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Introduction

The Australian Academy of Science was delighted to welcome the eighth group of twenty outstanding graduate students from the United States of America to Australia to participate in the East Asia and Pacific Summer Institutes (EAPSI) program for 2011.

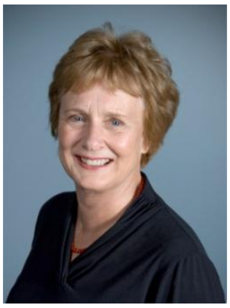
The program was developed in collaboration with the US National Science Foundation and aims to introduce the students to Australian science and engineering in the context of a research laboratory and to initiate personal relationships that will better enable them to collaborate with their Australian counterparts in the future. The program began on 13 June 2012 and lasted for eight weeks.

The Academy acknowledges the importance of research collaboration that goes beyond national borders and academic disciplines, and places great importance in strengthening exchanges that are both competitive and cooperative among talented young researchers.

It was with great pleasure that I read the participants' reports to learn that so many achieved, if not exceeded their immediate research goals, and initiated strong collaborative links that will provide the foundation for lifetime cooperative research. I was also pleased to learn that several students have expressed interest in returning to Australia to further their research, and some have already made enquiries into making this possible. These graduate students and the Australians with whom they shared their research will play an important role in advancing cooperative research between Australia and the United States in future years.

I would like to extend my gratitude to the Australian Government Department of Industry, Innovation, Science, Research and Tertiary Education for their continued support in funding this program, and of course to our colleagues at the National Science Foundation. Without their kind assistance and cooperation, this important activity could not be sustained.

The Academy looks forward to continuing this program in 2012 and beyond.



Professor Suzanne Cory AC FAA FRS

President
Australian Academy of Science

Orientation program

Monday 13 June

Afternoon	Arrival at Canberra airport Administrative details at Ian Potter House
Evening	Informal dinner at London Burgers and Beers

Tuesday 14 June

Morning	Guided tour of the National Gallery of Australia's Aboriginal and Torres Strait Island art exhibitions
Afternoon	Guided tour of New Parliament House Attend Question Time in the House of Representatives
Evening	Wine tasting and official dinner at Kamberra Winery

Wednesday 15 June

Morning	Official opening of the EAPSI program for 2011, Ian Potter House
	Welcome address: Dr Sue Meek, Chief Executive, Australian Academy of Science
	Lecture on Sex and Australian Mammals: Professor Jenny Graves Secretary for Education and Public Awareness, Australian Academy of Science
	Overview of the Australian Academy of Science Nancy Pritchard Manager – International Programs, Australian Academy of Science
	Postgraduate Science Opportunities in Australia Dr Fiona Leves Science Policy Research Project Officer, Australian Academy of Science
Afternoon	Depart Canberra for host cities

Participant: Jonathan Bittner, Harvard University

Australian research advisor: Professor Stuart Wyithe

Australian host organisation: The University of Melbourne

Title of research proposal: *Using a first generation prototype 21cm experiment to measure the redshift of reionisation*

Research description:
When the first galaxies and stars formed in the infant universe, they shed ultraviolet light, which ionised hydrogen in regions around these objects. This period of the universe's history is known as the "epoch of reionisation." Neutral hydrogen can be detected through its 21cm transition line, while ionised hydrogen does not have this transition, since it lacks an electron. The imprint of the ionised regions on the 21cm signal is thus a probe of how and when first stars and galaxies were created, and is one of the only ways to measure the distribution of matter during reionisation. But the cosmological 21cm signal has not yet been detected, due to strong galactic foreground emission which swamps out the faint background emission from the early universe.

Several radio interferometers should be able to observe the 21cm signal from the end of reionisation in the coming years. Two of the leading contenders are the Low Frequency Array (LOFAR) in Europe and Murchinson Widefield Array (MWA) in Australia. As part of the MWA collaboration, I came to Australia to study the detectability of the 21cm signal with early prototypes of the MWA instrument, specifically, MWA 32T (a 32-tile array) and MWA 128T (a 128-tile array), as opposed to a complete MWA at 512 tiles.

In a previous theoretical calculation, I had argued that the cosmological 21cm signal might be detectable in MWA 32T in a limited way, even with a sixteen-fold smaller instrument size. The specific proposal I made was to look at the redshift evolution of the variance of the signal. This method technically contains less information than a full power spectrum (the conventional approach), but is simpler to measure and interpret, and can be determined from snapshot images alone. Measuring the variance of a map was not a completely new idea, but my calculations suggested that the prospects for MWA 32T were better than had been discussed in the literature before. In order to calculate the observability of a given signal, I used a semi-numerical code called 21cmFAST to generate simulated data and added random noise by hand to my maps.

My proposed research for this summer was to travel to the University of Melbourne and work with Professor Stuart Wyithe, a reionisation and MWA expert, in order to test my calculation and attempt to measure the redshift of reionisation with the 32T data. However, project logistics and instrumental concerns dictated that instead of collecting enough 32T data to attempt my analysis, it made more sense for the collaboration to build out to 128 tiles in the near future (an instrument called MWA 128T). This did not allow for sufficient MWA 32T data to be taken to test my first research paper. Instead, it became important to reinvestigate what would be observable for MWA1 28T when it is completed in 2012. The goal was also to improve the calculations to include more instrumental effects, so that there would be increased plausibility that my simulated beams and simulated noise would match the actual experimental conditions on the ground. This became the goal of my summer research.

Research activities:
My research activities consisted of tapping into local expertise in the MWA instrument, as well as calculation techniques in radio astronomy, to improve and refine my calculation for the observability of the 21cm signal in MWA 128T. This consisted of implementing an automatic-beam generator that stored entire maps, computed the variance at different smoothing scales, and crucially simulated noise in the baseline distribution as opposed to in the real space map. These techniques were used by Stuart Wyithe and his students in previous work, and improved and validated my earlier calculations with Avi Loeb.

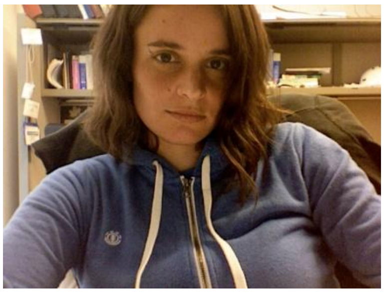
After building this calculation tool, we established some preliminary results on the detectability of the signal with MWA 128T, which were in line with expectations, but slightly more optimistic than others had expected. The signal to noise ratio we found (not including some minor corrections which would improve the ratio) was of order 10, cumulatively, for detecting the redshift of reionisation via the variance-excess method. We also established that one technical advantage of the method we were using would be that snapshot measurements would be sufficient to test the calculations, as opposed to storing all of the antenna baselines.

I also participated in research discussion sections of the literature while attending The University of Melbourne.

Perspective of research after this program:
Following this program, I will continue to improve and refine the calculation, comparing it to similar power spectrum calculations that have been done in the past. Once we have a good handle on all of the results, with the details cleaned up, we plan to submit the predictions in a research paper that should hopefully influence the observing strategy of MWA 128T and focus it on the goal of being the first detection of the 21cm signal and measuring the redshift of reionisation.

One of the discussions of the literature I had with Professor Wyithe lead to an acknowledgement in his recent paper, "The Shocking Truth: The Small Contribution to Hydrogen Reionisation from Gravitational Infall".

Australian advisor's remarks:
Jon Bittner visited Melbourne University for two months, during which we undertook work towards determining whether the forthcoming Murchison Widefield Array telescope will be able to detect the Epoch of Reionisation using the method of evolving variance. During his visit Jon developed software to calculate the sensitivity of the telescope to models for the predicted variance signature. From my perspective this was a very successful visit, and Jon's work is currently being written up for publication in a refereed journal.



Participant: Jessica Clopton, Florida State University

Australian research advisor: Professor Hans Lambers

Australian host organisation: University of Western Australia

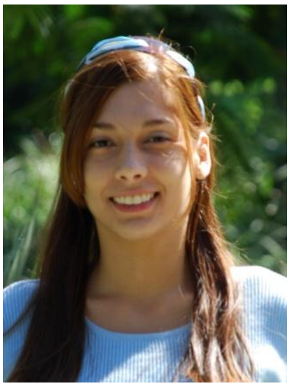
Title of research proposal: *Phylogentic context of phosphorus sensitivity in a focal clade of Hakea (Proteaceae)*

Research description:
My fellowship project complements current research in the Lambers lab. The goal of my project is to explore the evolution of a phosphorus sensitivity trait in a focal clade of Hakea (22 species, all endemic to SW Australia). I am investigating whether this trait has evolutionary and ecological relevance in these species. Specifically, I planned to (1) collect leaf tissue and soil samples, (2) generate DNA data and infer the phylogeny for the 22 species, (3) describe the natural conditions in which these species are found, (4) determine whether there are ecological (e.g., soil) or life history (e.g., fire-survival strategy) correlates of ability to regulate phosphorus uptake today and in evolutionary history.

Research activities:
I obtained locality information from Florabase and mapped out several trips in order to collect my focal plant species. I then travelled over 5,000 kilometres to various locations in SW Australia, ranging from east of Esperance and Cape Le Grand, north to Jurien Bay, and west to Cape Naturaliste in order to make multiple collections of the 22 species in my focal clade of Hakea. I sampled soil from each collection, and analysed these soils for plant available phosphorus and total phosphorus content. I assembled 56 voucher specimens to be deposited at the Western Australian Herbarium. I shipped leaf tissue from all collections to my home university in the U.S., enabling me to begin DNA extraction and sequencing when I return to FSU on September 6, followed by phylogenetic reconstruction and tests of correlation between soil phosphorus and phylogeny. During my stay in Perth, I also met several researchers at University of Western Australia, as well as King's Park Botanical Garden, and took part in two field trips with my host lab.

Perspective of research after the program:
My work in Australia this summer made something that was originally just an ordinary project into something much more personal and exciting. Being immersed in the natural environment of my focal clade of Hakea gave me new ideas for potential directions in which to take my PhD project back in the U.S. Based on my experience and things I learned and observed this summer, my entire PhD project may be heading in a new direction, which I look forward to.

