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Wang, Jinfeng, Tsuzuki, Takuya and Sun, Lu 2008, Optimizing the UV protection of textile with reduction of photocatalytic activity of ZnO, in *ARNAM 2008 annual workshop : conference booklet : Waurin Ponds Campus, Deakin University, 15 - 18, December 2008*, pp. 171-171.

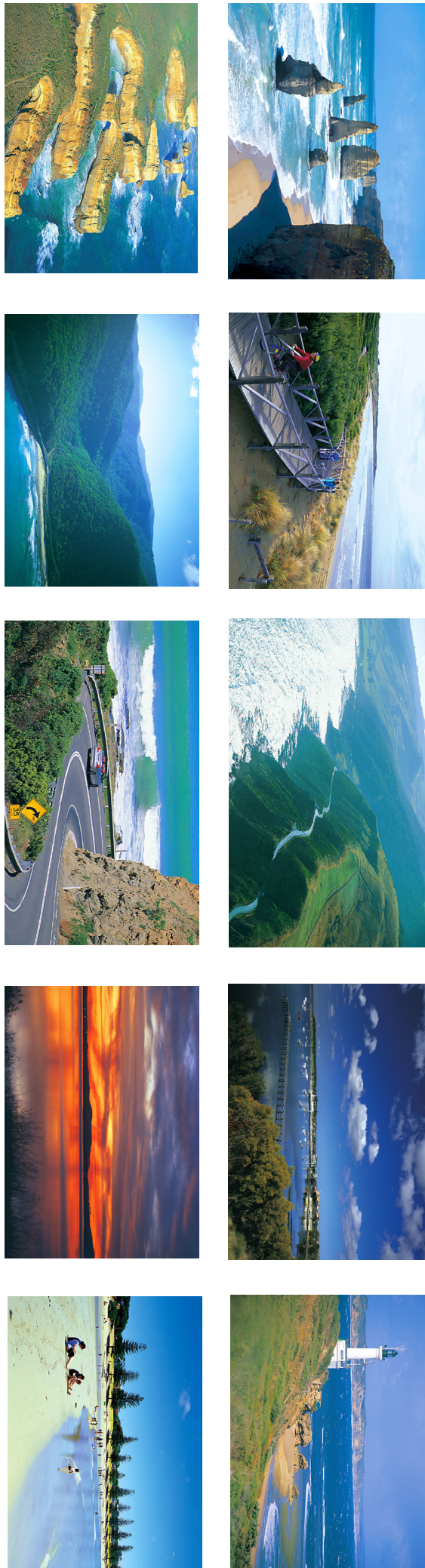
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ARNAM 2008 Annual Workshop

