

**2005 ANNUAL REPORT  
TO THE  
AUSTRALIAN RESEARCH COUNCIL**



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## RESEARCH DIRECTOR'S REPORT

The ARC Centre of Excellence for Electromaterials Science (ACES) was formally opened on February 16<sup>th</sup> 2006 by Professor Peter Hoj, the CEO of the ARC. However, ACES was established as of 1<sup>st</sup> July 2005 and this report spans the 6 months to the end of December 2005.

ACES brings us into an exciting era of development with core research programs in the areas of

- ❖ Electromaterials
  - Synthesis
  - Characterisation
  - Modelling
  
- ❖ Energy Conversion,
  
- ❖ Energy Storage, and
  
- ❖ Bionics

being consolidated. Additional resources have enabled expertise in molecular, electrochemical, mathematical and mechanical modelling to be attracted to the Centre. Prof. Maria Forsyth (Monash) will coordinate the establishment and growth of this critical group during 2006.

Additional resources will also be allocated to the Bionics program to strengthen our activities in this area. The inclusion of St Vincent's Health as a core partner along with the Bionic Ear Institute will bring tremendous benefits. Another exciting development within ACES is the establishment of the Ethics Research and Training Program led by Prof. Sue Dodds (UoW).

While the core ARC funding is to be used to support research activities that focus on the use of nanotechnology in Electromaterials Science, the scope of ACES is broader than that. Using other funding resources, we will investigate additional aspects of electromaterials. For example, during 2006 we will pursue:

- The use of ionic liquids in electrorefining processes (supported by an ARC Linkage Grant in collaboration with Rio Tinto).
- The development of novel electrochromic systems (ARC Linkage Grant proposal in collaboration with Schefenacker, Australia).
- Use of novel electrochemical sensors for packaging (Research activity supported by CRC SmartPrint).
- Polymer photovoltaics (Research activity supported by CRC Polymer).
- New pneumatic actuators (Research activity supported by DSTO).

- New stent materials (research activity funded by Boston Scientific, USA).

These projects provide an opportunity for us to expand upon our reputation in Electromaterials Science and to see the Centre recognised as a world leader in the area.

To achieve this goal we must also continue to attract and retain excellent research staff. During 2005 progress in this area has been significant. For example,

- Dr Stephen Pas (ARC Fellow) brings new talents to the characterisation team.
- Dr Udo Bach (ARC Fellow) brings extensive expertise in solar cell technologies.
- Dr Dan Li from UCLA was awarded an ARC QEII Fellowship to carry out research on novel organic conductor based nanostructures.

During 2005 the Centre continued to host a large number of scientific visits from collaborators around the globe as well as to support visits to other institutions. One highlight was the visit of Prof. Richard Kaner (UCLA) on a Fulbright Fellowship. Richard returns during 2006 as a Distinguished Lecturer supported by the ARC Nanotechnology Network.



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Professor Gordon G. Wallace  
Research Director  
ARC Centre of Excellence for Electromaterials Science

## OUTREACH ACTIVITIES

Since July 2005, outreach activities include:

Prof Gordon Wallace, Dr Simon Moulton and Dr Andrew Minett (pictured) hosted an evening on Bionics during the Uni at the Brewery series in 2005 that was organised by the University of Wollongong.



Prof Wallace was also involved in a podcast on “What’s all the excitement about nanotechnology?” that is posted up on the Australian Government Department of Industry, Tourism and Resources National Innovation Website.

Ms Kaylene Atkinson, Ms Jenny Causley and Mr Yanzhe Wu from the Centre presented live demonstrations of Centre technology at Science EXPOsed in October 2005 organised by the NSW Ministry for Science & Medical Research.

Prof Maria Forsyth, Dr Anita Hill and Nolene Byrne visited Rosamond School, Maidstone, Victoria, and interacted with a Year 9 class on Electrical Energy - From Lemon Batteries to Solar Cell Powered Cars.

Five undergraduate students won summer research fellowships to undertake projects within the Centre. The Summer Fellowship holders worked on projects spanning the use of nanotechnology in thermoelectrochemical cells (harvesting energy from waste heat), to nanotube electrodes for biofuel cells – harvesting energy from biological systems.

## EDUCATION AND TRAINING

### *Graduate Training*

Education and training have been mainly aimed at the PhD level. There are 30 PhD students, 1 French intern and 3 undergraduates (Appendix I).

### *Full Centre Meeting*

A full Centre meeting was held on the 5<sup>th</sup> of August 2005 at the Bionic Ear Institute in Melbourne. There were 52 attendees (Appendix II) who came from the University of Wollongong, Bionic Ear Institute, St Vincent’s Hospital (Melbourne), Monash University, Massey University and CSIRO. Fourteen oral and 26 poster presentations were given.

## **INDUSTRY/END-USER LIAISON**

### ***Activities of the Business Development Officer***

***Definition of role:*** The primary purpose of the role of the BDO is to identify and build relationships with business or government partners; take leading roles in the preparation of funding proposals; assist in patent and other intellectual property protection applications; and assist in maintaining appropriate websites. The Business Development Officer is based within IPRI, and will contribute to the growth of partnerships and funding from commercial and/or government organisations.

Activities to be undertaken to support linkage building include promotional events such as annual symposia, and training courses geared to the needs of industry. The Centre will also participate in wider network events such as those organised by the Australian Research Council Nanotechnology Network (ARCNN) at a national level, and UWS Nanotechnology Network on a local level and industry associations on relevant Centre technologies. The involvement of industry is also envisioned through the establishment of an end-users forum, where industry feedback can play a role in determining the strategic direction of Centre research. The goal is to establish an open dialogue with commercial partners, which will in turn cultivate collaborative research projects and ongoing partnerships.

#### ***Outcomes:***

The position of BDO was filled on 11<sup>th</sup> July 2005. The initial focus for the BDO was on profile building, utilising a variety of media such as personnel communications, conferences and internet newsletter services. The advantage of a central coordinator for networking and collaborative activities with industry has been clearly demonstrated. Key achievements in 2005 include: facilitation of an increased number of Centre visits from current and prospective industrial partners, greater exposure of the Centre through participation in networks and outreach events, and a dedicated resource pursuing government agencies for new linkage opportunities.

