

Section 1

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President's Report

2010 has been another excellent year for AINSE. AINSE membership, research output and researchers working with AINSE support have all risen in 2010.

Three institutions have joined AINSE - Victoria University of Wellington, the University of the Sunshine Coast and CSIRO – bringing the membership to 43 including 3 research establishments (ANSTO, CSIRO and GNS Science) and 40 universities including 4 New Zealand Universities. AINSE is one of few scientific institutions with such wide membership across the entire sector. .

One of AINSE's goals is to foster high quality research. An extensive review of AINSE research output over the period 2003-9 showed a 50% increase in journal output to over 200 publications per year. This work was performed by 291 holders of research awards, their students, postgraduate scholars (PGRAs) and research fellows, again a 50% increase over 2003.

Quality is high over all specialist areas with the work published in journals ranked A according to the ERA scheme. In addition, 23% of publications were in A* ranked journals. The average impact factor of journals used was 2.7 and citations were also above world norms for papers published in the physical, chemical and earth sciences.

Another AINSE goal is to develop the next generation of researchers through a succession of schemes - the Winter School for undergraduates, the PGRA program for postgraduates followed by the AINSE Postgraduate Fellowships for high quality young researchers. The Winter School continues to get excellent reviews from participants, thanks to excellent stewardship of Dr Danielle Meyrick over the last 3 years and Dr Vladimir Golovko in 2010. I thank them for their efforts. The PGRA program is also very popular. More offers were made in 2010 than ever before and the number of applications was still more than double the number of offers. The excellence of the research sponsored by this program is no more evident than in the work of Dr Sharath Sriram (RMIT) who was awarded the AINSE gold medal for excellence in postgraduate research in 2010.

To bridge the gap between the Winter school and the PGRA program, a program of Honours scholarships has been instigated, to run for the first time in 2011. We will award 10 scholarships and have received 30 applications. Finally, the AINSE fellowship scheme goes from strength to strength with two new fellows, Dr Popelka-Filcoff and Dr Dronov both working at Flinders University, but in very different fields, archaeology and biosensors respectively. The first AINSE fellows are now graduating from the scheme, with Dr Duncan McGillivray taking up a faculty position at the University of Auckland and Dr Daniel Riley joining ANSTO's Institute of Materials Research while still retaining strong links with the University of Melbourne. With the extension of the fellowships of Drs Goossens and Tehei, there are now 8 research fellows working at 6 Universities in Australia and New Zealand.

AINSE continues to facilitate applications to the ARC Linkage Infrastructure and Equipment Fund supporting access to ISIS (2008 – 2013), a beryllium filter (2009) for the OPAL reactor beamline (the first outside Europe or the US) and an ITRAX core scanner (2010) to obtain geochemical profiles in cores for environmental change studies. Australian access to ISIS - a world leading centre for neutron scattering in the UK, is coordinated by AINSE and has proved the excellence of Australian science, with Australian scientists receiving disproportionately high access and recognition at this facility.

AINSE continues to expand support for a wide range of conferences (8 in 2010) as well as



to finance initiatives, in particular support for Australian and New Zealand students to attend the regional nuclear science (AONSA) school in India.

But there are inevitable challenges for AINSE. The first challenge is to respond positively to the changing emphasis on collaborative and targeted research at ANSTO. There is a growing divide between collaboration and service provision, with ANSTO increasingly embarking on bilateral collaboration rather than linkages through AINSE. But there are also opportunities for AINSE in recent developments at ANSTO. The creation of ANSTO Life Sciences to expand research into physics of life sciences, the funding of the Australian Centre for Accelerator Science (funded by the Federal Government's Super Science initiative), the expansion of the Bragg Institute with new instruments coming on board at the OPAL research reactor and the increased support for fusion energy research are all developments within ANSTO to which AINSE is responding.

The above interactions with ANSTO are formally acknowledged in a memorandum of understanding. The existing Memorandum of Understanding with ANSTO, which expired in 2010, has extended for 1 year in order to leave time for current changes to bed down before a new memorandum is written.

The changing AINSE-ANSTO relationship is taking place in an uncertain scientific environment. For example, the proposal for full-funding of research may well have serious implications for University and hence AINSE funding. AINSE is being proactive in growing the organisation in order to be better placed to survive in this uncertain environment by, for example, exploring expanded linkages with the CSIRO and the Australian Synchrotron. AINSE has also successfully responded to the change in DIISR requirements for category 1 grant schemes. To maintain category 1 status required the merging of AINSE Research Awards and AINSE Research Fellowships schemes into AINSE Research Project scheme.

There are many people to thank for their efforts on behalf of AINSE in 2010. The AINSE secretarial staff, Gillian Blackburn, Rhiannon Still, Nerissa Phillips, Sandy O'Connor and John Studdert are the face of the organisation to our users and have done an excellent job again in 2010.

I would like to recognise the efforts of the executive – Professors Andrew Cheetham, Allan Chivas, Brendan Kennedy, Lyndon Edwards, Drs Ron Weiner, Rob Robinson and John Dodson – in meeting the challenges of 2010. I would especially thank Allan Chivas for sage advice in his role as immediate past president.

The members of the specialist committees make a large contribution in assessing applications and progress reports and giving advice on future directions for the organisation. Their input, as well as the input from our councillors, is invaluable in moving AINSE forward and I thank them for their contributions. Special thanks should also go to councillor Professor John Carver (University of Adelaide) for hosting the most recent council meeting in Adelaide.

Finally, and most importantly, in the latter part of 2010, Dennis Mather announced his retirement as from the middle of 2011. In AINSE's 50 year history, it has only had three executive officers – Bill Palmer OBE (1959-1988), Roger Gammon (1988-1998) and Dennis Mather (1998-). The success of AINSE has, in no small measure, been due to the commitment of these three executive officers over such a long period of time. We will certainly miss Dennis's outstanding contributions to the organisation as we start the search for a new CEO. On behalf of all the AINSE family, I thank him for his efforts on AINSE's behalf.

Bruce King
AINSE President

Managing Director's Report

This is my thirteenth and last annual report as managing director of AINSE, and it provides me with an opportunity to reflect on the changes which have strengthened the organisation as it moves confidently into a new decade.

Seven new members have joined AINSE since 1998, three of them in 2010: University of the Sunshine Coast; CSIRO and Victoria University of Wellington. This is no mean feat since there has been no new university established in Australia or New Zealand since the mid 1990s, and in 1998 AINSE already had all the universities which were conducting instrumental research as members. While most of the new members are in New Zealand, I believe there is still some work to do in recruiting more New Zealand members.

The average tenure of Councillors has continued to drop, from 6.5 years in 1998 to 5 years in 2010. Along with scheduled rotation on specialist committees members, this turnover ensured that AINSE is continually revitalised laying to rest the 'old boy's club' image.

In stark contrast to the turbulent years in the 1980s and early 1990s AINSE's funding base has been predictable and secure through the past decade. Average membership benefit ratios have been maintained close to, or above, the benchmark of three for a majority of the past dozen years, as well as steadily increasing income ahead of CPI. This has fed into a high level of member satisfaction over the period with very low requirement for intervention at membership renewal time.

The development of the postgraduate scholarship program has seen a significant increase in the number of postgraduate scholars, from 30 in 1998 to 80 in 2010. It has been particularly rewarding to see two PGRA alumni, and gold medalists, securing an AINSE Research Fellowship. A number of others have taken up post doctoral fellowships in ANSTO's Bragg Institute.

One of the keys to continuing success is the articulation of our programs. This year, for the first time, we have introduced an honours scholarship program as well as providing an opportunity at the Winter School for students to discuss an honours project with ANSTO's research scientists.

The reincorporation of AINSE under ASIC has given us an opportunity to rebadge the organisation, and this has coincided with redevelopment of on-line application forms, which will be introduced in 2011. The AINSE Trust has been another new development which will, I hope, see AINSE gradually develop greater financial independence.



Rhiannon Still

During the year AINSE made a submission to the House of Representatives Standing Committee on Industry, Science and Innovation inquiry into Australia's International Research Collaboration; and to DIISR's review of the Australian Competitive Grants Register.

Rhiannon Still left the secretariat in September after five and a half years at AINSE to take up a new position as Personal Assistant to Professor John Dodson, Head of ANSTO's Institute of Environmental Research. Her professional development over the past five years has been rewarding for me, personally. She has taken on all challenges and mastered them. We wish her well in her new position.