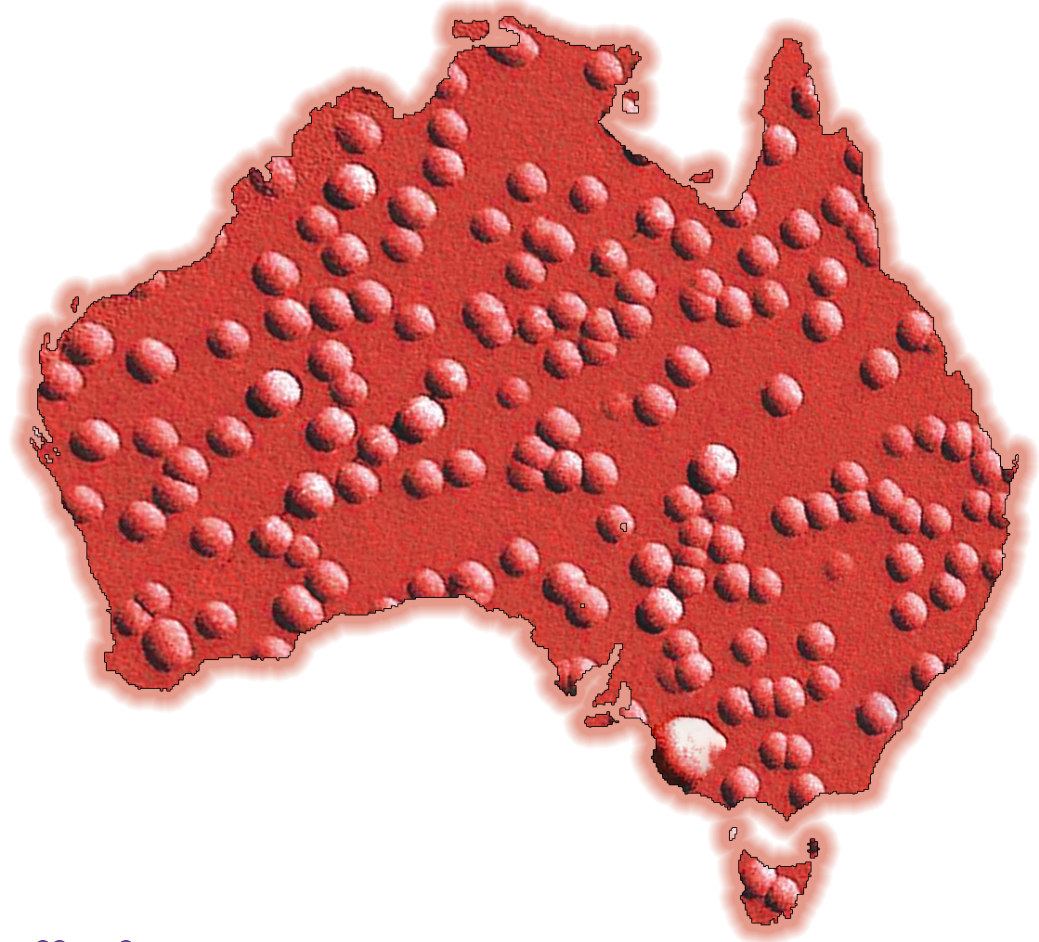
Waurm Ponds Campus, Deakin University, 15 - 18, December 2008

