Flinders
UNIVERSITY

School of Chemical and Physical Sciences

HONOURS INFORMATION BOOKLET

2016

What is Honours all about?

After completing a three-year degree or the first three years of an honours degree, many students go on to complete their Honours Degree. The Honours programs in the School of Chemical and Physical Sciences at Flinders consist of advanced course-work and a research project supervised by a member of the academic staff.

The Honours year is a different and exciting experience for most students. As well as continuing to acquire and understand existing knowledge they are working at the coalface experiencing the joys and heartaches of discovering new scientific phenomena and exploring new theoretical explanations. They also gain experience in designing experiments to test existing theories or new hypotheses. The wider scope that this gives to a student's view of science and problem solving is invaluable. We believe that every student who has the capacity to benefit from the honours year should experience it, even if they have no intention of pursuing a research-oriented career. For example, a schoolteacher is more likely to be able to interest students in science-based subjects if he or she has actually experienced the process by which scientific understanding is achieved and knowledge advanced. For many students Honours is a challenging but very exciting year. It's usually the first time that you actually get to work closely on a research project with a supervisor within the School. Many projects are funded by external bodies, and often involve collaboration with industry, other universities or with other government departments such as the CSIRO, Primary Industries and Resources SA, Forensic Science Centre or DSTO, to name just a few. Honours students become key players in many of the projects and quickly become part of new and innovative research project teams both within our School and with external collaborators. We would encourage you to speak to a few Honours students and see what they have to say about it too!
Here are just a few reasons why you should consider doing the Honours year:

- Working on a research project of your choice, closely with a supervisor and even a project team in many cases;
- Gives a better appreciation of what “real world” research is all about;
- Helps you to further develop independent problem solving skills within a project;
- Puts much of your undergraduate study in perspective by giving you an opportunity to make use of and apply your undergraduate training;
- Opens up a much wider range of career opportunities that would not be available to you with an ordinary Bachelor’s degree (many employers are now looking for Honours graduates!). It is often the ticket to getting good jobs in industry and government;
- It is the necessary basis for going on to further research study such as a MSc or a PhD and leading to high-level research careers in the government or industry and jobs in academia. You need an Honours degree to be eligible for most scholarships that support you whilst doing a postgraduate degree.

These are just a few reasons and there are probably many more. It is the year that you can get more heavily involved in research and play an active role in the direction of a research project. Sure, it’s challenging. But, if you speak to most Honours students you’ll find that most say the rewards are worth it. Many students who never thought they’d do Honours ended up doing it and really enjoyed it. For most, it is the best year of the University programme. Many are now even doing postgraduate degrees at Flinders University and at other Universities nationally and overseas too!

It is time to start talking to potential supervisors and to begin thinking about possible Honours research that you might be interested in. We hope to see you in the Honours year in 2016!

Getting into Honours: What you need to know

Students who have completed or who expect to complete the requirements for the Ordinary Degree of Bachelor of Science (majors in Chemistry or Physics, or any joint majors involving these disciplines), or the Ordinary Degree of Bachelor of Science (Forensic and Analytical Science) or Ordinary Degree of Bachelor of Science (Nanotechnology) or equivalent, or the first three years of an Honours degree (Nanotechnology, Science, Science (Enhanced Program for Higher Achievers), or Forensic and Analytical Science) are eligible to apply for permission to enrol in a further year of study. Successful completion of this year results in graduation with the Degree of Bachelor of Science (Honours), Bachelor of Science (Honours) Enhanced Program for High Achievers, Bachelor of Science (Honours) (Forensic and Analytical Science), or Bachelor of Science (Honours) (Nanotechnology).

Admission will be decided on the basis of performance in the student's final year of their Ordinary Degree. Results of students who have completed all requirements of the first three years of university study will be considered at a School meeting in December. Results of other students will be considered as soon as they come to hand. Those students who register an interest in proceeding to an Honours program will be notified of the decisions by letter.

A list of supervisors, brief descriptions of research interests and a list of course-work titles are attached. Students are encouraged to consider all the options on offer even if they are outside the area of the degree you have just completed.

- You are expected to have discussed research with supervisors before applying**.**

- Inform the Dean of School, Professor J. Shapter, in writing, on the attached form, of your preferences ***by no later than December 1, 2016.*** You are **strongly** advised to list 3 choices of supervisor indicating order of preference.

Course Work

Coursework will commence in early February and conclude by the end of June 2016. Coursework is worth 33 % of the marks in the honours year.

For further information on coursework topics and any other information you require on the program please go to http://www.flinders.edu.au/courses/rules/honours.cfm

Where to get more information

If you need any further information about the Honours year please see a staff member in the School or talk to the Honours coordinators. The Honours coordinators in the School are:

Boris Blankleider (Physics, and Chair of the Honours Committee)
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Claire Lenehan (Chemistry)
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PROFESSOR GUNTHER ANDERSSON

Professor Gunther Andersson
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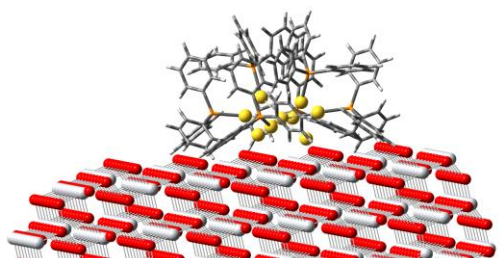
The field of research in my group is the investigation of the molecular structure of surfaces and interface. For these investigations specific and unique surface science methods and equipment have been developed in my lab.

Nano Clusters for Fabrication of Solar Fuels

We are developing catalysts for converting CO_2 and H_2O back to hydrocarbons, thus develop processes to fabricate solar fuels. The main components are small metal clusters which act as catalysts. The clusters contain only 4 – 100 metal atoms. We can be fabricated the clusters with physical methods in a cluster source or use chemically made clusters. The project is a collaboration between Flinders, Adelaide University, Canterbury University and Wellington University (both New Zealand), and the National Institute for Material Science in Japan.

- *Substrate – cluster interaction*: metal oxides are common supports in catalysts but depending on their nature offer a variety of interaction with the metal nano-cluster. The interaction of the cluster with the substrate has most likely a strong influence on the catalytic activity. The image below shows a ligand protected Au_9 cluster on a titania surface.



- *Catalytic testing*: the efficiency of the catalysts is tested with an instrument simulating solar radiation. The structure of the cluster is correlated to the production of H_2 and hydrocarbons.

Liquid Surfaces

Liquid surfaces play an important role in daily life processes but also in a number of technical processes. We are using unique experimental techniques to investigate the relation between the molecular structure and the properties of the surfaces.

- *Foam films*: In foam films two liquid surfaces approach each other to within a few nanometers. The internal structure determines the forces that stabilise these films. The internal structure of foam films is so far not understood and the concepts are purely based on theoretical concepts. In this project the internal structure of foam films will be measured directly aiding tailoring their properties for applications in daily life and industrial processes. Neutral Impact Collision Ion Scattering Spectroscopy (NICISS) is used to determine concentration depth profiles at liquid surfaces with a resolution of a few Angstrom to identify experimentally the internal structure of foam films.
- *Free-standing foam films as templates nanostructured coatings*: Free-standing foam films can be generated from surfactant solutions or as particle stabilised foams. These foams can

be transferred on substrates to generate nanostructured coatings. For understanding the conditions for successful transfer and what structures can be achieved, the surface composition and surface structure of both the foam films and the foam film transferred on substrates has to be investigated. Both types of structures are investigated by analysing the concentration depth profiles and the surface composition.

Biological Membranes

Cellular membranes are essential parts of every biological cell. They ensure compartmentalisation of the cell and are also a matrix, which hosts membrane proteins, responsible for many functions of the cell such as cell-cell signalling. Malfunctioning of membrane proteins is the origin for many diseases and about 60% of all drugs available actually target membrane receptors. Performing experiments on natural cell membranes is difficult due to its high complexity. Ingo Koeper's group has developed a range of model systems, which can mimic structure and function of natural membranes. In collaboration with the Koeper group we are investigating the layered structure of the model systems.

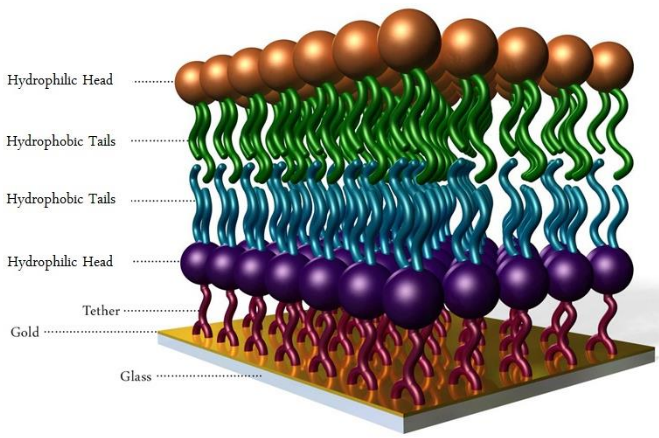


Figure 1: Schematic of a tBLM. A lipid bilayer is attached to a gold electrode through a spacer group.

Dye sensitized solar cells

Dye sensitized solar cells (DSCs) are one of the promising technologies for photovoltaic cells. The interface of the titania and the dyes in DSCs is the crucial place for their functionality and efficiency.

- *Interfaces in dye sensitized solar cells:* the morphology of dye layers on titania (thickness, coverage and homogeneity) and the electronic structure will be investigated with depth profiling techniques and electron spectroscopy. This is a project in collaboration with Prof Lars Kloo from the Royal Institute of Technology in Sweden.

Polymer based electronic devices

Electronic devices based on conducting polymers have the advantage over their silicon based counterparts that they can be produced much more cost effective.

- *Interfaces in polymer based electronic devices:* the interfaces play a crucial role for the functionality of polymer based electronic devices. The project will focus on the relation between the structure of the interfaces and the function of the devices. This project will be supervised by Prof Andersson and Prof Lewis in collaboration with CSIRO in Melbourne.

DR B BLANKLEIDER

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Projects include:

- **Theoretical Nuclear/Elementary Particle Physics**

  Some of the least understood and most mysterious phenomena in Nature happen at a scale more than a million times smaller than that of nanometers. This is the realm of "elementary particles": quarks, gluons, pions, rho-mesons, neutrons, protons, etc., all interacting through the little understood "strong interactions". Driving the research of this tiny realm are such fundamental questions as, "What is the atomic nucleus made out of?", "What stops the atomic nuclei from blowing apart?", and "How and why did nuclei (and therefore atoms and molecules) form in the Early Universe?". To help unravel the workings of this tiny world, there is a huge world-wide experimental effort to probe atomic nuclei and their constituents with high-energy beams of electrons, positrons, photons, protons, and many other types of particles (see for example, www.cern.ch, www.nikhef.nl, www.fnal.org, www.jlab.org, www.slac.stanford.edu). At Flinders we are developing novel theoretical models that aim to provide the world's most accurate descriptions of some currently measured strong-interaction processes. In conjunction with this effort, honours projects are available that will help implement these accurate models, thereby paving the way to a better understanding of strong interactions.

- **Condensed matter/many-body physics**

  The physics of many-body systems has wide-ranging applications: at one extreme it can be used to understand the structure of neutron stars, and at another it describes exotic quark matter states. Many-body physics is also of particular relevance to nanotechnology, as it provides the theoretical description of metals, semi-conductors, superconductors, etc. A number of Honours projects are available that will be of particular interest to Nanotechnology students – they involve the study of how properties of two- and three-particle systems (mass, wavefunction, superconductivity, etc.) change when taken from vacuum and embedded in an infinite-body medium (like a metal or neutron star).

PROF M J BRUNGER

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There are a number of Honours projects available in our group in 2016. Some of these are based at Flinders University, while others are based at the Australian National University (ANU) in Canberra.

At Flinders University a project is available to work on experimental measurements dealing with electron scattering from molecular radicals. This project uses a state-of-the-art crossed beam apparatus to measure elastic differential cross sections from radicals such as CF_2 and CF_3. These are precisely the species that are of great commercial interest to people trying to model the behaviour of plasma etch reactors for semi-conductor fabrication. The apparatus has 3 stages. In the first the radical beam is formed using photolysis, the second is where the electrons and the radical beam of interest scatter, while in the third the radical beam composition is determined using a time-of-flight-mass-spectrometer (TOFMS). Note that absolute elastic differential cross sections are set using a new technique we developed at Flinders. Any student undertaking this project will learn generic skills in high vacuum technology, electron optics and electron and radical beam production, electron detectors, TOFMS and laser technology.

