places for state-supported "pure" (i.e. undirected) research, but that the amount of financial support they receive for this activity in the future will almost certainly decrease. On the other hand, investigative work directed towards finding the answer to a specific problem, commonly called "goal-oriented" or "applied" research, can be classified as "inventive activity" or "development". Inventive activity and development work by university staff are likely to be funded to an increasing extent by industry and by government trading corporations and departments. The amounts of money available from these sources will be very large and will increase, but payments will be continued only in respect of work which is of a high standard, and which is carried out diligently and in accordance with agreed time and cost schedules.

Government Research

The largest of the state scientific organisations, the DSIR, was set up in 1926 specifically to provide "a suitable organisation for promoting the application of science to industry". The arguments for its existence, therefore, are that it benefits the New Zealand economy and gives the taxpayers, who pay for it, value for money. These claims can be judged by the ordinary methods of cost accounting. It is not difficult to identify and announce scientific achievements that have been of value to the country, and scientists are not slow to do so. Why then are the politicians and public so cynical over expenditure on science in New Zealand? I cannot do better than quote Professor Richard Batt:

"[It] . . . could be that the country no longer sponsors the type of science which gives returns. . . . New Zealand science is typically open-ended, devoid of defined commercial goals and seldom planned and executed to a time schedule. With little apparent interest in making New Zealand science pay, it is no wonder that the country is devoid of the essential facilities to take valuable scientific findings through the essential exploitation stages. Most results of significance from our scientists go into international journals and eventually the scientific papers do little more than become part of the scientist's curriculum vitae.

"The so-called 'science budget' in New Zealand for 1981 amounted to $142,531,000. If this was being spent on genuine "research and development", the return would be enormous. Overseas estimates put various levels of return on each dollar spent on research and development — $10 for every dollar spent would be one of the lower estimates. From our science budget should we be expecting a return of $1,400,000,000? Clearly the country is not benefiting to that extent and it is probable that New Zealand does not even benefit to the extent of the budget figure itself.

". . . As to what should be done, there could be no harm and maybe great benefit from a full investigation into New Zealand science in all its aspects with special reference to its productivity for the development of the country."

Well, Professor Batt wrote that some time ago (*NZ Engineering* 1 October 1983). The DSIR did nothing much, so now the economists of Treasury are doing it for them. And it is important that no scientist makes the mistake of imagining that the present policies — "user pays" and so on — are just a reversible political decision. They are not. They are an accurate reflection of the public's attitude to science and scientists. The anti-fluoride movement, health foods, dioxin hysteria, much of fringe medicine, and some of the more extreme parts of the environmental movement are underlain by the same agenda — distrust and dislike of science and scientists.

The public, represented by the ordinary non-scientist in the street, not unreasonably equates expenditure on science and technology with improvement in the material standard of prosperity in the country. It is obvious that the material standard of prosperity in New Zealand has fallen and continues to fall in comparison with that of our trading partners, and the public is very well aware of this. We now spend about $200,000,000 each year on "science", not including the universities. No government is going to maintain this level of expenditure, much less increase it, unless we can demonstrate convincingly that the money spent on science returns an acceptable social dividend. And if we, the scientists, cannot produce evidence to support this conclusion, it is unlikely that anyone else will do so.

Future Scenarios: The British Model

So where will we be in the 1990s? I shall try to outline two limiting scenarios for the future of scientists in New Zealand. Our language, our traditions, and our systems of law, government and education are British. It is a sad fact that, although Britain produced the industrial revolution, her industrial competitiveness has declined continuously since about the year 1851, and is still declining. In 1983, for the first time in 200 years, Britain imported more manufactured goods than she exported, and the deficit in manufactured goods alone, in 1985, has been estimated as about half the North Sea oil revenues. The other half was just about enough to pay the dole. Forty years ago, Britain had the second highest material standard of living in the world, after the United States. Now it is near the bottom of the industrial league, along with Italy. If the present trend continues, by the end of the century the British standard of living will be about that of Albania.

The problem is a cultural one. The top people of upper England never accepted the industrial revolution, although it made them very rich. The cultured Englishman or Englishwoman is still portrayed with a dog or a horse, rather than with a lathe or a laser. Only in English is the word engineer used both for the professional and the engine driver. Only in English can the word "science" be opposed to the word "arts". In other languages "engineer" is a title like "doctor", and the word for science means simply "knowledge". Sir Geoffrey Chandler, Director of "Industry Year 1986" for the Royal Society of Arts, has summed up the situation:

"What we define as causes of our industrial failure are in fact symptoms. They are symptoms of an inherited culture and of attitudes which put industrial activity at the bottom of the social pecking order and of an education which, by ignoring or denigrating it, obscures the connection between quality of life and industrial success."

All these statements apply with equal force to New Zealand in the year 1986.

In Japan and in Northern Europe the usual tertiary education for a senior industrial manager is engineering or physical science, so that managers are technologically literate. In New Zealand, as in Britain, it is accounting — a minor discipline of negligible intellectual content, based on simple arithmetic, unnecessary jargon, and study of last year's financial records when it is too late to do anything about them.

So one option for New Zealand is to continue to ape Mother Britain. And if you are in any doubt about where Britain is going, read *The Audit of War* by Corelli Barnett (Macmillan, London 1986). This is a thorough and scholarly study of British decline which is summed up bitterly, but accurately, in the final sentence of the book:

"As that descent took its course, the illusions and dreams would fail one by one — the Imperial and Commonwealth role, British industrial genius, and, at the last, New Jerusalem itself, a dream turned to a dank reality of a segregated, subliterate, unskilled, unhealthy and institutionalised proletariat hanging on the nipple of state maternalism."

At least until the last two years, we have followed the Brits. If we continue on this path, the best we can expect for ourselves is the dole, and for our children and our children's children, the hope that the slum they will inherit will still have some nice scenery. There will still be some splendid houses in that slum — suitably protected by advanced electronics and the paraphernalia of security — but they won't be occupied by scientists. They will be the fortresses of the paper entrepreneurs, who have become rich by moving industrial assets from place to place and in doing so contributed to our decline. And if you think that I am exaggerating, get out of your comfortable laboratories and find out what is happening in New Zealand right now.

The Japanese Model

Fortunately we have another option. It is commonplace knowledge that East Asia is the new centre of world trade and that Japan is the leader of this trend. Culturally, New Zealand is European, but geographically we are Asian, and we cannot succeed by pretending that we are a little England. I have just returned from two months in China, spent in universities and in industry. The Chinese have learned their lesson — they are now retreating from doctrinaire communism, and their policies towards industry and education owe much more to careful study of successful East Asian capitalism than to Marx or Engels. The important thing is, though, that they are following the Japanese model, and so are the Koreans, the Taiwan Chinese, the Singaporeans, the Malaysians, the Indonesians, the Thais, — in all, about one third of the human race. This Japanese model is based on nothing very complicated — simply the idea that in a society that is dominated by technology, the leaders must be technologically literate. Japan now graduates more engineers than the USA and Northern Europe combined, patents more inventions than the USA, has a high and rising material standard of living, and has almost no industrial disputes. "Pure" research has a low priority and social status, but "targeted" research — usually "inventive activity" by Schmookler's definition — is funded most liberally by both government and industry. Japan produces about 5 engineering graduates for every science graduate. Germany produces 3, and the USA, 2. In Britain there are 0.7 and, in New Zealand, about 0.35. As far as I have been able to find out, this is the lowest ratio of engineering to science graduates of any country in the world. If we followed the Japanese model, our universities would graduate the present number of science graduates — about 1400 — but instead of 500 engineering graduates, we would have 7000. And most of those graduates would never aspire to practise engineering or science — they would go directly into commerce and industry to become technologically literate managers. Many of the very best postgraduates in both science and engineering would spend much of their career in the marketing, manufacturing or public relations functions of their organisations. Remember, inventions arise because someone identifies "a costly problem to be overcome, or a profitable opportunity to be grasped". And that someone must have the authority to spend company money and time on the project. Some Japanese companies have abolished the "research" function altogether. I recently asked a director of a Japanese company, which had filed several thousand patents in the previous year, how many people he had in his research department. "None!" he replied. "We regard innovation as part of the ordinary duty of managers, so we put our best technical people in the marketing and manufacturing departments."

Hope for the Future

It is unlikely that New Zealand could ever wish to follow the Japanese model in detail, or that we could if we wanted to, but it is entirely possible that we could learn much from a careful study of the success of East Asia. If we assume New Zealand really does learn from these examples, what kind of society would our scientists and technologists live in by the middle of the 1990s? First, it would be a society with different values. The quality of many scientists' work insofar as it affects their careers is now judged by other scientists, according to the specialised standards of science. The work of engineers and of scientific technologists working in industry, however, is judged by economic standards and, ultimately, the public. In the future this will apply to nearly all scientists. Preferment and promotion will come to those scientists who can demonstrate that their work has created wealth for the nation. Publication in prestigious journals will be good for the ego, but not for the bank balance. Few academic scientists will have tenure, or even want it, and most, including the most highly paid, will work on short term renewable contracts. This means that lazy or incompetent university staff will be fired, just as now occurs in industry. Scientists and technologists will move freely between university and industry, and many more will become executive managers and directors. Most important of all, scientists will gain a much larger presence, in the media, in politics, and in the top echelons of industry. And they will have gained this presence only because they have worked for it by presenting the case of science to a public which now gives science and the scientific method a very low rating indeed. All this implies, of course, that the scientists have a valid case to present, and this is entirely in their own hands.