Australian advisor's remarks:
Jessica has been given ample opportunities to reach her goals; she informed me that she has collected all the species that were on her list, despite several of them occurring only at remote locations. Laboratory facilities were made available to take care of the relevant soil analyses. All of that has been achieved as well.



Participant: Yanet Cusido, University of Miami

Australian research advisor: A/Professor Andrei Zvyagin

Australian host organisation: Macquarie University

Title of research proposal: *Surface modification of nanodiamonds and upconversion nanophosphors for targeted delivery in cells*

Research description:
The goal of this research project is the development of valuable luminescent probes for biomedical applications based on the unique properties of nanodiamonds. In particular, these studies will lead to the identification of optimal experimental protocols for the attachment of hydrophilic chains to the surface of preformed nanodiamonds and the conjugation of the resulting nanostructures to biomolecules. The passivating hydrophilic shell is designed to ensure aqueous solubility and prevent aggregation under physiological conditions, while preserving the characteristic photobleaching resistance and nontoxic character of the carbon-based core. Thus, the proposed nanoscaled constructs are expected to overcome the main limitations associated with organic dyes (photobleaching) and quantum dots (toxicity), in the context of fluorescence imaging applications, and offer the opportunity to visualise live cells for prolonged periods of times. Hence, these fundamental studies at the interface of chemical synthesis and nanostructured materials can provide useful analytical tools for the investigation of biological specimens and, ultimately, have a significant impact on biomedical research.

Research activities:
Macromolecular constructs with pendant poly(ethylene glycol) chains can be designed to wrap around inorganic nanoparticles or organic dyes and solubilise them in aqueous environments. The polymer coating around the resulting assemblies prevents effectively their aggregation under physiological conditions, promotes their internalisation in live cells and has no adverse effects on cell viability. Indeed, the laboratory of the home investigator (Dr Raymo) is successfully relying on this convenient strategy to transport luminescent nanoparticles, based either on organic dyes or quantum dots, across the membrane of model cells and image the resulting specimens by probing the luminescence of the internalized nanostructured assemblies. Recent reports demonstrate that poly(ethylene glycol) chains can be designed to adsorb also on the surface of nanodiamonds, albeit their mode of interaction (covalent vs. noncovalent) with the carbon-based particles is not entirely clear. The resulting nanostructured constructs can effectively be dispersed in water, cross the membrane of live cells and are not cytotoxic. Similarly, another clever piece of work shows that hydrophobic, rather than hydrophilic, organic molecules can also be attached to nanodiamonds, while preserving the photophysical properties of the carbon-based core. On the basis of these considerations, we are proposing a synthetic strategy to append alkyl chains to preformed nanodiamonds and overcoat the resulting assemblies with amphiphilic polymers bearing poly(ethylene glycol) tails. Our hypothesis is that the layer of alkyl chains immediately around the luminescent core will ensure optimal photophysical properties and encourage the physisorption of the amphiphilic polymer. In turn, the pendant poly(ethylene glycol) tails will ensure aqueous solubility, prevent aggregation and permit bioconjugation. Specifically, we plan to oxidise exhaustively the functional groups on the surface of commercial nanodiamonds to –CO2H, couple them with octadecylamine and overcoat the resulting assemblies with amphiphilic polymers, incorporating alkyl and poly(ethylene glycol) side chains along a common macromolecular backbone. In addition, we will introduce appropriate functional groups (e.g., –CO2H or –NH2) at the termini of

the poly(ethylene glycol) chains to enable the subsequent attachment of the nanodiamonds to biomolecules.

Perspective of research after the program:
I plan to synthesise a variety of amphiphilic polymers with appropriate functional groups (e.g., –CO_2H or –NH_2) at the termini of the poly(ethylene glycol) chains to enable the subsequent attachment of the nanodiamonds to biomolecules. After synthesising these polymers, I will try to test the possibility of conjugating biomolecules to the proposed nanodiamonds. In particular, I will couple the primary amino groups of the peptide hormone somatostatin to the carboxylic acids at the termini of the poly(ethylene glycol) chains of under the assistance of EDC. I will purify the resulting conjugates by size-exclusion chromatography and confirm the attachment of somatostatin to nanodiamonds by ultraviolet–visible absorption spectroscopy. Specifically, we will probe the absorbance of the tryptophan residue of somatostatin in the ultraviolet region and quantify it relative to that of the nanodiamond in the visible region to estimate the average number of biomolecules per nanodiamond. Thus, these experiments will confirm that the proposed biocompatible nanodiamonds can indeed be conjugated to biomolecules with relatively simple synthetic procedures.

Australian advisor's remarks:
Luminescent nanomaterials hold considerable promise for biomedical applications due to their remarkable photostability, controllable cytotoxicity, and developed surface, which can be decorated with biocompatible chemical moieties. These form a crucially important interface that allows docking various biomolecules to be delivered to specific cells for diagnostic and therapeutic purposes.

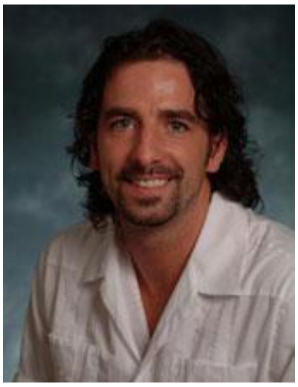
The EAPSI project was focussed on two types of luminescent nanoparticles: luminescent nanodiamonds (LND) and upconversion nanophosphors (UCNP). LND features extremely bright colour centres that form very attractive base for magnetometry and biomedical applications. Due to the carbon nature of LND, its acid-treated surface contains a variety of oxygen-containing groups, including carboxyl groups. As such, LND provides suitable interface for covalent attachment of biomolecules, although the low percentage of the carboxyl groups, estimated as 7% of the total amount of the functional groups, makes this attachment sparse and poorly controllable. The other type of nanomaterials, UCNP is very attractive for background-free imaging of biomolecules, where the cell/tissue background autofluorescence suppression is primarily achieved by using an infra-red excitation source, while detecting the UCNP emission in the visible spectral range, where no autofluorescence is excited by cells/tissue. The recent breakthrough in the synthesis of highly efficient UCNP has offered a range of small-size bright nanoparticles, and their promise for biomedical applications has been demonstrated. However, the as-synthesised surface moieties are hydrophobic, which is incompatible with biomolecular environment.

The EAPSI fellow, Ms Janet Cusido (US supervisor, Prof Francisco Raymo), offered an interesting approach to modify LND and UCNP surfaces to render them hydrophilic and biocompatible. In brief, the use of amphiphilic polymers featuring both hydrophobic and hydrophilic terminals, allows saturation of the hydrophobic moieties of e.g. UCNP, and converting them to hydrophilic moieties. LND was proposed to be initially surface-modified to render hydrophobic. This amphiphilic polymer had been synthesised in-house in the chemistry laboratory of the University of Miami, the host US institution, and applied to the luminescent nanomaterials offered in my laboratory.

The application of the amphiphilic polymer to both types of nanomaterials showed some changes in their aqueous colloidal properties: UCNP hydrophobic particles, originally unmixable in water were stabilised after addition of the amphiphilic polymer. Although the aqueous stability was limited to several days, the achieved short-term stability may allow performing bioconjugation reactions. Our transmission electron microscopy observations in combination with the dynamic light scattering showed negligible particle size increase, which indicated that no dense polymer coating was formed on the UCNP surface, whereas the sparse polymer attachment might account for the improved water dispersity of the modified nanophosphors. Ms Cusido also performed a surface-modification reaction described in the literature, where the weakly attached UCNP surface groups were replaced by strong-binding mercaptopropionic acid groups. The colloidal precipitation occurred, which was in good agreement with the other group observations, although contrary to the literature reports. The amphiphilic coating of LNDs showed more tangible results of the increased nanoparticle size, where the size increase of about 15 nm can be explained by the polymer thickness. The aqueous stability was also improved. Janet carried out several analytical testing of the modified surface functional groups, using, in particular, Fourier transform infrared spectroscopy. It was inconclusive due to the limited resolution of the available instrument – this analytical testing is to be continued to confirm the presence of the polymer surface groups.

In summary, during her short stay at Macquarie University, Ms Cusido carried out several reactions using her proprietary amphiphilic polymer and other chemical procedures reported elsewhere, to find a chemical pathway to stabilise luminescent nanodiamonds and upconversion nanophosphor particles in water, and in physiological buffers to enable bioconjugation reactions. She demonstrated that the amphiphilic polymer coating had some improvement on the colloidal stability of both LND and UCNP suspensions. If successful, this chemical pathway has potential to dress the existing lacuna in reliable surface modification of nanoparticles and enable their bioconjugation for cell delivery and imaging applications.

Janet has demonstrated a good deal of her primary chemistry expertise and experimental aptitude during her laboratory work. Her activity towards establishing collaboration between our laboratories is worthy of mentioning.



Participant: Eugene Farrell, Texas A&M University

Australian research advisor: Associate Professor Kevin Parnell

Australian host organisation: James Cook University

Title of research proposal: *Hydrodynamic modelling of beaches and reef flats in Torres Strait Islands*

Research description:
The field based project collected hydrodynamic (wave energy) and morphological (beach condition) data for beach and reef flat locations in the Torres Strait Islands, located between New Guinea and Australia. The data was collected, analysed (started at least; ongoing work) and will be presented in order to supplement a larger program (Climate Change Adaptation Program) that focuses on preparing coastal communities for the impact of climate change.

Research activities:
The collection of hydrodynamic, topographic and sedimentological data occurred during the south-easterly wind season. We deployed instruments (ADCCP, ADV) to measure the relevant hydrodynamic variables (wave height, wave period, wave direction, current velocity, and current direction, water depth) in order to model the incident forcing.

Shorelines (beaches and reef flats) were surveyed using a Trimble Real-time Kinematic Global Positioning System (RTK).

Perspective of research after this program:
I hope to collaborate with the host for many years to come. This work has direct reporting requirements that will feed into publications but there are also other directions to analyse the data that can lead to articles.