Council and Committees

I am grateful for the enthusiasm and generosity of all those who contributed to the various committees and to Council throughout the year. Their considerable input is critical to the continuing development of AINSE. In particular I thank the Councillors who have stepped down:

- Charles Darwin University's Graham Pegg who was replaced by Jim Mitroy
- University of New England's Ray Cooksey who was replaced by Annabelle Duncan
- Murdoch University's James Reynoldson who was replaced by Danielle Meyrick

Rotation of representatives on specialist committees has continued to provide fresh ideas and energy. I thank those members who retired from specialist committees in 2010: Patrick De Deckker; Michael Hay; David Bowman; Peter Healy; Chris Ling; Rachael Caruso and Andrejs Atrens.

Finances

In 2010, operating revenue of \$3,746,551 was made up of \$3,102,154 from memberships, \$392,250 from external grants, \$ 202,804 from interest, and \$49,343 from other sources, see Figure 1. Membership subscriptions are reviewed on an annual basis to determine AINSE support for each university.

AINSE's operating expenses in 2010 were \$3,945,382, leaving a deficit for the year of \$198,831. In line with budgets, the majority of AINSE funds were used to facilitate access and travel to Lucas Heights for university researchers \$1,287,761, to support PGRAs \$597,689, and Research Fellows \$883,369, and to develop ANSTO's neutron scattering capability and other facilities, and to provide access to ISIS, \$420,000, to see Figure 2.

Universities received research and training benefits amounting to 3.34 times their subscriptions in 2010.

The Financial Statements for the calendar year 2010 in Section 2 of this report were prepared by ANSTO Finance and audited by Mr David Aston of Escott Aston and Co.

AINSE Research Projects and Postgraduate Research Awards

A total of 199 Research Awards were funded in 2010, fewer than in 2009. The apparent decrease is due to a backlog of neutron scattering projects which were awarded in 2009 but not conducted until 2010. These projects were listed in the 2009 annual report and are not included here. Figure 3 shows the distribution of the 2010 AINSE Research Awards by specialist area. Research highlights can be found on pages 6 to 15. Progress reports for each of the projects can be found on our web site. Of the 199 AINSE Research Awards 188 or 94.5% were to be conducted in collaboration with ANSTO research staff. There were 73 first-time research award holders in 2010 representing 37% of the cohort, 28 were awarded neutron beam time through the Bragg Institute, and 45 were for other instruments at ANSTO.

In 2010, 21 of the 81 AINSE postgraduate research award holders received an award for the first time and 11 doctoral theses were received. A further 25 theses, where students conducted experiments under a research award in the name of their supervisor, are recorded in the publications list. The AINSE postgraduate research award holders accessed the facilities for a total of 1202 days. In addition, another 71 students gained access to the facilities via awards held by their supervisors, for a total of 1408 days.

We were notified of 414 publications in 2010, of which 238 are articles in refereed journals, 115 are conference papers, 15 are books or chapters of books, and 46 theses. Details of publications can be found in Section 2 of this report.

Acknowledgements

It has been a pleasure to work with AINSE President, Professor Bruce King of the University of Newcastle over the past year. I thank Dr Adi Paterson, CEO of ANSTO, for his encouragement and support of AINSE.

I am grateful for the dedication and support of the President, Professor Bruce King, and other members of the Executive Committee and Council who share the responsibility of running AINSE with me. I also extend my thanks to all those from the universities and ANSTO for their help and advice throughout the year. There are far too many to name individually. In the AINSE Secretariat, Gillian Blackburn, Nerissa Phillips, Sandy O'Connor, Rhiannon Still and John Studdert have continued to maintain the long-standing reputation of a friendly, supportive and effective secretariat.

I wish AINSE well in the next decade of its operation

Dr Dennis Mather, Managing Director

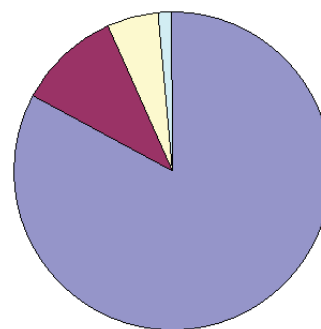


Figure 1 Operating Revenue

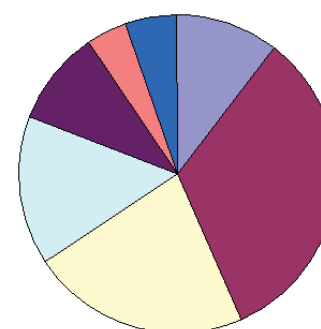


Figure 2 Operating Expenses

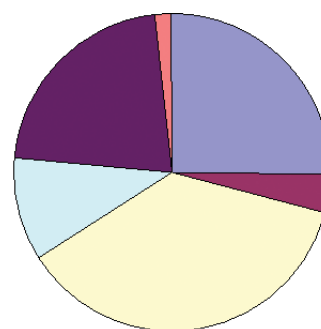


Figure 3 Awards Expenditure by Specialist Area

Research Highlights

Archaeology and Geosciences

Antiquity of Gunditjmara eel traps

The Gunditjmara Aboriginal people of southwest Victoria have a long history of freshwater fishing involving aquaculture practices that confound traditional understandings of hunter-gatherer lifeways. But what is the history of these traps and for how long have the Gunditjmara been aquaculture 'hunter-gatherers'?

Fine-grained archaeological excavation of Muldoons Trap Complex located on the southwest shore of Lake Condah, western Victoria, coupled with ^{14}C AMS dating provides preliminary answers to this question.

Excavation of a small section of trap channel in 2008 by an archaeological team from Monash University directed by Dr Ian McNiven, working in partnership with the Gunditjmara community, revealed that the lower 30cm of channel had been filled in over the years by flood sediments. By carefully removing these sediments in 2-3cm thick Excavation Units (XUs) the history of infilling was examined. Dr Ian McNiven collaborated with Dr Geraldine Jacobsen at ANSTO to carry out AMS dating of seven charcoal samples obtained from 7 XUs. The analyses revealed that construction of the stone walls flanking the channel commenced 700-800 years ago. However, basal sections of the channel below the stone walls were created by the removal of large basalt blocks. Infill sediments within these basal basalt voids contain stone artefacts and charcoal AMS dated to 6000-7000 years ago. Muldoons Trap Complex reveals a long history of use and staged construction and is currently the earliest dated freshwater fishing facility in Australia.



Part of a stone-walled channel feature at Muldoons Trap Complex, Lake Condah, western Victoria. Excavation trench across channel revealed infill by flood sediments over the past 6000-7000 years. ^{14}C AMS dating of charcoal within these infill sediments has helped establish the antiquity of the fishtrap.
Image source: Ian McNiven

Carbon sequestration in the Great Serpentinite Belt, northern NSW

Weathering and low-temperature alteration transforms ultramafic, magnesium-silicate rich rocks into magnesium carbonates. This mineral carbonation promises to provide safe and permanent storage for significant amounts of anthropogenically emitted carbon dioxide (CO_2), either through *in-situ* injection of CO_2 rich fluids into the ultramafic rocks or through *ex-situ* mineral carbonation in an engineered reactor. Both approaches require a thorough understanding of natural carbonation reactions as observed in the ultramafic rocks of the Great Serpentinite Belt (GSB) in northern New South Wales.

Magnesite and hydrated forms of magnesium- and iron carbonates form as weathering-derived or hydrothermal veins in the serpentinites of the GSB or as crusts on serpentinite mine tailings. In order to understand the naturally occurring carbonation processes, analysis of stable carbon and oxygen isotopes is commonly used to trace the sources and pathways of CO_2 in carbonate deposits but can be hampered by ambiguity of results and kinetic isotope effects. Radiocarbon (^{14}C) concentrations can be used as a robust tracer for atmospheric CO_2 and provide age constraints for the calculation of carbonation rates.

PhD students Hans Oskierski and Tim Oliver, supervised by Dr Judy Bailey and Professors Bogdan Dlugogorski and Eric Kennedy of the University of Newcastle, collaborated with Dr Geraldine Jacobsen of the Institute for Environmental Research, ANSTO in this study. Using accelerator mass spectrometry (AMS) radiocarbon dating the group verified the fixation of atmospheric CO_2 in different magnesium carbonate deposits and constrained carbonation rates of ultramafic rocks and mine tailings in the GSB.