Using the internet as a resource tool, considerable effort has gone into creating profiles of the Centre in various directories, particularly those utilised by industry such as the Australian Research Council Nanotechnology Network, Future Materials, and the NSW Ministry for Medical & Scientific Research. The Centre has, in the period July - December 2005 conducted laboratory tours with 22 individuals from 12 companies. Examples of some of these representatives include: BlueScope Steel, BOC Gases, Quantum Technologies, DSTO, AWI, Schefenacker Vision Systems, Ciba Geigy, CRC for Polymers.

The position of BDO has facilitated greater participation in industrial networks, such as the Technical Textiles and Nonwoven Association (TTNA) and the UWS Nanotechnology Network. Key meetings have developed from introductions made through these informal networking events. The BDO has interacted closely with the NSW Department of State & Regional Development (DSRD) to explore avenues for commercial exploitation of Centre expertise as well as new commercial partners. Networking events hosted by the NSW DSRD have also been invaluable in increasing the exposure of the Centre, and participation in Research and Development Organisations sessions enables benchmarking with other Centres of Excellence.

The Centre continues to consolidate End User Linkages and Liaison through the establishment of new ventures. The activities of the Business Development Officer (as previously described) are key to strengthening existing industry collaborations and attracting new industrial partners. Current collaborative projects are summarised in Table 1.

**Table 1**

	<b>Project</b>	<b>Duration</b>	<b>Source of Funds</b>
CRC Cochlear Implants and Cochlear Pty Ltd	Conducting Polymer Actuators and Sensors for Cochlear Implants	2003-2006	CRC Cochlear Implants
CRC Functional Surfaces	Conducting Polymer Sensors for Packaging	2003-2006	CRC SmartPrint
CRC Int. Manufacturing	Smart Mirrors	2004-2006	CRC IMST
Rio Tinto	Electrowinning using Ionic Liquids	2004-2007	Rio Tinto
DSTO	Artificial Muscles	2003-2007	DSTO
CRC Polymers and CSIRO (Holmes)	Polymer Photovoltaics	2006-2008	CRC Polymers
Boston Scientific (USA)	New Platforms for Cell Culturing	2004-2006	Boston Scientific

## **OTHER PARTNERS/NEW COLLABORATIONS**

A number of new collaborative ventures have been established. These include:

- *A/Prof. Justin Cooper White* (University of Queensland) – A collaborative project concerned with development of conducting biomaterials for muscle cell stimulation has been established. The project involves collaborative work with A/Prof. Justin Cooper White at UQ. Dr Simon Moulton was successful in attracting internal University of Wollongong funding for work on this project to be carried out in 2006.
- *DSTO – Corrosion Program*  
Corrosion prevention and monitoring is of critical importance in defence infrastructure. The need to detect early stages of corrosion in aircraft and to develop technologies which can enhance the lifetime of these has led to prior collaborative research between DSTO (team led by Dr. Bruce Hinton) and Monash. Through the centre, these links would be strengthened to investigate potential new corrosion sensors, the effect of new environmentally friendly inhibitors for coating applications and new passivation technologies for light alloys.
- The NanoBiomaterials Network team has been encouraged to join the ARC Australian Nanotechnology Network (ANN). Prof. Wallace is a member of the management board of ANN.

### ***ARC Centre Visitors***

During the second half of 2005 the Centre had many visitors (Appendix III) from national and international establishments. The international visitors came from Korea, USA, China, Croatia, Israel, Germany, Sweden, and Thailand. The visitors include 11 visiting scientists, 14 seminar speakers, and 4 visiting PhD students.

## **COMMERCIALISATION AND TECHNOLOGY TRANSFER**

Apart from the activities of the BDO (please refer to BDO section), the Centre was granted two patents as detailed below.

1. “Charged Conducting Medium” - July 2005. Australian Provisional Patent, 2005903481.
2. “Zwitterionic Additives for Electrochemical Devices” – August 2005. PCT AU2005 001237

## **PERFORMANCE INDICATORS**

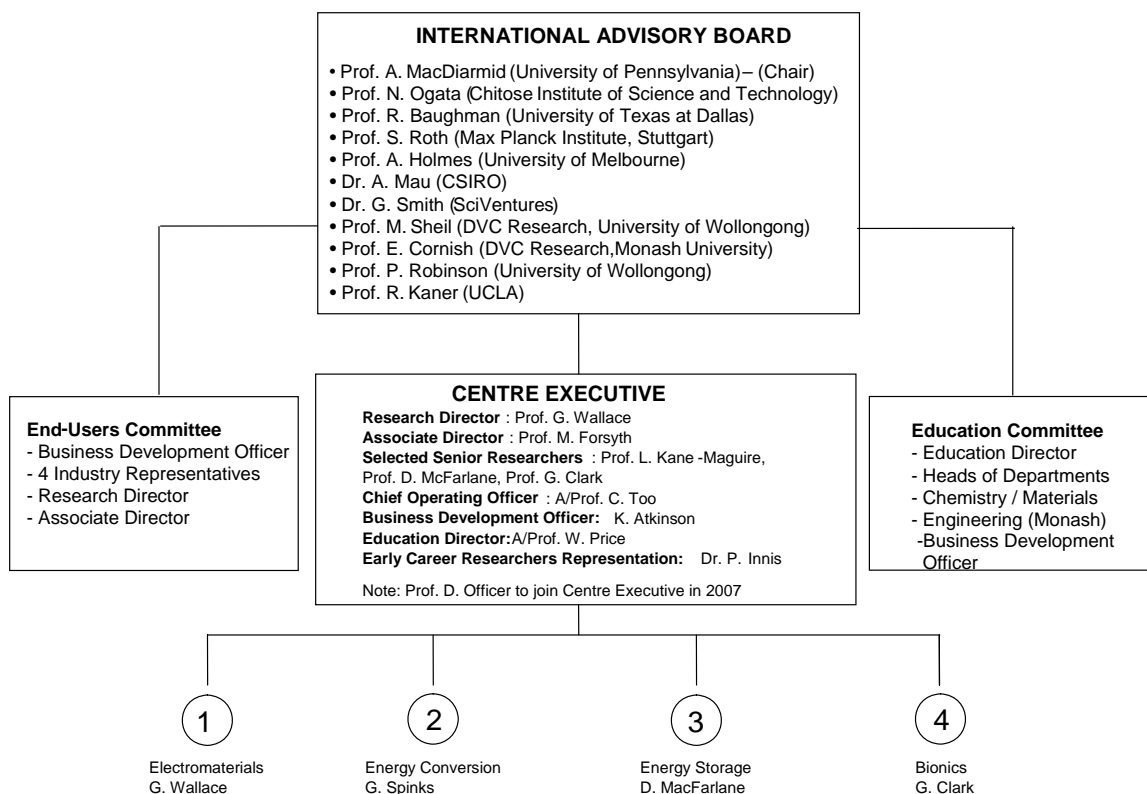
The Key Result Areas and Performance Measures Schedule for the Centre is given in Appendix IV. Due to the delayed commencement of the Centre, the main thrust of the activities was in finalising the Centre’s core activities (Milestones are given in Appendix V) and governance arrangements (see next section); thus there is no report against milestones for 2005. A report will be submitted for 2006.