Australian advisor's remarks:
It was a pleasure, in both personal and academic senses, to host Eugene for the period of his visit. Eugene is an extremely personable and hardworking person who immediately fitted into my research group. He was never demanding of attention, and just got on with the job. He produced good results, and wrote software routines that will be used by my group in the remainder of the project. He contributed his ideas on how we could do things better and was always willing to fully participate in our activities. Our research project was based in Torres Strait, and we spent a considerable period in the field. Torres Strait can be a challenging environment to work in, and researchers always need to be aware of the cultural aspects of the work. Eugene interacted superbly with the local people, particularly on Murray Island, where he developed friendships with the Rangers with whom we were working. I very much look forward to working with Eugene in the future, and would welcome him back at any time.

Participant: Kevin Field, University of Wisconsin - Madison

Australian research advisor: Dr Mark Blackford

Australian host organisation: Australian Nuclear Science and Technology Organisation

Title of research proposal: *Examining the variations in microchemistry of irradiated ferritic-martensitic steels for the next generation of nuclear power plants*

Research description:
Within the past decade it has become clear that the global dependence on oil and other fossil fuels for energy production must be significantly reduced. One method to produce energy without the utilisation of fossil fuels is nuclear power. The dependence on nuclear power has been predicted to increase over the next 40 years. In order to meet these demands, new designs of nuclear power reactors have been proposed which increase efficiency, improve safety, reduce waste and increase proliferation resistance. These advanced nuclear reactor designs will operate at higher temperature, have more intense radiation fields, and have more corrosive environments over the current global fleet of nuclear reactors.

In response to the increase of severity in operating conditions of these new reactor designs, existing and new materials must be investigated to determine their performance within these new environments. Ferritic-martensitic steels with a nine weight percent chromium addition are one material class being investigated for use as cladding and core structural components. The focus of this research is to understand the stability of these steels under intense radiation fields. Of particular interest is the damage imparted into the steel and how the microchemistry of the steel evolves during irradiation. This research utilises ion irradiated simple system ferritic-martensitic steels investigated using advanced electron microscopy techniques.

Research activities:
Damage from radiation fields can lead to embrittlement of the steel, an undesired effect. Radiation damage was studied in an irradiated model ferritic/martensitic steel using a technique known as weak-beam dark field (WBDF) imaging using a transmission electron microscope (TEM) at the Australian Nuclear Science and Technology Organisation (ANSTO). Using this technique the nanometre length scale damage from radiation can be imaged. WBDF images can then be post-processed to quantify the amount of damage imparted into the steel from the radiation environment. The technique also allows for spatial relationships to be determined between defects and inclusions within the steel. Several different degrees of damage created by different radiation environments were successfully observed over the course of the program which provided information on how the damage develops within the steel under irradiation.

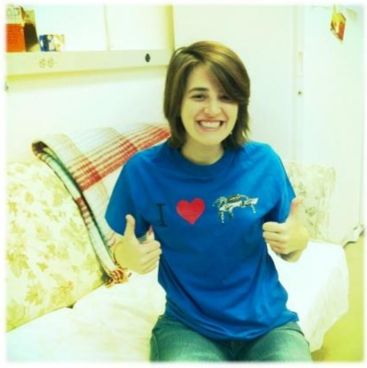
Changes in the steel's microchemistry were observed using a field emission gun scanning transmission electron microscope coupled with energy dispersive x-ray spectroscopy (FEG-STEM/EDS). It is important to understand the evolution of the steel's local microchemistry as a function of radiation damage as changes to the microchemistry can alter the steels corrosion resistance and strength leading to a loss in performance over time. During the program, the distribution of chromium, the major alloying element in the steel, was observed at different interface types within the steel as a function of damage. The quantification of the amount of damage imparted and the changes in the steel's local microchemistry has provided a more complete picture of how ferritic-martensitic steels will perform in the proposed advanced nuclear reactor designs.

Along with the analysis of samples already prefabricated before the program, there was sufficient time to make new samples as well as tour the research facilities at ANSTO and the University of Sydney. Sample fabrication allowed for more samples to be analysed over the course of the summer as well as provide an exchange of ideas and techniques between researchers. Many of ANSTO's research facilities, including the OPAL research reactor, Bragg Institute, and ion irradiation facilities were toured. Tours provided a 'big-picture' observation of the work being completed at ANSTO and throughout Australia in the field of radiation damage and materials science.

Perspective of research after the program:
My experience at ANSTO through the EAPSI program has been extremely positive and was a great opportunity for professional development. The program enabled me to work and collaborate with the top researchers in radiation damage and electron microscopy in Australia. Through this, I was able to learn new techniques including WBDF microscopy which has and will continue to greatly benefit my research with data being directly applicable to my PhD thesis. The daily interactions with the researchers at ANSTO also sparked new ideas and provided new avenues to investigate within my research as well as others. Data collected during the program will also be included into a peer reviewed journal article allowing it to be shared with the greater scientific community. Hopefully, the collaborations and connections made during the program will continue. Besides the technical aspects of the program, EAPSI also allowed me to travel throughout Australia which provided extensive insight into Australian culture. Living abroad provided a new prospective which will carry-on well past this program or any particular career path. The EAPSI program was a great opportunity and one I would highly recommend to others.

Australian advisor's remarks:
It was a pleasure hosting Kevin during his short time in the Institute of Materials Engineering at ANSTO. He very quickly integrated into the social and research activities of the Institute, making valuable contributions in both areas. During his stay IME researchers and technical staff provided guidance in numerous TEM related techniques which Kevin rapidly mastered. He developed advanced skills in TEM operation which will benefit his future research. However, the exchange of ideas and techniques was definitely a two way street. Kevin passed on his expertise in extraction replica sample preparation, a technique we now regularly employ in our own research areas.

Kevin's research interests in radiation damage behaviour of steels closely aligns with those of IME and I hope that we can continue our collaboration. He is a mature, highly competent and motivated researcher with a bright future. I wish to thank the EAPSI program for supporting Kevin's research experience in Australia.



Participant: Madeline Girard, UC Berkeley

Australian research advisor: Professor Robert Brooks

Australian host organisation: University of New South Wales

Title of research proposal: *Relative contribution of juvenile and adult environments on sexual trait expression in the field cricket, Teleogryllus commodus*

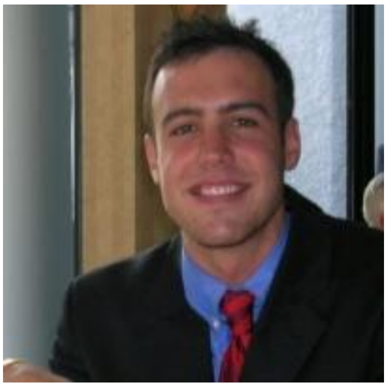
Research description:
The purpose of this research was to investigate how juvenile and adult social environments individually and interactively affect the expression of calling effort, a sexually selected trait, in the Australian black field cricket, Teleogryllus commodus. Male calling effort is condition-dependent, meaning that those in better condition are able to call more and can thus attract a greater number of mates. As a result, the density and quality of calls that males hear as juveniles provides them with information about the competitive environment they will encounter at maturity. Interestingly, recent research has demonstrated that these social cues actually affect sexual trait expression throughout a male's lifetime. Adult social experiences and a male's perception of his own quality may also be important to sexual trait expression in this system. For example, a male that successfully attracts and mates with a female can perceive himself as a high quality male and thus may not increase his calling effort as calling is costly and the level of effort is resulting in success. In contrast, a male that attracts a female but doesn't mate may increase his effort slightly, while a male that never attracts a female may continually increase his effort. In order to partition the relative importance of the juvenile rearing environment and the adult social environment we manipulated a male's perception of competitive intensity and his own 'quality'. This research is fundamental to our understanding of the role the social environment plays on sexual selection function.

Research activities:
The experiment I conducted examined how the expression of sexually selected traits changes within an individual's lifetime in response to various internal (ageing, reproduction) and external (juvenile and adult social environments) factors.

Males were reared in either in high/low density variable call quality environments. At maturity, size and weight measurements were taken and males were placed in a callbox, which measured their nightly calling effort. To examine how social experience and interactions affected the expression of calling effort (the sexually selected trait), males from each juvenile treatment were randomly assigned to one of five adult treatments. Treatments differed in whether males were allowed to mate with a female on days 14 and 21 (1) a female was experienced on day 14 and 21 but males were prevented from mating on both days, (2) males were allowed to mate on day 14 but prevented from mating on day 21, (3) males were prevented from mating on day 14 but allowed to mate on day 21, (4) mating was allowed on both days 14 and 21 and (5) a control treatment in which a male had no female experience. Using this design, we are able to examine the relative importance of the juvenile rearing environment and the adult social environment on calling effort. The data has yet to be analysed, but will hopefully allow us to determine how the competitive environment and perception of individual quality (through attraction and mating success) affects calling effort.

Perspective of research after the program:
My stay in Australia has been valuable in contributing a key piece of research to my dissertation project, building my intellectual skills and helping to hone some of my broad research interests. The EAPSI program gave me a unique opportunity to focus intensively on my research, and as I am in the beginning stages of my PhD, this experience will truly serve as excellent preparation for my future scientific career. In fact, I already feel more confident in my ability to conceive, plan and execute successful experiments. Additionally, I know that the quality of my research has been strengthened by the collaborations facilitated through this program. Overall, my experiences working at UNSW, in the Brooks lab, has only solidified my desire to pursue collaborative research projects as often as possible.

Australian advisor's remarks:
Madeline Girard has very quickly become an important and much valued member of my research group. She has worked on a variety of projects in several different invertebrate species, and gathered vaulable data that will certainly be written up for publication. She has also brought to our group and our School a broader perspective on science and how it is practiced in American universities. She has participated in and led discussion groups on a variety of evolutionary and behavioural topics and has helped my graduate students with their own work. I can only imagine that Madeline will go on to great success in science, and I'm hoping that my lab and I will continue to associate with her and watch her flourish.