Another Flinders-based project looks at the modelling of electron-driven processes in off-world planetary atmospheres, using our approach of statistical equilibrium. In this technique the rate of population and de-population of all the vibrational sub-levels of all the electronic states of a given molecule are studied. When the rate of population equals the rate of depopulation a steady state is achieved and statistical equilibrium is said to have been reached. At this time the calculated equilibrium number densities are used to determine the relevant emission spectra (Intensity versus wavelength), which are then compared to those measured by space probes. Of particular interest are the emission spectra observed under auroral conditions. Note that the atmospheric chemistry of the planet or moon in question is also important, so that the continuity equations for the electron-driven and atmospheric chemistry are solved simultaneously. Generic skills in FORTRAN programming and database formation and manipulation will be learnt as a part of this project.

The final project utilises a crossed beam apparatus to measure cross sections for excitation of biomolecules and molecules of relevance to the production of ‘green fuels’ by low-temperature plasmas. This work is conducted in collaboration with colleagues in Brazil and Europe, with travel to either destination as a part of the project being likely.

The ARC Centre of Excellence in Antimatter Studies (CAMS) was set up to investigate the ways in which positrons, the electron’s antiparticle, interact with matter. Our research program spans studies from the very fundamental to the very applied, for example from the way in which positrons excite and ionise the simplest of atoms and molecules, such as He, to the way in which they can be used as an analytical tool to develop new porous and conductive polymer membranes. The Centre also has a large program devoted to the study of positron interactions with bio-molecules, in particular the study of those molecules that are of relevance in the process of Positron Emission Tomography (PET).While CAMS closed at the end of 2013, the collaborations fostered over the last 8 years live on and are supported by an ARC Discovery Program grant to Professor's Brunger, Buchman (ANU) and White (JCU).

In 2016, an Honours project will be available for a student who would like to spend several (~6) months in Canberra using the Australian Positron Beam-line Facility (APBF). Scholarships, normally $6000 are allocated on the basis of Academic Merit, and support the students stay in Canberra.

We anticipate ANU-based Honours programmes being available in any of the following three areas in 2016

- A comparison of low energy electron and positron scattering from simple atomic and molecular systems. With their different charge and nature to the electron, positrons interact differently with atoms and molecules. We would like to track some of these differences for a number of important benchmark systems, such as the helium atom, and a simple molecule such as H_2 or N_2. This is an atomic collisions project which involves the measurement of quantities at the sub-nanometre scale. It offers the student an opportunity to gain expertise in ultra-high vacuum technology, low energy charged-particle beams, atomic and molecular spectroscopy, coordination of a large-scale experimental facility, data accumulation, analysis and interpretation.

- Positron interactions with materials.
  This programme will involve the implementation of instrumentation and specimen handling procedures to enable studies of near-surface properties of materials, using high-energy positron beams. It offers the student an opportunity to gain expertise in ultra-high vacuum technology, high-energy charged-particle beams, fast timing detectors, data accumulation, analysis and interpretation.

- Positron interactions with biomolecules.
  Positrons are used extensively in both cancer detection and treatment. Positron-emitting radioactive isotopes such as ^{18}F are attached to carrier molecules, which are chosen for their ability to seek out specific active sites in the body. Such sites may be a cancer, for instance. High energy positrons are emitted from the radioisotope at these sites and they quickly thermalise, by scattering, from an energy of hundreds of keV to an energy less than 10 eV where they readily either form positronium (an electron-positron pair) or directly annihilate with an electron. The two gamma rays that are given off in this process are detected in coincidence, and are the basis for the PET imaging process. Our goal in this programme of research is to quantify in laboratory-based experiments, the extent of the positron interactions with various biomolecules that are important in both the thermalisation and annihilation processes. It offers the student an opportunity to gain expertise in ultra-high vacuum technology, low-energy charged-particle beams, molecular spectroscopy, data accumulation, analysis and interpretation.

DR JUSTIN CHALKER

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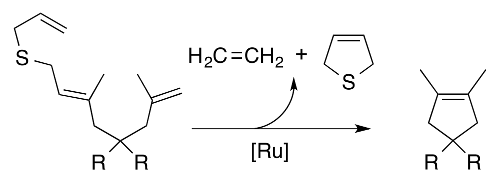
Research Summary

Research in our laboratory falls under the general purview of organic chemistry and its application to problems in chemical synthesis, biochemistry, and material science. The projects outlined below are representative ways in which Honours students can contribute to these priorities.

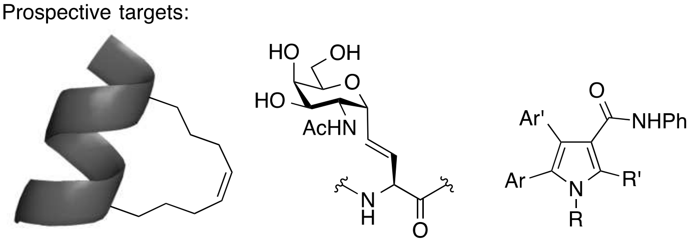
Organic Synthesis and Catalysis

Our lab has discovered that allyl sulphides are remarkably reactive in olefin metathesis. This project takes advantage of the allyl sulphide as a sacrificial promoter to access sulphur-free targets. This new methodology will be useful for synthesising valuable compounds such as therapeutic peptides and pharmaceuticals.



Allyl sulphides can promote olefin metathesis, enabling access to *sulfur-free* targets

Prospective targets:

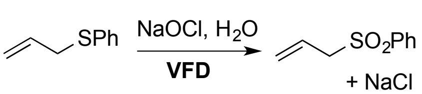


Stapeled peptides | Synthetic vaccines | Pharmaceuticals

Green Chemistry

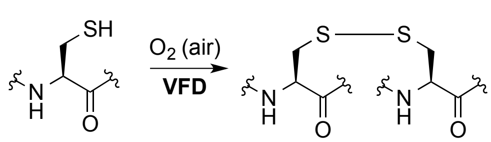
A collaborative project with Prof Colin Raston, this research will feature a Vortex Fluidic Device (VFD) in environmentally benign oxidations. Two types of reactions will be explored: oxidations with aqueous hypochlorous acid (bleach) and aerobic oxidations. The VFD enables intense mixing, which will facilitate the oxidation of non-polar compounds in aqueous bleach—producing only sodium chloride and water as byproducts. The thin film produced in the VFD also enables efficient gas exchange, a promising feature for using air or oxygen gas as an oxidant. These green oxidations will be useful in chemical synthesis and protein folding.

Oxidation of non-polar compounds in bleach



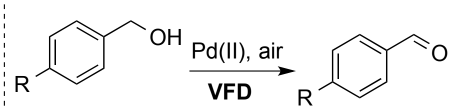
No organic solvent, innocuous byproduct

Aerobic oxidation in a thin film



mild oxidant (air), relevant to protein folding

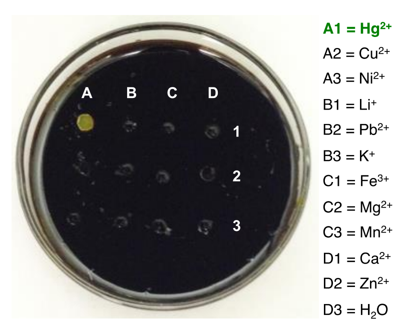
Catalytic aerobic oxidation



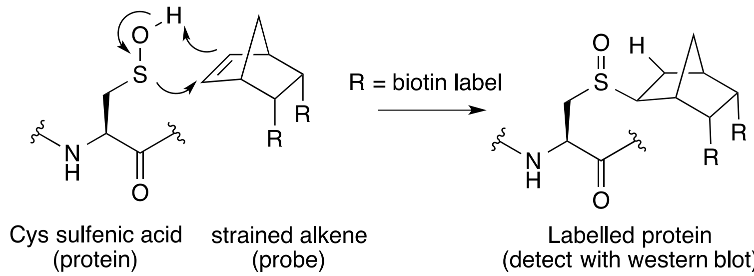
Fundamental transformation in synthesis

Material Science

Our laboratory recently discovered a new material made entirely from the industrial waste products sulphur and limonene. This material removes toxic metals from water and changes colour in the presence of mercury (see figure). This project will explore new types of high sulphur content materials and how they can be used in environmental remediation, drug- and agrichemical delivery, chemical sensing, and next-generation plastics. More than 70 million tons of sulphur are produced each year as a byproduct of the petroleum industry, so new uses of this feedstock are important. This project will involve several collaborations in the Centre for NanoScale Science and Technology.

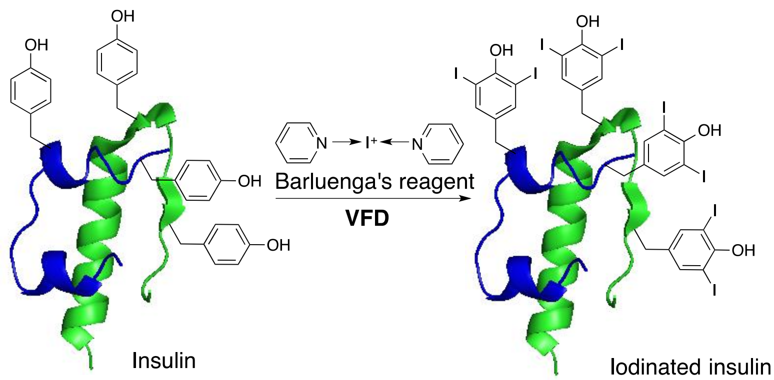


Chemical Biology of Oxidative Stress



Oxidative stress is implicated in aging, cancer, atherosclerosis and Alzheimer's disease. One of the hallmarks of oxidative stress is the cysteine sulfenic acid biomarker. Despite the importance of cysteine sulfenic acid, there are very few methods that allow efficient detection and quantification of this protein modification. This project will involve the synthesis of a biotin-labelled strained alkene to react with cysteine sulfenic acid on proteins. This probe will then be investigated in live cells to map proteins that contain cysteine sulfenic acid. This fundamental study will inform efforts to understand oxidative stress and its relationship to biological processes and disease.

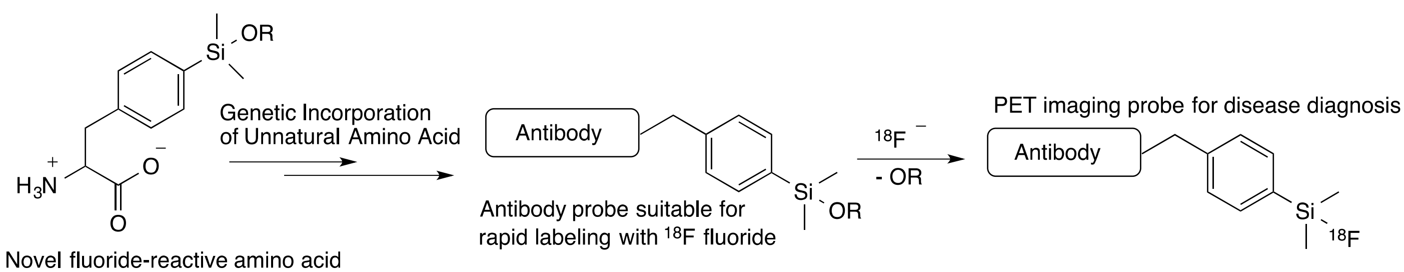
New Strategies in Protein Modification



The chemical modification of proteins is important in the study of protein structure and function, as well as the synthesis of therapeutic proteins. This project will use a Vortex Fluidic Device (VFD) to develop the first general method for protein modification in flow. Continuous processing is important for control and scale in chemical synthesis, but it has yet to be adapted to protein modification. The iodination of insulin will be used as a model system to determine the parameters necessary for controlled and continuous protein modification, while maintaining a correctly folded structure. Protein iodination is important in crystallography and the chemical modification of insulin is important in modulating its half-life and therapeutic potency. This is a collaborative project with Prof Colin Raston (CaPS) and A/Prof Briony Forbes (Flinders Medical Centre).

New PET Probes for Disease Diagnosis

The aim of this project is to prepare an amino acid that can be rapidly labelled with ^{18}F, a useful isotope for positron emission tomography (PET). The amino acid will then be incorporated into proteins using both chemical and genetic methods. The long-term goal is to use this technology to produce antibodies that are precisely labelled with ^{18}F and bind specifically to diseased tissue. This is a collaborative project with A/Prof Mike Perkins, Dr Gonçalo Bernardes (Cambridge), and Prof Hui-Wang Ai (UC Riverside).