The future, of course, depends very much on what we can do now. First, we must improve our credibility with the public and the media. This requires hard work, and the case presented must be based on the strict truth. As a first step, can we say truthfully that our work has generated wealth for New Zealand? (Remember, the quality of life and of the environment that we live in depend upon the continuing generation of sufficient national wealth to sustain the costs incurred.) As a second step, what can we do now for science? This is easier, because we can all engage in public debate, both as individuals and as members of professional organisations. Right now, science has a bad press, and the scientific method and even rational thought itself are threatened by a tide of anti-rational, anti-scientific sentiment. It can be argued, with some justification, that the scientists have brought this on themselves by simply not delivering value for money.

So what to do? As a first step, please join that excellent organisation "New Zealand Sceptics", which is fighting the battle for science in the media. As a second step, let us always remember that we are citizens before we are scientists.

Continued from page 11

Secondly, recognising that most individual scientists are not great communicators *yet*, the Institute, represented by its spokespersons, should speak up much more. What a timid response we have produced so far for the User Pays budget cuts on DSIR! Of course "Users" should pay something towards services they receive but who was the *expert* in Treasury or elsewhere who decided that New Zealand should only spend x% of last year's budget on science? Were you asked?

Thirdly, as suggested earlier, our Conferences, Meetings and Journal should put more emphasis on people and less on chemistry. We need a more human face. We need to share our failures and how we overcame them. Why do we keep writing technical papers that go from a to b to c as though the whole exercise went without a hitch and we never swore or tore out our hair? It's phoney. Everyone knows science is never like that so why the pretence?.

In 1987, in our own activities, in Institute affairs and in science in general lets have more "people" and less "chemistry".

NZIC: People or Chemistry?

Ian Devereux
Rocklabs, Auckland

Although some areas of science are flourishing, eg genetic engineering, computers and new materials, the traditional broad subjects of chemistry, physics and mathematics are in decline. Student numbers are static or falling, in universities where total rolls are growing and faculties such as commerce and social sciences are bulging at the seams. Presidents of chemical societies meet to discuss the decline of chemistry and their professional bodies' fortunes. Membership of our Institute is barely holding its own and a large proportion of potential members never join.

What is going wrong? Why is support for science fading away when it has brought mankind so much? Where is the Institute missing the boat? The answers are many and complex but just because they are difficult to define does not mean we should ignore the questions and hope they'll go away. As scientists we have been trained to inquire, to look for causes, to study trends and to reach conclusions. We need to apply all our skill to our own situation.

When the scientific age really got under way last century, the general population was involved in two ways. Science was discussed by educated people, they marvelled at the new worlds to be found under a microscope or through a telescope and science aimed at solving some of mankind's great problems such as disease and insufficient food supplies. It was people that counted. Science was exciting and successful. Scientists gave public lectures, scientific expeditions were supported and their fortunes followed by thousands.

In some ways science has been so successful that it has caused its own decline. The great problems of last century have largely been solved. We don't all die of smallpox, tuberculosis and cholera, we die of road accidents, bad diets, smoking, stress, etc; many self-induced. There is enough food and shelter in the world for everyone. Some countries are still badly off, but others have huge surpluses and unused potential. Some people are even paid not to produce. It is only the mechanics of distribution and politics that keeps enough from everyone. These are not scientific problems but scientists should be working on them.

Does all this success mean that science is no longer needed? Certainly not. There will always be those who strive to understand the universe, whether science is top of the hit parade or not. In a more practical way there are many major problems still facing us, not strictly life and death problems such as mankind faced last century but vital to our future well being: the provision of energy when fossil fuels are depleted, control of pollution, conservation of our natural environment and a better understanding of how we fit into the whole picture, a better standard of living for the majority of mankind, medical research into all the life-limiting conditions, etc, etc. All will take a true understanding of the basics of science including chemistry, physics and mathematics applied to these practical problems.

How are we as scientists to do this and how can our Institute help? In the early days of science, science was cheap. To discover penicillin, all you needed was a dish, a microscope, an observant eye and luck. Today you still need some luck and large amounts of money. If you've got your own money, get right on and spend it, but most of us haven't. Science needs public money and public support (Roger Douglas may disagree!) but we won't get that support unless the public believes that the money is well spent. To achieve this we need better communication from scientists to the public and we need this to be as human as possible. Forget the jargon and help the layman to see the problem and the need to solve it. We need to communicate something of the excitement of science; the advances, seeing the light after years of frustration, the difficulties, the mistakes and the triumphs. We need it to be more personal, so that science becomes a link between people, not a barrier. It is no good sitting in your laboratory whinging about the situation, get out and share your dreams with the world around you.

And how can our Institute help? By remembering that it is people not chemistry that makes our Institute flourish. Chemistry is the common thread that draws us together, but we stay together, attract new members and grow by human interaction. Why are our Conference papers all technical in content? Most are almost unintelligible to the majority of members. The jargon within chemistry is so bad that chemists can't even understand each other's work, let alone another scientist or the general public. Why don't we have papers on such topics as company management, budgeting for University departments, motivating research students, communication skills, marketing, etc. Why do we continue to pretend that a highly specialised technical topic is of much interest to anyone? Let those who are interested, join together in specialist meetings where everyone speaks the same language. Let us make every effort to make our Branch meetings, our Conferences and our Journal more human in interest and a base for communication to the general public.

It is all too easy just to recognise a need. What can be done about it? As individual scientists we need to understand that more time and effort must be put into improving our personal communication skills. Last year I attended an evening geology lecture at Auckland University given by a visiting Professor from Europe. He is known world-wide and he has worked and lectured in North America extensively. He should know how to give a lecture. His English was fine, his slides were appalling. One was a map of the world, used to show the location of one type of mineral deposit but it contained so much other irrelevant detail that it was useless. Other slides contained far too much data in far too small type to read anything. I have used this reference to a geologist to demonstrate that chemists do not have communication problems on their own. As a contribution to the improvement of NZIC members' communication skills I have obtained permission from the author and original publisher to reproduce the article "Tips on Talks, OR, How to keep an audience Attentive, Alert and Around for the conclusions at a scientific meeting" by H. Edward Clifton. (This will appear in a later issue. Ed.)

What are your oral and written communication skills like? Have you considered joining the Toastmasters or other similar organisation? If you are giving a paper at a Conference do you have several practice runs or do you just hope it will be "alright on the day"?

What can the Institute do to help its members and chemistry in general? Firstly, let's simplify our grades of membership. Let us welcome in *anyone* who is interested in chemistry. Full membership should be restricted as it is at present, Fellowships are an honour and everyone else should be an Associate, e.g. students, technicians, recent graduates, accountants, salesmen, etc. The route from Associate to Member would depend on circumstances, some would never be eligible. Students and others could be eligible for reduced subscription. Grades of membership should not be used as a divisive device. We are not a registered profession, we almost never expel anyone, c.f. Medical Association, so don't let's kid ourselves about membership standards.

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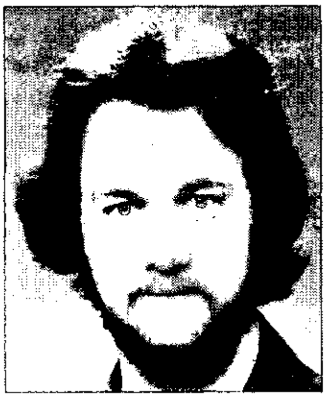
THE BRANCH CHAIRS 1987

Auckland — S J de Mora

Steve de Mora was born in London, England, and received his secondary education at a Canadian school in Germany. In 1976 he graduated from the University College of Swansea with a BSc joint honours degree in chemistry and oceanography. He undertook a PhD in estuarine manganese chemistry at the University of British Columbia. He then worked with Roy Harrison for two years at the University of Lancaster investigating lead speciation in tap water.



Steve came to New Zealand in 1984 to take up a lectureship in analytical chemistry at Auckland University. His main research interests are in metal speciation in the environment, the atmospheric chemistry of trace constituents and the analysis of sulphur compounds in wine. Field studies have involved a couple of visits to the Antarctic. He has been a member of the Institute since 1984. Last year Steve served as the Branch Secretary and is presently on the organising committee for the 1987 NZIC Conference.

Waikato — R T Gallagher

Rex Gallagher was born in Auckland, and graduated BSc and MSc (hons) in Chemistry in 1967 from Auckland University. He received his PhD in 1971 from Massey University, where he lectured in chemistry until 1974. He then worked as a research scientist with the Applied Biochemistry Division, DSIR, Palmerston North, and was a post-doctoral fellow at Iowa State University 1976-1978. In 1980 he transferred to the Ruakura Animal Research Station, MAF, Hamilton.

Rex has been a member of the Institute since 1971, and has served as a committee member for the Waikato Branch, and as a committee member and branch editor of the Manawatu Branch.

His research interests have centred around natural products chemistry, especially plant and fungal toxins. His work has included the purification, isolation and characterisation/structure determination of dothistromin, a phytotoxin from *Dothistroma pini*, and a range of potent tremorgenic neurotoxins, including aflatrem, the janthitrems, paspalinine, and the lolitrems — the latter being the causative toxin of the livestock disorder, ryegrass staggers. Currently he is working on immunochemical approaches to study and to combat plant and fungal poisoning of animals.

Manawatu — J M Waters

Joyce Waters was educated at the Diocesan High School in Auckland and attended Auckland University College where she graduated MSc, with first class honours in Chemistry, and PhD. After overseas experience in Professor J. Chatt's group at the Ahers Research Laboratories of ICI (England) and later in the Chemical Processes group at AERE Harwell, she returned to New Zealand and was appointed to a lectureship in Chemistry at the University of Auckland in 1961. She resigned from her position as Associate Professor in 1983 and moved to Massey University where she is now a Senior Research Fellow in Chemistry.