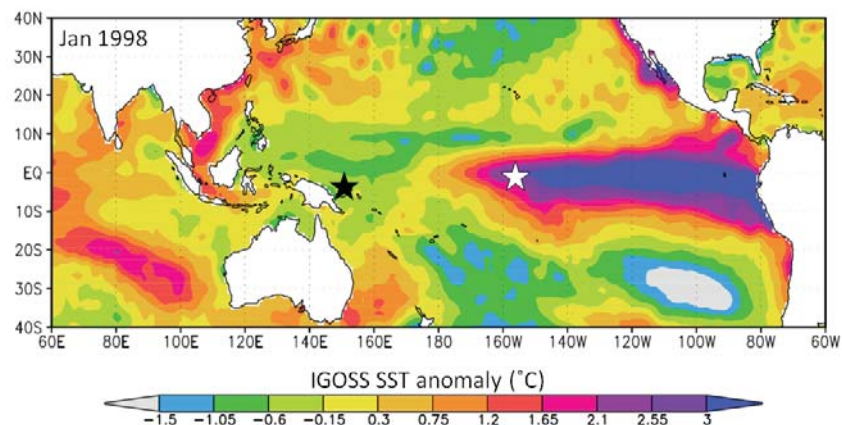
Crust of hydrated magnesium carbonates on mine tailings of Woodsreef Asbestos Mine
Image Source: Hans Oskierski

The story of late-Holocene sea surface temperatures from Kiritimati and Rambutso Islands

The El Niño - Southern Oscillation (ENSO) is the most important source of inter-annual climate variability on the planet, yet its response to global warming is still highly uncertain. Critical to understanding and forecasting future ENSO variability is knowledge of the sea surface temperature (SST) gradient between the cold eastern and warm western equatorial Pacific Ocean. The SST gradient is a crucial feature of ENSO, since during an El Niño event the mean SST gradient is reduced or absent, while during a La Niña event the mean gradient is enhanced.

Laura Glasbergen, of the Amsterdam University, completing her Masters research project under the supervision of Dr Helen McGregor, of the University of Wollongong, has used fossil corals to reconstruct the past equatorial Pacific SST gradient. The corals come from two critical nodes of the ENSO system; Rambutso Island, Papua New Guinea, in the Indo-Pacific Warm Pool, and Kiritimati (Christmas) Island, Kiribati, in the central equatorial Pacific. The past SSTs were reconstructed using the coral Sr/Ca ratio, analysed in collaboration with Dr Henri Wong of the Institute for Environmental Research (IER), ANSTO. The fossil corals were also radiocarbon dated in collaboration with Dr Quan Hua and Dr David Fink, also of the IER.

The results showed that about 1700 BP, the east-west equatorial SST gradient was -5°C compared to -2.7°C for modern corals from these sites. In the 20th century instrumental SST record, SST gradients of around -5°C are observed during very strong La Niña events. The increased equatorial Pacific SST gradient found in this study suggest that about 1700 BP it was harder for El Niño events to develop, since more force is needed to disrupt the stronger positive feedback loop between ocean and atmosphere.



SST anomalies (IGOSS SST ($^{\circ}\text{C}$), Reynolds et al., 2002) during peak of El Niño in January 1998. Maps created with the KNMI Climate Explorer (<http://climexp.knmi.nl/>). Black star indicates the location of Rambutso Island, and the white star Kiritimati Island.

First occupation of northwest Queensland

Determining when indigenous people first occupied different regions of Australia, and understanding the processes involved in their colonisation of new environments is critical to one of the major debates in human evolution: the adaptive capabilities of modern humans.

Despite recognition that the savannah belt of inland northwest Queensland potentially has a long history of human occupation and therefore centrality to such debates, until recently it had received very little archaeological attention. In 2006 Dr Lynley Wallis, now of the University of Queensland, working in partnership with members of the Woolgar Valley Aboriginal Corporation, discovered a small sandstone rock shelter in the foothills of the Gregory Ranges with the potential to redress this situation.

Excavations at the Gledswood Shelter 1 site revealed a cultural sequence extending to 2.75m below the surface, affording an important opportunity to produce a long term occupation record. Dr Wallis, working with research students Mr Ian Moffat, The Australian National University, and Mr Ben Keys, Flinders University, and Dr Geraldine Jacobsen of the Institute for Environmental Research, ANSTO, obtained ten ^{14}C AMC dates for the site, ranging in age from ca 3,600 to 33,600 years BP.

Gledswood Shelter 1 is the first rockshelter outside a well-watered local refuge in northwest Queensland to produce evidence for human occupation in the pre-Last Glacial Maximum period. When analyses of the recovered sediments and cultural materials have been completed, they will provide important data on the human colonisation of Australia's savannah corridors, as well as providing a valuable palaeoenvironmental record for a region which hitherto lacks any such local data.



ANU PhD candidate Ian Moffatt in the process of collecting sediment, micromorphology, radiocarbon and OSL samples from the stratigraphic sections of the Gledswood Shelter 1 site after excavation had been completed.

Research Highlights

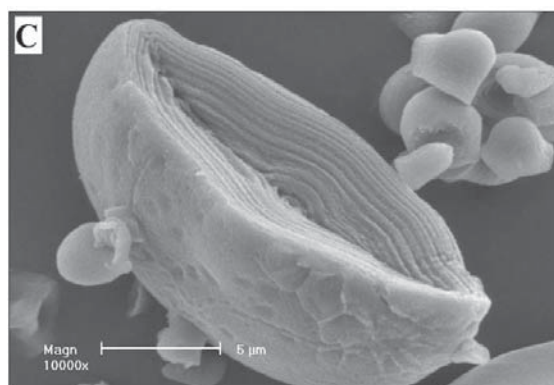
Biomedical Science and Biotechnology

Changing climate impacts grain quality

Starch is the main storage carbohydrate of plants and a biopolymer of considerable significance for humans. It is a macro-constituent of many foods and is also extracted industrially in large quantities for use in manufactured foods, pharmaceuticals and non-edible products. How we digest starch also has important risk implications for obesity and diet-related diseases.

Professor Les Copeland, Postdoctoral Fellow Dr Shujun Wang and PhD student Tri Nanh Ming, of The University of Sydney, in collaboration with ANSTO scientists, Drs Elliot Gilbert and Jara Blazek, are investigating the natural variability of starch that occurs between and within plant species and results in unpredictability of functional properties for processing and human digestion.

Using small- and wide-angle x-ray scattering techniques, in combination with multiple chemical analyses and functional tests, they are probing the internal crystalline structure of starch granules with the aim of understanding structure-function relationships. They aim to understand how environmental factors during plant growth, such as weather, soil type, crop management practices and seasonality, affect the structural and functional properties of starch, and in turn, food grain quality. Increases in variability of growth conditions from one season to the next is now a major factor that affects the fitness for purpose of food grains. Being able to assess the impact of seasonality on grain quality is a priority.



Partially digested wheat starch grain showing internal crystalline structure (from Blazek J and Copeland L 2010. *J Cereal Sci* 52, 295-302)

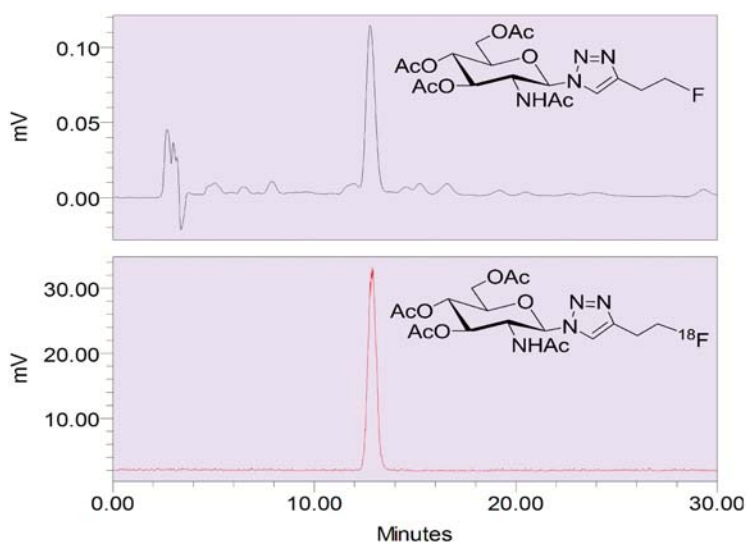
New selective tracers for PET cancer imaging

Integrins are cell surface receptors that mediate cell-cell interactions. The vitronectin receptor, $\alpha v \beta 3$, plays a key role in cancer progression and it has been found that inhibition of $\alpha v \beta 3$ -mediated cellular interactions leads to tumour cell death. Thus, antagonists to this receptor are currently being evaluated as new anticancer agents and radiolabelled analogues as cancer imaging agents; the most well known of which contains a key peptide motif known as RGD (Arg-Gly-Asp) and a sugar moiety appended to its terminus. The addition of the sugar moiety dramatically improves biodistribution and pharmacokinetics, leading to higher sensitivity imaging.