Prospective Honours students are encouraged to contact Dr Justin Chalker to discuss these research opportunities. Please email justin.chalker@flinders.edu.au

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PROFESSOR AMANDA ELLIS

Professor Amanda Ellis
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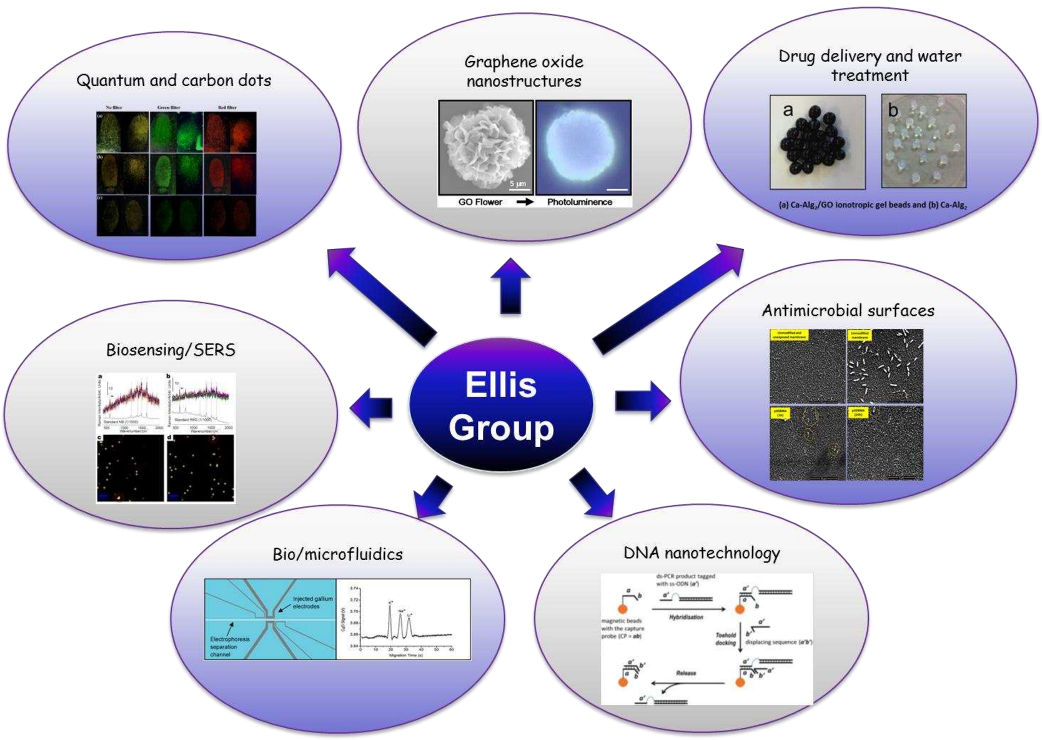
My group undertakes research into polymer chemistry/synthesis, DNA nanotechnology, nanoscale phenomena and nano/microstructures related to fundamental nanotechnology, water treatment, desalination, and biomedical diagnostics.



Please come and see me if you are interested in any of the following:

- Development of holograms and high refractive index materials using nanodiamonds (Reserve Bank of Australia)
- Development of supercapacitors and piezoelectric devices for energy production and storage (Reserve Bank of Australia)
- Synthesis of DNA-based smart polymers for biomedical diagnostics
- Fabrication of carbon-based quantum dots for forensic fingerprinting or biomedical diagnostics
- Surface modification of water treatment and desalination polymeric membranes
    - Modification using polymer grafting – ATRP or RAFT
    - Modification with graphene oxide (includes chemical synthesis)

DR JASON GASCOOKE and PROFESSOR WARREN LAWRANCE

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The Laser Spectroscopy and Reaction Dynamics Laboratory undertakes research in areas of chemical physics and physical chemistry that are related to molecular structure and molecular interactions. We use laser-based techniques to study isolated gas phase molecular systems in order to understand physical and chemical processes at the molecular level. Students working in the lab will undertake cutting edge experiments and learn generic skills in a range of areas such as experimental design, laser technology, optics, high vacuum techniques, data acquisition, data analysis, and programming.

Projects include:

- **Understanding weak intermolecular interactions**
  Weak interactions between molecular species can be overlooked, but are responsible for many "strong" effects. For example, these weak forces are responsible for protein folding and self-assembly, and are important in areas such as chemical reactivity (reaction rates) and atmospheric chemistry. In our lab we make species consisting of a few molecules (up to 4) held together via a weak interaction such as van der Waals or hydrogen bonds. These clusters are studied in an isolated environment at temperatures near absolute zero to learn about the fundamental interactions. They are interrogated using laser-based methods and various, purpose built, experimental apparatuses to determine physical properties such as:
  - Vibrational energies related to the relative motion of the species in the cluster (using "laser induced fluorescence" and "dispersed fluorescence spectroscopy").
  - Rotational motion of the entire cluster (using "laser induced fluorescence" and "band contour analysis").
  - Binding energy of species in the cluster (using "velocity mapped imaging").
  Experiments are also performed to understand the molecular motions occurring during the dissociation of these weakly bound clusters. This requires using "velocity map imaging" and "laser spectroscopy" to measure the translational, rotational, and vibrational energies of the products following dissociation.

  Our measurements are compared with high level, *ab initio*, theoretical calculations to gain more insight into weak interactions. The results provide a stringent test of the different models used by theoretical chemists to describe these intermolecular interactions.

- **What determines energy flow within molecules?**
  The flow of energy between the different vibrational modes, torsions and internal rotors of a molecule is an important process in gas phase chemical reactions and determines the reaction outcome. For example, a simple dissociation reaction requires internal energy to reorganise itself such that most of the energy resides in the vibration of the bond that is to be broken. Knowledge of how this redistribution of energy occurs will aid computer modelling of gas phase chemical reactions. It is also required for the growing field of mode-selective chemistry, where a particular chemical reaction is "forced" to occur by preparing molecules with energy in the "correct" vibrational modes.

Currently our research is focussed on how energy transfers from methyl-group rotation to vibration. In particular we are interested in using 2-dimensional laser induced fluorescence (see below) to investigate vibrational energy pathways between the methyl rotor levels and ring vibrations in toluene and *para*-fluorotoluene.

- **Developing new spectroscopic methods**
  To perform the type of experiments detailed above, the spectroscopy of the species being studied needs to be known. Unfortunately, data of the required quality often don't exist, or are ambiguous. We have recently developed an exciting new spectroscopic technique, high resolution 2-dimensional laser induced fluorescence (see figure). This method provides highly detailed images that allow us, for the first time, to tease apart overlapping absorption transitions, as well as accurately determining rotational energy levels of the molecule. As an illustration of just how powerful this technique is, we have recently identified the absorption transitions of the four carbon-13 isotopomers of fluorobenzene in natural abundance.

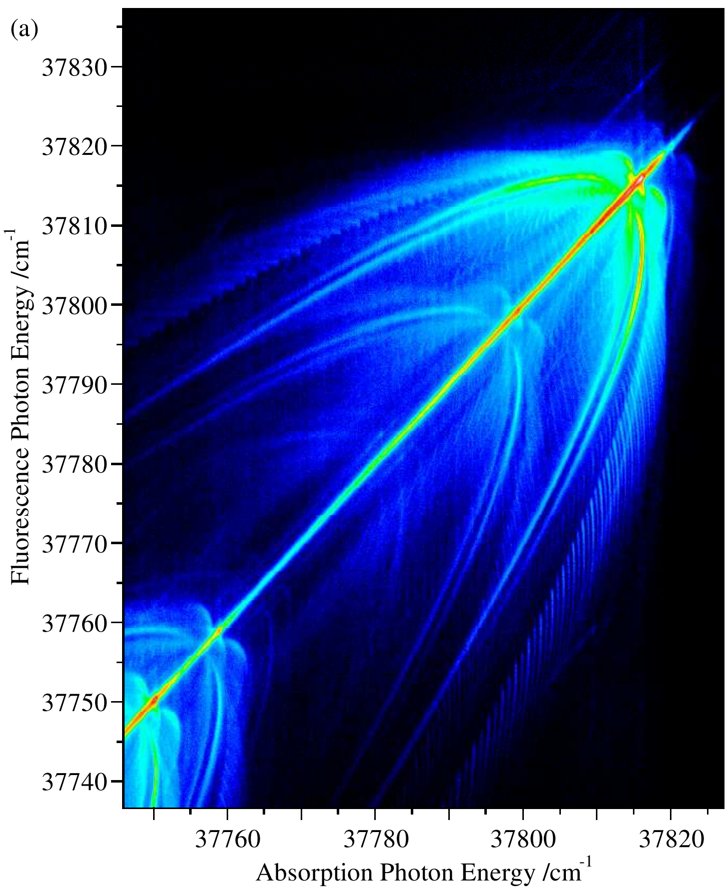

Figure 1: 2-dimensional laser induced fluorescence image of fluorobenzene. The detailed structure is due to the molecule undergoing vibrational and rotational changes during absorption (*x*-axis) and fluorescence (*y*-axis). These features can be analysed to determine internal energy levels and consequently the structure of the molecule.

DR SARAH HARMER

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Research interests of the Microbe Factory group include the fundamental electronic and magnetic properties of transition metal compounds and their use in industry. Studies include bulk and surface electronic structures; surface properties and reactivity; oxidation and reduction mechanisms and interaction with bacteria. The purpose of this research is the development of novel, innovative, environmentally benign processing techniques and the development of analytical techniques to study these systems more effectively.

Our research is heavily dependent on spectroscopy and the using of facilities such as Synchrotrons both in Australia and overseas. Techniques regularly used include but are not restricted to: Synchrotron X-ray Photoelectron Spectroscopy (SXPS); X-ray Absorption Near Edge Spectroscopy (XANES); Photoemission Electron Microscopy (PEEM); Scanning Transmission X-ray Microscopy; Conventional XPS; Time of Flight Secondary Ion Mass Spectrometry (ToF-SIMS); and Atomic Force Microscopy (AFM).

Examples of projects are listed below:

- **The Nanoreactor**
  In situ studies using Scanning Transmission X-ray Microscopy (STXM) will be carried out to observe the chemical interaction of bacteria with minerals under oxidative and reductive conditions. STXM studies will provide the distribution of chemical products formed as a result of microbial mineral attachment, oxidation, biomineralisation and bio-film formation. A nanoreactor, especially designed for high resolution spectroscopic imaging in a hydrated and controlled electrochemical states has been developed over the past year by Dr Harmer and collaborators in Canada (Adam Hitchcock). This novel environmental cell will allow for the structure composition, processes and dynamics of microbial communities to be elucidated, and the physicochemical composition of heterogeneous catalysts in their working state at the nanometre scale.

- **Fe 2*p* Multiplet Structure of Iron Sulfides**
  This project will involve the interpretation of high resolution Synchrotron X-ray Photoelectron Spectroscopy (SXPS) Fe 2*p* and X-ray Absorption Near Edge Spectroscopy (XANES) Fe $L_{2,3}$ spectra from *in situ* fractured samples combined with 1*s*2*p* Resonant Inelastic X-ray Scattering (RIXS) experiments at the European Synchrotron Radiation Facility (ESRF) and multi-configurational self-consistent field (MC-SCF) calculations. The outcomes of these experiments will be used to develop a complete model of the electronic structure of $Fe_{1-x}S$ and curve fitting routines for the Fe 2*p* XPS spectra of $Fe_{1-x}S$. Ultimately, this project will provide more quantifiable and precise XPS analysis.

- **The Surface Physiochemical Properties Resulting from the Attachment of Bacteria to Molybdenite (MoS_2)**
  Traditional mineral separation techniques require the use of toxic chemicals including cyanide and xanthates. Bioflotation is a new and unique process which has been designed to separate minerals in an environmentally friendly manner. Bioflotation is based on the ability of bacteria to modify the minerals surface chemistry through the excretion of extracellular polymeric substances. The attachment efficiency and the modification of the surface hydrophobicity are paramount to the success of bioflotation. In this project, Scanning electron microscopy and X-ray photoelectron spectroscopy will be used to elucidate mineral surface morphology and chemistry before and after bacterial attachment. Contact angle measurement will be used to determine the effect of bacterial attachment on the hydrophobicity of the MoS_2 surface. (Sarah Harmer and Allan Pring)

- **The Effect of Micro-Nanoscale Topography on the Adhesion of Bacterial Cells to Solid Surfaces**
  Enhancing the attachment of bacteria to mineral surfaces is important to both the separation of minerals and the extraction of metals from ores in an environmentally benign and economically friendly manner. This project will investigate the initial microbial attachment on surfaces of controlled roughness and hydrophobicity to determine preferential sites for bacterial adsorption. Atomic force microscopy, fluorescence microscopy and SEM will be used to view the attachment of bacteria on the surface such as defects, step edges, roughness and surface chemistry.

ASSOCIATE PROFESSOR MARTIN JOHNSTON

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Supramolecular Organic chemistry

The research we undertake is centered around organic chemistry that ranges from synthesis to the synthesis and testing of molecules. The testing may examine how the molecules interact with each other (supramolecular) or how they react to energetic stimuli for example. In the majority of cases we design and synthesise molecular systems with a specific function in mind. These specific functional molecules may be small or large depending on their end use.