Her research interests are in the application of the X-ray diffraction technique to chemical problems. Periods of research and overseas leave have been spent in Oxford, in Professor Dorothy Hodgkins' laboratory, on two occasions and at Northwestern University, Illinois with Professor J. Ibers.

Joyce became an Associate of the Institute in 1960 and was elected Fellow in 1977. She has served as Conference Secretary (1961), member of the editorial committee of Chemistry in New Zealand (1979-1983) and on the Manawatu Branch committee (1985-86). Since moving to Palmerston North she has also been active in the Federation of University Women and is currently a member of their National Executive, acting as Editor of their monthly National Bulletin. Her husband, Neil, another Institute member, is Vice—Chancellor of Massey University. In her spare time she enjoys gardening and growing orchids.

Wellington — R S Whitney

Rob Whitney is an Assistant Director at the Building Research Association of New Zealand (BRANZ).

While gaining a BSc(hons) degree in industrial chemistry from the University of Wales, Rob spent training periods at the British Iron and Steel Research Association and at Midland Silicones. He then moved to the University of Essex, where he completed a PhD in polymer science (polyester networks). The following year he was awarded a Royal Society European Fellowship for research into branched acrylic polymers at the Institute of Macromolecular Chemistry of the University of Freiburg in West Germany.

Rob migrated to New Zealand in 1972, joining BRANZ as a materials research scientist. Four years later he became Head of Materials Division. During this time he was involved in a wide range of research projects relating to the durability of building materials, including corrosion of metal fasteners in timber, roof paints, particle board flooring and metal roofing systems.

Rob was appointed as an Assistant Director in 1982. He is responsible for all aspects of the Association's laboratory activities and research programme. His current interests include developing a research strategy for BRANZ, and investigating the potential of "expert systems" for building information. He recently presented a paper on this latter subject to the Institute of Policy Studies seminar on Information Technology and Economic Growth.

Rob has been a member of the Institute since 1974 and a branch committee member since 1984. Last year he was Branch Editor.

Otago — K A Hunter

Keith Hunter was brought up in Auckland and graduated MSc in chemistry from the University of Auckland in 1973, working under the supervision of Prof. A L Odell. In 1974 he took up a Rutherford scholarship to study for PhD with Prof. Peter Liss at the University of East Anglia, specialising in marine chemistry. Postdoctoral work in France and the UK followed.

He returned to NZ in 1979 to take up a position in the Chemistry Department, University of Otago, where he is presently a senior lecturer. Keith teaches courses in both marine and analytical chemistry, and has a research group working on aspects of the geochemistry of trace elements in the ocean. His particular interests are the surface chemistry of minerals and their effects on trace element behaviour, and the analysis of trace elements at very low concentrations. His research group developed the first trace element clean laboratory in NZ in 1983.

COUNCIL NEWS

NATIONAL CHEMISTRY WEEK 15-21 AUGUST 1987

At its August 1986 meeting Council resolved to hold a National Chemistry Week in 1987.

This decision arose as the result of the widespread concern expressed about negative views held by some sectors of the community towards chemistry and chemists. Much of this was considered to stem from inaccuracies and incorrect information reported in the media.

It was Council's view that not only should misinformation be rebutted when it arises but that the Institute should embark upon a planned campaign to develop a more informed attitude in the community. A greater effort should be made, both locally and nationally to present to the public the importance and the value of chemistry and the positive contribution of chemists.

Branches are already running public lectures and educational activities as part of their annual programmes. These generate valuable publicity. Where possible, some of these will be rescheduled in National Chemistry Week.

Very successful National Chemistry Weeks are a feature of the activities of companion professional bodies in both Australia and the United States. Since this will be the Institute's first, limited goals have been set. Most activities will be focussed on secondary school pupils although some branches will be involving primary school children and also the wider public. The experience gained this year will provide a good basis for expanded programmes — in future years.

Publicity

Maximum publicity for chemical activities taking place during Chemistry Week is vital. Each Branch will be asked to designate a publicity officer to ensure that the widest possible coverage is given in radio, television and newspapers.

Council has set aside up to $2000 for national support. National coordinator is the senior vice-president, Terry Hitchings.

National Activities

In October, a group met in Christchurch and a series of proposals and suggestions was circulated to branches for comment. Analysis of the replies indicated good support for the following to be organised on a national basis:

1. Poster competition — directed at secondary and possibly primary school pupils.
2. Photographic competition — on a chemical topic for secondary school pupils.
3. A chemical essay — for secondary school pupils.

Appropriate prizes will be awarded during National Chemistry Week. Details will reach Branches during March.

Chemical Education Committee

A variety of useful proposals has been made by this committee, some of which will be implemented this year. In its consideration of the Chemical Education Trust, the committee was hopeful that some of the proposals requiring more development be sponsored in future years.

Local Activities

Branches have expressed their support for locally organised activities including analytical competitions, visits by pupils to working laboratories, and conversaziones. One idea which was floated and drew widespread interest was a crystal growing competition.

Visiting Speakers

All Branches agreed that the stimulus of able speakers on interesting topics was important. **Dr R B Bucat**, Department of Physical and Inorganic Chemistry, University of Western Australia, will be speaking at Conference in Auckland on 22-26 August. It has been possible to have him be here also for National Chemistry Week. An itinerary to enable him to speak at some Branches is at present being arranged.

From 1980 to 1984, Dr Bucat was seconded to the Australian Academy of Science as the full time supervising editor of the Academy's School Chemistry Project. This very large curriculum project has developed a new generation secondary school course that is based on philosophies derived from the inputs of the whole of the chemical and educational communities in Australia. If the course achieves its aims, chemistry in

Australian schools will be more understandable to the benefit of those going on to tertiary science courses as well as those who are not. Dr Bucat is now a part time consultant for the Academy of Science during the implementation, information, in-service support and evaluation stages of the project.

In 1980 Dr Bucat was awarded the medal of the Chemical Education Division of the Royal Australian Chemical Institute for contributions to education in chemistry.

All Branches will shortly be asked to confirm their proposals for National Chemistry Week. This combination of local and national activities, coupled with vigorous promotion and a well organised publicity campaign should ensure that the Institute's first National Chemistry Week is a success.

Terry Hitchings
First Vice-President

UNESCO'S 40TH ANNIVERSARY

Two NZIC members, Dr Harry Percival (NZ Soil Bureau, DSIR) and Graeme Valpy (CIT, Trentham) attended the national seminar "UNESCO, New Zealand and the Pacific" held at the Quality Inn Conference Centre in Wellington (31 October - 1 November 1986). This seminar, organised by the NZ National Commission for UNESCO, marked the 40th anniversary of UNESCO. A total of about 70 delegates participated in three sets of workshops running concurrently on the topics education, science, and culture and communication.

The major interest for the NZIC representatives was the Science workshop (chaired by Clive Palmer, DSIR Head Office) which covered three areas.

(1) Man and the Biosphere

This was introduced by Helen Hughes, then Acting Commissioner for the Environment. The history and activities of the NZ MAB Committee were discussed and, later, the particular issue of establishing Biosphere Reserves for New Zealand was covered. Reserves are for the conservation of natural areas and the genetic materials they contain.

(2) Technology and Training in the South Pacific

Clive Palmer focussed on the launching of a programme on the Management of Science and Technology for Development in the Pacific. This programme seeks to enhance the capabilities of the Pacific island states in technology-related decision making.

(3) Natural Hazards and Volcanology in the South-West Pacific Region.

Dr Ian Speden, Director of the NZ Geological Survey, provided an overview of this topic and was then followed by five contributors who briefly discussed volcanology, earthquakes, tropical cyclones (and wind storms), landsliding, and coastal erosion.

The above sessions were all highly informative to the delegats and were generally well presented. However, because there was little time available for substantive discussion and debate on recommended future action after the presentation of information, the sessions were more in the nature of seminars rather than workshops.

Other activities associated with the UNESCO celebration included a parliamentary reception hosted by Helen Clark MP, and preceded by a keynote address by Dr Clarence Beeby CMF (Assistant Director-General of UNESCO 1948-49; Chairman UNESCO Executive Board 1962-64) entitled "UNESCO — An Historical Perspective". There was a further keynote address by Mr F. Turnovsky OBE (Acting Chairman of NZ National Commission for UNESCO and conference host) entitled "UNESCO - What of the Future" to start the proceedings proper.

(H J Percival)

BRANCH NEWS

Manawatu

Our final activity for 1986 was an industrial visit to Hawkes Bay. First we called in to **Godfrey Husheer** at his Scientific Service Laboratories, Napier, to be shown the complexities of so-called "simple" inorganic chemistry. Godfrey illustrated his discussion with demonstrations of his home-designed and constructed equipment. Air conditioning has a new meaning for us now! Next we called in to the Vidal Winery in Hastings to be shown the processes necessary for the production of fine wines. After a tour of the plant, the group retired to the restaurant to sample some of the company's products and fine food. The participants in this tour considered it a most interesting, informative and amusing experience, even though they arrived back home in Palmerston North after midnight.

HONOURS AND AWARDS

Dr Philippa Wiggins has been appointed to a personal Chair at the Department of Medicine, University of Auckland. In response to a request for a "few notes", she has supplied the following.

"I graduated from Canterbury College, University of New Zealand, in 1948 with an MSc in physical chemistry, which was supervised by (then) Associate Professor Hugh Parton. The topic of my thesis (prophetically) was "The effects of neutral salts on the rate of ionic reactions in solution". From this I learnt that differences between sodium and potassium ions in aqueous solution were very small indeed. After lecturing for two years in the Chemistry Department at Canterbury College, I went with a Royal Institution Scholarship to the Davy-Faraday Laboratory, which at that time was directed by Professor (later Sir Eric) Rideal. Here began my interest in surface effects and ended (with my PhD) my career as a pure chemist.