Dr Danielle Skropeta and her students, Ms Suzi Sarowi and Mehalai Thillakan, at the University of Wollongong, have been working with Dr Andrew Katsifis of ANSTO Life Sciences on the incorporation of various radiolabelled sugars into $\alpha v \beta 3$ antagonists to generate new and highly selective tracers for PET cancer imaging.

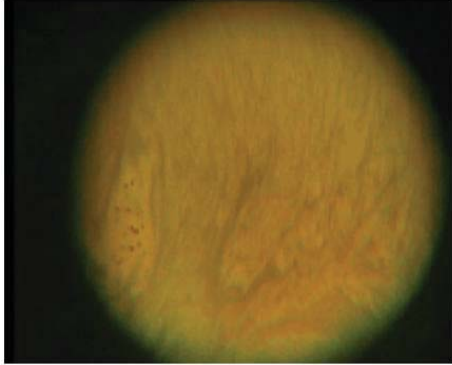
They are developing new methods for radiolabelling sugar substrates with the PET radionuclides F-18 using 'click chemistry' which can reduce the radiolabelling time from over 30 minutes to 8 minutes.

This work, performed in collaboration with the CRC for Biomedical Imaging Development, will contribute to the development of new technologies for the incorporation of radiolabelled sugars into both new and existing imaging agents to ultimately improve PET imaging selectivity and quality.



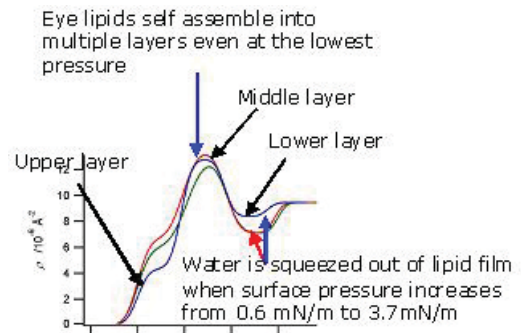
Co-injection of the fluoro sugar standard (top panel) and the ^{18}F -radiolabelled sugar (bottom panel) on a Bondclone 300 x 7.8mm HPLC column (solvent: 20% ACN, 80% H_2O , 0.1% TFA at 4 mL/min, $\lambda = 226 \text{ nm}$). UV detector shown in black and radioactivity detector shown in red.

Why dry eyes?



Dry eye has a prevalence of 10%-17% in the over 40s and this is likely to increase with an aging population. It occurs when the tears of the eye are absent or are not functioning properly. Although eye drops to treat the condition are available, they are prescribed on a trial and error basis because of poor understanding of the structure of tear film. Professor Thomas Millar and his two PhD students Shiwani Raju and Chendur Palaniappan from the University of Western Sydney along with his ANSTO collaborator, Professor Michael James, have been investigating the very surface of the tear film which has an oily layer that assists in spreading the tears across the eye and preventing evaporation of the tears. When this layer does not function properly, people get dry eye.

They have been investigating how the lipids from the eye assemble to make up this layer. They have been reflecting x-rays from a surface made from eye lipids or from other lipids as models for the eye lipids. A surprise was that the eye lipids form multiple layers even when there are few lipids in the film. These studies will help develop new eye drops for the treatment of dry eye.



Characterising a killer

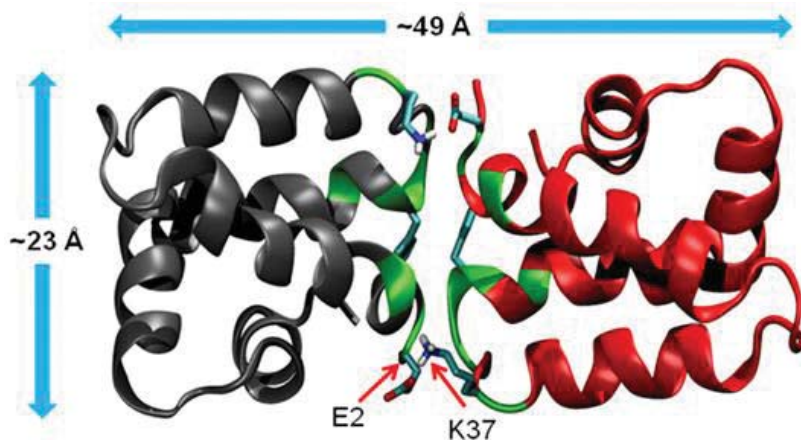
Amoebic dysentery is a life-threatening parasitic disease caused by *Entamoeba histolytica* (see image right). Approximately 50 million people are infected each year, with about 100,000 people dying annually. The antimicrobial protein amoebapore A was discovered to be one of the key pathogenic proteins of *E. histolytica*, and is capable of killing a broad range of cells. However, the detailed mechanism of how amoebapore A acts to achieve its toxicity remains unclear.

Research undertaken by AINSE postgraduate scholar Gloria Xun with her supervisors Dr Andrew Dingley and Dr Duncan McGillivray of the University of Auckland, and Professor Michael James of the Bragg Institute, ANSTO, is aimed at characterising the interactions of amoebapore A with model cellular membranes. A better understanding of this protein will enable development of therapeutic anti-infective agents using antimicrobial proteins as natural sources.

It is currently believed that the activity of amoebapore A is regulated by a pH-dependent dimerisation event. Dimers formed in solution are presumed to further aggregate and form a pore structure which embeds in the cellular membrane, disrupting cellular function. Investigations using small angle x-ray scattering (SAXS) and ANSTO's neutron reflectometer Platypus, showed that binding of native amoebapore A to membranes is partially reversible and is greater on incomplete membranes. This suggests that membrane-binding depends on membrane defects. These models will be tested in the future by comparing the behaviour of the native protein with mutants created especially to isolate the most significant features of the protein sequence towards membrane activity.



Entamoeba histolytica
Image source:
http://whatsinyourpants.info/More_Microbes.html



Dimer model of amoebapore A. K37 forms an ion-pair with E2. Two F41 residues from each monomer on the backside of the model form a pi-stacking interaction.
Image source: Pierre Tremouilhac, Gloria Xun

Research Highlights

Environmental Science

River terrace formation in the upper Hunter Valley

River terraces are significant features in the geomorphic development of inland channel systems. Terrace sequences can represent regional or continental scale factors such as climatic fluctuations, neotectonic activity, and base-level change. However, they can also reflect random incision events brought about by local scale, geomorphic threshold exceedance, and subsequent complex responses. Correlation of river terrace fills was undertaken by comparing the sedimentology and chronology of terrace remnants. This research project aimed to explore the formative processes of three discontinuous, but adjacent, late Pleistocene to late Holocene step-terrace sequences in the upper Hunter valley of New South Wales.

Charcoal samples were collected for radiocarbon dating from fluviially deposited terrace sediments in the Widden Valley by Dr Annabelle Keene and PhD student Mr Michael Cheetham of Southern Cross University. In collaboration with Dr Geraldine Jacobsen of the Institute for Environmental Research, ANSTO, samples were analysed using the STAR particle accelerator. This work identified that climate was not a dominant control on terrace formation. With base-level change and tectonic uplift also excluded, geomorphic threshold exceedance through either progressive landscape evolution and/or catastrophic floods emerged as the key control of channel incision and floodplain abandonment. The cyclic erosion and deposition of alluvial sediments was intermittently interrupted or accelerated by large-scale events that stripped the floodplain down to a basal gravel lag. Terrace formation in the Widden Valley has resulted from a series of nonsynchronous, episodic incision events beginning in the late Pleistocene.

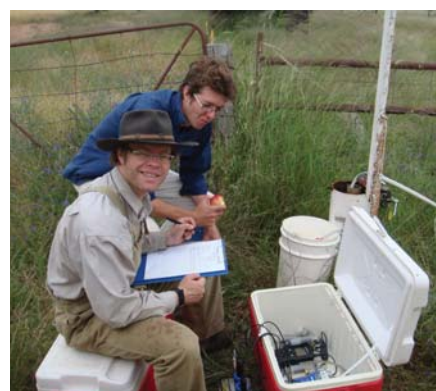


*Michael Cheetham and Paul Cheeseman examine sediment deposited in a Holocene river terrace.
Image source: Annabelle Keene.*

Replenishing aquifers in the Murray-Darling Basin, NSW

Groundwater resources or aquifers are increasingly being utilised across Australia, especially in the semi-arid and arid interior, where they serve as a secure supply of water in drought years. However, the rates and pathways through which an aquifer is replenished are not fully understood and such understanding is necessary if we are to manage these important water resources sustainably.