The synthetic preparations range from simple syntheses containing only a few steps to complex strategies containing numerous difficult steps. All of the compounds synthesised are characterised using IR, UV, and NMR spectroscopy. In some cases extensive use is made of GC-MS characterisation – especially as it relates to drug chemistry.

Honours Projects Available:

Peptide Mimics

There has been considerable interest in the synthesis of simple organic molecules that are able to act as peptide mimics – in particular of the α-helix structure. We propose to use our experience in polycyclic systems to rigidly position functionality at controlled positions. The polycyclic systems will have a distinct advantage over literature molecules due to enhanced water solubility. These molecules will then be tested for their ability to interact with peptides. This work will be carried out in collaboration with Prof. Peter Duggan (CSIRO Manufacturing Technologies, Melbourne).

Investigation of Clandestine Laboratory chemistry

Over the past years we have been running several project themes in collaboration with Forensic Science South Australia (FSSA) centered around the manufacture of clandestine methamphetamine. In particular the reagents and methods used produce characteristic by-products. These organic materials can be used as marker compounds to allow investigators to identify the reagents and method used in clandestine laboratories. We are synthesising these by-products directly so that they can be used as standards by FSSA.

A second theme that we have been examining is using commonly available starting chemicals to produce precursor compounds for amphetamine type stimulant (ATS) synthesis. This has been in a direct response to FSSA discovering several clandestine laboratories using non-main stream methods for drug manufacture. This is what cooks do in an attempt not to get caught !

Synthesis of New Countermeasure compounds (flares)

With the increasing sophistication of heat seeking missiles there is a need for smarter countermeasures. We have been examining the synthesis of several new flares (based on organic molecules) that have a combustion profile that is more closely aligned to jet exhaust plumes than that of currently used formulations. This work is in conjunction with DSTO (Weapon System Division) and will involve the inclusion of various functional groups into the molecules so as to alter the combustion profile of the flares.

Additional projects based around these above areas (or some new areas) may be offered in 2016, so contact Assoc. Prof. Johnston if you are interested.

PROFESSOR PAUL KIRKBRIDE

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I joined Flinders University after 26 years as a practicing forensic scientist and senior manager. My most recent position was Chief Scientist with the Australian Federal Police in Canberra. As a consequence, the research questions that I am most interested in exploring with research students arise from the needs of the forensic science laboratories in Australia and beyond. Although I mainly become involved in chemistry-based research I also look to collaboration more broadly with fields such as biology and microbiology. I believe that forensic science grows when collaborative teams are assembled. As such I welcome the opportunity to engage in Honours research that involves other Flinders academics who bring additional expertise and educational contributions to projects, such as Claire Lenehan, Adrian Linacre, Stewart Walker, Rachel Popelka-Filcoff, Mike Perkins, Colin Raston and others as indicated below. In addition, many projects will involve collaboration with other universities and agencies such as Forensic Science SA, the Defence Science and Technology Group (formerly DSTO) and the Commonwealth Scientific Industrial Research Organisation (CSIRO). Below is a selection of projects that are being offered to Honours students next year. Several other projects are currently under development that could be negotiated for next year.

- **Paint reflectance infrared microspectrometry**
  Automotive paints are very complex materials with distinctive and well-characterised spectral signatures in the visible and mid-IR regions of the electromagnetic spectrum. Paints feature prominently as trace evidence in crimes such as break-and-enter, hit-and-run and malicious damage. Currently however, methods for mid-infrared microspectrometry of multi-layer paint evidence require very tedious dissection of the specimen in order to obtain pure samples of each layer in the paint for analysis. A new approach to be explored by research is to record reflectance infrared spectra of a few layers at the one time, thus dramatically reducing the time and effort required to analyse a paint specimen.

- **Drugs and explosives**
  The organic peroxide explosives exhibit extraordinary chemical properties that make them very difficult and dangerous for emergency response, defence and forensic personnel to deal with. A project is on offer to examine whether ionic liquids or high shear forces generated in a vortex fluidic device can be used to control the destruction of these substances. This project would involve collaboration with DSTG and will be jointly supervised by Colin Raston.
  The Kirkbride research group will soon acquire a high performance GC-MS with a unique and sophisticated ion source. This instrument offers potential for the analysis of organic peroxide explosives, which can be problematic with conventional GC-MS equipment. A project will be offered that involves exploring the potential of this new instrument for the analysis of organic peroxide explosives. For the timid at heart, these projects will NOT be dangerous!
  Several projects involving the synthesis or toxicology of drugs are also on offer.

- **Gunshot residues (GSR)**
  Crimes involving firearms are inherently serious and the field of GSR analysis is an important one in forensic science. Flinders University is developing a strong research capability in the field of inorganic GSR and inorganic GSR. Projects are on offer in regards to both of these fields, with a priority project involving unified detection of both organic AND inorganic GSR.

- **The overlap between forensic biology and forensic chemistry**
  The Kirkbride research group offers projects jointly supervised with Professor Linacre that extend across the forensic biology-chemistry boundary. Projects on offer relate to developing techniques for recovering DNA from firearm cartridge cases and exploring the interaction between improvised explosives and DNA.

DR INGO KÖPER

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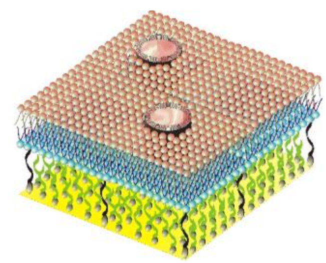
Research is my group is mainly centred nano-biology. We investigate for example model systems for biological membranes. These structures can be attached to solid supports and then used to incorporate membrane proteins and study their function. The solid support allows for the application of various surface sensitive techniques, especially surface plasmon resonance (SPR) spectroscopy and electrochemical impedance spectroscopy. However, we also make use of other techniques, such as neutron scattering. Additionally, there are other projects in areas of food science or drug delivery.



Projects include:

- **What makes a membrane? (Biophysics, Physical Chemistry, Nanotechnology)**
  How does the lipid composition of the bilayer affect the electrical properties of the membranes? What effect des that has on the ability to incorporate ion channel proteins? Can we incorporate membrane proteins and study their function? What is the detailed structure of the membrane (with G. Andersson)

- **Let's cook some lipids (Organic Chemistry)**
  Synthesis of novel anchor lipids. Tethered bilayer lipid membranes are based on lipids, which have been modified with a polymeric spacer group and anchor moiety that allows grafting to a substrate. This project will focus on the introduction of new spacer groups to modify the structural and electrical properties of the membrane. Work will include both the chemical synthesis as well as the physical characterisation of the lipid membranes. (with M. Perkins)

- **What's in your wine? (Physical Chemistry, Analytical Chemistry, Nanotechnology)**
  In cooperation with the Australian Wine Research Institute (http://www.awri.com.au/) we will analyse proteins occurring in wine and use surface Plasmon resonance (SPR) spectroscopy to study their binding affinities and investigate, how this might have an effect on the taste of the wine.

- **Small, smaller, smallest (Nanotechnology, Chemistry, Biology)**
  Nanoparticles are interesting. They can be used for a wide range of applications, for example as drug delivery vehicles. However, they also pose potential risks. We make nanoparticles, analyse them using all kinds of fancy techniques and also study their use or potential risk.

- **Don't stick! (Nanotechnology, Chemistry, Biology)**
  What makes a surface 'sticky'? What makes a surface attractive to proteins and bacteria? Can we modify surfaces so that bacteria don't stick? We study protein-surface interaction using a range of analytical techniques and also develop possible applications of novel surface coatings.

ASSOCIATE PROFESSOR CLAIRE LENEHAN

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A particular emphasis of our groups work has been on the development of analytical techniques suitable for investigating the fundamental chemistry of complex mineralogical, environmental and defence related problems. Other research has focused on the development of non-destructive spectrophotometric and chemometric methods suitable for analysis of heritage materials.

Projects include:

- **Minerals and Trace element speciation**
  Recent research has focussed on the development of analytical methodology for use in understanding of mineral dissolution and speciation in groundwater and mining samples. This work is directly relevant to mine waste treatment as well as minerals exploration. Studies include investigating i) the role of trace elements on mineral reactivity, ii) the role of trace elements in crystal formation and iii) determination and speciation of trace elements in groundwaters. These projects are in collaboration with Prof Allan Pring.

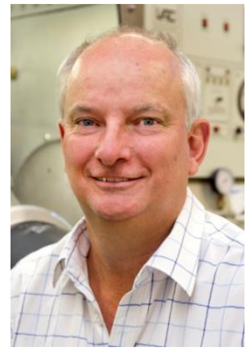
- **Analysis of plant extracts**
  Crude plant extracts are often used as herbal remedies for a variety of ailments, often without scientific evidence or toxicological evaluation. We are using applied analytical chemistry techniques can be used to determine the chemical composition of plant extracts and testing these components for the efficacy and toxicological response. Alternative 'green' extraction solvents prepared from readily available materials such as sugar are a key focus of this work. These projects are in collaboration with industry and Dr Barbara Sanderson (medical biotechnology).

- **Forensic and Environmental Health**
  The determination of drugs, pesticides and their metabolites is important for both forensic and environmental health. We are examining the fate of drugs and pesticides in humans and the environment, and are looking at pathways of exposure and mechanisms of degradation. Collaborators include Prof Paul Kirkbride, staff from Forensic Science South Australia and the Department of Health.

- **Analysis of energetic materials**
  Spectroscopic and chromatographic methods for the characterisation of energetic materials and improvised devices are currently under investigation. Collaborators include Assoc Prof Jamie Quinton and staff from DSTO.

- **Analysis of Cultural Heritage Materials and Characterisation of Ochre**
  We are developing techniques for the characterisation of archeologically and ethnographically important pigments and binding materials such as oils and waxes using spectroscopic and chromatographic techniques. Many of these projects are in collaboration with Dr Rachel Popelka-Filcoff and staff at the South Australian Museum, ArtLab and ANSTO.

PROFESSOR DAVID LEWIS



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My research interests have focused on addressing problems that have real world applications, by understanding and leveraging the relationship between molecular behaviour and structure at the nanoscale, with the macroscopic properties that they display, leading to an application.

Projects involve both Chemistry and Physics students and range from early evaluation of ideas and approaches to new product concepts with some of the companies we are currently working with. Within these relatively broad, highly multidisciplinary areas, there is the scope for a wide range of honours and PhD project opportunities which will be tailored to meet individual interests.

Most projects involve collaboration at some level with other Flinders University Academic staff or external organisations. If you have a potential interest in any of these areas, please come and speak with me.

Project areas include:

- **Novel Polymerisation and polymer synthesis**
  Controlling and understanding polymerisation mechanisms to create specific polymer architectures, grafting chains onto surfaces and controlling morphology (phase separation) for a range of applications from novel solar cells to dust free surfaces

- **NanoComposites and nanoparticles**
  Creating nanoparticles with controlled size and surface chemistry as a platform for a range of novel applications from micro-machines to controlled roughness surfaces; combine nanoparticles in unique ways to deliver advanced properties such as transparent conductors and for the creation of controlled roughness surfaces for easy cleaning

- **Organic electronics**
  Understanding and managing the interfaces in the fabrication of organic solar cells to enable novel approaches to fabrication

ASSOCIATE PROFESSOR M V PERKINS

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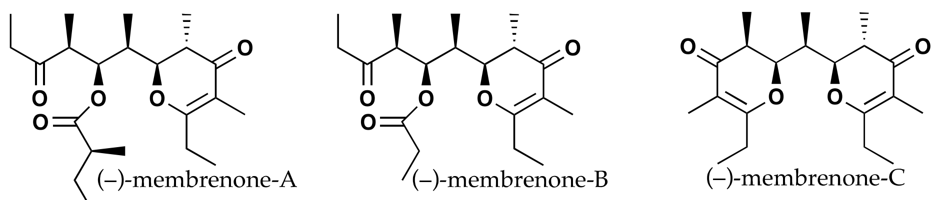
Projects are potentially available in the areas of **Stereoselective synthesis of natural products**. Collaborative projects are available in the areas of **Wine Chemistry** and **Clinical Pharmacology**. Some background material is provided below.

