Excellence of PFPC members honoured

**Professor Geoff Stevens is one of Australia's Top100 Engineers**

PFFC Director, Professor Geoff Stevens, was again listed as one of Australia’s 100 most influential engineers in *Engineers Australia* magazine’s sixth annual list. The list identifies the country’s leading engineers in academia/research, associations, consulting, engineering expertise, industry, public service and politics. Geoff’s inclusion reflects the leadership role he takes at The University of Melbourne and is recognition of his distinguished reputation within The University, Australia and indeed internationally. Geoff and the other chemical engineers featured on the list were also highlighted in the Chemical Engineering in Australia (CEA) June 2009 Newsletter, the newsletter of IChemE in Australia.

**Professors Frank Caruso and Paul Mulvaney are elected Fellows of the Australian Academy of Science**

In March 2009 Professors Caruso and Mulvaney were honoured by election to the Australian Academy of Science. The Academy was founded in 1954 by Australian Fellows of the Royal Society of London with the distinguished physicist Sir Mark Oliphant as founding President. It was granted a Royal Charter establishing the Academy as an independent body but with government endorsement. The Fellowship of the Academy is made up of over 400 of Australia’s top scientists, distinguished in the physical and biological sciences and their applications. Each year sixteen scientists, judged by their peers to have made an exceptional contribution to knowledge in their field, are elected to Fellowship of the Academy.

**John Provis, Brian Robinson Fellow**

In 2009 John Provis was awarded the Brian Robinson Fellowship to fund collaborative work he will undertake at the University of California, Berkeley in 2010. John is involved in the design of aluminosilicate “geopolymer” cements and concretes. The traditional cement industry is estimated to be responsible for approximately 5-8% of global anthropogenic CO₂ emissions. Geopolymers require much less energy consumption and can be made from industrial waste products, thus a “green” alternative to traditional production. The Brian Robinson Fellowship was established to recognise the late Dr Brian Robinson’s (AM) contribution to Victoria. Dr Robinson was the former Chairman of the Environment Protection Authority (EPA) and the Fellowship was set up by the State Government of Victoria to nurture young people making a significant contribution to the future sustainability of Victoria. The Fellowship is administered through the Banksia Environmental Foundation.
The PFPC hosts an international workshop: Advanced Materials for Australia's Future

On 18 and 19 May 2009 more than 140 participants gathered to exchange ideas on the key scientific challenges in the development of usable “Advanced Materials” based on nano-science principles.

Organised by the PFPC and made possible through financial support from the International Science Linkages – Science Academies Programme, the Australian Academy of Technological Sciences and Engineering (ATSE) and The University of Melbourne, the attendees included distinguished international guests who are leaders in nanotechnology alongside Australian experts in the field.

Advanced materials have the potential to make solar energy utilisation more economical, to open up new ways to clean our waste waters, to provide desalination technologies that consume less energy, through to offering medical practitioners with point-of-service clinical biosensors. Almost all of these new technologies depend on ultra-small particles, films and molecular assemblies. Our engineers of the next generation will produce solutions for the incorporation of nanotechnology into our manufacturing sectors of all kinds.

Our international guests presented a range of keynote lectures over the two days. The topics covered included discussion of the design, synthesis and characterisation of stimuli-responsive materials from Prof Alan Hatton (MIT, USA), surface force measurement in nanomaterials by Prof Kazue Kurihara (Institute of Multidisciplinary Research for Advanced Materials, Japan) through to a discussion of the use of shape forming methods used in ceramics processing for nanoparticles used in personal care products and advanced electronic components from Prof Fred Lange (UCSB, USA).

Prof Brian Vincent (University of Bristol, UK) addressed methods of controlled release of bio-active species, drugs, perfumes, dyes and nutrients as well as the use of porous materials as catalyst supports. Prof Richard Buscall from MSACT Consulting, UK talked on colloidal dispersions in processing technologies and Prof Luis Liz-Marzan (University of Vigo, Spain) explained his work on tuning the optical properties of metal nanoparticles and their usefulness in biosensing applications.

There was presentation of the research undertaken at Kyoto University, Japan, to understand the problems involved in producing advanced materials from functional nanoparticles by Prof Ko Hagihashi.