Participant: Gregory Hardy, Duke University

Australian research advisor: Professor Joseph Shapter

Australian host organisation: Flinders University

Title of research proposal: *Understanding HIV-1 antibody neutralisation and autoreactivity using atomic force microscopy*

Research description:
A major obstacle to generating a successful human immunodeficiency virus-1 (HIV-1) vaccine is the inability to induce broadly reactive neutralising antibodies (NAbs) after immunisation. The human monoclonal NAbs, 2F5 and 4E10, represent rare antibodies with broadly neutralising activity made from B cells of HIV-1 infected humans. Recently, it has been demonstrated that 2F5 and 4E10 associate with HIV-1 lipids are part of an essential first step in neutralisation before binding to membrane-proximal antigens. This unique lipid reactivity may explain the rarity of 2F5 and 4E10, because induction of these types of NAbs may be limited by immunologic tolerance due to autoreactivity with host cell membranes. Despite their autoreactivity, there is currently large research activity aimed at eliciting 2F5/4E10-like antibodies that maintain their rare neutralising breadth and efficacy. However, overcoming autoreactive tolerance issues is one of the major challenges to induce these types of NAbs and surprisingly, little is known about the NAb-membrane binding mechanism underlying both autoreactivity and HIV-1 neutralization.

Thus, the objective of this research is focused on further understanding the mechanisms that help drive NAb autoreactivity and neutralization, specifically in the context of how unique membrane domains control antibody-antigen interactions. This research has helped identify the physical properties of HIV-1 and host cell membranes that contribute to NAb autoreactivity and neutralizing ability.

Research activities:
We used supported lipid bilayers as engineered mimics of the HIV-1 viral envelope and host cell membrane to study the role of lipid domains on NAb-membrane binding. NAb-membrane interactions were interrogated by atomic force microscopy (AFM), a high resolution scanning-probe imaging tool able to detect subtle differences in membrane morphology with nanometer resolution.

Our results showed that lipid domains were easily observed for simple binary membrane constructs and for complex, biomimetic HIV-1 model membranes. Localised binding of HIV-1 antigens (MPER656) and NAbs were also observed. Both antigen and 4E10/2F5 bound preferentially on the most fluid membrane domain. This supports the theory that NAbs may interact with regions of low lateral lipid forces that allow antibody insertion to interact with the lipid’s hydrophobic tail. NAbs were also observed to cluster at the edge of domain interfaces suggesting NAbs affinity for high interfacial energy regions of the lipid membrane.

Perspective of research after the program:
The EAPSI program has allowed me to complete many of my research objectives by facilitating collaborations with the experts in my field. I am grateful for all the help I have received from the EAPSI program and for all I have learned from my host. This was truly one of the most rewarding experiences of my graduate career and I look forward to continuing our U.S.-Australian collaboration.

I would like to thank Dr Shapter for all his help and guidance with my research and would also like to thank the other fellows as well. One of the more interesting aspects of the program was the collection of such a diverse group of young researchers. It was great to get to know students in such different fields then my own and it was a pleasure to share this experience with all of you.

Australian advisor's remarks:
It was a great pleasure to have Greg in our group. He is a gifted scientist with a positive approach to his work and those around him. He worked exceptionally hard and got some terrific results undertaking what I would only describe as very challenging experiments. These results are a tremendous testament to Greg's endeavour and talent as a scientist. There is little doubt that the work done by Greg at Flinders will lead to a high quality publication and I hope will lead to further collaboration between the groups at Flinders and Duke.

Participant: Marc Hebert, University of South Florida

Australian research advisor: Dr Elizabeth Tunstall

Australian host organisation: Swinburne University of Technology

Title of research proposal: *A cultural model for designing e-government social services*

Research description:
National and local governments worldwide are increasingly steering their residents towards completing applications for social services through the Internet. These electronic government (e-government) programs are commonly designed for the "average" citizen or someone who is functionally literate, technologically knowledgeable and able to access the requisite technology often from their home. One effect explored through my research about Florida's e-government program for food, medical and cash assistance is employees at libraries and NGOs are increasingly assuming responsibilities of government social service workers because of their proximity to publically available computers connected to the Internet. I sought to learn whether and how this is occurring elsewhere, particularly Australia's Centrelink program: an internationally recognised leader for e-government welfare services that include food and cash assistance.

Using Cultural Consensus Analysis (CCA), I sought to adapt from Florida to Melbourne, Australia a model for understanding the experiences of e-government welfare users and the employees who help them in public libraries, NGOs and Centrelink offices. I also wanted to learn how CCA could be combined with a design anthropological approach for assessing the challenges users encounter with the Centrelink application process.

Research activities:
Unfortunately, Centrelink and three separate library councils either denied my repeated requests to research or they did not respond. This in itself is a research finding as members of these institutions concluded my analysis was not in their employees' and patrons' interests. As a result, much of my time was spent at a large public housing complex where its residents had access to a computer hub as well as a Community Information Centre (CIC). The staff at CICs serve as advocates for the general public in need of social services. They provide free access to Internet-ready computers, printing and telephones. Developing rapport with the employees and volunteers of the computer hub and CIC enabled me to do much of my research.

I also reached out to design firms and other researchers in Melbourne in an attempt to learn more about Centrelink. Dr Tunstall assisted with this effort, enabling me to speak with two experts in e-government design, one who evaluated Centrelink and the other assessed its Florida counterpart. I contacted employees at two other NGOs requesting permission to volunteer and to research among prospective Centerlink users in food pantries and homeless shelters. Because of the limited duration of my stay, I learned that volunteering was not possible since I needed to pass a background check. My messages requesting permission to do research on their premises were not returned. I was able to speak with volunteers from a Citizens Advice Bureau that provides financial and information assistance to those facing financial difficulties.

Perspective of research after the program:
Participation in the EAPSI program definitely enhanced my research experiences and provided professional collaborative opportunities. I achieved my overarching objective in the program by learning from Dr Tunstall who is a Design Anthropology pioneer. Through our numerous conversations, I applied her ideas to analyse my research findings in Florida that combined Cultural Consensus Analysis with Design Anthropology. This allowed me to produce two separate conference papers. One paper was presented at a workshop during the 5th International Conference on Communities and Technologies held in Brisbane in July. While there, I met a researcher from the University of Melbourne who invited me to speak about my work at her home institution, which I later did. The second paper was slated for a September presentation at a graduate symposium in Colorado, USA. Dr Tunstall led the symposium during the 7th Ethnographic Praxis in Industry Conference that attracts designers, anthropologists and corporate researchers.

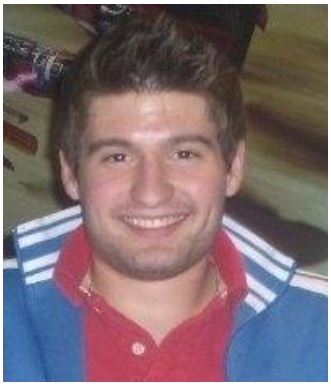
In Melbourne, I reconnected with an anthropologist at RMIT University who is globally recognised for her work to improve the way information and communication technologies are used by NGOs in developing countries. She asked me to speak about my work to a diverse set of researchers, one of whom later expressed interested to co-publish a paper. I also met a designer at a consulting company who teaches at RMIT. I spoke to his undergraduate class about anthropological contributions to the field of design.

Engaging in international research as a cultural anthropology graduate student provided me with valuable training by working in a new culture among a population with whom I have had little previous experience, namely immigrants and refugees. They appeared to be mostly positive with the design of the Centrelink application process. Additionally, Dr Tunstall introduced me to four key informants: two refugees with Centrelink experiences and two experts in the design of government websites. Though I did not have access to Centerlink offices or the public libraries, I adapted my research around the people who would speak with me. In this way, I was able to learn about several important services available to Centerlink users that their Florida counterparts do not have. I also discovered similarities between Australia and Florida in terms of access to services. NGO employees in both places, for example, advocate for their patrons to government welfare officials in order to receive social services that may not be readily forthcoming due to bureaucratic / logistic reasons. "Being able to ask the right question," was a common refrain from both seasoned welfare recipients as well as NGO employees who felt that by knowing what to ask Centerlink staff unlocked the necessary information to receive services.

I am very grateful to NSF, the Australian Academy of Science, the Swinburne University of Technology and my host researcher, Dr Tunstall, for the exceptional care and professionalism prior to and during my stay in Australia. This experience was the highlight of my graduate training and undoubtedly aided me in receiving a writing fellowship for the current fall semester to devote myself full-time to completing my PhD in a timely manner.

Australian advisor's remarks:
There is nothing more important for a researcher than to find individuals eager to apply his or her theory into exciting new areas. Design Anthropology is a new academic field, with Swinburne Faculty of Design having one of only two academic programs in the world, and the only one in a design faculty. Design Anthropology methodological approach advocates a holistic understanding socio-cultural values and how they are translated into tangible experiences through design processes and outcomes. Working with Marc through the EAPSI program has provided both of us the opportunity to clarify the designerly aspects of design anthropology, which makes it distinct from cultural studies or applied anthropology, which is Marc's background.

While there were certain frustrations with getting the permission to conduct Marc's data gathering with agencies and even individuals, this revealed important aspects of e-government in the Australian context. For example, people who receive government benefits feared investigation of their relationships with the Australian e-government, much like those in the United States. This fear exposes the self-perception of vulnerability of receivers positions vis-à-vis government agencies, and thus even their virtual representations through ITC's. Figuring out how to redesign Centrelink or other websites to address this experience of fear of the government agency could be an important next step in Marc's continuing post-doctoral research in this area. So thank you to the EAPSI Program and Marc, for providing a wonderful experience to expand the methodology of Design Anthropology into the area of poverty studies and e-government.



Participant: Joshua Lasinski, Washington University in St Louis

Australian research advisor: Dr Stephen Gibson

Australian host organisation: The Australian National University

Title of research proposal: *Vibrational coupling induced autodetachment in Cl-CH3I*

Research description:
Our research group has recently obtained results showing the potential of cluster anion imaging experiments as probes of electronic and vibronic energy transfer mechanisms. A particularly interesting case is Cl−•CH3I. Preliminary, relatively low resolution data and comparison with I−•CH3I photodetachment results indicate that competition between excited state relaxation via electronic and vibrational autodetachment processes is possible. However, the initial results obtained by our group lack the necessary resolution to compare these processes with absolute certainty. The velocity map imaging photoelectron spectrometer located at The Australian National University sets the standard for velocity map imaging resolution. Previous collaboration with Dr Gibson and Dr Cavanagh at the ANU has highlighted the orders of magnitude difference in resolution capable with their experiment. This resolution will allow assignment of the Cl−•CH3I photodetachment spectra that is not possible in our research group.