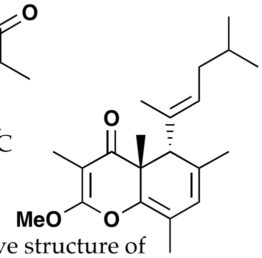
Stereoselective Synthesis of Natural Products:

The search for new drugs, with unique activities to combat the ever increasing strains of antibiotic resistant bacteria and to provide better treatments for diseases from cancer to AIDS, is an important international research area. This search has driven the chemical investigation of a huge range of terrestrial and aquatic organisms leading to the isolation of a vast array of novel chemical structures varying from rather simple to enormously complex. The amount of the compounds isolated from the organisms is usually minute and for this reason laboratory synthesis, where possible, is the only way to obtain sufficient compound for comprehensive biological testing. Furthermore, these syntheses must be highly stereoselective, as any biological function the compounds exhibit is critically dependent on their three dimensional shape. This basic idea has inspired the Perkins research group to develop new stereoselective synthetic methodologies for the total synthesis of novel structures. This research has resulted in the **total synthesis** of (–)-membrenone-A, -B and –C, two metabolites from *Siphonaria australis*, the putative structure of tridachiahydropyrone, (–)-maurenone and auripyrone-A.



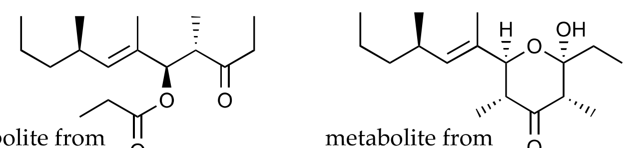
(–)-membrenone-A (–)-membrenone-B (–)-membrenone-C

Perkins, M. V.; Sampson, R. A. *Organic Letters* **2001**, *3*, 123-126.
Sampson, R. A.; Perkins, M. V. *Organic Letters* **2002**, *4*, 1655-1658.



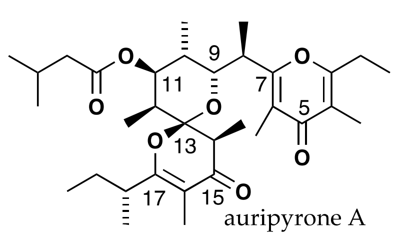
putative structure of tridachiahydropyrone

Jeffery, D. W.; Perkins, M. V.; White, J. M. *Organic Letters* **2005**, *7*, 1581-1584. Jeffery, D. W.; Perkins, M. V. *Tetrahedron Letters* **2004**, *45*, 8667-8671. Jeffery, D. W.; Perkins, M. V.; White, J. M. *Organic Letters* **2005**, *7*, 407-409.



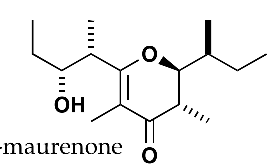
metabolite from *Siphonaria australis* metabolite from *Siphonaria australis*

Lister, T.; Perkins, M. V. *Australian Journal of Chemistry* **2004**, *57*, 787-797.



auripyrone A

Lister, T.; Perkins, M. V. *Angewandte Chemie Int. Ed.* **2006**, *45*, 2560 –2564.
Perkins, M. V.; Jahangiri, S.; Taylor, M. R. *Tetrahedron Letters*, **2006**, *47*, 2025-2028. Perkins, M. V.; Sampson, R. A.; Joannou, J.; Taylor, M. R. *Tetrahedron Letters*, **2006**, *47*, 3791-3795.



(–)-maurenone

Crossman, J. S.; Perkins, M. V. *Journal of Organic Chemistry*, **2006**, *71*, 117-124.

Figure 1. Compounds whose total has been achieved in the Perkins research group.

Our research program is focused on the stereo-selective synthesis of certain polypropionates. Polypropionates are typified by the macrolide antibiotics and many of these compounds have medical applications. This class includes a number of compounds isolated from marine molluscs (examples include auripyrone, dolabriferol, the tridachiapyrones and the membrenones), and the biological activity often exhibited by these compounds makes them important targets for stereoselective synthesis. These natural products are characterised by possessing highly oxygenated linear carbon chains, with methylation at alternate carbons. The current synthetic targets in the Perkins laboratory include a number of the tridachiones, auripyrone–B, ascosalipyrone, the spiculoic acids and dolabriferol.

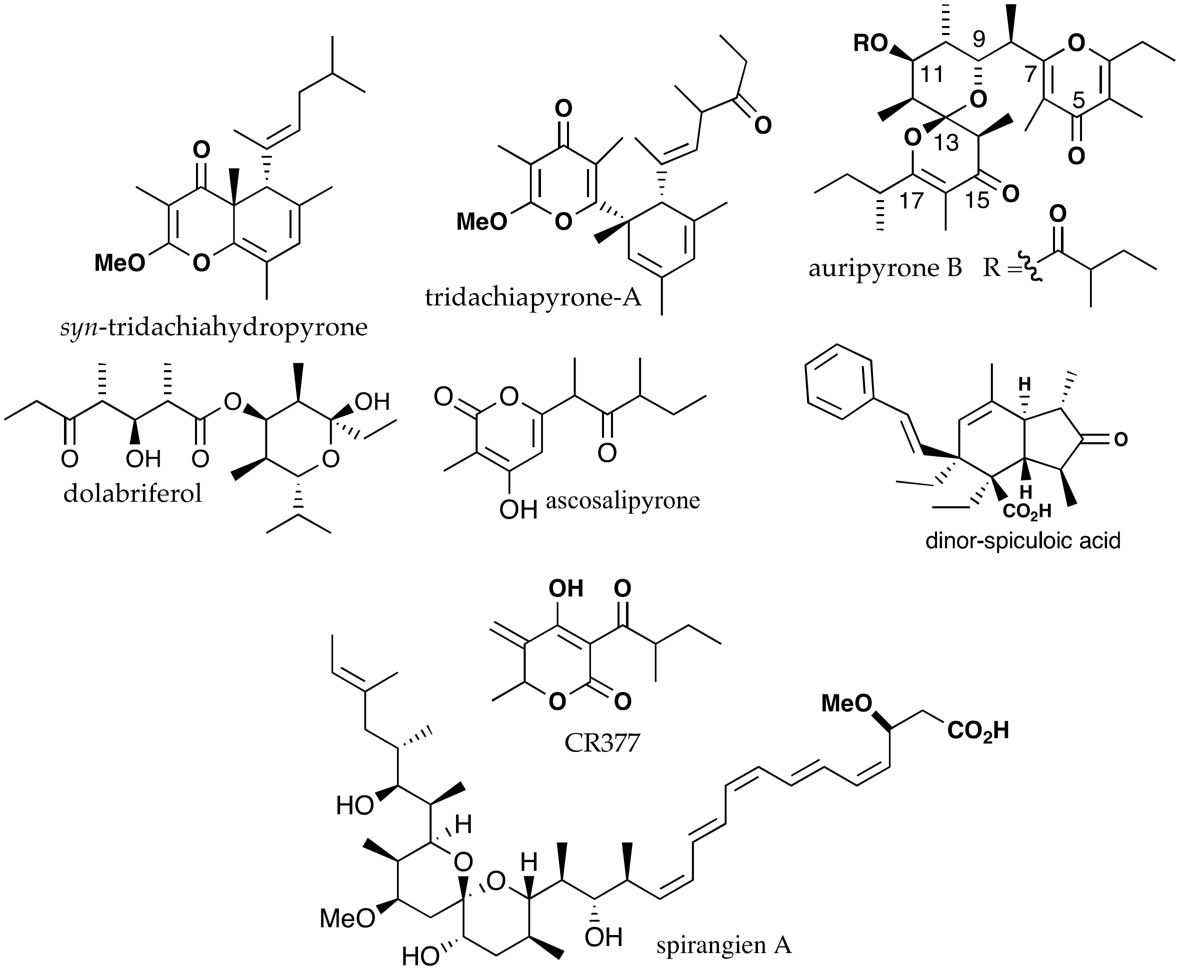


Figure 2. Current synthetic targets in the Perkins research group.

Possible Projects: A number of projects aimed at the synthesis and structural determination of small natural products will be available in 2014. Any students interested in perusing a project in synthetic organic chemistry are welcome to talk to Mike Perkins about specific projects. He is contactable at mike.perkins@flinders.edu.au or by phone 8201 2496.

Collaborative Projects

Wine Chemistry

A project in the area of **wine chemistry** in collaboration with the Australian Wine Research Institute (Dr Paul Smith) on the "**Formation and fate of positive (enhancing) and negative (detracting) sulfur compounds"** in wine is available. Anyone interested should speak to Dr Perkins for further details of this project. He is contactable at mike.perkins@flinders.edu.au or by phone 8201 2496.

Clinical Pharmacology

A project in the area of ***Clinical Pharmacology*** in collaboration with the Department of Clinical Pharmacology, School of Medicine (Dr Ben Lewis) may be available for 2014. The project possibilities involve the identification of the pharmacophore for dimethylarginine dimethylaminohydrolase-2 (DDAH-2) enzyme or the identification of possible compounds that will bind into the pharmacophore. Further details are available from Dr Perkins (He is contactable at mike.perkins@flinders.edu.au or by phone 8201 2496.)

DR RACHEL POPELKA-FILCOFF

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The focus of our group's research is the application of nuclear and spectroscopic methodologies to complex analytical problems in cultural heritage, nuclear/radiochemistry, environmental and forensic research. Samples from these cases provide interesting and complex cases for analytical method development and instrument development. Our group works with Associate Professor Claire Lenehan, Professor Allan Pring and Professor Paul Kirkbride. Our projects are in partnership with colleagues at ANSTO (Australian Nuclear Science and Technology Organisation), South Australian Museum, Artlab, FSSA (Forensic Science South Australia), SA EPA (South Australian Environment Protection Authority) and others. Experiments are performed both at Flinders and at collaborating laboratories; therefore some projects will involve travel opportunities and lab experience at ANSTO in Sydney at the OPAL research reactor.

The techniques used in our group include:

- Neutron activation analysis (NAA)
- X-ray fluorescence (XRF)
- Near-IR and other spectroscopic techniques
- Scanning electron microscopy (SEM) and EDAX
- Mass spectrometry techniques
- Radiation detection and materials

- **Characterisation of Indigenous Australian Pigments and Analysis of Cultural Heritage**

There are opportunities for the analysis of materials such as analysis of pigments, stone objects, ceramics, and other cultural material. We are developing a suite of sophisticated and non-destructive techniques toward the chemical and physical characterisation of complex materials towards understanding properties as well as cultural interpretation. Aspects of the project include using techniques such as neutron activation analysis, as well as spectroscopic techniques such as near-IR spectroscopy and elemental techniques such as X-ray fluorescence. Opportunities include characterisation of binders in cultural heritage objects (pyrolysis gas chromatography and IR spectroscopy) and material and pigment analysis by X-ray and spectroscopic methods. Collaborators include Associate Professor Claire Lenehan, Associate Professor Jamie Quinton, and Dr John Bennett (ANSTO).

- **Nuclear Forensics**

Illicit trafficking of nuclear and radioactive material is a significant problem worldwide. One component of a forensic investigation into seized trafficked material is the determination of provenance (source attribution). This is particularly challenging, and no single technique has been identified as being suitable for the unambiguous identification of nuclear material origin. This analysis is further complicated by the diversity of samples that could be encountered. Flinders University has been collaborating with the Nuclear Forensic Research Facility (NFRF) to develop new analytical methodologies for the characterisation of uranium ore concentrates (UOCs) as well as the original uranium ore. This project involves several analytical techniques at Flinders as well as potentially at ANSTO and is in collaboration with Associate Professor Claire Lenehan, Professor Paul Kirkbride and the Nuclear Forensic Research Facility (ANSTO).

- **Analysis of Environmental Radiation**

Quantitative Analysis of Environmental Radiation
In South Australia, there has been little assessment or data gathered regarding the natural radiation background radiation and isotope ratios in the environment from terrestrial, freshwater and marine flora and fauna. While this has been researched in Europe using the Environmental Risk from Ionising Contaminants: Assessment and Management (ERICA) integrated approach, it has not been rigorously investigated specifically to South Australia's climate, flora and fauna. This research would include method development (including spectroscopic and mass spectrometry and radiation detection methods) and validation and will be working with Associate Professor Tony Hooker at the Environment Protection Authority South Australia as well as Jim Hondros, Director & Principal Consultant, JHRC Consultants, and Professor Allan Pring.

Measurement and assessment of radionuclides in South Australian wastewater treatment plants
Hospitals often treat people with nuclear medicine and radiotherapy isotopes. Patients then pass bodily fluids into the waste water system with approval from the EPA. This project in collaboration with Associate Professor Tony Hooker at the Environment Protection Authority South Australia includes the measurement and assessment of radionuclides in South Australian wastewater treatment plants (e.g. water, sludge) and in reclaimed water for irrigation. Methods could include isotopic measurements, mass spectrometry and separations as well as radiation detection. This project is also in collaboration with Professor Allan Pring.

- **Environmental and Forensic Analysis**

Several analytical techniques in our group are applied to forensic and environmental applications. Possibilities include analysis of metals, paints and glass in forensic cases (collaboration with Professor Paul Kirkbride, Professor Hilton Kobus, and Forensic Science South Australia). Environmental applications include soils and related materials. Please see me for additional project descriptions.