"Ten years later, when our second child started school, I became part-time research assistant to Professor J R Robinson in the Department of Physiology, University of Otago Medical School. Here I learnt, on the first day, that the differences between sodium and potassium in aqueous biological systems are extreme and of far-reaching biological importance. Armed with these two pieces of apparently conflicting information about the properties of sodium and potassium ions in aqueous solution and, with my interest in the effects of surfaces on water, I began my long-lasting involvement with the possible mechanisms cells use to control their ionic composition of high potassium and low sodium on one side of a slightly permeable membrane just 5nm thick, the other side of which is bathed by a solution which is high in sodium ions and low in potassium ions.

"From this time onward I have been very generously supported by the Medical Research Council of New Zealand. In 1973, Dr Glen Metcalf (another chemist) of Christchurch and I were appointed the first Career Fellows of the MRC.

"In 1966 we came to Auckland, where I joined first the Department of Cell Biology, and then the Department of Medicine where I have been ever since, in pursuit of my sodium/potassium ion paradox. Last year I had the misfortune to identify a non-biological aqueous system which closely resembles a water-enzyme binding cavity, and which shows a selectivity towards sodium ions relative to potassium ions which at least equals that of any biological system; this leaves me with much less to think about while I wash the dishes but fortunately the solution chemistry of this new water is both complex and surprising."

A C Kennett Award 1986

The A C Kennett Award for 1986 was presented to Mr D W Postins of Air New Zealand for his paper "Deterioration of Plastics in the Aircraft Industry". This paper described the use of plastic materials in aircraft, methods of testing and some of the interesting degradation effects that have occurred including the crazing of flight deck windows due to specific atmospheric conditions. A very interesting paper dealing with a topic fully in line with Arthur Kennett's specific interests.

This is the third year that the Award has been available and in some respects it is disappointing that the number of papers offering for the Award is still small — this year only three papers were considered, 2 from New Zealand and one from Australia. The award consists of a framed certificate and a cash sum of approximately $250 and is therefore a worthy prize. To be eligible papers must have as their principal theme "corrosion" and "non-metallics" but the Judges are allowed a degree of latitude after this condition has been fulfilled. For example a paper dealing with coating systems would probably be acceptable provided the paper dealt with the coating system rather than the substrate.

The Award Committee would be pleased to receive papers from NZIC members.

OBITUARY

Malcolm M. (Bob) Burns 1910-1986

KBE, MSc(NZ), PhD(Aberdeen), HonDSc(Cant), FRSNZ, FNZIC, FNZIAS.

The death on 17 October of Sir Malcolm Burns ends a career which embraced an unusually wide range of service to science, agriculture and the university system in New Zealand. Indeed it would not be easy to match it.

Bob Burns was born in Rangiora in 1910 and educated at its High School in the notable era of J E Strachan's headmastership. At Canterbury College, he studied botany and chemistry — his MSc thesis in botany having a strong chemical flavour. With a post-graduate scholarship, he pursued soil science at the Macauley Institute and graduated PhD at the University of Aberdeen. A Commonwealth Fund Fellowship (now Harkness Fellowship), gained at the same time as another distinguished New Zealand chemist, Jim Melville, took Burns to Cornell. On his return to New Zealand in 1936, he investigated the possibility of tung oil production in Northland, for a short time, and then spent 11 years (1937-48) as senior lecturer at Canterbury Agricultural College (Lincoln College). After a brief term as Director of the New Zealand Fertiliser Research Association, he returned to Lincoln as Principal in 1952. For 22 years, he presided over New Zealand's senior agricultural college. This was the period in which the university system was developed and transformed. Burns guided Lincoln's development into a faculty of full university status with a staff of quality in teaching and research.

In these years he was president of both NZIC (1956) and the Royal Society of New Zealand (1974-77); chairman of the DSIR Council (1959-63); on the committee of Vice Chancellors of the New Zealand Universities and the Nuffield Advisory Committee for New Zealand; and chairman also of a Committee on Nuclear Energy. His memberships included the National Development Council, the Hellaby Institute, the Cawthron Institute Trust Board, the South Island Beech Forests Council, the National Museum Council and the Vernon Willy Trust Board. He was a trustee of the Norman Kirk Memorial Appeal Fund, advised the Department of External Affairs on Colombo Plan projects, and was a Fellow of both ANZAAS and the Institute of Agricultural Science. His war service was with the 8th Independent Mounted Rifles (1942).

This wide range of interests reflects Bob Burns' enthusiasms and his willingness to serve. He belonged to an older generation of scientists who were proud of their versatility and proud to serve a wider public. His personality was of great help in his outside work, because his warm enthusiastic manner allowed him to be at ease with people of any age and from all professions or none.

(H N Parton)

NOTICES

INTERNATIONAL BI-CENTENARY CONFERENCE OF THE RACI—NZIC, Hobart, January, 1988

With the Conference Theme: Chemistry Today for Tomorrow's World, a first joint conference of the RACI and NZIC is to be held in Hobart, Tasmania, January 19-25, 1988. The programme will include plenary and other lectures, poster sessions, excursion visits to industries and government science establishments and pre- and post- Conference tours of Tasmania. The lecture programme has been arranged for the period 19-22 January and will cover presentation and discussions in the following provisional topic areas as relating to the work of chemists and the profession of chemistry:

- chemistry in agriculture
- chemistry in the pulp and paper industry
- education policies for chemistry
- energy and mineral chemistry
- food chemistry
- government - industry science policy
- hazardous chemicals in transport and handling
- marine chemistry
- drugs, natural products and essential oils
- waste management and environmental matters

A trade exhibition will also be held.

A first circular, with reply card inviting expressions of interest in these or other areas, will be circulated shortly.

Correspondence should be addressed to:

Dr. J. Bonham, ARACI,
Secretary,
RACI-NZIC Conference,
P.O. Box 405,
Sandy Bay, Tasmania,
7005.

IUPAC Recommendations

Comments are invited on the following IUPAC recommendations. Copies of the synopses and further details are available from the General Secretary, NZIC, P.O. Box 29-183, Christchurch. The closing dates for comments are indicated in brackets alongside each entry.

Recommendations for EPR/ESR Nomenclature, and Conventions for Presenting Experimental Data in Publications (September, 1987).

Detailed Linear Representation of Reaction Mechanisms (August, 1987).

UNIVERSITY NEWS

Auckland

Dr Bernie Swedlund retired at the end of 1986. Bernie joined the Chemistry Department as a lecturer in 1958, having graduated MSc from Victoria University College in 1943 and PhD from University College, London, in 1955. He brought to Auckland experience in physical organic chemistry, an area which hitherto had not been one of the strengths of the department.

As a teacher of mechanistic organic chemistry he has had few peers, instilling into his students a real desire to understand the subject. At the same time he has also taken a close interest in the welfare of his students.

For many years, "Swed" has given long and devoted service as an advisor of students, as a member of the Staff-Student Consultative Committee and, especially, as the Departmental Library Liaison Officer. He has a fine appreciation of good wine, a close interest in University affairs, and a love of good music. Related to this latter interest was his office as Treasurer for the Auckland University Singers from their inception in 1971 until 1985.

His forthright but always enthusiastic and friendly attitude will be missed by his colleagues. We wish him well in his retirement and look forward to continuing contact with him in the years ahead.

Massey

Dr Alfred Gartner, a postdoctoral fellow in the Department for the last twenty months, has moved to a similar position at the University of British Columbia.

Dr Ted Baker attended a Metal Ions in Biology Gordon Conference, held in Santa Barbara in late January. He presented a paper on the single crystal X-ray structure of lactoferrin.

Dr Mike Hardman has gone to Melbourne for his sabbatical leave.

The Department was pleased to welcome **Dr P. Healy** from Griffith University who addressed a seminar on "The Structural Chemistry of Univalent Metal Compounds".

Canterbury

Dr Andrew Abell has taken up his position as lecturer in Chemistry. After completing his Ph D at Adelaide University, he spent two years working with Professor A R Battersby at the Cambridge Chemical Laboratories. Dr Abell plans to work on the synthesis of enol lactones and their applications as potential serine protease suicide inhibitors.

Dr Murray McEwan returned in December from study leave at Caltech's Jet Propulsion Laboratory, where he studied the association of ions and molecules in plasmas and interstellar clouds.

Professor Leon Phillips has left to spend study leave at Rice University.

Dr K F Mok, Associate Professor at the University of Singapore, is spending part of his sabbatical leave in the department. Dr Mok is a graduate of Victoria University of Wellington.

The marine chemistry group, led by **Drs John Blunt** and **Murray Munro** has received a further $165,000 for 1987 from SeaPharm, and a grant of $1,753,000 over five years from funding by the U.S. National Cancer Institute through SeaPharm. The NCI grant will be used to collect marine sponges, ascidians and bryozoans from New Zealand and Fijian waters. These organisms will be screened for anti-viral, anti-fungal and anti-cancer agents, and the Canterbury group will continue its work on the isolation and identification of the active compounds.

Otago

Dr Lyall Hanton has gone on leave for 9 months doing preparative work with **Dr Bill Levason** at Southampton University and then 3 months back at Cambridge with **Dr Malcolm Gerloch** to look at crystallographic problems.

Two research students have recently completed PhDs and have gone to postdoctoral positions abroad. **George Slim** has gone to Cambridge to work with **Dr A B Holmes** and **Steven Lorimer** is working with **Professor Michael Benn** at the University of Calgary.