PhD student Andrew McCallum and his supervisor Dr Martin Andersen from the Connected Waters Initiative at the University of New South Wales, in collaboration with Dr Karina Meredith from ANSTO, set out to investigate how an aquifer system is replenished by applying environmental isotopes such as ^{14}C dating. They sampled groundwater from monitoring bores in the Maules Creek catchment which is located on the western slopes of the Great Dividing Range in NSW, Australia. Their results generally show that groundwater adjacent to rivers or streams is comparatively young (< 60 years), even at considerable depth (> 60m). The use of environmental isotopes shows that the origin of deeper modern groundwater is river water that flows into the aquifer (i.e. induced recharge). The reversal in hydraulic gradient of the river has occurred due to lowered groundwater levels induced by widespread groundwater pumping in the aquifer. At a distance of greater than 1 km from the rivers and streams, groundwaters were found to increase in age with depth beneath the ground surface with ages of up to 10,000-20,000 years. Long-term average rainfall recharge rates were calculated from this data at 5-10 mm/yr. Further research is required to estimate the induced recharge rates from the rivers and streams.



PhD student, Andrew McCallum, enjoys an apple while his supervisor, Dr Martin Andersen, continues the research.

Interaction between a river and its wetland

Since regulation of the River Murray, Australia, commenced in 1922 many associated wetlands have switched from clear water, macrophyte rich wetlands to turbid, phytoplankton dominated systems. A decline in a macrophyte population may indicate water quality problems

The Sinclair Flat wetland, located within the gorge section of the River Murray floodplain Blanchetown, South Australia, is closely linked to the river. High summer evaporation rates deplete the volume of water within the wetland. This is compensated by perennial inflow via a permanent inlet from the river which provides continuous river influence and so makes this an excellent field site to explore the relative contribution of river and wetland diatom flora to the sediment record, and the fluvial and aerial contribution of radiometric isotopes to the system.



Inlet channel, Sinclair Flat, South Australia
Image source: Peter Gell



Weir pool, Lock 1 at Blanchetown, South Australia.
Image source: Peter Gell

Research undertaken by Professor Peter Gell, Dr Keely Mills and Honours student Rosie Grundell from the Centre for Environmental Management, University of Ballarat, in collaboration with Dr Atun Zawadzki of the Institute for Environmental Research, ANSTO, involved extracting multiple sediment cores along a transect from across the wetland to investigate how diatom assemblages and isotopic records varied spatially and temporally. The results reveal Murray River water contributes diatom flora and radionuclides to the wetland and suggests a recent, unprecedented shift to more saline, and eutrophic river waters. The investigations indicate that considerable environmental change has occurred within this wetland over the last ~80 years and supports many other records that attest to the degraded state of the Murray River and its wetlands from the upper, middle and lower reaches of the River

Assessing sea level changes using oyster bed deposits

Despite over 40 years of research effort in eastern Australia, no study to date has determined precisely when the sea level reached its present level. Such knowledge would provide insights for a range of scientific disciplines including recent geomorphological changes in the coastal zone, coral reef development and the historical movements of indigenous people. Oyster bed deposits attached to rocky shorelines on the continental islands of the Great Barrier Reef provide a means of assessing recent sea-level changes. Oysters grow within a restricted tidal range and, with continuous and uninterrupted growth, form beds up to 1 m thick providing a rich proxy record of sea-level.

Dr Stephen Lewis and Dr Raphael Wüst from James Cook University in collaboration with Dr Geraldine Jacobsen of the Institute for Environmental Research, ANSTO, radiocarbon dated 20 elevated (from +0.2 m up to +2.1 m above living oyster zone) fossil and living oyster beds from Orpheus Island, Hinchinbrook Island and Magnetic Island, north Queensland, to better refine the sea-level curve and to precisely date when the sea level fell to its present position. Living oyster bed deposits on the Great Barrier Reef are up to 800 years old. While each living and fossilised oyster bed displayed consistent growth rates over time, rates were highly variable across the sampling sites. One elevated (+1 m) fossil bed contained a continuous growth record from 2200 to 1200 years before the present and suggested that the sea level was stable at +1 m for at least 1000 years before falling to the present level between 1200 and 800 years ago. The period of stability between 2200 and 1200 years before the present also suggests that sea level has not fallen smoothly over the last 6000 years.



Research Highlights

Materials – Properties and Engineering

Magnetic spiral order in multiferroic hexaferrite

Multiferroic materials have the potential to advance data storage and processing speeds tremendously and today are considered a priority for future innovations in information technology. Multiferroics are advanced materials which simultaneously exhibit electric polarization and magnetic order. These two phenomena were considered mutually exclusive, until recently when they were found to coincide in frustrated charge ordered or magnetically ordered materials.

The underlying physics of these materials is not yet understood. One possibility is that ferroelectricity arising from magnetism may be driven by coupling between the magnetism and lattice distortions or due to an inherent electronic effect.

Dr Mulders and her collaborators at UNSW in Canberra investigate hexaferrite, a magnetic material that becomes multiferroic in applied magnetic field. The aim of this research is characterise changes in the magnetic 3d electronic shell when the material enters the multiferroic phase. Together with PhD student Andrew Princep and Dr James Hester of the Bragg Institute at ANSTO, Dr Mulders used the Wombat high-intensity powder diffractometer at OPAL to investigate the temperature and magnetic field dependence of the magnetic structure. The diffracted intensity in the image shows the structural reflections at (0 0 15) and (0 0 18). Magnetic diffraction from the magnetic spiral is evident at (0 0 $15 \pm 3\tau$) and (0 0 $18 \pm 3\tau$), with the wavelength of the magnetic spiral, and at (0 0 16.5) with applied magnetic field. These findings on the magnetic structure complement recent resonant x-ray diffraction studies that probe the electronic structure.

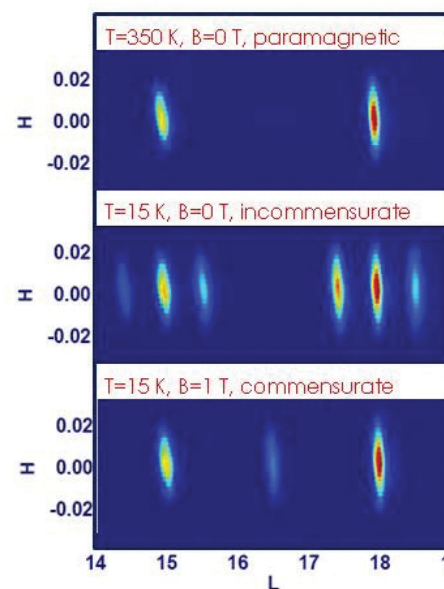
Trapping and containing contaminants

Porous materials can be used to trap and contain contaminants such as heavy metals in environmental systems, for industrial waste storage, for the encapsulation of biomolecules, and as catalysts or catalytic supports.

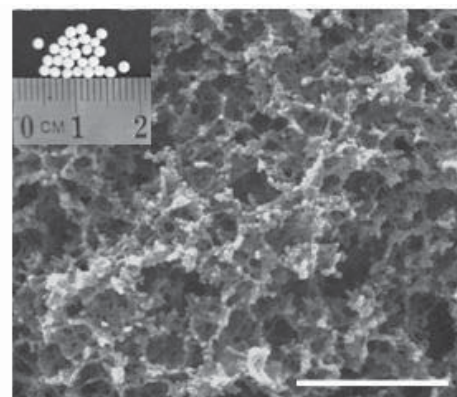
In this study, porous $\text{TiO}_2/\text{ZrO}_2$ millimeter-sized beads were prepared using a sol-gel templating technique for use as adsorbents for radionuclide sequestration. A variety of polymeric beads were synthesized and investigated as templates to impart similar morphological properties into the final inorganic beads. $\text{TiO}_2/\text{ZrO}_2$ is an ideal mix as it is radiolytically and hydrolytically stable and the mix can be used to immobilize radionuclides, following adsorption, through conversion to a dense ceramic which could then be safely disposed.

The synthesis and characterization of the $\text{TiO}_2/\text{ZrO}_2$ beads were carried out by post-graduate student Maryline Chee Kimling under the supervision of Dr Rachel Caruso of the University of Melbourne. A study of the uptake of radioactive elements (total quantity and rate) by the beads was conducted in collaboration with Dr Tracey Hanley, Dr Paolo Imperia and Mr Nicholas Scales at the Institute of Materials Engineering, ANSTO using Inductively Coupled Plasma Mass Spectrometry.

The beads showed high adsorption capacities and higher adsorption rates than beads containing monomodal pores. Adsorption rates were comparable to those obtained for a microparticulate xerogel system despite the macroscopic size of the beads. The ease of recovery of these larger-sized beads is an additional asset over the use of microparticles.