PROFESSOR ALLAN PRING

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I have recently formally joined Flinders University after 30 years as a senior researcher at the South Australian Museum, where I ran a large research group exploring the physics and chemistry of ore deposit formation. I work largely on minerals. Minerals are just naturally occurring inorganic compounds. Most ore deposits are formed by the action of high pressure and temperature hydrothermal fluids (very hot ground waters) moving through the crust and the minerals are dissolved and precipitated by aqueous fluids. It turns out that many technologically interesting materials can be synthesized by mimicking these natural mineral forming processes. Ultimately all mineral forming processes operate as the interaction between atoms, so this is chemistry not geology! Below is a selection of projects that are being offered to Honours students next year. I work closely with Joe Shapter, Claire Lenehan and Sarah Harmer.

- **Preparation of High surface area precious metal sponges for catalysis and filtration.**
  Preliminary studies showed that we can synthesize high surface area gold sponges from dissolution of gold tellurides and gold alloys in hydrothermal fluids and it appears that the solution conditions control the morphology and size of the gold filaments formed. This project aims to use a well constrained reaction method to explore the effects of solution chemistry on the spong morphology, with the aim of being able to optimize the size of the gold filaments for different applications. This project will be co-supervised by Prof Joe Shapter

- **Analyses of halide elements in sulfides- the forgotten anions.**
  Nearly all minerals do not have fixed exact chemical compositions, they contain minor or trace amounts of other elements substituting for the main elements. In minerals, one group of elements has long been neglected, the halides which can substitute for sulfur in sulfides. In ore minerals their presence is rarely analysed for and one recent study showed the lead sulfides at Broken Hill, NSW contain around 10,000 ppm Br substituting for S and this change in chemistry lowers the melting point by some 300 °C! We know from solution chemistry studies that certain metals are preferentially transported in Nature as different halide complexes. Cu with Cl, Au with Br and Fe with F. In this honours project we plan to look at some of the key ore minerals at Olympic Dam and other copper deposits and determine the halide levels substituting for S using a range of analytical techniques which give both bulk and local concentrations
  This project will be co-supervised with Associate Professor Claire Lenehan

- **Variation in the reactivity of pyrite and its effect in acid mine drainage and ore processing**
  A recent Flinders Ph.D. graduate, Dr Owen Osborne showed that the mineral pyrite, FeS_2, the most common sulphide mineral in the crust and the major cause of acid mine drainage, has an inherently variability in rate of oxidation in solution of around an order of magnitude. This means that pyrite from one location maybe up to 10 times more liable to oxidize than a pyrite for a different locality. In this project we want to use that same samples already measured by Dr Osborne and measure their surface oxidation by X-ray photoelectron spectroscopy during controlled oxidation after cleaving in a vacuum to investigate if the surface and the bulk oxidation properties are controlled by the same factors.
  This project will be co-supervised with Dr Sarah Hamer and Associate Professor Claire Lenehan

- **Preparation of zeolite arrays**
  Zeolites are aluminium silicates that are widely used catalysts and molecular sieves. They are porous compounds with a high accessible surface area and can be structurally tuned be size selective. While they are highly porous, fluid flow through zeolites can be slow. The idea of this project is to synthesis zeolites which have porosity on different scales: the nanometer scale and the 100 nanometer scale to increase fluid flow and greatly increase functionality. This project will explore ways of synthesising geometric arrays of zeolite nanocrystals, to increase the flux of fluid flow yet retain the structural functionality.
  This project will be co-supervised with Prof Joe Shapter and Associate Professor Claire Lenehan

- **Trapping Fluids in solids**
  Coupled dissolution-reprecipitation reactions occur wildly in nature, they are fluid mediated reactions where one compounds is dissolved into solution and in the process triggers the precipitation of a new compound. An important feature of these reactions is that the product is always porous and that the porosity, can decay with time forming fluid inclusions in the solid. The physical chemistry of the process of porosity generation and destruction is poorly understood, yet has profound implications for the minerals and petroleum industry. This project will explore the creation and destruction of porosity on simple inorganic systems.

DR SUE PYKE

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My background is as a synthetic organic chemist with experience in the synthesis of natural products of medicinal interest and their analogues. My current interests focus science education and on improving the experience, engagement and retention of science students, in particular in chemistry, through first year and beyond. Key areas of interest are the assessment of student competency with key chemical concepts in first year students, trialling interactive learning techniques in large lecture classes using Process Oriented Guided Inquiry Learning (POGIL) (www.pogil.org) and improving the student experience of chemistry through informed improvement to the laboratory experience.

Science Education

- **Evaluating the experiences of students in undergraduate laboratories to enable informed improvements.**

The laboratory experience is a significant factor influencing students' attitudes to their science topics. Consequently, good laboratory programs should play a major role in influencing student engagement, learning and performance. The laboratory experience can be a crucial link in influencing the student's attitude to the discipline. This can be either a positive or negative influence on the student's perceptions of discipline and their abilities within it. The aim is to provide students with laboratory activities that are relevant and engaging while providing effective learning opportunities. The Advancing Science by Enhancing Learning in the Laboratory (ASELL) project (www.asell.org) has developed over the last 10 years with the aim of improving the quality of learning in undergraduate laboratories, and provides a means of evaluating the laboratory experience of students.[1] This project will involve collecting and interpreting data on undergraduate laboratory activities using the ASELL survey instrument (ASLE). The findings of this work will be used to influence further development of the laboratory activities examined to enhance the student experience. This project has the potential to be extended to the laboratory experience in secondary schools in the future.

- **Identifying and remediating misconceptions around key concepts in undergraduate chemistry students.**

Misconceptions of key concepts in undergraduate chemistry can provide a "roadblock" when students attempt to build on those key concepts as they move on with their study of chemistry. Early diagnosis of these misconceptions and provision of strategies and tools to enable the students to build a better foundation in areas where there are difficulties, would be of great benefit to student learning and would enable those teaching to have an accurate perception of the knowledge base of the cohort and to encourage revisiting of key concepts. Investigation of common misconceptions both at the first year level and at higher year levels would provide useful information as to importance of early interventions and to the extent and longevity of the misconceptions.

PROFESSOR C L RASTON

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The Clean Technology Laboratory focuses on developing chemical reactions and processing that can make a contribution to sustainability by incorporating green chemistry metrics at the inception of the research, in addressing issues facing humanity in the areas of medicine, the environment and energy. The research covers a wide range of chemistry including organic and inorganic synthesis, materials synthesis, device technology, self-assembly, characterisation techniques, and more, often at the interface with physics, biology, medicine, forensic science, food processing and engineering. A core activity of research is the development of flow chemistry based on dynamic microfluidic thin films, where continuous flow processing allows the basic fundamental research to be readily scalable, with the research processor also the production platform, and this approach is attractive to industry.

We recently patented a continuous flow microfluidic platform, as a vortex fluidic device (VFD), Figure 1, and a number of publications and patents have resulted for a range of applications. Overall, the VFD represents a new paradigm in controlling synthesis, and the organisation of hard and soft matter, as a potentially disruptive technology. Highlights of the research using the VFD include:

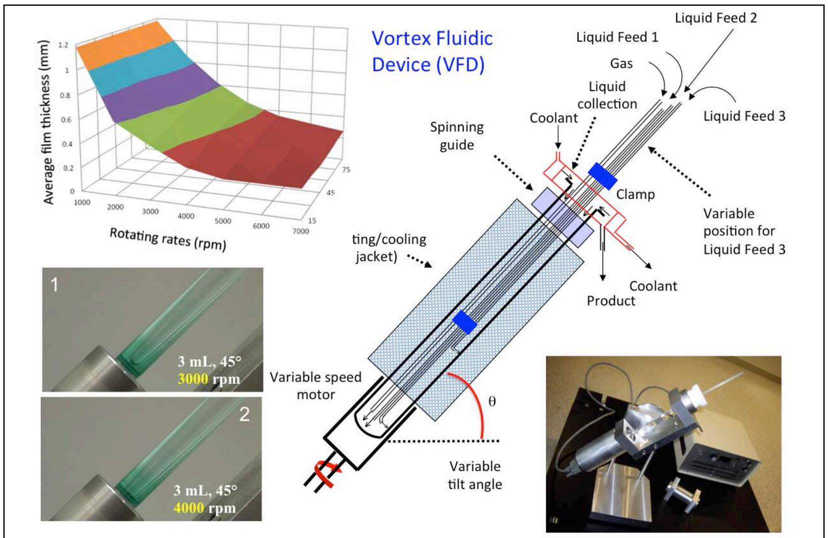

Figure 1. Vortex fluidic device for continuous flow, and confined mode processing.

- Control chemical reactions and selectivity, as one of the 'Holy Grails' in organic synthesis.
- Exfoliate graphene directly from graphite, including as scrolls, and slicing carbon nanotubes into a narrow length distribution, as 'top down' fabrication of nano-materials.
- Control the nucleation and growth of functional nano-materials such as silica and superparamagnetic nanoparticles, drug nano-particles for targeted drug therapy, as bottom up' fabrication processes.
- Entrapping algae cells with graphene and polymers, for waste-water treatment.
- Controlling protein folding ('unboiling' and egg) for the pharmaceutical industry.
- Enhancing the quality of wine.

The vortex fluidic device (VFD) has many exciting applications, which are alluded to in Figure 2, and honours projects relating to these are on offer. Importantly the VFD allows real time monitoring of chemical reactions where thin films of liquid are subject to intense shear, and the chemistry is not limited to diffusion control. The VFD allows exquisite control of chemical reactions, which

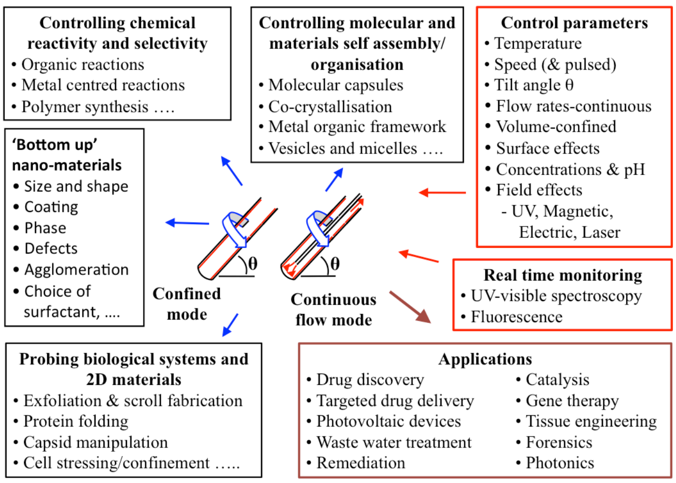

Figure 2. Summary of some of the capabilities and applications of the vortex fluidic device (VFD).

can occur at lower temperatures, often without the need for heating. Also important is that the intense micromixing for liquids injected in the VFD tube ensures that every molecule is treated in the same way, unlike in conventional batch processing (the round bottom flask). The same also applies where heating is required, with rapid and uniform heat transfer, in contrast to round bottom flask processing. The VFD can also be modified for introducing field effects in a novel way, including UV, plasma (patented), tuneable lasers, and magnetic and electric fields.

Designer Honours Projects: A number of projects aimed at organic and inorganic synthesis, materials chemistry, biochemistry, and beyond are available in 2016, with the diversity of research under the umbrella of clean technology being flexible in catering for students' interests. Project below are only a guide on what is available, and discussion for fine-tuning projects is welcomed.

Shear stress induced fabrication of functional nano-carbon

New forms of carbon nano-materials, including composites of fullerenes with carbon nano-tubes and graphene, will be investigated using self-assembly strategies and innovative approaches such as laser induced processing using a vortex fluidic device (VFD), in collaboration with Jason Gascooke and warren Lawrance. Also included is an extension of our recent work on using thin film microfluidics to form graphene scrolls directly from graphite (application in gas storage and supercapacitors), and the slicing of carbon nano-tubes in a controlled way. The ability to slice carbon nanotubes, without the use of waste generating chemicals offers scope for developing short carbon naotubes for drug delivery applications (≥ 120 nm), and longer lengths for device fabrication, as in solar cells (in collaboration with Joe Shapter) and membrane technology (water purification). Importantly, technology needs to be developed based on carbon, as some metals become scarce, and in overcoming their health risks. Aspects of this research are also in collaboration with Kasturi Vimalanathan.