## **MANAGEMENT ARRANGEMENTS**

The Governance/Organisation Chart for ACES is shown below as Scheme 1.



## ARC CENTRE OF EXCELLENCE FOR ELECTROMATERIALS SCIENCE



Scheme 1. Organisation Chart for ACES

During 2005, 2 Centre Executive Committee meetings were held on 19<sup>th</sup> August and 26<sup>th</sup> October; and as mentioned earlier, there was also a full Centre meeting held on 5<sup>th</sup> August 2005.

The End-Users Committee and the Education Committee will be established during 2006.

### CENTRE STAFF AND STUDENTS

The Centre is led by the Research Director, Professor Gordon Wallace of the Intelligent Polymer Research Institute who is recognised as a world leader in electrode materials. He is assisted by Professor Maria Forsyth (Monash University) as Associate Director. The Centre brings together a team of internationally respected scientists in advanced materials science, whose research has a strong emphasis on nanocomponents and structures and their application in areas of technological importance to Australia. The day to day management/administrative activities of the Centre are overseen by Associate Professor Chee Too as Chief Operating Officer.

Centre Staff and Student details are provided in Appendix VI and Appendix I respectively. The staff of the Centre comprises of 19 Chief Investigators, 35

Associate Investigators and 26 research fellows. There are 30 PhD students, 3 undergraduate students and 1 French intern in the Centre.

## **ACTIVITY PLAN FOR 2006**

Our strategic objectives for 2006 fall under the core activities of the Centre.

### ***Research Programs***

The milestones to be achieved in 2006 are listed below. A complete list of milestones for a 5 year period are given in Appendix V.

These milestones and the identification of new opportunities can only be realised through the maintenance of effective and vibrant collaborative research environments within the Centre.

We will host two full Centre meetings in 2006. Monthly technical abstracts from all RFs and PhD students will be circulated within the Centre and exchange visits strongly encouraged. We will also continue to build upon our international visiting scientists program encouraging visitors to visit each of the Centre nodes.

### **Year 1 ACES Milestones**

#### **P1. ELECTROMATERIALS**

- Establish wet-spinning fibre drawing facilities (End Year 1).
- Prepare functionalised aligned CNTs for P2 and P3 (End Year 1 then ongoing).
- Dr Peter Innis (QEII Fellow) will coordinate and educate on the use of conventional characterisation tools such as SEM, AFM, NMR, UV-vis and electrochemical methods, as well as specialist in-situ techniques such as Electrochemical-Electronspin Resonance, Electrochemical-Raman and Localised Electrochemical Impedance Spectroscopy (Ongoing).
- Utilisation of novel characterisation tools in P1-P4 (Ongoing).
- Characterisation of reactive metal interfaces to develop understanding of interfacial phenomena at electromaterials interfaces and in applications including corrosion, electrowinning and energy storage and conversion (Ongoing).

#### **P2 ENERGY CONVERSION**

- Establish basic mechanisms of gel adhesion to electrodes (End Year 1).

#### **P4 BIONICS**

- An understanding of the interfacial chemistries required for efficient cell adhesion and cell proliferation (End Year 1).

#### **EDUCATION MILESTONES**

- Establishment of ethics program and first cohort of staff and students trained (End Year 1).
- Development of characterisation short courses and workshops (End Year 1).

#### ***Research “New” Initiatives: Biofuel Cells/Biobatteries***

Although flagged in our original proposal the area of biofuel cells has been dropped from our milestones due to a reduction in funding. However, this area has been identified as an area where the unique combination of Centre expertise and facilities can be put to great use.

Research proposals to attract funding in the area of biofuel cells and biobatteries will be developed in the course of 2006.

#### ***Governance***

An International Advisory Board Meeting was held on 15<sup>th</sup> February 2006.

Executive Meetings have been scheduled for 15<sup>th</sup> February, 15<sup>th</sup> March, 12<sup>th</sup> April, 12<sup>th</sup> May and every 2 months thereafter during 2006.

The Education Committee will meet three times during 2006: Thursday April 6<sup>th</sup>, Thursday July 20<sup>th</sup> and Wednesday 18<sup>th</sup> October.

The composition and role of the End-Users Committee will be established during 2006.

#### ***Intellectual Property***

An IP register has been generated and maintained (Appendix VII).

Commercialisation of IP will be explored by the Business Development Officer in consultation with the IAB and possibly the End-User Group.

### *Education and Outreach*

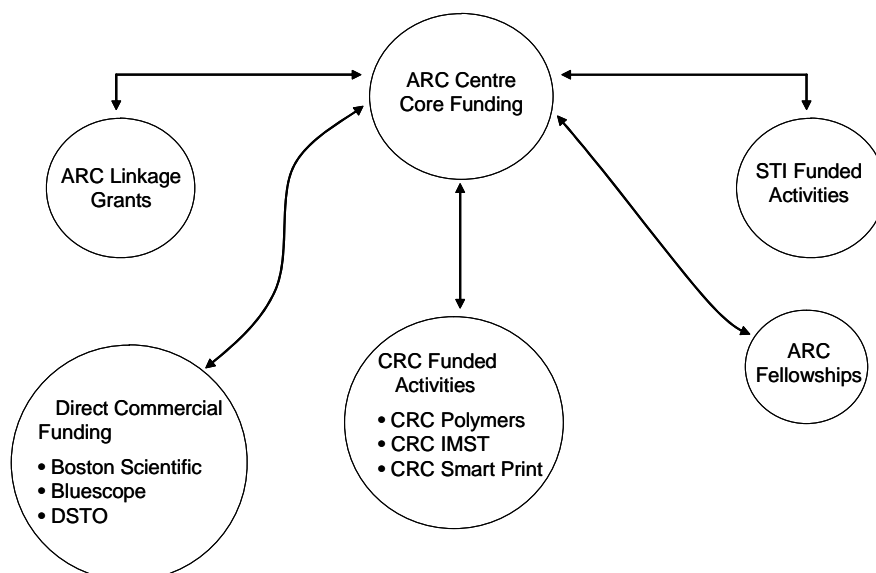
Centre staff will participate in activities during Innovation Week as well as in visits to High Schools. In addition, discussions with Science Centres on collaborative activities will be initiated.