Neutron diffraction in the (HOL) reciprocal lattice plane of hexaferrite, recorded at Wombat.



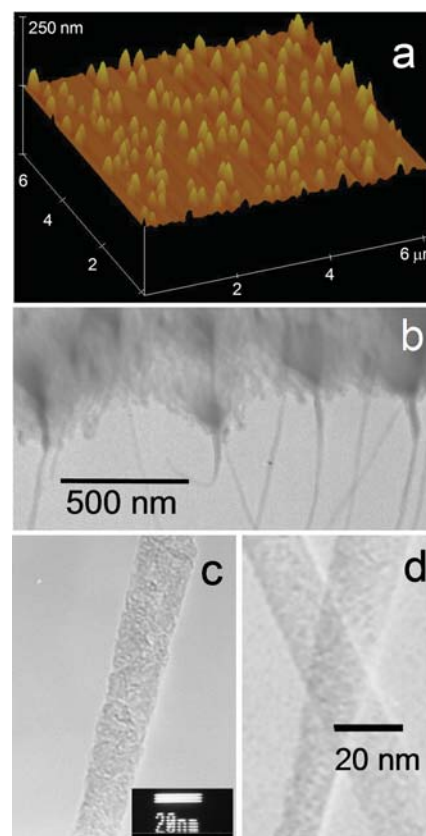
Optical image of $\text{TiO}_2/\text{ZrO}_2$ beads (inset) and SEM image of pore architecture of $\text{TiO}_2/\text{ZrO}_2$ bead prepared using a polysaccharide template

Electrically active arrayed carbon nanostructures

Functional polymeric materials have the potential to improve the way we design advanced active and passive components for microelectronic devices. Electrically active arrayed nanostructures embedded within polymer matrices continue to generate considerable research interest because of their wide potential application in future generation of light weight, flexible and strategic microelectronic devices as passive components, switching elements and enhanced field emitters as well as active components such as gas, pressure and deformation sensors.

Professor David Mainwaring and Dr Pandiyan Murugaraj of RMIT, with Dr Rainer Siegele of the Institute for Environmental Research, ANSTO, have been developing a reactive ion beam irradiation technique to produce high aspect ratio carbon nanostructure arrays in polymeric thin films exhibiting novel electronic functionalities.

Irradiation by 55MeV Cu^{3+} ions generated highly directional conductive nanochannels within an aromatic polyimide. Formation of arrayed carbon nanostructures within the polymer medium was confirmed by topographic scans of the irradiated polymer surfaces using atomic force and high resolution transmission microscopy studies of the transverse cross section of the irradiated films. Temperature dependent electron transport studies and the electromechanical characterisation of these films demonstrated complex charge transport mechanism active in these composite system namely, electron hopping between carbon clusters within the nanochannels and tunnelling conduction between the nanochannels when in close proximity. Further studies have shown that the electron transport is modulated by the local nanoscale dielectric characteristics. Electromechanical sensitivities of the order of 1000 has been achieved in these nanocomposite films which makes them attractive materials for the fabrication of embedded strain sensors in structural health monitoring applications.



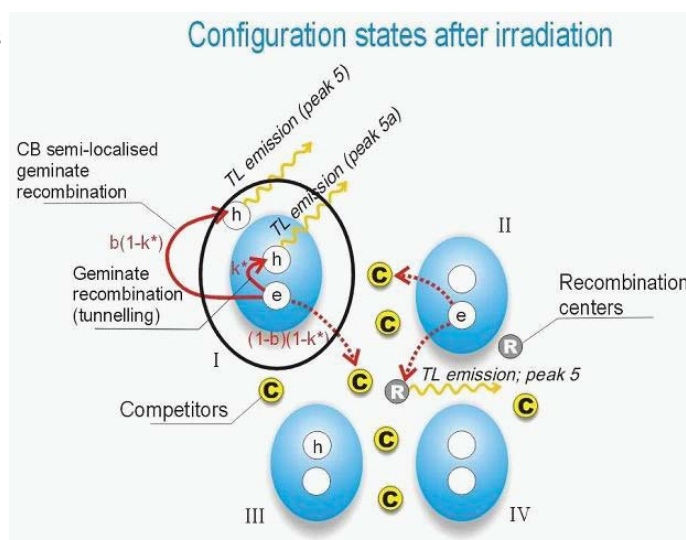
(a) AFM topography of the irradiated polyimide film
(b) multiple overlapping tracks formation
(c) single ion-track
(d) overlapping ion tracks

Thermoluminescence Nanodosimetry Based on LiF:Mg,Ti

The measurement of energy deposited per unit mass (dose) in human tissue via ionizing radiation fields is an important field of endeavor in the protection of workers in many occupational arenas including nuclear reactors, aircraft, spacecraft, radiobiology, oncological and diagnostic radiology, and many others in the fields of science and industry. In addition, the measurement of dose must be accompanied by an estimate of ionization density since the deleterious effects of ionizing radiation on DNA are known to depend on this factor which largely determines the Radiobiological Effectiveness (RBE) of the radiation field.

In the thermoluminescent material LiF:Mg,Ti it has been demonstrated by that a molecular complex of about 20 Å dimensions based on Mg^{2+} -Livac trimers possesses ionization density characteristics similar to radiation induced damage comprised of single-strand-breaks (SSBs) and double strand breaks (DSBs) in DNA. The measurement is made in specially prepared material via the relative intensity of two glow peaks in the spectrum of emitted light as a function of sample temperature.

Collaborative research by Professor Anatoly Rosenfeld, Dr Michael Lerch and PhD student Jayde Livingston of the CMRP University of Wollongong, ANSTO researcher Dr Rainer Siegele utilizing the heavy ion microprobe and researchers at the Radiological Research Accelerator Facility (RARAF) of Columbia University has show that the behaviour of the ratio of glow peaks 5a/5 is strongly dependent on ionization density for a variety of charged particle radiation fields including electrons, protons, and helium, copper and iodide ions of various energies. Further irradiations are planned at the ANSTO, the University of Melbourne and the HIMAC facility in Japan to model deep space radiation environment.



Research Highlights

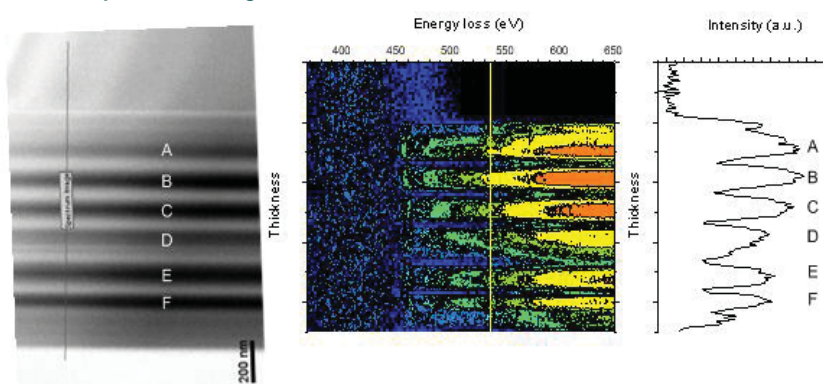
Materials – Structures and Dynamics

Design and synthesis of advanced broadband optical coatings

AINSE postgraduate scholar, Nemo Biluš Abaffy recently completed his PhD research on advanced broadband optical coatings. The work was supervised by Professor Dougal McCulloch of RMIT University, Mr Gerry Triani and Dr Peter Evans of ANSTO, and Dr James Partridge at the University of Canterbury. They used advanced microscopy and microanalysis methods to determine the relationship between the microstructure and physical properties of tailored thin film materials derived from mixed aluminium and titanium oxides deposited using atomic layer deposition (ALD). The research has led to the discovery of new techniques for the preparation of the next generation of gradient index optical coatings.

The synthesis of advanced broadband optical coating designs has proven to be a major challenge in the field and the ALD method that has been developed shows promise for the

production of complex gradient index optical filter designs. The Figure shows a bandstop filter coating deposited according to one such design. The ALD method has been used to deposit metal oxides at temperatures low enough for the coating of temperature sensitive substrates.



(a) A scanning transmission electron microscopy image of a gradient index coating deposited using the novel ALD method. The region across which an electron energy loss spectroscopy line scan was taken is shown.

(b) Ti L and O K edges presented in an electron energy loss near edge structure contour map of the region shown in (a).