Research activities:
The research activities for this experiment consisted primarily of ion formation and subsequent photodetachment of the species of interest. My previous experience with this species allowed me to work with my advisors in modifying their experimental setup to generate the Cl-CH3I cluster.

Perspective of research after the program:
This project has allowed me to realise that eight weeks is a short time to see a project go from start to finish. While I have done these experiments in the past using a different instrument, the intricacies of different experimental setups can bring about unforeseen difficulties. However, in overcoming these difficulties, I have gained a greater insight into high resolution spectroscopic techniques that I can take back to my research group. Additionally, working alongside two of the world's leading experts in anion imaging was not only incredibly helpful for this experiment, but will be a boon to my scientific career as well.

In the process of creating the cluster anion of interest for this project, we were also able to generate other interesting species for future studies. Some of these experiments are already underway, and will lead to further collaborative research between my research group and the Australian National University.

Australian advisor’s remarks:
Josh is an excellent student and is a great ambassador for the USA. He has adapted extremely well to the intellectual challenges of his project and also to the cultural and the physical challenges of living in Canberra during the winter months. Josh has embraced the EAPSI program thus maximising the programs outcomes by not only dedicating his time to the experimental program but also avenues for future collaborative research.

The Australian National University spectrometer is the only apparatus in the world with the capabilities of detection efficiency and resolving power sufficient enough to resolve enough spectral details to fully understand the anomalies discovered in Josh's original low-resolution experiments. The project has proven a challenge, surprisingly not in the actual measurement, but from difficulties in generating the anion species of interest. The $Cl^-\cdots CH_3I$ species was finally coaxed into existence near the end of Josh's visit, with initial measurements being started before his departure and continued since. Josh's project has also yielded important new measurements on several precursor species, which are interesting in their own right. In addition, the molecular anion clusters of $Cl^-\cdots CCl_4$ and $Cl^-\cdots H_2O$ were also observed in the ANU's mass time-of-flight spectrometer, opening up the prospect of new and exciting collaborative research projects. The abundant measurements not only set new standards for spectral resolution and clarity but will also provide significant new information on electron detachment processes and the associated chemistry of the species. Lastly, with the identification of several new and poorly studied species Josh's visit has enhanced the collaborative efforts between Washington University St. Louis and the ANU.

Participant: Oren Leaffer, Drexel University

Australian research advisor: Professor Andrew Dzurak

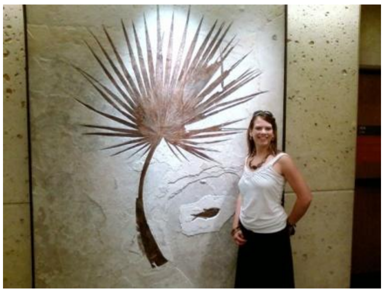
Australian host organisation: University of New South Wales

Title of research proposal: *Fabrication of nanowire devices with enhanced light absorption using integrated plasmonic lens*

Research description:
The overall goal of my project is to design, fabricate, and characterise nanowire based photodetectors with improved sensitivity through the integration of plasmonic lenses in the contacts. The design and characterisation phases of the work were to take place at my home institution and the fabrication was to be conducted in the ANFF NSW node's cleanroom facilities, primarily using the ebeam-lithography (EBL). EBL is an ideal method for contacting nanowires as it allows for extremely high resolution features (in the case of EBL conducted at ANFF-NSW, this means <10nm) and the ability to contact individual nanowires with customised contacts through the use of pattern registration to predefined marks.

Research activities:
I was trained by the process engineers at ANFF-NSW on a variety of processes necessary for the overall fabrication process as well as how to work in a cleanroom facility. I was also given training in laboratory safety as required by the OHS policies in place at ANFF. The bulk of my time was spent working in the cleanroom or customising EBL designs for individual nanowires.

Perspective of research after this program:
I successfully fabricated a set of devices that I will test at my home institution, Drexel University. EBL is a technique I use at Drexel, so I expect to apply what I learned at ANFF to help improve our processes there. This was my first experience working in a cleanroom facility, which made the experience all the more interesting. As an added enrichment, I had opportunities to meet with a number of scientists in my field. The overall experience renewed my excitement for the prospect of an academic career and I hope to collaborate with some of the scientists that I met as well as return to Australia to conduct more research.



Participant: Casee Lemons, Baylor University

Australian research advisor: Dr Ian Wright

Australian host organisation: Macquarie University

Title of research proposal: *Leaf economic traits of extant ferns as a proxy for growth habits*

Research description:
Extant ferns possess a variety of growth strategies, contributing to their cosmopolitan distribution. When these growth strategies evolved is unknown. To investigate the ecology and evolution of ferns in geologic history, new methods of analysis must be tested. In this project we are developing approaches to estimate the leaf mass per area (LMA) of fossil fern species and assemblages, and thus to gain insight into shifts in their environment and ecological niches over evolutionary time-scales.

Why LMA? Leaf mass per area indexes a species' position along a multi-trait, "leaf economic" spectrum that describes key features of the dry mass and nutrient economics of carbon gain. Typically, species near the low-LMA end of the spectrum have high leaf nutrient concentrations and photosynthetic capacity, and are relatively fast growing, but also tend to be highly palatable to herbivores and have short leaf lifespans. Species towards the high-LMA end of the spectrum tend to show the opposite suite of traits, consistent with far more conservative nutrient-use strategies.

Previously both leaf mass and LMA of extant species have been shown to be reliably correlated with the width of the petiole (both for biomechanical and hydraulic reasons), allowing estimation of LMA for fossil gymnosperm and angiosperm leaves. Here we investigate the potential of using a similar approach for fossil ferns

Research activities:
I travelled to various herbaria in Australia and New Zealand, measuring preserved ferns. To measure them, I massed and photographed the leaves. Image analysis was performed to determine leaf area and petiole width. Those pictures remain available to me for analyse various leaf features, if so desired. Petiole width-squared over leaf area, a biomechanical and hydraulic scaling relationship, and leaf mass per area (LMA), an economic trait that indexes a species' ecological growth strategy, were correlated to calibrate a mathematical model of leaf trait correlations. The model functions to estimate the LMA of fossil ferns, therefore interpolating the ecological growth strategy within the fossil species.

Petiole and leaf traits were measured on ~120 extant species in order to generate predictive regression equations for LMA. LMA could be predicted well from petiole dimensions within some fern families and orders, but not in others. Whether a family belonged to a monophyletic or paraphyletic clade had no bearing on this, although growth form potentially plays a role, for as yet unknown reasons. Overall the relationship between petiole dimensions and LMA was considerably weaker for ferns than for previously-tested plant groups, and the variance within ferns was considerably larger. Thus, although measurements made on fossil petioles can indeed aid in reconstructing LMA for species in some plant groups, at this point this particular method appears less generally applicable for fossil fern species. That said, for fossil species in at least some clades this approach looks likely to greatly aid investigation of their ecology and evolutionary history.

Perspective of research after the program:
I am very thankful to have been provided the opportunity to participate in the EAPSI program. My research, personal life, and professional outlook have been enriched by the opportunity to interact with scientists across all disciplines. I am honoured to have been able to meet and be mentored by Dr Ian Wright, an ecologist respected for his research across the world. I aspire to achieve the level of knowledge and experience I have witnessed. Notably, the level of kindness and interest exhibited by scientists and professionals, in both my own disciplines and others, is inspirational. This same attitude I will strive to maintain in my own career and interpersonal communications.

Australian advisor's remarks:
Ms Casee Lemons is a bright, highly motivated and very organised young scientist. It was a pleasure to act as her host under the EAPSI program. The research project that we chose has turned out to be quite a bit more difficult (less straightforward) and even more scientifically interesting than we anticipated, yet Casee has taken this in her stride. Casee has already presented a poster on our work at the annual Ecological Society of America conference (Austin, Texas) and will do so again at the annual conference of the Geological Society of America, later this year. We anticipate that a written publication will also result. I would like to thank the Australian Academy of Science and EAPSI program for facilitating this collaborative interaction.

Participant: Maureece Levin, University of Oregon

Australian research advisor: Professor Sue O'Connor

Australian host organisation: The Australian National University

Title of research proposal: *Understanding prehistoric agricultural development in the Pacific through the study of phytoliths*

Research description:
The study of plant remains in archaeological contexts, known as paleoethnobotany, provides archaeologists with useful information about human interactions with plants in the past. Through these types of studies, we can learn about prehistoric agricultural systems and other types of vegetation management, diet, medicinal practices, and tool use. While there are many types of plant remains preserved at archaeological sites, this project focuses on the study of one particular type of microscopic plant remain known as phytoliths, from Pacific Islands contexts.

Phytoliths are microscopic silica bodies produced by plants in both intracellular and extracellular spaces. The shapes produced by phytoliths are often diagnostic of plant family, and sometimes genus, and thus can help to identify plants that were present at a particular location. Phytoliths do not degrade as much in soils as most other plant parts do; this makes them especially useful for studying prehistoric plant use in the hot and humid tropics, where organic remains are less likely to be preserved. However, at this point, phytolith research in the Pacific Islands is still in relative infancy.

The goals of this project were to 1) develop a Pacific Islands phytolith reference collection based on herbarium specimens and 2) analyse sediment core samples collected by Dr Matthew Prebble from Tikopia in the Solomon Islands in order to look for evidence of early food production strategies. In doing this, I aimed to develop my knowledge base and skills in phytolith analysis so that I can apply them to my dissertation research in Pohnpei, Micronesia.