BOOK REVIEW

ORGANIC MARINE GEOCHEMISTRY

Ed. Mary L Sohn
American Chemical Society Symposium Series, No 305
Washington, 1986, 428pp.
$(US)89.95

"Organic Marine Chemistry" is a collection of papers from the ACS Meeting in Miami Beach, Florida, in April/May 1986.

The editor has selected papers covering a wide range of topics. Marine has been interpreted to mean anywhere from deep-sea to estuarine and saline-lake environments. These features together with the multi-disciplinary approach of many authors leads to a book of much wider appeal than the apparently specialised title might suggest.

The 23 papers are divided into 6 general areas. The first section deals with "molecular markers", compounds diagnostic of particular depositional environments or biological origin. There is a heavy reliance on GC-MS data which is then used to interpret early diagenesis of chlorophyll, fatty acids, polysaccharides and sterols. Humic substances are considered in the second section which includes 2 papers on NMR studies. Will New Zealand's recent investments in high field NMR prompt interest in environmental chemistry? The widespread importance of humic substances is such that they are considered elsewhere by several authors. Thirdly, 5 papers cover organic pollutants. The studies consist of environmental distributions of various contaminants, with PCBs well represented. Again analyses are largely by GC-MS. Volatile organics are considered in the fourth section. Case studies are presented for the biogenic evolution of methane and poly-bromomethanes. A rather limited section about organosulphur compounds is included. One paper deals with the biogeochemistry of thiols and another outlines speciation analyses by polarography. A major omission is a chapter on dimethyl sulphide. The final section is about organic-inorganic interactions, with content ranging from handling mixed ligand complexes in thermodynamic speciation models to experimental studies of the effect of humic material on plutonium speciation.

As is usually the case with symposia collections, the scientific content of the papers varies in quantity and quality but the overall impression is good. Subject matter does range from theoretical modelling through analytical techniques development to routine monitoring-type studies. With such a variety of topics presented, virtually anyone interested in marine chemistry or the early diagenesis of sediments should find something of interest. Selected chapters would appeal to specialists but, hopefully, general perusal of the book will lead to some cross-fertilisation of ideas.

Despite the camera-ready format of the papers, a high standard of presentation has been achieved. The cost is likely to deter purchase of personal copies but libraries with an interest in marine science should consider this book a necessary acquisition.

S J de Mora
Chemistry Department
University of Auckland

INDUSTRIAL NEWS

New Zealand Aluminium Smelters at Tiwai have welcomed three new laboratory staff. **Stuart Keir** from Auckland, **Robert Leadbetter** from Wellington and **Lisa Ackland** also from Wellington.

TELARC assessors have been active in the Invercargill area reassessing the Southland Catchment Board and conducting signatory interviews at both the SCB and NZAS.

In Auckland, **Alan Rohde** has moved from Rohm & Haas to Chemiplas Agencies.

Branch Chairs Cont.

Keith has served on the Otago branch committee for several years and was conference treasurer in 1982. He is also a member of the National Committee for Oceanic Research and a member of several international scientific committees concerned with marine chemistry.

His outside interests include being a swimming coach, messing about with microcomputers and enjoying the continued improvement of NZ wines.

GOVT DEPTS & RESEARCH INSTITUTES

DSIR, Applied Biochemistry Division

Dr Cam S W Reid, Director of ABD since 1983 is retiring at the end of this month. Dr Reid started his career at Plant Diseases Divison, DSIR in 1940 and over the next four years completed his BSc at Auckland University College. In 1944 he moved to Otago University where he was a Scientific Research officer for the MRC. As part of this work he completed his MSc in 1946. He then moved to the Wallaceville Animal Research Station, Department of Agriculture, where he worked for seven years on the pathogenesis of liver diseases in sheep. Dr Reid then transferred in 1954 to the then Plant Chemistry (now Applied Biochemistry) Division of the DSIR in Palmerston North. During the period 1958-1962 he studied for his PhD at the Physiology Laboratory, Cambridge Uniersity.

A major aspect of Dr Reid's work has been the study of legume bloat in cattle. He came to the problem in the early 1950's with a background in physiology and pharmacology and contributed these skills to the team effort which identified persistent foam in the rumen as the cause of the disorder. This concept is so well established now that it is difficult in hindsight to appreciate the significance of the finding at the time. The benefit was not immediate, but the concept lead to the testing of anti-foaming materials and ultimately to new and successful methods that have saved the dairy industry millions of dollars.

In subsequent years Dr Reid has developed his interests in the physiology of ruminant and other herbivore digestive systems. He has been a leading light in establishing ABD as a World centre for the study of ruminant digestion; a programme that still attracts many well-known visiting scientists. Dr Reid's term as Director has been notable for his interest in and fostering of younger scientists and his drive to maintain academic excellence during a period when science has been under attack by the cost accountants.

Dr Reid has been associated with many scientific societies through his career and is a Life Member of the Nutrition Society of NZ and a Fellow of the NZ Institute of Agricultural Science. He has also been closely associated with Massey University for many years as an Honorary Lecturer. Dr Reid was awarded the Hector Medal of the Royal Society of NZ for his work in digestive physiology of ruminants in 1977 and elected a Fellow of the Royal Society of NZ in 1978.

During his retirement Dr Reid plans to form a close association with the Veterinary Faculty at Massey University and perhaps to complete some of those papers he was diverted from finishing during his term as Director.

(Dr Marc Ulyatt)

Mr Murray Fisher, Scientist-in-Charge of the Analytical Laboratory, resigned from the Division in January to move south to Ashburton. For the past six years Mr Fisher has specialised in protocol validation of analytical methods and developed computer assisted quality control aspects of automated equipment. A highlight of his analytical work was the month that he spent in the Analytical Chemistry Department of the University of New South Wales studying computer optimisation of high performance liquid chromatography mobile phases. Mr Fisher will be setting up his own computer service business, offering word processing, spreadsheet and data base facilities. Eventually he will provide computer assisted design (CAD) services for small industries, particularly in the area of light engineering.

Dr Julian Lee will take over Mr Fisher's role as TELARC signatory for the Analytical Laboratory.

Miss Pauline MacDonald recently worked for six months with Dr Kieron Scott at the Centre for Recombinant DNA Research at the Australian National University, Canberra. Miss MacDonald used cloned *R. trifolii* nodulation genes to identify and clone nodulation genes from a *Rhizobium* strain that has the capacity to nodulate and fix nitrogen with the non-legume tree *Parasponia*.

At the end of December, 1986, **Dr Clive Pankhurst,** Leader of the Biochemistry and Microbiology Group, left the Division to work in the Soil Biology Section of the C.S.I.R.O. Division of Soils in Adelaide. For the past eighteen years Dr Pankhurst has studied aspects of the symbiosis between a given *Rhizobium* strain and its legume host, in particular the identification and characterisation of the *Rhizobium* genes involved in nodulation and nitrogen fixation. In Australia he will be studying fungal root diseases of wheat and their control through the use of various soil bacteria.

DSIR Chemistry Division, Gracefield

Hugh Brewerton retires from Chemistry Division this month. Hugh was the Group Leader responsible for the Food, Pharmaceutical and Toxicology sections and coordinated the work in the food chemistry area for the three branches of the Division.

Hugh originally joined the Public Service in 1947 and later completed an MSc with 1st Class Honours in Chemistry at the Victory University College. Apart from a period with the Patent Office of the British Board of Trade from 1959-1964, Hugh spent the remainder of his career with the Dominion Laboratory and Chemistry Division. He worked mainly in the areas of organic, pesticide and food chemistry.

We all wish Hugh well in his retirement.

DSIR Chemistry Division, Christchurch

Dr Jeff Plowman, Canterbury Branch Secretary, has been on holiday in Australia and took the opportunity of visiting laboratories to further his interest in meat speciation.

Wool Research Organisation of New Zealand

Dr Campbell Page and family have recently departed for the USA. Dr Campbell is on secondment to the Wool Bureau (US Branch of the International Wool Secretariat, Atlanta, Georgia) for a period of 6 months initially. His principal objective is to assist the bureau with the introduction of new techniques relating to the setting of wool yarns for continuously dyed carpets.

MOWD, Hamilton

Mike Fox, Canada Centre for Inland Waters, recently arrived on an exchange visit. He will be working with **Dr Bob Wilcock** for the next 12 months on a pilot study examining pesticide run-off from horticulture and agriculture. Mike's speciality is the analysis of trace amounts of organic pollutants in water, sediments and biological tissues.

Conferences

(Further details on the following are available from the Editor)

ASCHEM Seoul (Asian Chemical Congress '87)
Challenge in Chemistry for Asian Development, June 29 - July 3, 1987, Seoul, Korea.

RACI 8th National Convention
University of New South Wales, August 24 - 29, 1987, Sydney, Australia.

International Symposium on Copolymerisation (in conjunction with RACI 8th NC above)
August 24 - 29, 1987, Sydney, Australia

7th IUPAC Conference on Organic Synthesis
July 4 - 7, 1988, Nancy, France.

Australian Conference on Lasers & Spectroscopy

Experts from the United States, Europe, Japan, South East Asia and Australasia, together with other specialists, will speak at the Australian Conference, organised by UniQuest Conference Systems will attract 500 delegates and key speakers.

Themes addressed by the speakers will include laser devices and applications, non-linear optics and quantum optics, molecular dynamics, interaction induced spectra, spectra of solids and surfaces.

Included in the conference will be four separate workshops: Laser and Spectroscopy in Medicine, Applictions of FT-IR Spectroscopy, Laser Applications in Industrial Materials Processing, and Laser Remote Sensing.

An extensive exhibition of lasers, laser related and spectroscopic equipment will be a feature of the conference. All Australian manufacturers of such apparatus are expected to attend and many major overseas companies will be represented through their agents.