## **INCOME FROM OTHER SOURCES**

The NSW State Government is providing a total of \$97,968 for 2005 to 2007.

A number of specific projects funded by CRCs, DSTO and Industry collaborators have been established.

### **ARC Centre of Excellence Funding Sources**



## **PUBLICATIONS**

There is no Key Performance Measure for publications for 2005. The target for 2006 is 30.

## **INCOME AND EXPENDITURE FOR 2005**

A certified Centre Outputs and Detailed Income & Expenditure Report (CODIE) will be submitted to the ARC separately to this Annual Report.

## **ANTICIPATED INCOME AND EXPENDITURE FOR 2006**

The disbursements of Centre income for 2006 have been finalised and ratified at a Centre Executive Committee meeting on 15<sup>th</sup> February 2006.

## APPENDIX I

### ARC CENTRE STUDENTS

<b>Name</b>	<b>Host Institution</b>	<b>Commenced</b>	<b>Title</b>	<b>Financial Arrangements</b>
Liu Yong	IPRI/UoW	January 2004	Nanostructured electrodes based on carbon nanotubes.	UoW. ARC scholarship
Orawan Ngamna	IPRI/UoW	January 2004	Synthesis and characterisation of ICP nanoparticles.	UoW. ARC scholarship
Jenny Causley	IPRI/UoW	January 2004	Use of electrode nanostructures for fluid movement.	UoW scholarship/ARC top up
Xiao Liu	IPRI/UoW	2005	Cell culturing on organic conductors	ARC Centre scholarship
Fatemeh Masdarolomoor	IPRI/UoW	2003	Nanostructured PMAS	Overseas scholarship
Salvador Larios	IPRI/UoW	2005	Hydrogel micro and nano actuators	IPRS
Vahid Mottaghtalab	IPRI/UoW	2003	Spinning polyaniline fibres	Overseas scholarship
Mehrdad Samani	IPRI/UoW	2004	Modelling of polypyrrole helix tube actuators	Iranian Government
Stephen John	UoW	2005	Conducting polymer based micro and nano manipulation systems	APA
Brianna Thompson	IPRI/UoW	2005	Cell culturing on conducting polymers	APA scholarship/ARC top up
Yanzhe Wu	IPRI/UoW	2003	Conducting polymers and Cochlear implants	CRC scholarship
Javad Foroughi	IPRI/UoW	2006	Nanostructured fibres	ARC Centre scholarship
James Williams	UoW	2004	Methods for the Synthesis of Chiral and Polyfunctionalized Fullerenes.	APA
Bill Hawkins	UoW	2003	Methods for the Synthesis of Polyfunctionalized Fullerenes.	UoW/ARC
See How Ng	ISEM/UoW	July 2004	Nano-structured materials for electrode in Li-ion battery.	UoW

Min Sik Park	ISEM/UoW	September 2005	Thin film lithium-ion batteries	ISEM
Sau Yen Chew	ISEM/UoW	February 2006	Develop highly conductive nanocomposite electrolytes and electrodes for lithium batteries	ARC
Nolene Byrne	Monash	March 2003	The effect of composition on the ion dissociation in polyelectrolyte gels.	ARC
Sharyn Long	Monash	February 2002	Ionic conductivity in doped molecular plastic crystals.	ARC
Churat Tiyaiboonthaiya	Monash	March 2001	Ionic Liquid Polyelectrolyte Gel Electrolytes.	Internal funds submitted 2004
Jackson Hu	Monash	March 2001	Light emitting Nanocrystallized Materials.	ARC submitted 2004
Gary Annat	Monash	March 2004	Ionic Liquids for stable lithium cathode materials.	CSIRO Li Project funds
Jim Efthimiades	Monash	July 2001	Ion transport in doped organic plastic crystals based on N,N' substituted pyrrolidinium tetrafluoroborate salts.	ARC submitted 2004
Natalie Ciccolo	Monash (undergrad)	January 2005- August 2005	Effect of nanofiller on conductivity in plastic crystal electrolytes	ARC
Paul Bayley	Monash (undergrad)	August 2005	New electrolyte gel materials	ARC
Tracey Markely	Monash	July 2005	Electrochemical and Surface characterisation of rare earth inhibited aluminium alloys	Monash
Youssef Shekibi	Monash	March 2005	Novel Plastic Crystal Electrolyte Materials	ARC & CSIRO Energy Technology top up.
Nickita Rajoo	Monash	March 2003	Development of Biosensors Based on Peptide Nucleic Acids.	ARC
Andrew Nattestad	Monash	February 2006	Dye Sensitised Tandem Solar Cells for Improved Conversion Efficiency	Monash
Simon Thompson	Monash	March 2005	Development of Three Dimensional Dye Sensitised Solar Cells	Monash
David Menzies	Monash	March 2003	Nanostructured Electrodes for Dye Sensitised Solar Cells	Monash

Stephen Zhang	Monash (undergrad)	December 2005	Mg alloy corrosion protection using IL treatments	ARC
Katarina Johansson	Monash	January 2005	New ionic liquids	Monash
Matthias Pauly	Monash	Monash French intern	Pretreatment of reactive metal surfaces	Monash/BlueScope Steel



## APPENDIX II

### **ARC Centre of Excellence for Electromaterials Science Full Centre Meeting Attendance List 5<sup>th</sup> August 2005**