Research activities:
Under the guidance of Dr Prebble, I processed 115 phytolith reference samples from 47 plant species, aiming for approximately 0.5-1.0g per sample when possible. I ashed samples in a muffle furnace, digested them in dilute HCl, and then mounted them on slides in a permanent mount. This process should theoretically destroy all of the plant tissue with the exception of silica bodies. I then viewed them under an optical microscope at 670x and measured and photographed phytoliths. Due to time constraints, I was only able to measure and photograph about half of the samples; however, I should be able to complete this at the University of Oregon. We intend for these photographs to eventually form part of a greater Pacific Islands phytolith reference database. This collection will also contribute to my dissertation research.

Additionally, I also counted and identified (when possible) phytoliths from ten sediment core samples from Tikopia, Solomon Islands. I viewed slides at 670x under an optical microscope and counted phytoliths to 200; if there were fewer than 200, I counted the entire slide. This work contributes to Dr Prebble's project on Tikopian paleoecology and archaeology.

Finally, I also processed some sediment samples from Pohnpei, Micronesia for phytolith analysis in order to get more experience with and to better understand this process. Samples were processed according to a protocol modified from that outlined in Piperno 2006. This involves deflocculation, sedimentation, and acid digestion of soils before separation of phytoliths with heavy liquids. I intend to conduct analysis of these samples at the University of Oregon labs.

Perspective of research after the program:
As an archaeologist with interests in food production systems in the Pacific Islands, this experience has been invaluable for me. Under the guidance of Dr Prebble, I have developed skills in the major aspects of phytolith research in archaeology and paleoecology. I should now be able to incorporate this technique into my dissertation research. I also benefited tremendously from interactions with many people in the department. As many in the Australian National University's Archaeology and Natural History Department are involved in research in the Pacific Islands and in paleoethnobotanical and paleoecological research, I had productive discussions with many people on a near daily basis. This has opened up possibilities for future collaborative research. Finally, because I was able to focus just on this project for two months, it proved to be a very productive trip.

Australian advisor's remarks:
Maureece Levin contributed to the development of an atlas of phytoliths covering the Indo-Pacific region. Phytoliths are plant microfossils which form an important part of archaeological and palaeoecological research, a key focus of the Department of Archaeology and Natural History. Her work involved the analysis and description of phytoliths extracted from plant tissues taken from existing plant herbarium collections from the Indo-Pacific region. Not only will her work extend the utility of phytolith analysis for research in the region, but will form an integral part of her own doctoral research. I believe Maureece benefited from her time in the department and is now well-equipped for undertaking further research in the field. I would encourage any other potential applicants to take up this summer program.

Participant: Debra Lin, Cornell University

Australian research advisor: Professor Dietmar Hutmacher

Australian host organisation: Queensland University of Technology

Title of research proposal: *Control of osteoblast functions by hydroxyapatite nanoparticle characteristics*

Research description:
With age, location, injury, and disease progression, hydroxyapatite (HA, Ca10(PO4)6(OH)2), the hard mineral component of bone can have different materials properties. These differences include amount of carbonate substitution, size, crystallinity and more. Bone remodelling cells such as osteoblasts which form new bone may be sensitive to these changes in the bone microenvironment and respond differently. Designing platforms with variation in bone-like mineral properties to control bone-matrix formation on surfaces may provide insight to how osteoblasts are affected by properties of existing bone matrix to form, remodel, and heal bone and provide new materials for bone repair. The aim of this project was to develop platforms presenting hydroxyapatite of different crystallinities and then introduce primary human osteoblast cells to the platforms to evaluate cellular activity in response to the different environments presented by the hydroxyapatite.

Research activities:
Phase one of the project was to develop platforms to present HA of different crystallinities to osteoblast cells. I constructed the platforms through a two-step process consisting of first synthesising hydroxyapatite nanoparticles through a wet precipitation reaction. Particles were washed and dried before being dry annealed for different durations to obtain different crystallnities while maintaining particle morphology. For step two, the HA nanoparticles were then combined with polylactide(co-glycolide) (PLG) polymer in tetrahydrofuran solvent and spin-coated into films on glass substrates. PLG-only films and commercially available HA-PLG films were also constructed for controls. Surfaces were characterised by light microscope and scanning electron microscopy (SEM) for HA distribution on the substrate, X-ray Diffraction for phase, and Fourier Transform Infra-red Spectroscopy for crystallnity. Exposure of HA at the surface was qualitatively via SEM and Alizarin Red staining.

In phase two, I learned a lot of new techniques from Anna Taubenberger, a post-doctoral student in Professor Hutmacher's lab which allowed me to work with osteoblasts. I learned to harvest osteoblasts from the tibial plateau of patients undergoing knee replacement surgery and seeded those cells onto the HA platforms. A series of assays were conducted to examine osteoblast interaction with the different surfaces throughout the culture period. Alamar Blue assay to compare metabolic activity, Pico Sirius green assay to examine proliferation of the osteoblasts on the surfaces, RNA extraction for PCR to quantify gene expression, and immunofluorescent staining to study spreading morphology and fibronectin production. HA-film integrity on the glass substrates were also monitored throughout the culture periods along with non-cell-seeded controls.

Further analysis of the data will be completed after return to my home institution at Cornell University.

Perspective of research after the program:
The EAPSI program has been a wonderful experience, providing the opportunity to start an international collaboration between my lab at Cornell with the Hutmacher group in Australia. Throughout the course of the program I have gained a solid understanding of the intricacies of planning a successful project in a lab on the other side of the world in a limited time period. Due to the long times required for cell culture, the project had to be well thought out and preparations were made in the US and Australia before I arrived at QUT. The project was designed so that work could be done before, during, and after the EAPSI program. There was a lot of great correspondence with my host supervisor Professor Hutmacher as well as Anna Taubenberger who mentored me during my time at QUT and introduced me to a lot of the areas surrounding Brisbane. However, the communication could not replace the usefulness of communicating face-to-face with hands on demonstrations and explanations and even the most thought out plans need flexibility and adjustment on execution. I have learned many techniques applicable for my future work and found opportunities to share my knowledge and skills in return. It was a wonderful environment and I was able to meet many skilled scientist based in the institute as well as other visitors. This experience as well as other opportunities abroad is something I would encourage all young scientists to participate in.

Australian advisor's remarks:
We are very pleased that, thanks to the EAPSI program, Ms Debra Lin had the opportunity to spend three months in our laboratory, the group of Regenerative Medicine at the Queensland University of Technology. During her stay, Debra worked very efficiently on the project described above. Although a period of three months is relatively short in relation to the amount of work that was planned, Debra was able to obtain significant results. These results will hopefully be the basis for a new scientific collaboration between her laboratory at Cornell University, and our group. Debra was always very motivated and quickly learned the new techniques in which she was trained at our laboratory. Debra also integrated very well within our group, so that her stay at our institute was a very positive experience.

Participant: Jonathan Puritz, University of Hawaii

Australian research advisor: Professor Maria Byrne

Australian host organisation: University of Sydney

Title of research proposal: *Investigating anthropogenic influences on population connectivity and the role of microhabitat selection in determining functional genetic variation and distribution*

Research description:
The works build upon my previous research that demonstrated urban runoff and sewage effluent limited pelagic larval dispersal of a sea star with high dispersal potential. Population connectivity in marine organisms is often interpreted in terms of two factors: dispersal potential, or how long a larva can live in the water column before settling, and the role of ocean currents in transporting those larvae to different populations. However, several recent studies have shown that not only does dispersal potential (or pelagic larval duration) not correlate with genetic connectivity, but also that factors such as habitat distribution, urban runoff and sewage effluent may be more important than ocean currents in determining patterns of dispersal. The coast of New South Wales, Australia offers an exceptional landscape to specifically test the role of sewage effluent limiting genetic connectivity, with the 5 major effluent outfalls of the greater Sydney area located along a linear coastline. This coastline also happens to be one of the main habitats of the Cushion Sea Star, Meridiastra calcar. Using these populations of M. calcar, effects on population connectivity will be analysed in a specific seascape genetic framework using the matrix regression methods of Puritz and Toonen (2010).This study will further the understanding of how human beings dictate the evolutionary trajectory of species in the sea, and its results and implications will fundamentally change marine conservation, likely aiding in the design (and redesign) of all marine reserves near urban populations.

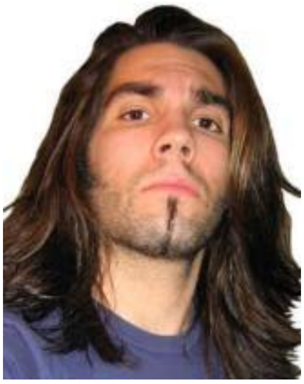
Research activities:
During the EAPSI program, I collected over 600 tissue samples from 10 different locations along the coastline of NSW. These locations span over 50 km and bracket the five major sewage outfalls of NSW. This represents a fantastic success for field research, as I was able to sample every population of the original experimental design, with high sample numbers at every location. This field research was also entirely environmentally friendly. I primarily used public transportation and a bicycle as forms of transportation. The few times that I used a car, I was carpooling with a fellow researcher working on both of our projects. My sampling is a non-lethal small tissue biopsy that the sea stars quickly regenerate. Lastly, all samples were labelled, preserved, and transported back to my lab in Hawaii.

Perspective of research after the program:
For me, the EAPSI program represents a bridge between my dissertation research and my post-doctoral research. I will be defending my PhD in October, and I now have all the samples I need to complete my next project. It is an amazing advantage to have.

The length of the EAPSI program is what I think puts the program over the top and is what I truly believe allowed for the overall success that I enjoyed. Doing field collections is often a daunting process, dependent on knowledge of the organisms, weather, waves, and tides. The expense of doing collections often forces us to squeeze as much work in as possible in as little time as possible. Often, some sort of sacrifice must be made in experimental design to accommodate these unthinkable issues. The extensive time and support of this program not only allowed me to fully complete my research objectives, but it also allowed me to be an active member of a lab and set up multiple collaborative opportunities.

In short, this research experience has made me seriously consider returning to Australia on a more permanent basis, either as a post-doctoral researcher or a faculty member.