Chairman of the Organising Committee, Dr David James from the University of Queensland, believes the ACOLS '87 Exhibition will be the largest display of lasers ever held in Australia and the Conference will facilitate fruitful liaison between scientists, technologists and the laser industry.

He also stressed the importance of the four workshops covering rapidly developing areas of science and technology. These will be of interest to anyone wishing to become familiar with the fields and will provide both an introduction and a representative coverage of each field.

Date: 11-15 May, 1987
Venue: Chevron Paradise-Surfers Paradise Queensland
Cost: $100 per workshop or $135 for five day conference (including workshops)
Contact: Julie Bartley, UniQuest Limited, (07) 377-2733.

A HAZARDOUS MATERIALS IDENTIFICATION SYSTEM FOR THE NEW ZEALAND PAINT AND COATINGS INDUSTRY

Alan Sheath, Chief Chemist, Lusteroid Paints Ltd

In recent years we have seen a heightened interest in occupational health and safety in the paint and coatings industry. One result has been a recognition of the need for employers to inform their workers of the hazards associated with the performance of the employee's job.

At Lusteroid Paints we have instituted the in-plant Hazardous Materials Identification System (HMIS) developed by the US National Paint and Coatings Association in conjunction with the Canadian Paint Manufacturers. This is a proven system that uses simple combinations of colours, numbers and pictures to tell our staff what hazards they are likely to encounter with the multitude of substances used in the making of paints and coatings, and what specific protective equipment is necessary to avoid injury and illness.

We are actively promoting the idea that this system be adopted as a standard by the New Zealand paint and coatings industry, and so far we have received a favourable response.

With so many raw materials being used in the paint and coatings industry (up to 20,000 different substances), the problem exists for manufacturers to identify any hazard associated with their use. Hazards may range from those with severe immediate impact, such as acute over-exposure to solvent fumes or drying of the skin from solvent exposure; to more subtle health effects such as sensitisation to isocyanates. Long term or chronic effects from certain solvents or pigments must also be included.

However, any identification system must accurately and concisely communicate hazard details without inundating the employee with so much information that the hazard warning is lost.

The HMIS is a standardised way of telling employees at a glance what kind of hazard each material presents, and how to protect themselves during handling. Raw materials imported from North America already use this system and we have asked raw materials suppliers in New Zealand to adopt it also and to asign hazard ratings to their products. Health, flammability and reactivity ratings are determined using data from material safety data sheets.

Posters summarising the HM15 system are displayed in key positions around the plant.

All of the raw materials in our plant have a four-colour label on their packaging. This is the visual element of the system and is designed to communicate to the employee the relative degree of hazard presented by the raw material. Each of the colours stands for a specific kind of hazard and the number in that colour indicates the seriousness, or the degree, of the hazard.

The blue section at the top indicates the overall level of health hazard from contact with the material. Hazards are assessed by a five-tiered scale ranging from 0 to 4. A "0" denotes a minimal hazard, while a "4" is a severe hazard.

The red part of the label indicates the flammability of the material — again on a scale of 0 to 4. Materials rated at 4 are flammable even at room temperature. All other ratings require the product to be heated to a certain degree for it to burn.

The yellow part of the label rates the reactivity of the material — its likelihood to explode. Most materials used in the paint industry are rated zero, which indicates that they are chemically stable even in fire. Materials rated at 4 may explode at normal temperatures and pressures.

The white part of the label refers to the safety equipment to wear when handling that particular material. Each of the letters used in the personal protection section represents a specific combination of personal protective equipment. Employees must wear that combination whenever handling that material.

For example, B means safety glasses and gloves are required to handle the particular product safely. If marked F, gloves, splash goggles, a synthetic apron and a respirator that filters out both dust and vapours are required. Items marked X require special handling under the direction of a supervisor.

The HMIS visual codes virtually eliminate confusion over how materials are to be handled.

At Lusteroid Paints we introduced the HMIS programme along with a thorough education and training system to explain it to all employees.

Each staff member also received a wallet-size information card, which is to be carried at all times while working in the plant. Posters with the personal protection index and hazard rating scale are also displayed all over the plant. Both the wallet card and the posters are there so staff can check the meaning of the rating or personal protection code at any time.

With HMIS we are making sure every possible effort is made to protect employees from sickness and injury. We are confident this svstem will be a success, for both our employees and for the company. Better worker protection and a safer working environment mean not only improved staff morale but also reduced down-time and lost production time.

CONSULTANTS

Analytical chemist **Malcolm Smith** has joined W Grayson & Associates as group manager nal Sprott company who left at the Grayson takeover, and who has returned to a familiar group of skilled workers to head the new geochemistry division.

Malcolm Smith was a BSc from Auckland University and from there he joined the Sprott laboratory in 1970 as an analytical chemist. He worked his way up to be the geochemistry section manager, with special responsibility for getting the fire assay department "up and running". He is a member of the NZ Institute of Chemistry and an associate member of the Australian Institute of Mining and Metallurgy.

Chemby bought out the Sprott Laboratory in 1982 and Malcolm became laboratory manager of Anatech with five departments to run. When Bill Grayson bought the company from Chemby, Malcolm did not go with the deal, and in fact he went to Analabs in Newmarket. Now he's back with the original group, largely intact in spite of its changes of ownership.

NOTICE

Thermal Analysis Users Group

The growth of Thermal Analysis in all its various forms has been rather haphazard in New Zealand and there has been little contact between users. The Chairman of the Education Committee of the International Confederation of Thermal Analysis (ICTA), Dr Edith Turi has offered assistance to a local users group which could be affiliated to ICTA. She could provide both educational and promotional material as well as provide contacts overseas. One important use of thermal analysis not well covered in New Zealand is in the developing area of plastics.

To do this though we need to know who is interested and what equipment is available in the country. Would anyone who has any form of thermal analysis equipment such as DTA, TGA, DSC, TMA, EGA, or even calorimeters please contact:

Dr N B Milestone
Chemistry Division
DSIR
Private Bag
PETONE
Phone 690 673

DIGILAB FT - IR SPECTROMETERS

INFRARED SPECTROSCOPY — FT-IR

With the availability of Fourier Transform instrumentation, infrared spectroscopy has emerged from its role as a back bench qualitative technique, into a new light as a well respected analytical tool.

FT-IR is much more than a modern method of acquiring infrared spectra as it provides an entirely new set of spectroscopic tools.

The two principle spectroscopic advantages enjoyed by Fourier Transform instruments, namely Fellgett's (1) "FT detects all spectral elements simultaneously" and Jacquinot's (2) "fast optics and no slits in an FT instrument", are more than theoretical constructs. They provide the basis for the revolutionary advances in the problem solving capabilities of infrared spectroscopy over the past few years.

The multiplex advantage, seen by Fellgett, means very high signal-to-noise ratios can be obtained by accumulating the required number of interferograms. The throughput advantage, described by Jacquinot, results in much more energy being available in the sample compartment. Together these advantages have enabled the development of a variety of new sampling methodologies such as diffuse reflectance, photoacoustic, and microscopic spectroscopy which are additional to the enhancements to old problems such as thin films, thick samples, and mixture analysis.

Beyond the spectroscopic advantages inherent to FT instrumentation, there are advantages due to its computational nature. As computers continue to increase their speed and power, the ability to apply FT spectroscopic advantages to real-time tasks becomes more and more real. Modern FT instruments can keep up with capillary gas chromatography. They are being used in process control environments. They can perform kinetic and/or time-lapse studies. Quantitation with FT-IR is now routine. New mathematical tools are being developed. Correlation spectroscopy allows the measurement of "properties" and does not limit the instrument to the measurement of individual compound types. These new numerical techniques are due solely to the successful partnership of the spectroscopic and computational advantages found in FT techniques.

There's more! Since FT instruments are faster, more sensitive, more accurate, more stable and more robust than dispersive instruments, the operating staff become more productive. Not only can a larger number of samples be analyzed, but the problem-solving capabilities of the staff are extended. FT-IR naturally allows archival storage/retrieval of raw data, if desired. FT techniques are in the happy position of maturing and expanding simultaneously. On the one hand, you can be sure that FT techniques can accomplish your current tasks better, faster and more reliably than dispersive techniques. On the other hand, an FT instrument successfully applied to current problems is certain to find itself being applied to new problems as well.

WHY DIGILAB?

All of these advantages are realized in the Digilab FTS 40 and FTS 60 Series spectrometers. With these spectrometers, Digilab maintains its leadership; a position held since 1969 when Digilab delivered the first commercial rapid-scanning Fourier Transform Infrared spectrometer. Since that initial installation, Digilab has been in the forefront in the development of FT-IR instrumentation and accessories and FT-IR computational methods and software.

The optical bench of the FTS 40 and FTS 60 series spectrometers is a precision instrument designed around a robust frictionless air bearing, a 60 degree interferometer (high optical throughput), and a minimum optical path. These features coupled with the highest energy source in the industry and a very sensitive DTGS detector, give these modern instruments a baseline peak-to-peak signal-to-noise ratio of 1400:1 (rms, 7000:1) for a 1 second collection time at 1 wavenumber resolution; a sensitivity that is not approached by any other FT-IR spectrometer. The optical benches have standard resolutions better than 2 wavenumbers for the FTS 40, 0.5 wavenumber for the FTS 45 and FTS 60, and 0.1 wavenumber for the FTS 65. The spectral range of the standard optical bench is 4,000 to 400 wavenumbers. Kits and additional optical benches are available which extend the range to 15,000 wavenumbers in the near-IR and to 10 wavenumbers in the far-IR. Mylar purge windows isolate the sample compartment from the rest of the optical bench so that samples and accessories can be changed with no loss of purge in the bench itself.