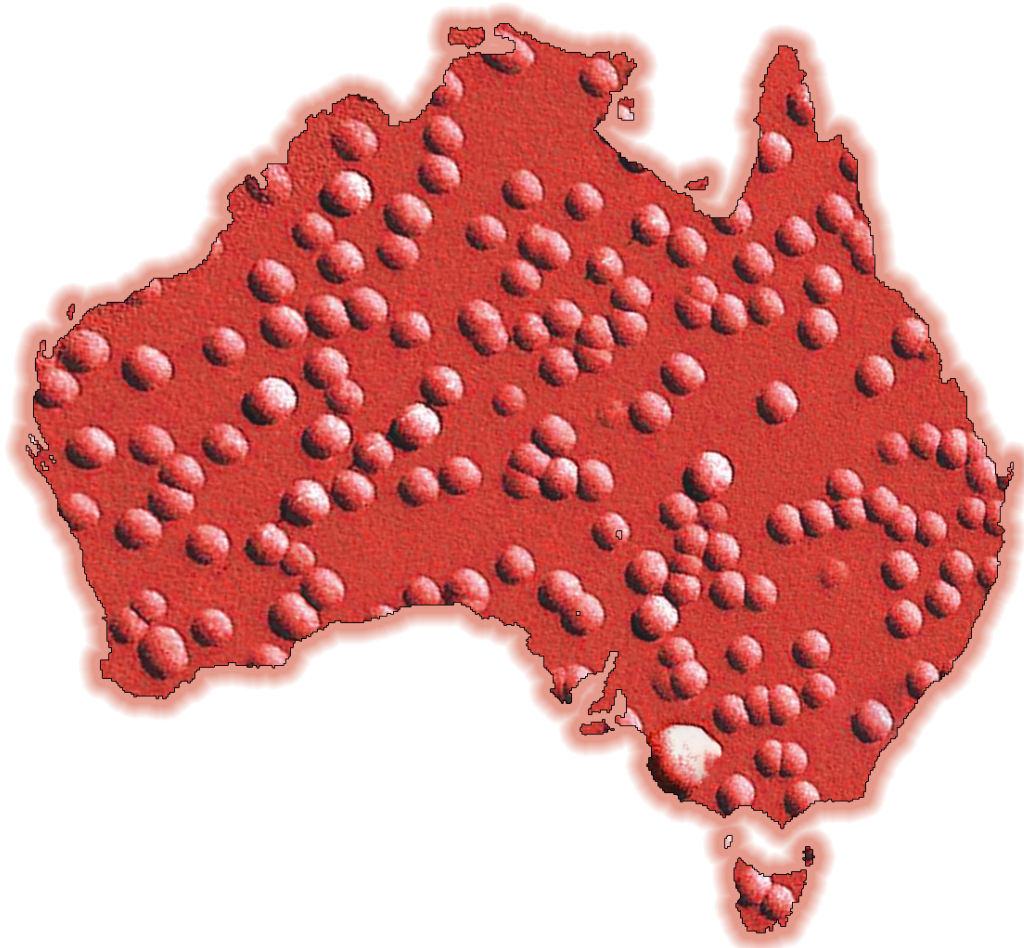


ARNAM 2008 Annual Workshop

Conference Booklet

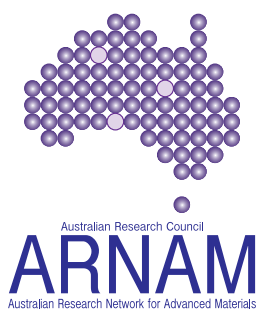
Waurm Ponds Campus
Deakin University
15 - 18, December 2008





ARNAM 2008 Annual Workshop

Conference Booklet



Waurin Ponds Campus
Deakin University
15 - 18, December 2008

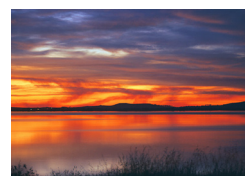
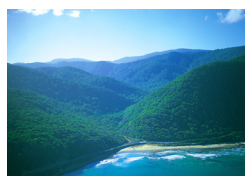


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Workshop Organisation

Conference co-chair:

Xungai Wang and **Jim Williams**

Program Committee:

Structural and Functional Materials:

Geoff Spinks (Wollongong)

Chris Hutchinson (Monash)

Electronic, Photonic and Magnetic Materials:

John Dell (UWA)

Barbara Fairchild (UniMelb)

Energy, Environmental and Bio Materials:

Liangzhou Wang (UQ)

Ian Goon (UNSW)

Manufacturing Materials:

Liangchi Zhang (USyd)

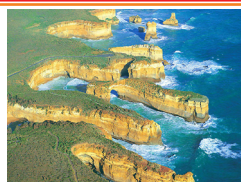
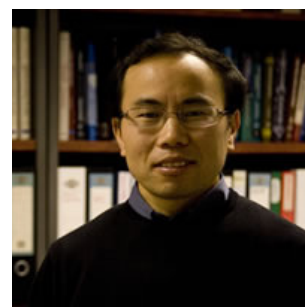
Kevin Magniez (Deakin)

Materials Characterisation:

Klaus-Dieter Liss (ANSTO)

Julie Cairney (USyd)

Administration: Belinda Barbour, Christine Rimmer and Elena Williams.





Deakin University

Geelong Campus at Waurin Ponds

Deakin's Geelong Campus at Waurin Ponds is located on the western edge of the historic port city of Geelong, 72 kilometres south west of Melbourne. Geelong is Victoria's largest regional centre with a population of more than 200,000 people.



The Campus features expansive landscaped grounds and extensive sporting facilities. It is the second-largest Campus of the University, with more than 4000 on-campus students.

Mobile Coverage: There is full mobile coverage available at the campus.

Computer Access: Deakin has Eduroam which is available to registered Universities:

<http://www.deakin.edu.au/its/wireless/eduroam/>

Eduroam website: <http://www.eduroam.org/>

Eduroam participants in Australia: <https://wiki.aarnet.edu.au/display/eduroam/For+End+Users>

Your own computer will be required or there are a couple of computers in the library that could be used provided you have Eduroam access.