Australian advisor's remarks:
It was a pleasure to host Mr Jonathan Puritz in my laboratory in Sydney. Jon came with his research program organised and so he fully availed of his time in Sydney. His research on the impacts of pollutants on the population genetic structure of ecologically important marine invertebrates endemic to Eastern Australia will generate key insights into processes underlying connectivity along our coast. I look forward to seeing the data analyses. Jon shared his expertise in analyses of population genetic data with my team in Sydney. This was of great assistance. I have no doubt that Jon will have a successful postdoctoral career and look forward to a continued association with Jon. We thank the EAPSI program for supporting Jon's visit.



Participant: Mark Rocco, Cornell University

Australian research advisor: Dr Daniel Christ

Australian host organisation: Garvan Institute of Medical Research

Title of research proposal: *Engineering fully functional tandem scFvs as a breast cancer therapy*

Research description:
Antibodies are large, Y-shaped proteins produced by the immune system to combat foreign invaders such as virus particles and bacteria. They accomplish this feat by binding to a specific epitope on a particular antigen, and do so with great affinity. The concept of using antibodies as a therapy to treat illness dates back to the late 19th century with the pioneering work of Emil von Behring and Erich Wernicke on the development of an antitoxin against diphtheria. As might be expected, great strides have been made in the field of medicine and antibody therapeutics since these early experiments. A major breakthrough in the field occurred relatively recently in 1975 with the advent of hybridoma technology. In particular, this marked the first time in which almost unlimited quantities of extremely pure affinity reagents could be generated in the form of monoclonal antibodies. Even so, the successful development of such monoclonal therapies has only truly blossomed in recent years. Today, twenty-four FDA-approved monoclonals are currently on the market and more than 150 new monoclonals are entering clinical trials. Altogether, these novel therapies show great promise in providing a new means to treat a number of different human illnesses and comprise more than a $30 billion market in 2010 alone. Nevertheless, there still remains several major difficulties in their successful formulation - the top two challenges being antibody stability and the propensity for aggregration. Both of these pitfalls render the protein unusable as a therapy. As such, the focus of my EAPSI research has been to further develop the tools necessary to create and improve novel antibody therapies for the treatment of human disease.

Research activities:
The focus of Dr Christ's research laboratory at the Garvan Institute of Medical Research lies within a very specialised subcategory of the overarching field of protein engineering, that is, the field of antibody engineering. Over the years, Dr Christ and his colleagues have developed specific tools allowing for the rapid isolation of high-quality, humanised antibodies against a variety of very important disease markers. Moreover, the information gained from such repeated successes has proven to be instrumental in the rational design of novel antibodies with enhanced affinity for their cognate antigens, as well as improvements in their biophysical properties. The research conducted herein, under the auspices of a 2011 NSF EAPSI grant, encompassed using these specialised techniques to generate a panel of mutant proteins and test them for the aforementioned improvements.

Perspective of research after the program:
EAPSI Australia is an excellent program and one I would highly recommend to any future applicant. The rewards both personal and professional are boundless. From a research perspective, one of the most rewarding aspects of this program was the freedom to choose a host researcher anywhere in Australia, and therefore, the ability to tailor your own program to your own specific needs. Personally, after having recently finished my PhD, I desired to branch out of academic laboratories and sought to discover the manner in which research science was conducted in a different environment. Being granted the privilege to work in the laboratory of such a well-regarded scientist,

in a world-renowned private medical research institute, the EAPSI program provided me with the ideal opportunity to achieve this goal. The insights gained from this experience have been extremely rewarding and have given me a completely new perspective on applied research science. Furthermore, the cultural exchange and professional development that invariably comes with such an international collaboration is a very special type of edification and an experience that I believe will stay with me forever. While I have learned many new scientific techniques over the past few months, it is the soft skills and the professional collaborative network I have developed that I truly value, and thus, I wholeheartedly believe that I will continue to maintain close ties with my Australian host researcher, even after the program has now come to a close.

Australian advisor's remarks:
It was a pleasure to host Dr Mark Rocco from Cornell University during his stay in my lab at the Garvan Institute of Medical Research. Mark integrated very productively into the research group and progressed extremely well with his experiments, given the limited time frame. Considering his talent and excellent work ethic it was no surprise to us that he was awarded a prestigious fellowship to undertake postdoctoral work at Imperial College. We wish Dr Rocco all the best with his endeavours in the United Kingdom. The success of Dr Rocco's visit further highlights the fact that interactions between Australia and the US through EAPSI are highly desirable and of mutual benefit.

Participant: Christopher Shearer, Georgia Institute of Technology

Australian research advisor: Dr John Provis

Australian host organisation: University of Melbourne

Title of research proposal: *Synthesis and analysis of co-fired fly ash geopolymers*

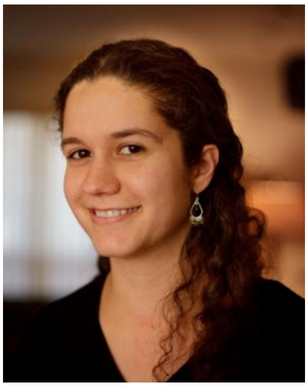
Research description:
The goal of this research was to develop a beneficial pathway for utilisation for an emerging class of energy by-products—co-fired fly ash. This ash is produced during co-combustion of coal with biomass, which is a rapidly growing renewable energy source. Possible reuses for this ash to prevent its disposal in landfills have not been well-examined. My research has shown that the chemical composition and physical attributes of co-fired fly ash make it a suitable option for geopolymer synthesis. These composites are formed by alkali-activating solid fly ash aluminosilicates to produce a mineral binder that has broad applications in the construction field as a cost-effective and less carbon intensive alternative to ordinary portland cement (OPC) concrete. This research aimed to not only develop these novel co-fired fly ash geopolymers, but also to understand the science behind their formation.

Research activities:
The first task of this research was to create viable geopolymer mixes. Ash samples brought from the U.S. including two co-fired fly ashes with differing biomass sources and co-firing weight percentages and one commercially available coal fly ash (typically used to replace cement in OPC concrete) were used in this research. Drs John Provis and Susan Bernal helped to develop chemical formulations based on years of experience in this field to alkali-activate these fly ashes accounting for their unique properties (e.g., some of the samples have unfavourable high carbon contents). All of the ashes were successfully geopolymerised through altering various parameters in the mix design. The wide spectrum of binder compositions developed during this process were then analysed using advanced techniques to understand the mechanisms of synthesis. Dilatometry was used to assess the reactivity of the fly ash as well as the mechanical performance of each mix. A Fourier transform infrared spectra of each sample was measured at two ages to determine the degree of polymerisation and the extent of activation of each matrix. Lastly, x-ray diffraction was used to identify the crystalline phases present in each sample before and after geopolymerisation.

Perspective of research after the program:
This interdisciplinary and international cooperative experience has given me the opportunity to conduct research in a new and exciting environment. Before this summer I knew little about and had even less experience with geopolymers. By researching under the expert tutelage of my advisor and his group in Melbourne I have developed a much stronger understanding of the topic and an interest to conduct further research in this field. Specifically, I plan on developing more mix designs and using additional analytical techniques here at Georgia Tech to observe the fundamental behaviour of the geopolymers during durability assessments. This experience has also changed my perception on how to properly organise a research methodology, run experiments, and interpret complex data. These newly acquired skills will be particularly helpful as I approach the final years of my PhD study. The lasting benefits of this collaboration include a future publication and an on-going communication with this research group and many others. This program has prepared me for my

future career in research by establishing international scientific relationships, which is vital for success in this globalised world.

Australian advisor's remarks:
It has been a pleasure to host Chris at the University of Melbourne, and the EAPSI program has presented us with an unmatched opportunity to build research links between my group and the excellent research team with which he is involved at Georgia Tech. During his short time in Melbourne, Chris was able to develop some detailed science underpinning the utilisation of co-fired biomass fly ashes in the production of environmentally beneficial new concretes. His background in civil engineering provided a very good complement for our research work in materials chemistry and chemical engineering, and we have been able to combine approaches from the two research fields to bring new understanding, knowledge and capabilities. There is now just the minor issue of completing the analysis of the mountain of data that Chris was able to generate during his time in Melbourne, and then we look forward to some important high-impact joint publications and an ongoing collaboration. Chris has been a very active participant in the life of my research group during his time in Melbourne, and his cheerfulness and desire to interact, work and learn are a strong credit to him. I am very glad that he was able to enjoy his time in Melbourne, and I look forward to seeing his future career success building from the foundation he is developing through his PhD studies.



Participant: Emily Shepard, Portland State University

Australian research advisor: Dr Mick Morrison

Australian host organisation: Flinders University

Title of research proposal: *Classification and statistical analysis of culturally modified trees on the Weipa Mission, Western Cape York Peninsula, Australia*

Research description:
On the Western Cape York Peninsula of northern Queensland, sustained Indigenous-European relations began in the late 1800s with the establishment of cattle stations and missions. In various ways, this was an era of significant change for Indigenous peoples, many of whom were subsequently conscripted as labourers or forcibly removed from their land onto reserves or missions. However, Indigenous peoples' experiences of these cross-cultural engagements are not adequately represented by historical documents. Archaeological research can be used to increase understanding of Indigenous communities during this time period.

Archaeological surveys in the Weipa region of the North-western Cape York Peninsula have documented thousands of culturally modified trees (CMTs) created by Indigenous peoples during honey collection. Honey was harvested from stingless bees known locally as "sugarbag" by making apertures in trunks to access hives, a process which leaves distinctive scars on trees. Large apertures facilitate quick access to honey, but are likely to disrupt production and preclude further harvest.

Oral histories and historical records provided limited data concerning honey collection prior to the 1940s, but suggest that harvest intensified in the early 1900s. Honey collection practices provide insight into several aspects of Indigenous responses to European settlement, including changes in land use and resource management strategies, which are not accessible by historical documents, oral histories or other types of archaeological data.

Research activities:
I conducted field work at the Weipa Mission site, located near Albatross Bay on the North-western Cape York Peninsula. During this time, I worked with a traditional owner to locate and record CMTs created during honey production. This information was added to the already large database of CMTs in the region. After using digital photos to obtain precise measurements of scars in the database, I then conducted various statistical tests to investigate temporal and spatial shifts in honey production.