Organic synthesis: Controlling chemical reactivity and selectivity

This is part of an ambitious project to map out organic reactions using the VFD, in controlling chemical reactivity and selectivity beyond the normal diffusion control, while operating under high green chemistry metrics. Features of organic synthesis in the VFD beyond classical round bottom flask processing include: (i) High mass transfer of reagents/gases into the dynamic thin film which are otherwise sparingly soluble – important for catalytic reactions such as olefin metathesis. (ii) High mass transfer of by-products to drive chemical reactions. (iii) Uniform photolytic reactions through controlled exposure. (iv) Field effects to promote reactions, eg plasma for radical initiation without using chemicals. (v) Multiple reactions for a single pass in a VFD by the strategically placement of different jet feeds along the tube, as in our synthesis of Lidocaide. (iv) Potential auto-catalysed reactions in water through higher dissociation of water under shear, and more. In collaboration with Justin Chalker.

Controlling inorganic and organometallic reactivity under shear

Research here focuses on 'bottom up' materials synthesis using the VFD, including controlling the phase and particle size of calcium carbonate (vaterite, aragonite, calcite) for drug delivery applications, silica (including mesoporous systems) and metal organic frameworks (MOFs), for the same application and also for catalysis and gas storage. This builds on our recent finding in controlling the pore size and pore thickness of mesoporous silica in a flash at room temperature under the intense shear in the VFD, dispensing with the need for 24 hours hydrothermal treatment. There is also exciting projects on preparing superparamagnetic nanoparticles, for coating with catalysts for various organic transformations, with then the prospect of confining the particles in a magnetic field in the VFD which will ensure that the particles stay in the VFD, and only a solution of the product exits the VFD under continuous flow. In collaboration with Justin Chalker.

Protein folding and enzymatic reactions

Recombinant protein overexpression by bacteria offer higher yields, lower costs, and simpler operation than mammalian cells. However, bacterial overexpression of large proteins typically results in insoluble and mis-folded proteins directed to inclusion bodies. Conventional approaches to refold such proteins, such as dialysis, are inefficient, time consuming, and require large liquid volumes. We have developed the use of the VFD in being able to rapidly refold protein aggregates, with the ability to recover the protein >100-times faster than conventional, overnight dialysis, at 86% of its native level (compared to 50% for conventional high pressure and energy intensive current technology). The refolding of specific protein will be the focus of the project, along with studying the fluid dynamics to control enzymatic reaction in the VFD under shear. In collaboration with Justin Chalker, and Greg Weiss (University of California, Irvine).

Sheer stress-mediated refolding of recombinantly expressed insulin

The worldwide annual cost of insulin in 2011 was USD$16.7 billion. It is forecast that by 2025 there will be a need for the production of approximately more than 16000 Kg insulin/year. Improved efficiency of production will have enormous health care cost benefits. Recombinant synthesis of insulin has been achieved using yeast and *E. coli* expression systems. Methods to produce single chain insulins that are correctly folded using *E. coli* are multistep and not high yielding due to low refolding efficiency. In overcoming this, constructs will be made to express proteins in *E. coli* to generate inclusion bodies which will be solubilized in the presence of oxidizing conditions for folding using the VFD as a shear stress-mediated refolding approach. Refolding conditions will be explored using buffers with different oxidizing conditions, systematically mapping out the operational space of the VFD, including rotational speed, to promote refolding. In collaboration with Briony Forbes, Medical Biochemistry.

Production of insulin containing nanoparticles for the oral delivery of insulin

Despite advances in devices for the injection of insulin, other administration routes continue to be investigated. Oral administration remains the most convenient and physiologically advantageous albeit the most technically challenging: Insulin absorbed by the intestinal epithelium reaches the liver via the portal vein and directly inhibits hepatic glucose output, whereas only 20% of subcutaneously injected insulin is available to the liver. Significantly, the bioavailability of insulin delivered orally is substantially lower (0.5%) because it is poorly absorbed through intestinal mucosa and rapidly degraded enzymatically (by pepsin, trypsin, chymotrypsin, insulin degrading enzyme and others) in the gastrointestinal tract. One of numerous strategies developed to protect insulin from biodegradation and to improve intestinal absorption involves the inclusion of insulin within a drug-delivery system. Here will investigate the use of sheer stress mediated VFD processing for the encapsulation of insulin into surface active nanoparticles. In collaboration with Briony Forbes, Medical Biochemistry.

Wine processing

We have established that the VFD is effective in improving the quality of wine, in colour and aromas. Importantly this is based on the application of shear in the thin films within the VFD, without the addition of chemicals. The proposed research will explore the use of the VFD in systematically quantifying the effect of the shear on the wine, for these properties, and other areas of processing wine, including denaturing white haze proteins often present in white wine, in collaboration with Paul Smith (Centre for marine Bioproducts Development and the Wine Research Institute) and wine producers.

Forensic Chemistry

Projects available in 2015 in the area of forensic chemistry are in collaboration with Paul Kirkbride , Stewart Walker, Claire Lenehan and Ramiz Boulos, and DSTO. This includes the use of the vortex fluidic device (VFD) in controlling the decomposition of high-energy materials under continuous flow conditions, and the processing of human hair using deep eutectic melt ionic liquids, for DNA analysis, and detection of illicit drugs. Reactions under extreme shear in the VFD have been shown to follow atypical pathways and/or take place under mild conditions, which is important for these applications.

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The ***Smart Surface Structures*** research group at Flinders is primarily interested in *technology enabling surface architectures*, which are achieved through exploiting the physics and chemistry of surfaces and interfaces. We seek to understand atomic and molecular mechanisms that take place and with knowledge of these, produce enhanced interfaces with properties tailored and optimised for their specific application. At the moment, our group's research effort is concentrated in the following areas

- ***Atomic and Molecular Surface Nanostructures*** – Nanoscale surface phenomena, mechanisms of assembly, structural transitions and kinetic processes in atomic and molecular surface clusters, nanoparticles and thin films
- ***Surface Attachment*** – supporting structures for sensor design materials
- ***Surface Modification*** – tailoring the chemical, physical and mechanical properties of surfaces and interfaces for compatibility in their specific application
- ***Corrosion protection*** – alternatives to currently used, hazardous, inorganic treatments
- ***Novel Photovoltaics*** – building new architectures for harvesting solar power
- ***Catalysis*** – the influence of morphology and particle size upon catalytic behaviour of surfaces
- ***Polymer Physics*** – the influence of crystallinity and morphology on material properties
- ***Molecular Electronics*** – producing atomic and molecular-scale wires and devices

and involves a range of spectroscopic and surface science techniques, such as (but not limited to) electron spectroscopy (XPS, UPS, AES) and microscopy (SAM), streaming zeta-potential measurement (SZP), mass spectrometry (ToFSIMS), scanning probe microscopies (STM, AFM), scanning electron microscopy (SEM), Raman confocal microscopy and synchrotron measurements.

Current Projects
Our group is actively engaged in the following research areas

- Functionalised carbon surfaces (graphite, nanotubes, diamond, glassy carbon)
- Understanding and controlling molecular self-assembly processes (eg orientation)
- Determination of the adhesion energy of surface-bound species
- Environmentally superior corrosion protection coatings
- Fabrication of improved solar cells
- Soft Lithographic, molecular-level controlled surface architectures
- Optically active coatings

and undertakes a number of collaborative efforts with other groups within the school, as well as other researchers outside Flinders. Some of the collaborations from outside Flinders involve people from CSIRO, Australian Nuclear Science and Technology Organisation (ANSTO), Institute for Medical and Veterinary Science (IMVS), Defence Science and Technology Organisation (DSTO), University of New South Wales (UNSW), University of South Australia and the University of Adelaide and national research networks such as the Australian Microscopy and Microanalysis Research Network (AMMRF) and the Australian National Fabrication Facility (ANFF).

Honours Projects currently planned for next year (there are likely to be some that are not on this list too) will involve research in a variety of areas, including those already mentioned and also the following:

- Carbon Nanotube Attachment to Si surfaces and development of sensors, new water filters and solar cells (JS, JQ)
- Building new Nanostructured Templates for Molecularly Selective Filtration Membranes (JS, with Dr. D. Losic, UniSA)
- Plasma modification of surfaces to produce new nanostructured architectures (JQ)
- Development of Solar Cells Using only Carbon Nanomaterials (JS)
- Development of Environmentally Benign Solutions for Corrosion Resistance, Environmental Restoration and Energy Production challenges (JQ)
- The ongoing development of Laser Induced Breakdown Spectroscopy (JQ, with Assoc. Prof. Claire Lenehan and Dr Ben Rogers, DSTO and CEEM).
- Fundamental studies of bacteria-surface interactions for minerals bioflotation applications (JQ, with Dr Sarah Harmer-Bassell)
- Designing and building new instrumentation for chemical analysis of environmental and mineralogical samples (Assoc. Prof. C. Lenehan)
- The ongoing development and application of neutron activation analysis (NAA) as a technique for studying trace elements in mineralogical and archaeological samples, including some nuclear physics project opportunities (JQ, involving Dr R. Popelka-Filcoff; and Dr J Bennett from ANSTO).
- Molecular electronic devices, vertical transistors (JQ, with Prof. David Lewis)
- Organic and Dye Sensitized Solar cell interface phenomena (JQ, with Prof. Gunther Andersson)
- AFM technique development for superior surface force measurements of single species (JQ, with Dr C. Gibson).
- Computational modelling of the molecular level kinetics of thin film self-assembly (JQ).

Some of these projects will be supervised by Prof. Shapter or Prof. Quinton, while others will be supervised jointly. If any of these research areas are of interest then please come along and see us. We'd love to chat with you about them!

ASSOCIATE PROFESSOR PAUL SMITH

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I am Deputy Director of the Centre of Marine Bioproducts Discovery (CMBD) and previously Research Manager – Chemistry at The Australian Wine Research Institute (AWRI), with ongoing collaborations at AWRI. My research interests focus on the application of chemistry to practical applications that have tangible benefits to people and industries.

I received my PhD in Chemistry from Flinders University (2000), doing research into organic synthesis of bridged, bicyclic amines using free-radical techniques and did post-doctoral research at CSIRO Molecular Science in Melbourne. Subsequently, my interest in drug-discovery led me to the Department of Clinical Pharmacology at Flinders University, where I studied structure-function relationships of human drug-metabolising enzymes (2001-2003), before joining the AWRI (2003-2015) where I specialised in macromolecules such as phenolics, proteins and polysaccharides related to texture and mouth-feel properties, structure-function relationships, formation of protein haze in white wines and roles of oxygen and sulfur chemistry in winemaking. Now, my key role as Deputy Director at CMBD is supporting research and development, innovation, education and commercialisation in marine bioprocess technologies and bioproducts for sustainable and profitable seafood and functional foods, marine bioproducts and biomaterials, biomedicine, and marine biofuels industries.

Potential Research Projects for discussion with students:

• Structure-function characterisation of macromolecules (phenolics, proteins, polysaccharides) from wine and marine products (e.g. seaweed) for many applications (taste, health, improved processing);
• Elucidating the mechanism, and ways of managing, protein haze in white wines;
• Understanding extractability of macromolecules (tannins, proteins, polysaccharides) from grapes or marine bioproducts during processing;
• The use of Vortex Fluid Dynamics (VFD) for improved processing of marine bioproducts or for optimising the taste and properties of wine (with Prof. Colin Raston, Prof Wei Zhang);
• Determining fundamental mechanisms and analytical method development for 'stinky' sulfur compounds in wine (with Assoc. Prof. Michal Perkins);
• The use of tannins from seaweed and grape marc in different applications including reducing methane emission from ruminants or in health (with Prof. Wei Zhang);
• Development of nano- and –biosensors for measurement of sulfite and haze-forming proteins in wine (with Professor Joe Shapter);
• Application of isotope measurements for authenticity of foods, beverages and natural products (with Assoc. Prof Stewart Walker).

For details of more potential projects please have a look at the CMBD and AWRI websites below. I'm happy to discuss anything of interest to you.

http://www.flinders.edu.au/medicine/sites/marine-bioproducts/
https://www.awri.com.au/

ASSOCIATE PROFESSOR STEWART WALKER

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Associate Professor Stewart Walkers research interests covers the application of advanced analytical techniques to solve problems in the areas of Analytical, Environmental, Industrial, Forensic and Medical science. He has undertaken collaborative research projects and forensic investigations with, and for, Forensic Science South Australia, United States Department of Homeland Security/Department of Justice, Australian Federal Police, CSIRO, ACFSS (Australian Centre for Forensic Soil Science), SafeworkSA, AWRI, DSTO, International Atomic Energy Agency, United Nations Development Program, other universities and other partners. Major research opportunities in 2016 include the continued collaboration with these research partners.