We invited Prof Wayne Morrison (Bernard O’Brien Institute of Microsurgery) to illustrate how his collaboration with members of the PFPC has advanced the use of biomaterials in tissue engineering, an apt demonstration of the real benefits of new generation materials in clinical practice. A number of senior PFPC members outlined the research ongoing within the Centre and the Workshop also afforded some of our Early Career Researchers (ECR) the unique opportunity to present their work to their peers and to the leaders in their fields. Our ECR members covered topics ranging from drug delivery systems, to synthesizing safe functional peptides, and the use of microscopy technologies to assess the microstructure of dairy products.

In addition to presentations, two panel discussions were run. The first “Do particles of true nanodimension present ‘new’ processing problems?” was moderated by Prof Tom Healy with panel members Prof Calum Drummond, A/Prof George Franks, Prof Franz Gieseler, Prof Alan Hatton, Prof Ko Hagihashi, Prof Luis Liz-Marzan and Prof Paul Mulvany.

The outcomes of this discussion identified a range of issues that will form the basis of research projects for participants as well as larger questions that need to be addressed by the community. These include issues around safe processing and public health concerns and how we “scale up” existing laboratory scale processing technologies to produce commercial quantities of these materials.

Prof Brian Vincent moderated the second panel “What special processing problems do ‘bio organic’ particles present?” In a lively analysis panel members Prof Richard Buscall, Prof Frank Caruso, Dr Ray Dagastine, Prof Kazue Kurihara, Prof Fred Lange and Prof Peter Scales discussed with the audience the problems that arise when dealing with biological systems. These systems do not always behave in predictable ways and pose particular challenges when engineering new materials designed to interact with such particles.

Through participating in the Advanced Materials for Australia’s Future Workshop Australian participants received a comprehensive briefing on the latest science and technology of advanced materials applications. This enabled our Australian scientists and engineers to better understand and explain the key advantages of the use of nano-scale systems and has armed them to better contribute to nanotechnology debates in the public arena. The ECR participants were afforded an invaluable opportunity to meet the invited Workshop participants and begin to develop collaborative exchanges in the field.

From Left to Right: Postdoctoral researcher Dr Carolina Talon, Postgraduate students Prang Chuanawatansukul, Josephine Lim, Stephen Tanudjaja, Rorry Anderson, Ankit Kivist-Maranor

PHD student Maryline Chee Kim Ling enjoys a break with her colleagues Dr Derkong Chen, Ms Ivy Lee and Dr Weifang Zhou

Prof Tom Healy (left) with international participants Prof Richard Buscall and Prof Brian Vincent
Dr Sally Gras wins the opportunity to participate in a collaborative research exchange with China

Dr Sally Gras was successful in her Australia China Young Scientists Exchange Scheme nomination which was considered by the Australian Academy of Technological Sciences and Engineering (ATSE) in a very competitive round. Sally took one of the eight places on the exchange visit that was conducted in China from the 16-30 April 2009.

The Australia China Young Scientist Exchange Scheme is targeted at mid-career researchers who have shown both technical expertise and leadership potential in science and technology. Host organizations provide mentoring to their visitors and through these visits, promote collaboration between younger Australian and Chinese scientists by allowing participants to form research networks and explore possible areas of collaborative research. The scheme is funded through the Australian Government Department of Innovation, Industry, Science and Research (DIISR) and the Chinese Ministry of Science and Technology (MOST) and organised by ATSE.

On her trip Sally visited several universities and delivered seminars at each. Her hosts included Professors Bao Guo Wang and Wei Li from the School of Chemical Engineering, Tianjin University; Professor Sarah Perrett, Chinese Academy of Sciences, Beijing; Professor Guangsheng Luo, Chairman and Professor of the Department of Chemical Engineering Tsinghua University, Beijing; and Professor Huizhou Liu, Institute of Process Engineering, Chinese Academy of Sciences, Beijing.

Welcome Associate Professor Greg Qiao and the Polymer Science Group

Following strategic review of our science through 2008, we identified a need for a stronger involvement in synthetic chemistry and are happy to welcome Associate Professor Greg Qiao into the PFPC. Greg received his B.Eng. in Polymer Engineering at East China University in 1982 and his PhD at the University of Queensland in 1996 on synthetic organic chemistry. He then worked as a Postdoctoral Fellow at The University of Melbourne when he entered the field of synthetic polymer chemistry and engineering. He became a Lecturer in the Department of Chemical and Biomolecular Engineering in 2002, then was promoted to a Senior Lecturer in 2004 and Associate Professor and Reader in 2007. He is now also the Assistant Dean (Research) in the Melbourne School of Engineering. He was elected a Fellow of the Royal Australian Chemical Institute (FRACI) in 2006. Since 2000, Greg has been the leader of the Polymer Science Group in the Department. In the past 15 years, he has brought to the university and his group more than $11 million research funding. His research group now consists of seven Research Fellows and 12 PhD students. The group's current main research interests are in the synthesis of novel macromolecular architectures by controlled polymerisations, polymeric membranes for gas separations, functional polymers for specific applications in mineral, point, packaging, water and special composite industry, and biomacromolecular scaffolds for soft tissue engineering. In the past 15 years, he has produced more than 170 publications including 18 patents and 80 refereed international journal articles. We’re happy Greg has joined the Centre and his strengths in synthetic chemistry will benefit a range of our ventures.