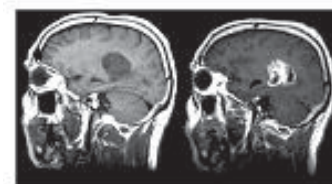
(c) Intensity depth profile of the O K edge along the vertical yellow line in the contour map.

Superparamagnetic nanoparticles for MRI contrast enhancement

Magnetic Resonance Imaging (MRI) is a widely used, powerful technique for imaging soft tissue within the body. It has given medical practitioners an indispensable tool in the diagnosis of many diseases, yet the question remains, can the contrast in these images be sufficiently increased to enhance the ability of the medical practitioners to make a more accurate or earlier diagnosis? The answer to this question lies in the emerging field of nanotechnology with research into superparamagnetic nanoparticles.

A research team at the University of Western Australia (UWA), including former AINSE postgraduate scholar Matthew Carroll, Dr Robert Woodward and Professor Timothy St Pierre, have been studying systems of polymer coated magnetite superparamagnetic nanoparticles. When injected into the body these particles significantly affect the local magnetic fields, ultimately leading to a substantial increase in the contrast of the final MRI image. The team were interested in what effect the polymer coating had on the final image contrast.

By using a variety of techniques such as Transmission Electron Microscopy, SQUID Magnetometry and Proton relaxometry at UWA, combined with small angle neutron and x-ray scattering (at ANSTO and NIST), the team has discovered that it is the level of particle agglomeration in the nanoparticle suspension that predominantly causes the increase in image contrast. This work will allow designers of future polymer-coated MRI contrast agents to maximise the contrast through the generation of regulated clusters with no need to account for any confounding effects caused by the nature of the polymers' interactions with water.

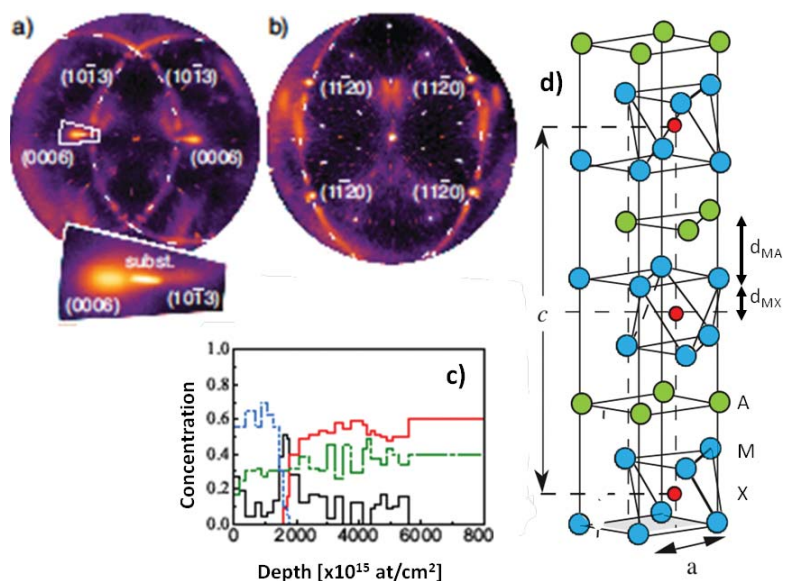


MRI images of a brain tumour before (left) and after (right) an injection of magnetic nanoparticle contrast agents.

Developing new materials for reducing friction in high temperature applications

The MAX phases are a family of nanolaminate ternary alloys which exhibit a unique combination of metal and ceramic properties. With their layered crystal structure, MAX phases offer a combination of elastic stiffness, low friction coefficient, high temperature stability, machinability, thermal shock resistance and relatively high electrical and thermal conductivity, making them ideal in high temperature structural components and low friction coatings and contacts.

Working with Dr Mihail Ionescu of ANSTO, Professor Bilek of the University of Sydney and her team demonstrated the deposition of MAX phase materials using highly ionised power pulsed discharges. Through axiotaxy with a TiC seed layer they showed that crystal orientation of the Ti_2AlC MAX phase could be controlled during deposition pathing the way to applications as low friction coatings. Studies of these materials by ion beam techniques at ANSTO revealed resilience of the Ti_2AlC MAX phase crystal structure to the outdiffusion of carbon. Surprisingly the structure was stable with carbon vacancies at up to 50% of sites and oxygen was readily incorporated at these vacancies. *Ab-initio* simulations by the group showed that minimal changes in elastic constants are expected with these compositional changes as would be required for applications in high temperature oxidising environments.



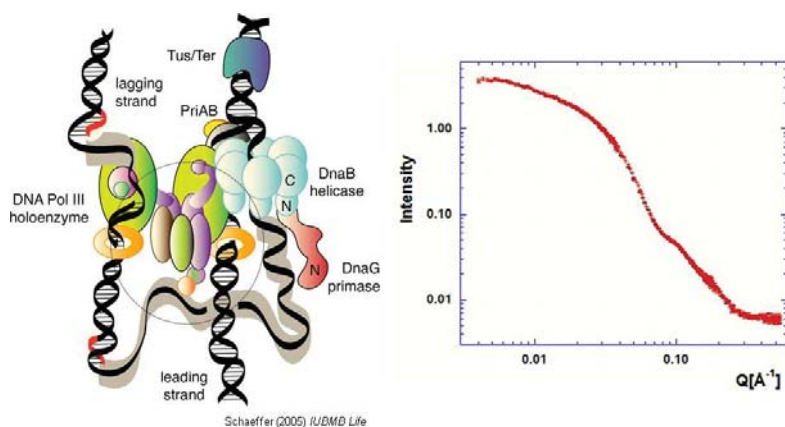
Pole figures with a logarithmic intensity scale showing axiotaxy. *a*) is a pole figure of the Ti_2AlC (0006) and (10-13) planes. The inset shows a separate higher-resolution scan of the main peaks. *b*) shows a pole figure of the Ti_2AlC (11-20) plane. The dashed curves overlaid are the patterns expected from axiotaxy with TiC, calculated from the geometry of the Ti_2AlC unit cell and the location of the (0006) pole. *c*) ERDA elemental composition depth profiles of a TiAlC MAX phase film on sapphire (001) substrate. The depth profiles show carbon aggregating at the film/substrate interface (at a depth of approximately 1600 - 1700 at/cm²) and to a lesser extent, the surface (left side of graph). *d*) Schematic diagram of the (n=1) MAX phase nanolaminate crystal structure.

Protein interactions and behaviour in multi-protein complexes

Understanding how proteins interact and behave in large dynamic multi-protein complexes is an important area of significance in many human diseases that are associated with faults in these interactions. Increasing understanding of the well-characterized bacterial DNA replication machinery (the replisome) will continue to enrich our understanding of other dynamic complexes, including those that carry out human DNA replication. This research focussed on pairwise interactions that involve one of the key organizational centres of the bacterial replisome, the DnaI helicase loader and the DnaB replicative helicase. AINSE postgraduate scholar Mr Flynn Hill measured the dynamics of the hydrogenated DnaI, DnaB and the DnaI-DnaB complex at the Institut Laue Langevin (France, Grenoble) with the IN6 scientist Marek Koza.

The measurements established that internal molecular flexibility and diffusive motions are significantly lower in the DnaI-DnaB complex compared to those evaluated in DnaI and DnaB helicase. The analysis also revealed that DnaI-DnaB complex structural rigidity is larger than that of DnaB and DnaI. Working with his supervisors Professor Nick Dixon and AINSE Research Fellow Dr Moeava Tehei of the University of Wollongong, and Dr Katy Wood of ANSTO, preliminary small angle neutron scattering (SANS) spectra of DnaB were also collected on Quokka. In collaboration with Dr Agata Rekas of the National Deuteration Facility, the 100% and 80% deuterated Dnals will be produced in order to better distinguish the dynamical and structural contributions of each component in the complex.

The work was selected for oral presentation at the AANSS2010 and was awarded best talk at the 24th Annual Chemistry Conference.



Left: Protein – protein and protein – nucleic acid interactions in the *E. coli* replisome
Right: Resulting SANS profile of the replicative helicase DnaB obtained on Quokka

AINSE Winter School 2010

Saturday 3 July to Wednesday 7 July 2010

The Winter School continues to be a most valuable AINSE activity for the promotion of research opportunities at ANSTO to prospective research students. One student is selected by the AINSE councillor at each of the 39 member universities.

Despite the dominance of students with chemistry majors there was a variety of disciplines represented, see the table below.

The experiments and lectures cover a wide range of disciplines and scientific techniques and are designed to broaden the scientific outlook of the students. Working in teams and socialising are also important parts of the Winter School experience.