The data systems that make the FTS and FTS 60 series spectrometers such high-performance tools feature Motorola 68000 chips, Idris operating systems and advanced architecture e.g. independently operating arithmetic, graphics, and spectrometer interface processors. They employ 1 Mbyte of RAM, 5¼" floppy disc drive and high capacity Winchester (up to 280 Mbyte) drives for efficient storage and spectra, applications, programmes and libraries. Both have multiple RS-232 and IEEE 488 ports for connecting to other peripheral devices and/or central computer systems such as a VAX. They come equipped with colour graphics monitors, high speed plotters, and a keyboard with 14 function keys and a joystick for data handling ease. In addition to software to collect and process "normal" IR data, these Digilab systems come complete with software capable of handling GC-IR experiments, sophisticated library search and identification tasks, and quantitive analyses of complex mixtures. All of these software features can be used in a menu driven mode so that inexperienced users can obtain optimum results. More experienced users can use Digilab's high-level spectroscopist's language for more flexible operation.

Digilab FTS 40 and FTS 60 series spectrometers can be used with a wide range of accessories for application to almost any sampling requirement. An external sample compartment provides for multiple experiments to be set-up and/or left in place for long periods of time. Sample accessories available include:

- GC-IR for coupling high-performance capillary GC with IR;
- Universal Microscopes for both transmittance and reflectance analysis of hairs, fibers, flakes, chips and spots on large objects;
- Diffuse Reflectance for samples such as powders, grains, minerals and catalysts;
- Liquid ATR (Cylindrical and Prism) for highly absorbing solutions;
- Solid ATR for highly absorbing and scattering solids such as rubbers and carbon-filled polymers;
- Photoacoustic spectroscopy for difficult solids such as moulded parts, catalytic surfaces, and ceramics;
- Specular and Grazing Angle Reflectance for analyzing coatings and surface deposits;
- Gas cells;
- LC-IR flow cells.

As FT-IR advances, more techniques advance from the laboratory to routine use. Digilab engineers, and chemists and scientists using Digilab instrumentation are at the forefront of these developments. The open architecture design and experimental adaptablity of Digilab spectrometers means that the FTS 40 and FTS 60 series spectrometers are capable of implementing a number of advanced techniques including emission spectroscopy, skin analysis, double modulation and vibrational circular dichroism, and thermogravimetric analysis/evolved gas analysis.

The Sadtler comprehensive range of IR spectral libraries is also available from Digilab as both Sadtler and Digilab are now divisions of Briorad Laboratories, U.S.A.

References:

(1) P.B. Fellgett, J. Phys. Radium, 19, 187, 237 (1958)
(2) P. Jacquinot, 17e Congres due GAMS, Paris, 1954.

For more information on how Digilab FTS 40 and FTS 60 series spectrometers can apply the power and flexibility of FT-IR to your analytical needs, circle **49** the reader reply card.

PRODUCT NEWS

New Oil Mist Filters for Vacuum Pumps

Edwards High Vacuum International has introduced a new range of oil mist filters featuring replaceable elements, a sight window and a built-in odour eliminator. Designated EMF3, 10 and 20, the filter sizes match the Edwards' range of oil-sealed rotary vacuum pumps from E2M1.5 to E2M18. An hermetically sealed version of the largest filter is available, the EMF20HS.

Filter elements can be easily replaced. Use of the activated charcoal odour element is optional but is recommended to neutralise oily smells from the pump's exhaust. A clear area in the lower half of the filter body shows when collected oil should be drained. An accessory allows this oil to be automatically returned to the vacuum pump.

Made in a strong nylon based material, the filter bodies are resistant to many solvents and are safe for use with azides. NW10 or NW25 connections make them compatible with most manufacturers' rotary pumps, and an NW to BSP adapter is included for connection to Edwards' pumps.

The units are available through Salmond Smith Biolab Ltd, Wilton Instruments Division.

For further information please circle no. 7 on reader reply card.

Hood for protection from toxic substances

Sold in New Zealand through Kempthorne Medical Supplies, the CAPTAIR is a fume hood equipped with a filtration system so efficient that the air it recirculates into the room is totally pure. Air is purified in the room at a rate of 2.8m^3/min. CAPTAIR hoods are mobile, modular, and economical. The CAPTAR does not need any ductwork. No installation is required and it is usable without delay. These hoods are for handling toxic substances such as toluene, hydrogen sulfide, alcohol, xylene, ethylene chloride, pyridine, formaldehyde, and osmium tetroxide. The hoods are particularly useful when a problem with toxic gases (solvents, acids, fumes, odors) occurs. CAPTAIR hoods do not consume heat or cool the air. They have been sold in Europe and Japan since 1970, and 20,000 are in service throughout the world. A detailed product bulletin is available from Kempthorne Medical Supplies, PO Box 1234, Auckland.

For further information please circle no. 8 on reader reply card.

Northrop Instruments and Systems Limited offer a new model 3-100 portable total hydrocarbon analyzer

A portable total hydrocarbon analyzer model 3-100 has been added to the J.U.M. instruments offered by Northrop. Possible applications of this equipment include the following:

LEL Monitoring: Monitors solvent laden air streams in coating machines, printing machines, or curing ovens, for the safe operation of the equipment near the LEL (Lower Explosive Limit).

Vehicle Exhaust Monitoring: The 3-100 is ideal for vehicle exhaust monitoring **inside of the vehicle during driving.** It analyzes for total unburned hydrocarbons in the exhaust gases and provides for verification of emission control compliance.

Safety: The 3-100 monitors work areas to detect leakage of dangerous fumes. It measures concentrations of fumes in solvent and fuel storage areas, and in natural gas supply systems.

Incinerator and Carbon absorption system performance: The 3-100 monitors hydrocarbon exhaust emissions to ensure compliance with environmental regulations and to provide information with which to determine combustion or capture efficiency, and avoid premature regeneration.

Some of the features of the instrument are listed below.

- ** The 3-100 uses a hydrogen flame ionization detector (FID) in a heated oven which is adjustable up to 200°C. This prevents the loss of high molecular weight hydrocarbons. It also provides reliable performance in the analysis of trace levels of contaminants in high purity gases, in air, and in other gases.
- ** The 3-100 conveniently measures hydrocarbon concentrations from as low as 1ppm full-scale reading, up to 5% on a digital output display.
- ** The 3-100 has an optional built-in fuel gas cylinder that gives approximately 150 hours of independent operation. A built-in calibration gas cylinder is also available as an option.
- ** The 3-100 has its own built in combustion air supply. No extra air bottle is necessary.

For further information please circle no. 12 on reader reply card.

PRODUCT NEWS

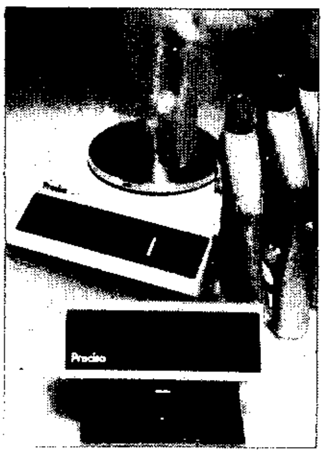
Air sampling catalogue includes expanded standards guide

Northrop Instruments and Systems Limited announces its 1987 SKC Comprehensive Catalogue and Guide for air sampling, worker monitoring, chemical hazard detection, and industrial hygiene. The enlarged 78 page publication gives the complete line of equipment for air sampling and analysis. Included are sorbent tubes and accessories, long-duration colour detector tubes, sample bags, calibrators, filters, impingers, gas monitoring badges and constant flow pumps — featuring our new computer controlled pump. In addition, a personal cascade impactor, a parallel flow impactor and a complete line of air flow meters has been added to the '87 catalogue.

The catalogue contains an expanded and updated guide to NIOSH, OSHA, and EPA air sampling standards. The guide lists over 1700 established NIOSH/OSHA procedures for sampling and analysis of organic compounds covered by air sampling standards. For each chemical hazard the recommended SKC collecting equipment is identified and indexed.

In addition to enabling the Industrial Hygienist to quickly evaluate and select equipment that meets specific air sampling needs, the new catalogue explains operation principles and offers an expanded line of industry reference books.

For further information please circle 4 on reader reply card.



New readout comfort with PRECISA 280 series

There are now two alternative display stations available for the new PRECISA type 280 balance. The remote display with cable connection can be adapted to suit any workplace. The elevated display fixed permanently to the back of the balance makes reading off easier, especially when weighing large objects. Stop control is integrated in both floating displays with 7-segment fluorescent display.

These new display variants, perfectly matched to the superior design of the 280 series, go still further in meeting the demands of weighing practice for precise readout reliability. All 13 models, covering the weighing range from 160g/0.001g to 12kg/1g, can be fitted with the new displays.

In general, the 280 series with its specific features has proved itself in practice. Its low profile and generous round or square weighing pans are perfect for weighing their respective weight ranges. A variety of analog and digital data outputs ensures compatability with DP systems. The new soft-touch tare key not only enables various functions and settings to be adjusted, but also fully-automatic calibration to be carried out. Proven PRECISA specialities such as the multi-function box for special weighing programmes, the unique capacity display and below-the-balance weighing equipment fitted as standard are all still part of the well-thought-out equipment of this quality Swiss product.

For further information please circle no. 9 on reader reply card.

New ISCO Catalogue from Wiltons

Just received from ISCO, USA, is their NEW catalogue, number 2, illustrating liquid chromatography (LC), and electrophoresis equipment. This full colour catalogue illustrates their classical LC and electrophoresis equipment in full details with easy-to-read descriptions, clear, colourful illustrations and extensive use of chromatograms as examples.