Professor Neil Furlong joins the PFPC team

With key Centre personnel planning to bid for an ARC Centre of Excellence once the next funding round is announced, we welcome Professor Neil Furlong on board to assist with the preparation of our application. Neil has kindly agreed to consult with us on the new Centre of Excellence plan and to critically appraise our application.

Neil recently retired from RMIT University in Melbourne where he served as Pro Vice Chancellor (Research and Innovation) for ten years. He is now Professor (Emeritus) at RMIT University, Honorary Professor here at The University of Melbourne, Fellow of the Australian Academy of Technological Sciences and Engineering and Editor of the Journal Colloids and Surfaces A. Neil has a very distinguished research career. Over the last 20 years he has worked as an active researcher and research leader in the fields of nanoscience, nanotechnology, surface and surfactant chemistry and environmental technologies at CSIRO, in industry and universities in Australia and Europe. He has been an active contributor to the development of the chemistry profession in Australia through lead roles in the Royal Australian Chemical Institute and the Academy of Technological Sciences and Engineering as well as internationally via editorships and co-ordination of international forums and conferences.

Neil has a strong record of research output with around 120 refereed journal articles, 4 patents, more than 100 technical reports and others to his credit. Neil’s experience is a very valuable asset to us as we prepare our bid and we are grateful for his assistance as we move forward.
RESEARCH FEATURE

The Surface Science and Technology Group

Professor Robert Lamb joined the PFPC as an Executive member last year. His interest in surface and materials science complements the work in the Centre and in this edition we focus on some of the work undertaken by his research group at The University of Melbourne.

The Surface Science and Technology Group is focused on the study of interfaces. With its expertise in synchrotron analysis techniques, thin film formation and vacuum science, the group applies itself to a diverse range of research topics. This is done on a number of fronts within The University of Melbourne and externally with various other research institutes and industry partners.

The group’s work is currently centred on understanding the underlying science of ultra-thin, yet transparent, superhydrophobic surfaces.

The group joined the PFPC in early 2018 after relocating from the Chemistry School at the University of New South Wales (UNSW). Rob’s return was a homecoming since he obtained his first PhD here at the School of Chemistry in 1984.

At UNSW the group had a diverse scientific makeup drawing from each member’s different backgrounds to form a cohesive research unit, often obscuring the lines between physics and chemistry. The main focus of the group’s activities included fundamental surface science and the development of innovative surface technologies. The knowledge gained fed into research areas involving chemical deposition of semiconductor and insulator thin films, superhydrophobic coatings, nanomaterials and nanoelectronics, mineral processing science and biomaterials. The group has, amongst other things, an x-ray and ultraviolet photoelectron spectroscopy (XPS/UPS) imaging surface analysis system as well as a time-of-flight secondary ion mass spectrometry (ToF SIMS) system for undertaking surface mass spectroscopy.

Here in Melbourne, the group is still interested in modifying surfaces with both chemical and physical treatments at the nano-scale such that they achieve unique properties. One main area of research for Rob’s team is the formation of superhydrophobic thin films. The application of this technology is broad and can be used to produce surfaces that are self-cleaning, stain resistant and anti-fouling. One can imagine buildings with self-cleaning windows and walls, fabrics that resist staining and roads that are never icy.

Surfaces on which the contact angle with water is larger than 150° are commonly referred to as superhydrophobic and may have both physical roughness and chemical hydrophobicity. Perhaps counter intuitively, the rougher the surface, the more waterproof it becomes.

Current research in the group focuses on the fabrication of superhydrophobic types through the combination of novel elements of synthetic organic/inorganic nano-hybrids and advanced physical characterisation. Thin, yet ultra-thick films are prepared by packing hydrophobic modified nano-scale particulates. The process demonstrates nanotechnology in making unique products in an easier and less expensive way.