AINSE postgraduate Scholars, Khay Fong, from Monash University, and William Brant, from the University of Sydney, provided the students with a presentation on their research projects on the Tuesday evening, and made a very important contribution to the School as demonstrators and role models. Chris Costable also assisted for part of the Winter School. They were warmly welcomed by the students and the Winter School Committee and AINSE are grateful for their commitment to the School.

Dr Joel Gilmore, from ROAM Consulting gave a presentation entitled *How a Nuclear Reactor Works* and Dr Barry Green who spoke about *Energy Options*. Both presentations were received with enthusiasm.

This year AINSE, for the first time, asked the students to come to the School with an idea for an honours project. This initiative was well received with 19 out of the 37 students submitting a proposed honours idea. This was reinforced with the AINSE Research Roundup that was incorporated into the school's program, 17 ANSTO research scientists attended with a poster describing the science that can be done on their instrument. The students circulated and discussed their experiments with the the relevant ANSTO research scientist. The aim of the Roundup was to provide a focus for each student and to encourage them to do an honours project which utilises one of ANSTO's facilities. This was a beneficial event which the students thoroughly enjoyed, one student commenting "This was one of the most important aspects of the Winter School". The ANSTO instrument scientists also found the event to be very useful., and a number of the students have followed through with applications for an AINSE honours scholarship.

The Convenor was unexpectedly grounded in Perth a couple of days before the winter school with a perforated eardrum, so the responsibility for the running of the event fell to Dr Vladimir Golovko.



Winter School Convenor Dr Danielle Meyrick



Trieu Luong ACU, Sarah Kenyon WOL and Jeremy Just TAS

Discipline	No
Physics	11
Chemistry	9
Engineering	8
environmental science	5
biomedical science	4
Climatology	1
geographical sciences	1
Geoscience	1
Pharmacology	1
Science	1

Student	UNI
Trieu Luong	ACU
Trent Grubb	ADE
Hannah Holtkamp	AKL
Richard Hocking	ANU
Tara McIlroy	BAL
Sam Drew	CAN
Gregory Cole	CBR
Ruth Patterson	CDU
Kate Henkel	COU
Jayne Dickinson	CSU
Andrew Buckley	CUR
Jamie McDonald	ECU
Rhiannon Murrie	FLI
Timothy Webb	GRI
Juliana Donovan	JAM
Romany Witton	LAT
Julian May	MAC
See Weng Tan	MEL
Tessa Charles	MON
Adriana Sanchez	MUR
Andrew Gibson	NCT
Derek Wong	NSW
Tamara Daus	QLD
Callum Spink	OUT
Anthony Hope	RMI
Melissa Gibbes	SCU
Carolyn Thai	SWI
Thomas Keevers	SYD
Jeremy Just	TAS
Martin Blicavs	UNE
Namsoon Eom	USA
Angelina Skye Lunenburg	USQ
Jordan Drenth	UTS
Meng Bi Zhang	UWA
Mark Ferrara	UWS
Mahdi Nosatti	VIC
Sarah Kenyon	WOL



*Left to right
Richard Hocking ANU,
Julian May MAC and
Hannah Holtkamp AKL*

Thanks

The Convenor of the 2010 Winter School and the Managing Director of AINSE record their gratitude to Dr Vladimir Golovko and the rest of the organising committee, to the postgraduate students and the staff, CEO and Board of ANSTO for their generous contribution to the School. They thank the ANSTO staff who gave so much of their time and talents in making the school a success.

2010 Conferences & Workshops

AINSE conferences play a major part in the information exchange process for scientific and technological information, providing a forum for debate and an opportunity for young researchers to present their work. In 2010 the only AINSE conference was AANSS. In addition to this meeting, participants from member organisations are assisted with travel and accommodation to attend a number of other AINSE approved conferences.

Industrial and Fusion Plasmas Minischool

Australian National University, 7 - 9 July 2010

This mini-school, organised and chaired by Dr Matthew Hole from ANU's Research School of Physical Sciences and Engineering, incorporated three lecture series: *Fundamental plasma processes in low temperature plasmas*; *Electrodynamics for plasma Physics*; and *Toroidal Magnetic Confinement*. These were presented by ANU staff.

Of the 35 students who attended, 13 students from 6 universities had AINSE bursaries.

Synchrotron and Neutron New Users Symposium

Monash University Clayton Campus, Friday 9 July, 2010

32 students were supported to attend this meeting, which attracted over 200 delegates. This was the first year that the meeting had incorporated new neutron users. Arrangements have now been made for continuing AINSE support, and for the meeting to alternate between Lucas Heights and Clayton.

ANSTO - AINSE Neutron School on Dynamics and Kinetics

ANSTO, Lucas Heights, 15 - 20 August 2010

Of the 33 students from 24 institutions who attended, AINSE supported travel and accommodation for 15 who came from member universities. A significant number of students from institutions in south east Asia and South Africa attended. The purpose of this school was to provide research students with experiences on the neutron instruments at OPAL and to introduce them to data reduction techniques.

16th International Conference on Solid State Dosimetry

Sofitel Hotel, Sydney, 19-24 September, 2010

4 students were supported by AINSE.

3rd AONSA (Asia Oceania Neutron Scattering Association) School

Mumbai, 4 - 9 October 2010

AINSE provided a return airfare to Mumbai for 5 postgraduate students and one lecturer. This school, in addition to providing instruction on neutron scattering techniques, provides an opportunity for students from the diverse cultures in the region to mix and learn about each-other's cultures.

Neutrons and Food Workshop

Amora Hotel Sydney 31 October - 3 November 2010

The meeting was co-chaired by Professor Mike Davidson from the University Tennessee and Dr Elliot Gilbert from the Bragg Institute, ANSTO.

The application of neutron scattering to food-based systems is still in its infancy but has significant potential to understand the complex relationship between food structure, processing, rheology, nutrition, food quality and security. The purpose of the meeting was to identify the future scientific needs in the application of neutron scattering to food science. The findings will help neutron facilities to adapt their infrastructure to the requirements of the wider scientific community and to enable potential users to develop collaborations with neutron scattering researchers.

AINSE supported 5 of the 52 attendees. About half of the participants came from overseas institutions.

Fusion Materials Workshop

AINSE, Lucas Heights, 4 November

32 people from 8 institutions attended this workshop, AINSE supported 10 delegates who came from outside the Sydney area.

AANSS 2010: Neutron and X-ray Scattering - from Biology to Physics

AINSE, Lucas Heights, 1 - 3 December 2010

The AANSS meeting is held every year and this one was the largest ever with 113 delegates from 23 institutions. 97 papers were presented including an oral program of 41 presentations. The best oral student presentation was awarded to Andrew Princep at ADFA. The best poster presentation by a student was awarded to Gloria Xun from the University of Auckland.

OZ-INTIMATE 2010

AINSE, Lucas Heights, 7-8 December 2010

Twenty-two Australian and New Zealand researchers attended the third OZ-INTIMATE workshop. The primary aim of the workshop was to refine our regional event stratigraphies for presentation at the upcoming INQUA congress in Bern, Switzerland, July 2011. AINSE supported 6 delegates who came from outside the Sydney area.

Australian Collaboration for Accelerator Science (ACAS) Workshop on Accelerator Feedback Systems and School for Accelerator Physics

13-15 December, and 13 - 17 December respectively

The first School for accelerator physics to be held under the ACAS banner was attended by 21 people the School, from 9 institutions. Presenters included representatives from ANSTO, the Australian Synchrotron; a lecture series by Professor Ken Peach from the University of Oxford; and guest seminars by Professor John Fox from Stanford University and Dr Ralph Steinhagen from CERN.

Bragg Institute IAT meetings

AINSE supported 3 IAT Instrument Advisory Team meetings. These meetings provide technical and user advice to ANSTO's Bragg Institute on new instrument development.

International Conference Travel Scholarships

These scholarships usually provide up to \$900 as a travel and accommodation subsidy for students and post doctoral fellows from AINSE member universities who wish to present their AINSE supported research at an international meeting. Details are provided in the following table.

Awardee	UNI	Conference/Facility	Month	Amount
Elizabeth Abbey	SYD	American Geographical Union Fall Meeting San Francisco	December	\$900
Patryck Allen	SYD	Asian Crystallographic Association Conference in Busan	November	\$900
William Brant	SYD	Asian Crystallographic Association Conference in Busan	November	\$900
Sarah Hagerty	LAT	International Association of Hydrogeologists World Congress in Krakow	September	\$900
Yue Wu	SYD	Asian Crystallographic Association Conference in Busan	November	\$900

For more information about International Travel Scholarships see AINSE's web-site www.ainse.edu.au.