This study suggests that honey harvesting strategies changed substantially as Indigenous communities were denied access to traditional land and reorganised their subsistence pursuits to incorporate providing food for area missions. Scars on CMTs that are located closer to nodes of European settlement are statistically larger and trees were more likely to have been felled to access honey than those CMTs in areas relatively isolated from European incursions. These shifts in sugarbag collection point to marked changes in honey collection from a strategy that allowed continued revisiting and reuse of hives to a strategy focused on short-term intensification of honey production. Furthermore, these CMTs provide evidence of continued, albeit modified, traditional practices and landscape use of Indigenous peoples in the Weipa region.

Perspective of research after the program:
Participating in the EAPSI program has provided me with a variety of beneficial experiences. Working with Dr Morrison enabled me to learn new approaches in database management, recording procedures and analytical techniques. Talking with fellow students and lecturers at Flinders University allowed me to become familiar with new developments and issues in the field of archaeology in Australia. Perhaps most importantly, I gained experience with conducting research in collaboration with Indigenous communities, which is an important aspect of archaeology but something I had little practical experience with in the United States. I believe the work Dr Morrison and I accomplished during the EAPSI program will highlight the potential of CMTs to be used in archaeological research and will aid in illuminating the histories of Indigenous peoples in the Weipa region.

Australian advisor's remarks:
Emily has been a valuable addition to our department as a whole and my research team more specifically. Her intellectual contribution to the project has been considerable and she has undertaken analytical work that has greatly enhanced the outcomes of the research project she was involved in. he has worked extremely hard in her time here and has produced consistently high quality results. Emily has also provided other students with important insights into academic life in the USA and has expanded the knowledge of numerous students about the nature of archaeological research and scientific enquiry. On a personal level, it has been an absolute pleasure to host her and she will be missed by many upon her return.

Participant: Brian Simonds, Colorado School of Mines

Australian research advisor: Dr Ivan Perez-Wurfl

Australian host organisation: University of New South Wales

Title of research proposal: *Towards an understanding of carrier dynamics in Silicon quantum dot superlattices*

Research description:
The next generation of solar cells aim to produce energy from the sun more efficiently and cheaply than current technologies. Several proposed concepts capitalise on specific quantum mechanical phenomena which exist in nanostructured materials. Silicon quantum dots, due to the abundance and benign character of silicon and the numerous synthesis techniques which exist for silicon quantum dots, are one such material which show promise. However, a key issue in realising silicon quantum dots as a solar cell material is understanding the conduction between an ensemble of dots in a film that will eventually be used in a solar cell device. Basic electron transport measurements in these materials are hindered by the extreme small size of these dots, 5 nanometers or less in diameter. This restriction necessitates the use of non-contact photoconductivity techniques like those available at The Colorado School of Mines (CSM) to study transport. In order to systematically study transport in silicon quantum dots, it is imperative that the distance between the dots in the ensemble film is well controlled and varied. This is so that a distinction can be made between quantum mechanical tunnelling and hopping transport.

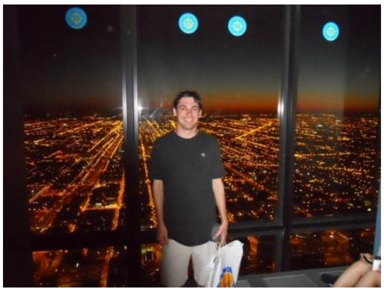
This can be accomplished with the silicon quantum dot superlattice structures currently being investigated at The University of New South Wales (UNSW) for the next generation of solar cells. My project during the EAPSI program was to create a suitable series of samples using the expertise and facilities at UNSW which I will bring back to CSM in order to perform transient photocurrent measurements.

Research activities:
My primary research objective at UNSW was to prepare a series of silicon quantum dot superlattice structures for a systematic study of electron transport between dots. The samples were made at the clean room facility of The School of Photovoltaic and Renewable Energy Research at the UNSW. They were prepared by a radio frequency sputtering technique according to proven procedures. To compare my sample with others as well as to gain a more complete picture of the optical and electronic properties of the samples several other characterization techniques were employed. These include optical reflection and transmission, photoluminescence, and x-ray reflection and diffraction. These EAPSI Report (30 day).doc 5 initial results helped to guide later sample preparations.

Through interactions with my host group, it was also determined that CSM had another unique experimental capability that would be useful for their understanding of these silicon quantum dot structures. Specifically, electron spin resonance would be useful for them in understanding the doping mechanism which is also crucial for realising a silicon quantum dot solar cell. A series of samples was also prepared for preliminary studies to this end as well.

Perspective of research after the program:
The work done during the EAPSI program is merely the beginning of this research project. Now that the appropriate sample set has been prepared, the experiments to determine the conduction mechanisms can begin. The initial transient photoconductivity measurements and electron spin resonance experiments should be able to be completed in a few months following my return from the program. It is anticipated that these initial results will guide further research in the understanding of fundamental properties of silicon quantum dots.

Australian advisor's remarks:
Brian's visit exceeded all expectations. This exchange opened new possibilities for studying and understanding materials for third generation photovoltaics. I'm looking forward to an ongoing collaboration that will certainly result in a few scientific publications. Based on this experience I would recommend this exchange program without a doubt.



Participant: Paul Smith, Rutgers University

Australian research advisor: Professor Gerhard Swiegers

Australian host organisation: University of Wollongong

Title of research proposal: *An electrolytic water splitting device from a bioinspired catalyst*

Research description:
The threat of continuation of the world's current policy on energy - which sees increasing demand on environmentally hazardous carbon-based fuels that will gradually become more expensive to extract - gives rise to efforts towards finding alternative fuel sources. The capacity for energy storage in media as batteries and solar cells is still being optimised, but for a modern, fuel-consuming infrastructure, hydrogen (H2) is a viable non-carbon source that one can envision being obtained from the world's most abundant resource: water.

The energy required to split water into H2 and O2 is unfortunately too large as to make it practical, but the challenge has been solved over the course of billions of years of evolution in plants. As a part of photosynthesis, a CaMn4O4 "cubane" core universally found in the protein Photosystem II has been identified as the light-driven catalyst for O2 emission from water in all plant life. The mechanism of how this cubane works, as well as the concepts behind nature's ability to perform this reaction using only sunlight- remain elusive and highly debated topics. Thus, attempts at using this knowledge in the form of practical artificial photosynthesis focus on understanding how the cubane geometry gives efficient water splitting and designing easily synthesisable cubane analogs. Cubane water oxidation catalysts routinely exhibit improved performance and longer durability relative to dimers and monomers, and hold more promise in practicality than comparable catalysts with noble metals. It is this conservation of geometry which highlights our efforts towards water splitting on a large scale industrial setting.

My research is dedicated to making devices which split water into hydrogen and oxygen via cubane catalysts, with the goal of high current and photocurrent outputs at low applied potentials and activation by light. In coming to the University of Wollongong, I was able to use equipment regarded as essential in device development. Our goals were to improve upon a previously published Gratzel type dye-sensitized-solar-cell model in three areas: charge transfer, costly materials, and catalyst. Combining these qualities, our aptly named "MacGyver Device" target is proposed to deliver hydrogen from water using cheap materials which can be assembled feasibly.

Research activities:
Research activities can be classified into deposition, optimisation, and characterisation.

Our goals were to create porous polymer membranes which contained our catalysts, and place these membranes onto conductive surfaces via commercially available printing and deposition techniques. Dispersions of our catalysts in polymers were spincast, inkjet printed, flexographic printed, or screen printed onto various conductive substrates. Additionally, I was introduced to the design of conductive substrates via sputtercoating and evaporative deposition.

Optimisation of the membrane's properties- layer thickness, type of catalyst and concentration, type of conductive substrate, and type of polymer and weight %, has given us a foundation with which to base our system. Development of new catalysts combined with an optimised system has led us to improve current density output (hydrogen production per unit area) 100 fold over our previous device.

Characterisation of our films was performed by techniques and resources not available in the U.S. Optical profilometry - a technique which I had not known existed - was used to characterise film thickness as well as particle aggregational effects, if any. Electrical Impedance Spectroscopy, a type of electrochemistry based on modelling complex plots of data and which is best learned by practice with guidance from experts, has given us characterization of charge flow effects at varying pH levels.

Further characterisation includes EPR spectroscopy, thermogravimetric analysis, and incident photon to collected electron (IPCE) measurements, which are essential in reporting light-active unit efficiencies.

Characterisation by XAS allowed using the resources of the Australian Synchrotron at Monash University in Melbourne, which also provided an opportunity to meet additional collaborators and learn about EXAFS and XANES measurement techniques. The resolution of the Synchrotron's beamlines is unmatched by university equipment.

Perspective of research after the program:
The transition from the science performed in the laboratory to the devices that work in the real world is never straightforward. It is sometimes impossible to apply, on a large scale and for the benefit of humankind, the discoveries found in many research projects ongoing in laboratories today.

Water splitting is a project often cited as the "Holy Grail" of energy in that solving it will have an effect no less than worldwide. But such solutions will require, out of necessity: simple, cheap, and durable components. One could argue such a system that has all three of these properties- which are more often than not mutually exclusive- is a miraculous achievement. For this reason, water splitting is a project that needs multiple perspectives- the scientists who make durable catalysts, the engineers who apply them easily, and the industrialists who can use them inexpensively. Only by having these properties can any water splitter who hopes to make a difference in this world have a chance at actually doing so.

Through this program I was able to bring my catalyst design background to a table with engineers and industrialists. But more importantly, I will bring back to the U.S. a mind that now has more exposure to each of these perspectives, and in doing so, a greater probability that we will succeed in the future.

I will continue to design prototypes of our water splitting device, with the goal of demonstrating a working unit which produces hydrogen at a competitive rate of scale and cost by year's end.

Australian advisor's remarks:
Paul has had a very successful and constructive visit to the University of Wollongong. He has clearly learnt and been able to apply several new techniques that were not available in his home University. In so doing, he has also advanced the objectives of our research program in Wollongong and helped cement future cooperation between our two Universities. It has been a pleasure to host Paul. We are grateful for the opportunity afforded by the EAPSI program.