Recently, the group has achieved success in fabricating a transparent superhydrophobic coating. Since surface roughness causes light scattering one would not think that an ultra-thick film could be transparent. However, the Surface Science and Technology Group have demonstrated that there exists a window of opportunity where these two phenomena may co-exist. Furthermore, the group has expanded its experimental work to studying a previously unobserved but related beneficial use for these coatings, marine antifouling. Since currently used marine antifouling coatings are highly toxic, many governments worldwide are seeking a more environmentally friendly alternative opening another application opportunity for the Group’s research.

Along with his appointment as Professor of Chemistry at The University of Melbourne, Rob also serves as the Director of the Australian Synchrotron. The Australian Synchrotron is a source of highly intense light ranging from infrared to hard x-rays. Synchrotron radiation is a powerful tool in a wide range of research fields including materials science. It is applied to the study of structure and dynamics in many aspects of science.

The Surface Science and Technology Group utilise the Synchrotron to study surface and interface characteristics of nanomaterials, semi-conductive materials and minerals. In addition to work carried out at the Australian Synchrotron, group members make use of the National Synchrotron Radiation Research Center (NSRRC) in Taiwan and the Pohang Accelerator Laboratory in Korea. Of particular use to Rob’s team is small angle scattering (SAXS) and wide angle (WAXS) diffraction, normally combined on one beamline. They are particularly useful for the study of the structure and dynamics of molecular assemblies. SAXS provides a method to investigate the in situimmersive wetting of ultrathin surfaces. This is done by observing the contrast of scattering observed from rough surfaces when partially or totally wetted revealing the significant physical differences between superhydrophobic surfaces that otherwise appear from conventional contact angle measurements.

Rob is currently supervising three PhD students, Lauren Palmer, Jacky Cho and Alex Wu, on the superhydrophobic surface project. He has a final year doctoral student, Alex Duan, who is writing up his thesis on alumina thin films. Dr Irving Liew is the postdoctoral fellow in the group. He works with Professor Andrew Holmes’ Group at the Bio21 Institute on organic solar cells.

The ToF SIMS system for surface mass spectroscopy analysis

The Thermo VG Scientific Escalab 220 XPS

Schematic diagram of a water drop on a superhydrophobic surface. The contact angle (θ) is indicated.

The traditional macroscopic understanding of superhydrophobic surfaces in terms of contact angles and surface tension is well understood. However, there exists a wealth of information with regards to hydrophobic interactions at the nanoscale which cannot be explained using these methods. A major issue being whether the concept of surface tension and contact angle actually apply at the nanoscale.

For more information contact Prof Rob Lamb (mlamb@unimelb.edu.au) or Dr Irving Liew (iliew@unimelb.edu.au)
PFPC Postdoctoral Research Fellows
Our talented postdoctoral fellows are a valuable asset to the Centre.
Four of our more recent recruits are profiled below.

Dr Anthony Fernando
Melbourne born and bred, I completed my undergraduate honours degree in pure mathematics at La Trobe University and went on to do a PhD at the Centre for Environmental Safety and Risk Engineering (CESARE) at Victoria University of Technology. My topic was the modelling of fire growth in enclosures using Computational Fluid Dynamics (CFD), and in particular, the modelling of ignition and flame spread on flammable items in the enclosure itself. The problem drove on fluid modelling, combustion science, some chemical kinetics, plenty of mathematics, and both bench scale and full scale experiments. I incorporated the novel approach of using cellular automata (CA) to model flame spread as a series of discrete ignitions, in order to simplify and generalise the flame spread phenomenon for CFD. After graduating, I spent some time in the defence industry as a software engineer and system analyist, working on projects such as the JORN over-the-horizon radar, and self-guidance algorithms for unmanneled aerial vehicles. During this time, I had the opportunity to undertake a 12-month postdoctoral position at the Atomic Energy Commission (CEA) in Saclay, on the outskirts of Paris, where I helped develop their in-house finite element CFD code, looking particularly at the modelling of radiant heat transfer in helium-cooled systems. I am currently a Research Fellow with Professor Kory Landman and Dr Matthew Simpson, researching Neural Crest Cell (NCC) colonisation in the embryonic gut. The NCCs migrate or invade the unoccupied gut tissue and ultimately form the enteric nervous system responsible for normal gut function. CA-modelling is once again brought to bear, as well as the continuum limit of such models, in this area of research. A key feature of this dual approach is that it provides a mechanism to understand both the interaction of individual cells at the cellular level, and at the level of the overall population in a developmental process.