<u>Name</u>	<u>Organization</u>	<u>Oral Presentation</u>	<u>Poster</u>
Prof Graeme Clark	Bionic Ear Institute	yes	
Dr Adrian Cameron	Bionic Ear Institute	yes	
Dr Rachael Richardson	Bionic Ear Institute	yes	
Dr David Lawrence	Bionic Ear Institute		
Lisa Gillespie	Bionic Ear Institute		
Dr Rob Kapsa	St Vincent's Hospital/Bionic Ear Institute	yes	
Prof Gordon Wallace	University of Wollongong	yes	yes
A/Prof Chee Too	University of Wollongong		
A/Prof Sue Dodds	University of Wollongong	yes	
Prof Hua Liu	University of Wollongong		yes
Dr Peter Innis	University of Wollongong		yes
Dr Simon Moulton	University of Wollongong	yes	
Prof Geoff Spinks	University of Wollongong	yes	yes
Kaylene Atkinson	University of Wollongong	yes	
A/Prof Will Price	University of Wollongong		
Dr Kerry Gilmore	University of Wollongong		
Brianna Thompson	University of Wollongong	yes	
A/Prof Paul Keller	University of Wollongong	yes	
Dr Carol Lynam	University of Wollongong		yes
Dr Andrew Minett	University of Wollongong	yes	
Jenny Causley	University of Wollongong		yes
See How Ng	University of Wollongong		yes
Prof Hugh Brown	University of Wollongong		
Prof Doug MacFarlane	Monash University	yes	yes
Latha (Nicki) Rajoo	Monash University		
Amy Mulholland	Monash University		
Dr Yi-Bing Cheng	Monash University		yes
Dr Sophie Cerneaux	Monash University		yes
Simon Thompson	Monash University		
Matt Belousoff	Monash University		
Dr Gilles Gasser	Monash University		yes
Prof Leone Spiccia	Monash University	yes	yes
Rob Brimblecombe	Monash University		
Dr Bim Graham	Monash University		yes
Dr David Menzies	Monash University		yes
Prof Maria Forsyth	Monash University		yes
Dr Jenny Pringle	Monash University		yes
Dr Patrick Howlett	Monash University		yes
Katarina Johansson	Monash University		yes
Kevin Fraser	Monash University		yes
Dr Masahiro Yoshizawa-Fujita	Monash University		yes
Dr Kyoko Fujita	Monash University		yes
Dr Qing Dai	Monash University		yes
Youssof Shekibi	Monash University		

Dr Jiazeng Sun	Monash University	
Sharyn Long	Monash University	
Dr Peter Newman	Monash University	yes
Nolene Byrne	Monash University	yes
Suzie Tan	Monash University	
Dr Gerry Swiegers	CSIRO	
Dr Anita Hill	CSIRO	yes
Prof David Officer	Massey University	yes

## APPENDIX III

### ACES VISITORS DURING JULY TO DECEMBER 2005

#### Visiting Scientists

<b>Date</b>	<b>Visitor</b>	<b>Affiliation</b>
25/7/05	Mr Chris Harris	University of Newcastle
1/8/05 (3 days)	Andrew Rowlands	University of Queensland
15/8/05 (2 months)	Brian Shedd	University of California, USA
22/8/05 (2 months)	Christina Baker	UCLA, USA
29/8/05 (2 weeks)	Dr Tan Truong	DSTO
4/10/04 (3 months)	Dr Davor Margetic	Rudjer Boskovic Institute, Croatia
17/10/05 (6 months)	Weimin Zhang	Zhejiang University of Technology, China
14/11/05 (2 weeks)	Daniel Ho	Monash University
14/11/05 (4 days)	Dr Shanqing Zhang	Griffith University
14/11/05 (4 days)	Dr William Wen	Griffith University
6/12/05 (2 weeks)	Dr Trevor Lewis	University of Tasmania

#### Seminar Speakers

<b>Date</b>	<b>Visitor</b>	<b>Affiliation</b>
8/7/05	Dr Trevor Lewis	University of Tasmania
11/7/05	Prof. Paul Calvert	UMass, Dartmouth, USA
11/7/05	Prof. Doron Aurbach	Bar-Ilan University, Israel
4/8/05	Prof. Ralph Brodd	Broddarp of Nevada, USA
12/8/05	Dr Ben Mattes	SFST, USA
12/8/05	Prof. Alan Bond	Monash University
16/8/05	Prof. Sam Adeloju	Monash University
31/8/05	Dr John Bartlett	ANSTO
31/8/05	Dr Vittorio Luca	ANSTO
12/10/05	Dr Greg Smith	SciVentures
11/11/05	Dr Gerhard Wagner	Max Planck Institute for Polymer Research, Germany
18/11/05	Dr Dieter Veit	RWTH Aachen, Germany
30/11/05	Prof. Julian Gale	Curtin University, WA
6/12/05	Prof. Per Jacobsson	Chalmers University, Sweden

**Visiting PhD students**

<b>Date</b>	<b>Visitor</b>	<b>Affiliation</b>
30/8/05 (1 month)	Shin su ryon	Hanyang University, Korea
12/9/05 (2 months)	Kwang Min Shin	Hanyang University, Korea
6/10/05 (1 ½ Years)	Chonlada Dechakiatkrai	Chiang Mai University, Thailand
6/12/05 (2 weeks)	Nathan Newman	University of Tasmania

**SCHEDULE E**

**ARC Centre of Excellence for Electromaterials Science  
Administering Institution: University of Wollongong**

**Key Result Areas and Performance Measures**

<b>Key Result Area</b>	<b>Performance Measure</b>	<b>Target</b>	<b>July to December 2005 Outcome</b>
<i>Research findings</i>			
	Quality of publications	At least 50% of journal articles in journals with impact factor >2	
	Number of publications	2006 – 30 2007 – 35 2008 – 40 2009 – 45 2010 – 50	No target for 2005
	Number of provisional patents lodged	2 per annum	2
	Invitations to address and participate in international conferences	6 per annum	
	Invitations to visit leading international laboratories	6 per annum	
	Number and nature of commentaries about the Centre's achievements	Print, radio, TV media: 1 per annum	8 Print
<i>Research training and professional education</i>			
	Number of postgraduates recruited	20 over 5 years	30
	Number of postgraduate completions	4 per annum	
	Number of Honours students	-	
	Number of professional courses	1 per annum	
	Participation in professional courses	-	