Projects include:

1) Forensic Science Projects

Stewart will offer a range of collaborative projects in the field of forensic science including continuing the analysis and discrimination of materials (condoms, glass, paint, soil, wine, hairs and fibres etc) and the identification and quantification of drugs and metabolites for improving techniques used in forensic toxicology.
In addition to those projects offered with FSSA - three specific projects are outlined:-

1.1 Post-mortem decay of drugs

Benzodiazepines are the most prescribed drug family and can be analysed using GCMS, LCMS, CE and (because of the 17 individual H sites) NMR. Previous work with FSSA (Michaela Kennealy (BTFA, BSc(Hons) Danielle Butzbach (BTFA, BSc(Hons), PhD) both now working at FSSA) have shown that Olanzapine in blood, and other drugs, can go off in storage. This project will use the above chemical techniques to study the mechanism and rates of the reactions that occur in the post-mortem degradation of benzodiazepines and other classes of drugs. (Copies of papers from this work are available).

1.2 Condom Differentiation

This project will extend the initial work of Rachel Hughes (BTFA, BSc, PhD) which has shown that MALDI-TOF-MS can be used to discriminate between the lubricants in different brands of condoms. Also condoms with different flavours show no differences in lubricants. Can we use SALDI or DIOS MALDI-TOF-MS or GCMS to look at low molecular weight volatiles from condoms to aid in the linking of sexual crimes with perpetrators?

1.3 Chemical and Spectroscopic Investigation of blood and bruises

This project is a continuation of a series of research projects which seeks to combine spectrochemical interpretation of the colour of bruises with the chemical analysis of the different chemicals that give blood and bruises there colour changes with time. This project is co-supervised by AProf Neil Langlois, Forensic Pathologist at FSSA.
(See: Re-oxygenation of post-mortem lividity by passive diffusion through the skin at low temperature, Watchman, Hannah, Walker, Stewart, Randeberg, Lise L and Langlois, Neil Edward Iain, Forensic Science, Medicine, and Pathology, 2011; 7(4):333-335)

Other collaborative projects in the area of forensic science are also available.

2) Environmental Projects

The field of environmental forensics is the application of forensic and analytical techniques to provide legally admissible evidence on the presence and concentration of metals, compounds and isotopes and also the likely source of the pollutant. Environmental Forensics projects include–2.1) Analysis of Coral Cores to Detect Heavy Metal Contamination 2.2) Extraction And Analysis Of Fluorescent Bands In Black Corals 2.3) Analysis of Elemental Ratios in Corals to Determine Global Warming and Localised Thermal Excursions 2.4) Sea Cucumbers as Bio-Monitors and Bio-Remediators. Other collaborative projects in the area of environmental forensics are also available.

2.5 Creating the Great Barrier Reef in a Test-Tube

Recent research, by an honours student in 2013, has shown that we can create synthetic coral by mixing chemicals in a test-tube or in the Vortex Fluidic Device in the Ralston laboratory. By ‘growing’ aragonite $CaCO_3$ in a range of different chemical environments (i.e. temperature, pH and heavy metal concentration) we are now able to study the impact of changing environmental conditions on the uptake of metals in coral reefs around the world and clarify models that predict the effect of global change.

(See S Walker, Analysis of Soils in a Forensic Context: Comparison of Some Current and Future Options, in *Criminal and Environmental Soil Forensics,* K Ritz, L Dawson and D Miller ed, Springer p395-411 ISBN 978-1- 4020-9204-6)

2.6 Evidence Based Decision Support System for Coastal Restoration

A recently funded collaborative project is developing an evidence-based system to enable decisions to be made based on chemical and other scientific evidence. Working with researchers in schools of Biology and the Environment at Flinders and researchers in UniSA and ANU in Canberra this project will provide the chemical data and analysis that will assist in making the right decisions for coastal restoration of the South Australian coast including around the Penrise Salt Works and up the Gulf.

3) Analytical Projects

3.1 Mass Spectrometry and Related Projects

Associate Professor Walker has a strong background in the design, development and application of mass spectrometric techniques. These projects will utilize a range of advanced mass spectrometers. **MALDI –TOF** Matrix Assisted Laser Desorption Ionisation Time of Flight, **SALDI** (Surface Assisted Laser Dissociation Ionisation). **LC MS/MS** – instrument used to compliment GCMS and for proteomics and Drug analysis. – good for non-volatile or thermally labile analysis. **IRMS** – Stable Isotope Ratio Mass Spectrometer – used to determine isotopic ratios, and therefore source of N, C, H, O and S in environmental and forensic samples. The acquisition of a Compound Specific IRMS will enable the isotopic ratios of individual components in a mixture to be determined. **ICPMS** and **LA-HR-MC-ICPMS** for determining metals and isotopes for analytical and forensic applications. Including extraction of drugs, metabolites and bioactive chemicals from a range of matrixes. Projects using these techniques can be personalised to match the individual interests of the student and collaborating supervisor(s).

3.2 Food and beverage – Food Security

A novel spectrometric and chemometric process has been developed which has been applied to differentiating inks, paint, glass and wine. An opportunity exists to extend this research into the wine and food industry in collaboration with South Australian, interstate and international collaborators to apply environmental monitoring and provenancing of wine and other foodstuffs. (See article on https://www.iaea.org/newscenter/news/farm-fork)

3.3 Comparing and discriminating drugs

Illicit drug manufacture is only one side of clandestine laboratories. Reports suggest that there is a large amount of forged drugs in circulation. Many analytical techniques have been applied to detect and discriminate between genuine and forged drugs. Using a collection of over-the counter drugs (such as Paracetamol) as a surrogate for illicit drugs analysis will be undertaken to improve the detection and discrimination of drugs.

3.4 Wine Authenticity

Australian wine is increasingly the subject of substitution or counterfeiting, particularly in export markets. While some cases can be easily detected, such as those involving spelling errors on labels, (for example 'Jacobs Creek wine sold in England labelled as product of 'South Eastern Austrlia' and 'King-Ao' sold in Hong Kong coming from the 'Connawarra') other cases suggest that an increasingly sophisticated approach to addressing counterfeiting is required. Efforts to establish the authenticity of a wine sample have been underway for many years, particularly in Europe, with mixed success. Building on previous work in Australia and overseas this project aims to protect Brand Australia and individual producer brands by: developing a robust way to quickly ascertain the authenticity of an unknown wine sample (using inherent product compositional attributes such as stable isotope, metal isotope ratios and ratios of elemental content); building an elemental database (and/or validating existing databases) of wines of known origin both domestically and internationally; and validating use of rapid spectral techniques to compare counterfeited wines against a known reference wine.

3.5 Formation and fate of positive (enhancing) and negative (detracting) sulfur compounds

Volatile sulfur compounds (VSCs) can contribute both positive and negative attributes to wines, and their control in a winery environment is an important avenue to increasing the value of wine by either increasing positive sensory attributes or through the reduction of those deemed to be negative. Their occurrence can be influenced by factors including yeast selection and fermentation conditions, the nature and quantity of precursor compounds; the availability or absence of oxygen at different points of the winemaking process; and availability and speciation of transition metal ions such as copper. A current honours project has investigated the mechanism of thiol removal by addition of copper as copper sulphate, copper rods and copper nanoparticles.
The project will continue this research to develop an in-depth understanding of:

- the main precursors of the sensorially important VSCs, with focus on hydrogen sulfide (H_2S), methanethiol (MeSH), dimethylsulfide (DMS), phenylmethanethiol (BnSH), 3-sulfanylhexan-1-ol (3-MH) and 3-sulfanylhexyl acetate (3-MHA);
- the metabolic and chemical pathways that lead to their formation; and
- the chemical and environmental switches which lead to otherwise innocuous sulfur based compounds being converted to those that have a significant sensorial impact.

For more details about both of these projects contact either or both Paul and/or Stewart.

4) Centre of Expertise in Energetic Materials Projects

CEEM offers honours projects that have supervisors at Flinders and Defence Science and Technology Group (DST Group).

Three specific projects on offer with Assoc. Prof Walker are :-

4.1 Analysis, Characterisation and Chemometrics for Provenancing Home Made Explosives (HME) and Improvised Explosive Devices (IED). Information from a range of analytical techniques can be interpreted by chemometrics to provide information that can link IME/HME on a batch-to-batch basis and also to a source of origin. Isotope and trace elemental analysis of urea, hexamine and other precursors of homemade explosives.

4.2 Detection of explosives on surfaces, on skin, in blood and in hair – a combination of forensic toxicology and energetic materials.

4.3 Using Vortex Fluidic Device (with Prof Raston) improved green methods of selective production of Energetic Materials will be continued.

Full details of these and other CEEM projects which are also on offer will be distributed in the separate booklet for CEEM honours projects.

Other collaborative projects are also available.

Centre of Expertise in Energetic Material

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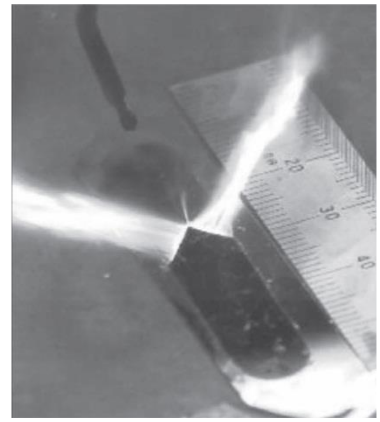
Deputy Director, Dr Chad Prior (DST Group)
Weapons & Combat Systems Division
Defence Science and Technology Group
Phone: +61 8 7389 4935
Email: CEEM@dsto.defence.gov.au



The Centre of Expertise in Energetic Material (CEEM) is a joint research and education centre linking expertise at Flinders and DST Group. CEEM initiates and funds research projects, research tasks and contract work for national and international agencies. CEEM undertakes research and development in the field of energetic materials and in particular the following key focus areas:

Safety and Environment

- Remediation
- Demilitarisation and recycling
- Waste disposal
- Hazards and sensitivity
- Green munitions, green manufacturing
- Surveillance and service life

Materials and Properties

- New ingredients
- Improved understanding of existing ingredients
- Improved application of existing ingredients
- Materials ageing
- Decomposition/destruction of energetic materials

Detection and Analysis

- Detection and analysis of energetic materials including homemade explosives
- Detection and analysis of decomposition products
- Detection and analysis of detonation products
- Analytical techniques

There have been over 33 honours and 6 PhD research projects in areas as diverse as environmental aspects of munition, bioremediation of contaminated sites, safety of stored munitions, synthesis of novel energetic material (or precursors), analysis and provenancing of explosives and improvised explosive devices.

Undertaking a research project with CEEM provides a strong environment of collaboration (each project has at least one supervisor at Flinders and DST Group) and gives the student access to the facilities and knowledge at both Flinders and DST Group. Prior to starting the project CEEM students will obtain Police Clearance (paid for by CEEM) and, if appropriate, will undertake an Energetic Material Handling Safety Course (provided by DST Group).

Specific CEEM research projects will be circulated in a separate CEEM Research Project Booklet. Further details of CEEM and research projects can be found on the AEMS and CEEM websites and by contacting the Director (Stewart Walker, Flinders) or the Deputy Director (Chad Prior, DST Group) CEEM@flinders.edu.au

APPLICATION FOR ADMISSION INTO AN HONOURS PROGRAM

SCHOOL OF CHEMICAL AND PHYSICAL SCIENCES

Flinders UNIVERSITY

School of Chemical and Physical Sciences
GPO Box 2100
Adelaide 5001 South Australia

I wish to apply for a place in an Honours Program commencing ☐ FEB 20_ _ ☐ MID YEAR 20 _ _ ☐ FULL-TIME ☐ PART-TIME

LAST NAME: ______________________

FIRST NAME: ______________________

PREFERRED NAME: ______________________ **DATE OF BIRTH** / /

TITLE: **EMAIL ADDRESS:** ______________________

FLINDERS UNI STUDENT ID: ☐☐☐☐☐☐☐ **MOBILE PHONE:**

CURRENT ADDRESS:

ADDRESS: ______________________

SUBURB: **POSTCODE** ______________________

VACATION ADDRESS:

ADDRESS: ______________________

SUBURB: **POSTCODE** ______________________

PROGRAM DETAILS (Please select program of study from list below)

☐ **HBSC** – (Chemistry) – Bachelor of Science (Honours)

☐ **HBSCNN** – Bachelor of Science (Nanotechnology)

☐ **HBSC** – (Physics) – Bachelor of Science (Honours)

☐ **HBSCCT** – Bachelor of Science (Clean Technology)

☐ **HBSCFS** – Bachelor of Science (Forensic and Analytical Science)

☐ Others (Honours): ______________________

☐ Admitted to a 4 year Honours Program (specify program) ______________________

SUPERVISOR: (Please list your 3 preferences below)

Option 1: ______________________ Contacted Supervisor ☐ **YES** ☐ **NO**

Option 2: ______________________ Contacted Supervisor ☐ **YES** ☐ **NO**

Option 3: ______________________ Contacted Supervisor ☐ **YES** ☐ **NO**

Students Signature: ______________________ **Date:** ______________________