Dr Aaron Gosling
I took the long road to get to my first postdoc, here at the PFPC. I didn’t go to university after high school. I travelled and worked at many varied jobs, which was good for a time, but I didn’t find anything that engaged me for long. So at 26, I went back to school. I undertook an undergraduate degree at Swinburne University, and discovered that I loved chemistry and biochemistry. My life settled down, and I had a wife and daughter by the time I graduated. Soon after, my son was born, and four weeks later I began my PhD at the Commonwealth Scientific and Industrial Research Organisation (CSIRO). That project involved using microbial metabolism to convert renewable chemicals into polymer building blocks. It’s an odd comparison, but I could never stop myself comparing the way my PhD research and my boy grew next to each other. I think Jack will always be cleverer than anything I do in a lab, and also more out of my control than any experiment should be.

While at CSIRO, Dr Sally Gras, from the PFPC, gave a seminar and mentioned that she had an interest in metabolic engineering. I thought she and I were probably the only two Melbourne-based researchers that had that interest, so I talked to her after her presentation. We developed an idea for a collaborative project between The University of Melbourne and CSIRO. Then, while I was finalising my PhD thesis, a postdoc position became available in Sally’s lab to research enzymatic modification of lactase in dairy products. I was fortunate enough to get the job. I am learning a lot in the multi-disciplinary environment of the PFPC, and enjoying it.

Dr. rer. Nat. Andreas Ide
My scientific pathway started at the Humboldt University of Berlin (Germany), where I obtained the German “Diploma” in Chemistry. My major emphasis at that time was on organo-titanium catalyzed asymmetric synthesis. Additionally, I supervised a project which investigated the degradation behaviour of the oxidant in Berlin’s natural gas network. The focus of my PhD changed towards materials chemistry and I received a doctorate in polymer and colloid chemistry with Prof. Markus Antonietti at the Max-Planck-Institute of Colloids and Interfaces in Potsdam (Germany). My research involved the rational design of a boron-silane-precursor allowing targeted structuring of highly functionalised mesoporous silica materials in a straightforward fashion. This led to a variety of functional hybrid nanomaterials which primarily possessed chiral surfaces. It could be shown that these materials can be employed as stationary phases for HPLC and in asymmetric catalysis.

Extending the scopes of my research interests and working on cutting-edge nanomaterials as well as enjoying the beauty of “Terra Australis Incognita” has always been a goal. I am now working as a research fellow with Dr Rachel Caruso within the Advanced Porous Materials Group in the School of Chemistry. We are collaborating with the Australian Nuclear Science and Technology Organisation (ANSTO) to develop functionalised durable nanomaterials which allow a sustainable treatment of fission products obtained from the nuclear fuel cycle. Titanium zirconium oxides which are tailored with organic selectors have been shown to possess outstanding properties and can be used for both recycling and safe storage of fission products. A substantial aspect of my work is the synthesis of organic selectors as well as the assessment of their performance in extreme environments.

Dr Kathryn Mumford
I graduated with a Doctorate of Philosophy from The University of Melbourne in 2009, after first receiving Bachelor degrees in Engineering (Chem.) (Hon.) and Commerce in 2004. My postgraduate studies were focused on the development of a temperature dependent thermodynamic model for ice exchange. This model contributed to the design of a permeable reactive barrier system for the capture and biodegradation of fuel contaminants in the soil in Antarctica. During my PhD studies I had the opportunity to spend approximately one year in Antarctica. Since completing my thesis I spent a year in the Northern Hemisphere, working for WorleyParsons, Canada and BP Exploration (Alaska) Inc on the remediation of contaminated sites in the high Arctic. I have recently returned to The University of Melbourne and the PFPC to take a position as a Research Fellow. I am involved with two major projects. One is with the Cooperative Research Centre for Greenhouse Gas Technology (CO2CRC) assisting in the development of new technologies for the capture of carbon dioxide from flare gas streams. I have also returned the Antarctic Research Group and am continuing work on the remediation of contaminated sites in Antarctica.
Publications (cont.)


Patents

Other

Publicity

* Selected as Editor's Suggestion and front cover for the issue.


The research undertaken by Frank Caruso and his research team has been highlighted by EurekAlert! EurekAlert is an online, global news service operated by the American Association for the Advancement of Science (AAAS).


Refereed Conference Papers