	Number and level of undergraduate and high school courses	Undergraduate: 1 per annum. Honours: 1 per annum from 2007. Schools: 1 per annum.	
<i>International, national and regional links and networks</i>			
	Number of international visitors	4 per annum	14
	Number of national and international workshops	1 per annum	
	Number of visits to overseas laboratories	6 per annum	1
<i>End-user links</i>			
	Number & nature of commercialisation activities: Licences, assignments or options.	1 per annum	
	Number of government, industry and business briefings	2 per annum	12
	Number of Centre associates trained/ing in technology transfer and commercialisation	2 per annum	1
	Number and nature of Public Awareness programs	1 per annum	1 Uni at the Brewery. 1 podcast. 1 Science EXPO. 1 school visit.
<i>Organisational support</i>			
	Annual cash contributions from Collaborating Institutions/Organisations	<u>UoW</u> \$712.6K indicative p.a.  <u>Monash</u> \$257K indicative p.a.  <u>BEI</u> \$0	<u>UoW</u> \$310,000  <u>Monash</u> \$95,000  <u>NSW Dept of State &amp; Regional Development</u> \$48,984

		<u>St Vincent's Health</u> \$0  <u>NSW Dept of State &amp; Regional Development</u> \$48,984 p.a. until 2007	
	Annual in-kind contributions from Collaborating Institutions/Organisations	<i>Years 1 to 5:</i>  <u>UoW</u> \$3,835,129 \$1,093,753 \$1,120,223 \$1,146,511 \$1,173,048  <u>Monash</u> \$569,424 \$583,869 \$598,411 \$613,051 \$627,791  <u>BEI</u> \$596,751 \$487,451 \$512,739 \$539,391 \$567,477  <u>St Vincent's Health</u> \$553,812 \$570,426 \$587,539 \$482,138 \$498,612  <u>NSW Dept of State &amp; Regional Development</u> \$0	<u>UoW</u> \$526,718  <u>Monash</u> \$252,878  <u>BEI</u> \$62,005
	Number of new Organisations recruited to or involved in the Centre	3 over 5 years	

	Level and quality of infrastructure provided to the Centre	-	
	Annual cash contributions from other Organisations	-	
	Annual in-kind contributions from other Organisations	-	
<b><i>Governance</i></b>			
	Breadth and experience of the members of the Advisory Board	Extensive Considerable	
	Frequency and effectiveness of Advisory Board meetings	1 per annum. Minutes will be provided.	
	Quality of the Centre strategic plan	Evaluated by IAB	
	Effectiveness of arrangements to manage Centre nodes	Centre Exec to meet 4 times per annum	2
	The adequacy of the Centre's Key Performance Measures	Evaluated by IAB	
<b><i>National benefit</i></b>			
	Measures of expansion of Australia's capability in the priority area(s)	International Visitors : 20. International Exchange Visits : 10. International Joint Publications : 10.	
	Case studies of economic, social, cultural environmental or other benefits	1	

The ARC recommends that a sum of money of the order of 5% of the annual ARC Centre funding should be spent each year on Centre community awareness programs, possibly including:

- professional and technical training;
- primary and secondary school awareness;
- “front-office” service for, and interaction with, Australians end-users; and
- workshops, international visitor programs and other networking activities that engage cognate Australian researchers who might not be formally associated with the Centre.



**MILESTONES FOR THE ARC CENTRE OF EXCELLENCE FOR  
ELECTROMATERIALS SCIENCE**

**P1. ELECTROMATERIALS**

**P1-1 Synthesis and Processing**

*Synthesis of nano-organic materials*

**Milestone 1**

Prepare porphyrins, oligothiophenes, ferrocenes and fullerenes for attachment to ICPs, CNTs and nano-inorganic materials for **P2** and **P3** (End Year 3).

**Milestone 2**

Prepare cell growth promoters, peptides and polyelectrolytes for **P4** (End Year 3).

**Milestone 3**

Prepare functionalised ICPs and CNTs for **P2** and **P3** (End Year 3).

**Milestone 4**

Elucidate biomolecule – nanosized bioconjugate interactions (End Year 3).

**Milestone 5**

Supply of new materials to P2-P4 (Ongoing).

*Synthesis of nano-inorganic materials*

**Milestone 6**

Prepare thin-film cathodes and anodes for **P3** (End Year 2).

**Milestone 7**

Development of efficient ZnS nanoparticle synthesis (End Year 2).

**Milestone 8**

Prepare porphyrin-functionalised Au or ITO surfaces for photoelectrodes in **P2** (End Year 3).

**Milestone 9**

Preparation of functionalised inorganic nanoparticles and nanofibres for **P2** and **P3** (End Year 3).

**Milestone 10**

Prepare ICP-coated inorganic nanostructures for **P3** (End Year 3 then ongoing).

## *Processing*

### **Milestone 11**

Establish wet-spinning fibre drawing facilities (End Year 1).

### **Milestone 12**

Prepare functionalised aligned CNTs for **P2** and **P3** (End Year 1 then ongoing).

### **Milestone 13**

Establish sol-gel methods for self assembly (End Year 2).

### **Milestone 14**

Supply of fabricated structures to P2-P4 (End Year 2 then ongoing).

## *Functional electrolytes*

### **Milestone 15**

Develop and characterize enhanced performance electrolytes including plastic and solid gel electrolytes (End Year 2).

### **Milestone 16**

Develop and characterize highly conductive zwitterion based electrolytes (End Year 3).

### **Milestone 17**

Prepare new functionalised nanoparticles for incorporation into gel electrolytes (End Year 3).

### **Milestone 18**

Develop and characterise nanocomposite electrolytes containing functional fillers (End Year 3).

### **Milestone 19**

Supply/refinement of electrolytes for P2-P4 (End Year 2 then ongoing).

## **P1-2 Characterisation**

### **Milestone 20**

Establishment of co-ordinated characterisation users' network (End Year 2).

### **Milestone 21**

Dr Peter Innis (QEII Fellow) will coordinate and educate on the use of conventional characterisation tools such as SEM, AFM, NMR, UV-vis and electrochemical methods, as well as specialist in-situ techniques such as Electrochemical-Electronspin Resonance, Electrochemical-Raman and Localised Electrochemical Impedance Spectroscopy (Ongoing).

### **Milestone 22**

Utilisation of novel characterisation tools in P1-P4 (Ongoing).

### **Milestone 23**

Characterisation of reactive metal interfaces to develop understanding of interfacial phenomena at electromaterials interfaces and in applications including corrosion, electrowinning and energy storage and conversion (Ongoing).

## **P1-3 Modelling**

### **Milestone 24**

Simulate model electromaterials and processes (End Year 3).

### **Milestone 25**

Integrate advanced characterisation and theory for material development (End Year 4).

## **P2 ENERGY CONVERSION**

### **P2-1 Solar Energy Conversion**

#### **Milestone 26**

Develop nanostructured photoelectrochemical solar cells with >5% efficiency (End Year 3).