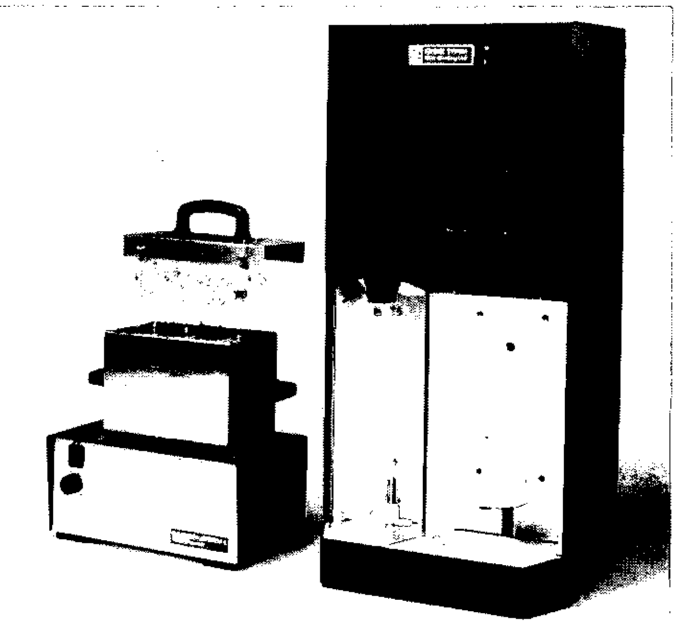
ISCO's Catalogue 22 introduces two new instruments which have recently been released. The new equipment includes:

* Retriever IV, large linear fraction collector
* peak collection instruments

Other equipment detailed includes:

* multiwavelength detectors
* gel scanner
* fraction collectors
* peak collection instruments
* Wiz smartpumps — peristaltic and piston
* Tris peristaltic pump
* concentrator electroelutor
* electrophoresis power supplies
* recorders

For further information please circle no. 10 on reader reply card.



A new distilling unit for Kjeldahl and other steam distillation analyses

A typical Kjeldahl distillation takes only about four minutes with the new 1026 Distilling Unit, which perfectly matches the needs of a laboratory performing 10-50 samples per day. The 1026 Distilling Unit, which is very safe and easy to operate, is a result of Tecator's long experience and know-how in manufacturing Kjeldahl equipment. It can be combined with any of our well-known digestors to perform accurate and fast Kjeldahl analyses.

Dilution of the sample with water, dispensing of alkali, and steam distillation for preset time are automatically carried out by simply closing the safety door after placing a test tube in the unit. All steps are microprocessor controlled and indicated with LED's. The Steam generator heats up and is ready to use in just a few minutes. It can be fed with either distilled/deionized or tap water by the built-in pump, which also allows automatic dilution of the sample prior to the distillation.

Parameters such as alkali volume, delay and distillation time are easily preset with panel controls. This makes the 1026 Distilling Unit a flexible and universal apparatus, suited not only for Kjeldahl but for many general steam distillation analyses.

Tecator are represented in New Zealand by Salmond Smith Biolab Ltd, Wilton Instrument Division.

For further information please circle no. 11 on reader reply card.

New columns for high performance aqueous GPC

A new family of seven Ultrahydrogel columns containing hydrophilic polymer gels for high performance aqueous gel permeation chromatography (GPC) is being introduced by Waters Chromatography Division of Millipore Corporation.

Waters Ultrahydrogel columns are designed for aqueous GPC applications to characterise water soluble polymers used in manufacturing adhesives, foods, drugs, cosmetics, pulp and paper, textiles, and paints and coatings, as well as being used in water treatment and oil recovery.

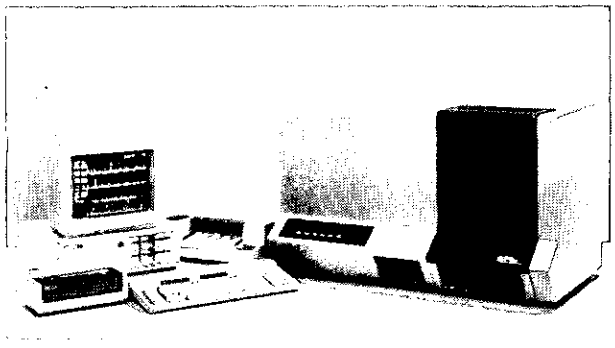
Based on a methacrylate resin, Waters Ultrahydrogel columns are compatible with all aqueous mobile phases and water soluble polymers such as polysaccharides, polyacrylates, polyvinyl alcohols, polyamines, and soluble starches, cellulosics and gelatins.

Waters Ultrahydrogel columns have a small particle size and higher efficiencies than conventional aqueous gels. They are available in pore sizes ranging from 120 Angstroms to 2000 Angstroms, as well as a linear configuration, to ensure high resolution over a wide molecular weight range. An optional guard column also is available. The Ultrahydrogel packing chemistry is durable and stable over a 2-12pH range for longer column life, more versatility in mobile phase selection, ability to solubilize polymers, and for low adsorption to more accurately calculate molecular weight distributions.

Waters Ultrahydrogel columns are available from Alphatech Systems Ltd.

For further information please circle no. 13 on reader reply card.

PRODUCT NEWS



The Applied Biosystems Model 370A Sequencing System

Applied biosystems introduces automated DNA sequencing

The new Applied Biosystems Model 370A DNA Sequencing System is the first instrument for automated analysis of products from dideoxy sequencing reactions.

The 370A is a complete system composed of an electrophoresis-detection unit and a data station includes hardware and software for data display and interpretation.

The use of a different fluorescent dye label for each of the four bases allows sequences to be determined using a single lane rather than the four lanes required when radioactivity is used. The sequence reaction products are detected during electrophoresis while they are still in the gel. Initial data are available within 1 to 2 hours of gel loading and wedge or gradient gels are not needed. Up to 16 templates or clones may be simultaneously sequenced in 8 to 10 hours on a single gel.

Applied Biosystems, Inc. develops, manufactures, and markets automated instruments and fine biochemicals which are used in biochemistry, molecular biology, and biotechnology research and applications. The company is represented in New Zealand by Alphatech Systems Ltd, Auckland.

For further information please circle no. 1 on reader reply card.

Northrop Instruments and Systems Limited introduce a new microprocessor-controlled moisture balance.

The new MB301 Electronic Moisture Balance from Ohaus cessor technology. It is designed for rapid, automatic determinations of dry weight or moisture content of aqueous solutions, adhesives, cereals, chemicals, detergents, fertilizers, paint, paper, plastics, soils, pharmaceuticals, etc.

This advanced instrument features random sample size to 300 grams, instant taring of container weights and a self-calibrating percent range. Software controlled prompting of the moisture determination sequence simplifies operation of the balance, reducing probable errors and minimizing operator training. An audible alarm indicates end of test. A microprocessor-controlled heater automatically corrects for line voltage variations. In the direct weighing mode, the unit operates as a laboratory balance with 300 gram capacity by 0.01 gram readability. An RS232 serial bi-direction interface allows computer control of the moisture balance functions and provides data output to personal and laboratory computers.

For further information please circle no. 2 on reader reply card.

The SGE CSS-4 packed-to-capillary conversion system.

Scientific Glass Engineering (SGE), of Melbourne, announces the release of a new system designed to convert gas chromatographs with ¼" injector and detectors for use with capillary columns. The kit is simple to install, yet offers the premium performance of a fully integrated capillary system with variable split injection.

As most gas chromatographs designed for use with ¼" packed columns are fitted with mass flow controllers, the CCS-4 kit includes a premium grade metal diaphragm pressure regulator to enable precise non-contaminating pressure control of the pneumatic system — an essential feature with variable split capillary injection systems.

A standard 12QC3/BP1 0.5 capillary column is also included to provide a standard by which the system capillary performance can be evaluated and for later use with actual samples; this column is a cross-linked bonded phase non-polar methyl silicon general purpose column with a 0.5 micron film thickness. For further information, quote Part *093400.

For further information please circle no. 6 on reader reply card.

A new range of standard syringes from SGE

SGE announces the release of a new range of syringes, the 10A-N family, that incorporate a range of important features, providing improved precision, accuracy, and lifetime over other, similar styles available.

Using proprietry technology, SGE is producing syringes which are leak-tight to higher levels than previously available — even to the extent of being designed for use under vacuum, and positive pressure applications. Coupling this performance with a strengthened plunger and an anti-parallex scale with white backing the operator can achieve the highest level of precision and accuracy available from syringe dispensing.

A range of needle styles is available to suit specific applications, from on-column injection in 0.53mm GC capilliary columns, to domed tipped needles for use in Rheodyne and Valco LC injection systems. Autosampler systems are also catered for, with specific high performance syringes styled to fit all popular P-E, HP, Varian and Shimadzu autosampler systems.

SGE are represented in this country by Alltech New Zealand.

For further information please circle no. 3 on reader reply card.

Hitachi scientific instruments

Alphatech Systems has assumed responsibility for sales and service of the range of Hitachi instruments with the sole exception of their centrifuges. Hitachi are leading manufacturers of —

electron microscopes; surface analysis equipment;infrared spectrophotometers; uv-visible spectrophotometers; nmr spectrometers; atomic absorption equipment; fluorescence spectrophotometers.

In each field of application, Hitachi offers a selection of instruments of varying sophistication. All are conservatively specified and built to work to specification for many years of service.

The Hitachi company has a high profile in many overseas countries including Australia with a solid user base and established service organisation. It is expected that a comprehensive marketing programme will ensure a similar situation evolving in New Zealand.

For further information please circle no. 5 on reader reply card.