#### **Milestone 27**

Develop nanostructured solid state polymer solar cells with >4% efficiency (End Year 4).

#### **Milestone 28**

Develop nanostructured photoanodes for integration into both solar conversion cells (End Year 5).

### **P2-2 Electromechanical Actuators**

#### **Milestone 29**

Establish basic mechanisms of gel adhesion to electrodes (End Year 1).

#### **Milestone 30**

Develop phenomenological models of ICP and gel actuation under low voltage electrochemical stimulus, taking into account the influence of ion movements, osmotic effects, chain conformation changes and changing mechanical properties (End Year 2).

#### **Milestone 31**

Develop artificial muscles with 5% strain at loads up to 10 MPa and strain rates of >10% sec<sup>-1</sup> (End Year 3).

### **Milestone 32**

Develop electrochemical pneumatic actuators using nanostructured electrodes and electrolytes (End Year 5).

## **P2-3 Nanostructured Electroluminescent Materials**

### **Milestone 33**

Develop and demonstrate energy efficient nanostructured electroluminescent devices (End Year 3).

### **Milestone 34**

Optimise materials in nanostructured electroluminescent devices (End Year 5).

## **P3 ENERGY STORAGE**

### **P3-1 All Solid-State Thin-Film Lithium-Ion Microbatteries**

#### **Milestone 35**

Develop nanostructured materials for electrode in Li-ion rechargeable battery (End Year 3).

#### **Milestone 36**

Develop polymer electrolytes for advanced lithium-ion batteries (End Year 3).

#### **Milestone 37**

Investigate the capacity loss and rechargeability of thin film anodes (End Year 3).

#### **Milestone 38**

Develop chemically stable and structurally stable thin film cathodes (End Year 4).

#### **Milestone 39**

Develop long life, high energy density all solid-state thin-film Li-ion microbatteries (End Year 5).

### **P3-2 Advanced Metal Batteries**

#### **Milestone 40**

Develop highly conductive nanocomposite electrolytes and electrodes for metal battery applications (End Year 3).

#### **Milestone 41**

Develop an understanding of the interfacial phenomena at the electrode surfaces and use this to develop optimal performance in operational batteries (End Year 5).

### **P3-3 Organic Batteries**

#### **Milestone 42**

Develop an all-polymer battery with capacity of  $80 \text{ mA hr g}^{-1}$  using nanostructured materials from P1 (End Year 3).

#### **Milestone 43**

Develop an all-polymer capacitor with capacity of the order of  $100 \text{ F g}^{-1}$  (End Year 3).

#### **Milestone 44**

Develop fabrication techniques for flexible membrane structures utilising these materials (End Year 3).

#### **Milestone 45**

Develop wet-spinning techniques that enable the use of wet-spinning to produce fibre batteries and supercapacitors (End Year 4).

#### **Milestone 46**

Integrate fibre batteries into textile structures (End Year 5).

### **P4 BIONICS**

#### **P4-1 Nerve Cell Communications**

#### **P4-2 Bio-stability and Biocompatibility**

#### **Milestone 47**

An understanding of the interfacial chemistries required for efficient cell adhesion and cell proliferation (End Year 1).

#### **Milestone 48**

An understanding of how energy transfer processes (electrical, optical stimulation) influence these interfacial chemistries (End Year 2).

#### **Milestone 49**

Utilise and refine fibre fabrication protocols (P1) that allow for production of micro-devices to control the direction of neurite outgrowth (End Year 3).

#### **Milestone 50**

Develop nanofabrication protocols that allow construction of 3-dimensional networks and devices for integration with fibrous tissue as well as cell adhesion and proliferation (End Year 5).

## **P5 ETHICS**

### **P5-1 Biosystems, Electromaterials and Commodification of Human Health**

#### **Milestone 51**

An understanding of the social-legal and ethical context of developments in bionics (End Year 2).

#### **Milestone 52**

An understanding of the impact of commodification on the development of bionics and the clinical applications of bionics (End Early Year 3).

### **P5-2 “Bionic People”**

#### **Milestone 53**

An understanding of the significance of bionics for self-identity and uses of the self: ethics and the self (End Year 3).

#### **Milestone 54**

Develop an integrated position on the development of bionics, human health and ethical relations (End Year 5).

## **EDUCATION MILESTONES**

#### **Milestone 55**

Establishment of ethics program and first cohort of staff and students trained (End Year 1).

#### **Milestone 56**

Development of characterisation short courses and workshops (End Year 1).

#### **Milestone 57**

Full Development of community outreach programs at Monash and Wollongong Science Centres (End Year 3).

## APPENDIX VI

### STAFF MEMBERS OF THE CENTRE

<b>Member</b>	<b>Role</b>	<b>Affiliation</b>
Prof. G.G. Wallace	Research Director and Program 1 Leader	University of Wollongong
Prof. M. Forsyth	Associate Research Director	Monash University
Prof. G.M. Spinks	Program 2 Leader	University of Wollongong
Prof. D.R. MacFarlane	Program 3 Leader	Monash University
Prof. G.M. Clark	Program 4 Leader	Bionic Ear Institute
A/Prof S. Dodds	Program 5 Leader	University of Wollongong
A/Prof. W.E. Price	Education Director	University of Wollongong
A/Prof C.O. Too	Chief Operating Officer	University of Wollongong
Prof. L.A.P. Kane-Maguire	Chief Investigator	University of Wollongong
Prof. D.L. Officer	Partner Investigator	Massey University
Prof. H.K. Liu	Chief Investigator	University of Wollongong
A/Prof. P. Keller	Chief Investigator	University of Wollongong
Prof. H. Brown	Chief Investigator	University of Wollongong
Dr. P. Innis	Chief Investigator	University of Wollongong
Dr. A. Minett	Chief Investigator	University of Wollongong
Dr G. Alici	Chief Investigator	University of Wollongong
Prof. L. Spiccia	Chief Investigator	Monash University
Prof. Y-B. Cheng	Chief Investigator	Monash University
Dr R. Kapsa	Partner Investigator	St Vincent's Health
Prof. S. Adeloju	Associate Investigator	Monash University
Prof J-H. Ahn	Associate Investigator	Andong National University
Prof A. Bond	Associate Investigator	Monash University
Prof. D.N. Butler	Associate Investigator	University of Wollongong
Dr D. Buxton	Associate Investigator	BlueScope Steel Limited
Dr E. Evans	Associate Investigator	BlueScope Steel Limited
Dr T. Bastow	Associate Investigator	CSIRO-Manufacturing Science & Technology
Dr T. Hollenkamp	Associate Investigator	CSIRO Energy Technology
Dr G.F. Swiegers	Associate Investigator	CSIRO-Molecular and Health Technologies
Dr W. Humphries	Associate Investigator	CSIRO-Textile & Fibre Technology
Dr A. Hill	Associate Investigator	CSIRO-Manufacturing Science & Technology
Prof. S. De Leeuw	Associate Investigator	Delft University of Technology
Prof. L. Dai	Associate Investigator	Wright Brothers Institute
A/Prof P. Dastoor	Associate Investigator	University of Newcastle
Prof. D. Diamond	Associate Investigator	Dublin City University
Prof. R. Forster	Associate Investigator	Dublin City University
Prof J. Hill	Associate Investigator	University of Wollongong
Prof. A. Ivaska	Associate Investigator	Abo Akademi University
A/Prof S.J. Kim	Associate Investigator	Hanyang University
Prof. J-Y. Lee	Associate Investigator	Korean Institute of Metals and Materials
Assist. Prof. J. Madden	Associate Investigator	University of British Columbia
Dr D. Paganin	Associate Investigator	Monash University
Dr P. Poulin	Associate Investigator	CNRS

A/Prof S. Ralph	Associate Investigator	University of Wollongong
Prof. L. Samuelson	Associate Investigator	University of Massachusetts Lowell
Prof. M.E. Smith	Associate Investigator	University of Warwick
Prof. D.E. Tallman	Associate Investigator	North Dakota State University
Prof D. Theodorou	Associate Investigator	National Technical University of Athens
Dr V-T. Truong	Associate Investigator	DSTO
Prof F. Walsh	Associate Investigator	University of Southampton
Prof R.N. Warrener	Associate Investigator	University of Wollongong
Prof K. West	Associate Investigator	Riso National Laboratory
Dr Z. Guo	Associate Investigator	University of Wollongong
Dr K. Konstantinov	Associate Investigator	University of Wollongong
Dr J. Wang	Associate Investigator	University of Wollongong
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Dr C. Lynam	Research Fellow	University of Wollongong
Dr S. Moulton	Research Fellow	University of Wollongong
Dr. V. Misoska	Research Fellow	University of Wollongong
Dr S. Ashraf	Research Fellow	University of Wollongong
Dr L. Chaker	Research Fellow	University of Wollongong
Dr G. Wang	Research Fellow	University of Wollongong
Dr Jenny Pringle	Research Fellow	Monash University
Dr Qing Dai	Research Fellow	Monash University
Dr Josephina Adebahr	Research Fellow	Monash University
Dr Jiazeng Sun	Research Fellow	Monash University
Dr Peter Newman	Research Fellow	Monash University
Dr M. Yoshizawa	Research Fellow	Monash University
Dr Kyoko Fujita	Research Fellow	Monash University
Dr Gilles Gasser	Research Fellow	Monash University
Dr Bim Graham	Research Fellow	Monash University
Dr Patrick Howlett	Research Fellow	Monash University
Dr Adrian Cameron	Senior Research Fellow	Bionic Ear Institute
Ms. Siu Wai	Associate Research Fellow	University of Wollongong
Dr. Binbin Xi	Research Fellow	University of Wollongong
Dr M. Imisides	Research Fellow	University of Wollongong
Dr G. Tsekouras	Research Fellow	University of Wollongong
Dr C. Wang	Research Fellow	University of Wollongong
Dr J. Wu	Research Fellow	University of Wollongong
Dr U. Bach	Research Fellow	Monash University
Dr E. Izgorodina	Research Fellow	Monash University
Dr S. Pas	Research Fellow	Monash University



## APPENDIX VII

### INTELLECTUAL PROPERTY REGISTER FOR THE ARC CENTRE OF EXCELLENCE FOR ELECTROMATERIALS SCIENCE

Centre Milestones	Organisation	Names of Inventors	Intellectual Property (IP) Details		Date
			Background IP	New IP	
31	UoW/IPRI	G.M. Spinks, G.G. Wallace, D. Zhou	PCT/Au02/01608, "An electrochemical actuator and means of providing same".		Nov. 2001
35	UoW/ISEM	G.X. Wang, K. Konstantinov, H.K. Liu, S.X. Dou	Innovation Patent No: 2002100000 "Cathode materials for rechargeable batteries and a process for production"		Jan. 2002
35	UoW/ISEM	S.X. Dou, K. Konstantinov, H.K. Liu, G.X. Wang	Innovation Patent No: 2002100190, "Fabrication of cathode materials for li-ion batteries"		Mar. 2002
35	UoW/ISEM	K. Konstantinov, G.X. Wang, H.K. Liu, S.X. Dou, S. Bewlay	Innovation Patent No: 2002100403 "Development of new positive compounds for lithium-ion batteries"		May 2002
1	UoW/IPRI Trinity College Dublin	G.G. Wallace, S. Moulton, A. Minett, W. Blau	Provisional patent. PCT lodged, "Use of biomolecules as selective dispersants for carbon nanotubes".		Feb. 2003  Feb. 2004
15	Monash/CSIRO	P. Howlett, T. Hollenkamp, D. MacFarlane and M.Forsyth	PCT/AU2004/000263 Energy Storage Devices		Mar. 2004
15	UoW/IPRI/ Virginia Tech	M. Bennett, D. Leo, G. Spinks, G. Wallace	US Patent Ionic solvents for ionic polymer transducers		Aug 2004

23, 41	Monash	P. Howlett, D. MacFarlane, M.Forsyth	Aust. Prov. Patent, 2005901074 “Ionic liquid surface treatments for reactive metals and their alloys”	Mar 2005
15	UoW/IPRI	Wallace, G.G., Innis, P.C., Mazurkiewicz, J., Edwards, S.	Provisional Patent Application No. 2005903481. “Charge Conducting Medium”	July 2005
16	Monash/CSIRO	N. Byrne, P. Howlett, T. Hollenkamp, D. MacFarlane and M.Forsyth	US Provisional Patent Application No. 60/603524 (20 Aug 2004) PCT AU2005 001237 “Zwitterionic Additives for Electrochemical Devices”	Aug 2005