Local Shops: The rather large Waurin Ponds Shopping Centre is just 2.3 km (about 6 mins by car). There is a bus service which runs from near the residences at Deakin to the Waurin Ponds Shopping Centre on route to and from Geelong city.

General Safety and First Aid

Please exercise your common sense and be responsible for your health and well-being while at the workshop. Please contact us if there are any medical, health, disability, dietary or emergency issues you think should be brought to our attention. Belinda Barbour is a qualified first aider and will be on call for the duration of the workshop.

There is also a Part-time nurse on campus and will be available during the time of this workshop. Phone: 5227 1221/3. You could also get medical advice from NURSE-ON-CALL, 1300 60 60 24 for the cost of a local call from anywhere in Victoria. (Calls from mobile phones may be charged at a higher rate.)

If you think your situation is an emergency, ring:

Ambulance: 000 or go to emergency (Geelong Hospital – Corner Bellerine and Ryrie Streets, Geelong)

Poisons Information Service: 131126

Locations on Campus

The main lecture theatre and foyer (initial gathering/registration and the main lectures/workshops) - room number ia1.006 (Lecture Theatre 1 - Peter Thwaites LT).

Meals will be in the East Dining Room at jb1.103. Participants will be housed in the Residences.

The extra breakout rooms are;

Lecture Theatre ka3.403

Lecture Theatre ka3.411







Presentation Guidelines and Prizes

Plenary presentation session

Plenary addresses are to be no longer than 40 minutes. There will be 5 minutes for questions and changing presenters as necessary. All other guidelines for plenary addresses are otherwise similar to contributed oral presentations.

Contributed Oral presentation sessions

Oral presentations are to be no longer than 16 minutes. Each session will have a chair who has strict instructions to not allow presentations to continue for longer than 16 minutes. There will be 4 minutes for change over and question time.

Two different theatres will be used for oral presentations, and both are equipped with the computers, data projectors and overhead projectors. Presenters should bring their presentations on a CD or a portable flash drive, but presenters can use their own computers if necessary.

2-minute presentations

IMPORTANT: Electronic slides must be submitted early!

Overhead transparencies are encouraged, and need not be submitted.

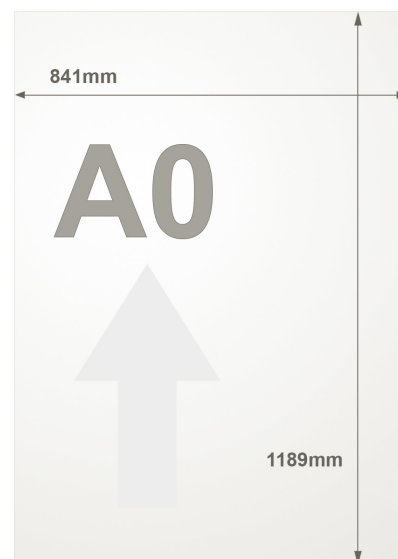
Powerpoint/digital slides **will not be accepted** at the time of the presentations and must be loaded at least before lunch on the day of presentation.

Poster presentations will also be presented as a 2 minute oral summary (2 electronic slides or transparencies) of your work. This will be followed by a poster presentation for presenters to discuss their work.

Pointers on how to summarise for 2 minute presentation:

No detail - give an overview only.

You need to sell your research so that the audience comes to your poster.



Prizes and Awards

Prizes will be available for students and early career researchers. Different prizes are offered for oral presentations and the 2-minute (poster) presentations. Up to 10 cash prizes totalling more than \$3,000 will be awarded for the best presentations. Plaques will also be awarded to prize winners.

Assessment will be made on: scientific content; novelty of the findings and quality of the presentation.

Prize Selection committee

A prize selection committee will be selected close to the event, consisting primarily of existing committee members and session chairs.



Early Career Researcher (ECR) Workshop

Grant Writing and Industry Day 18th December 2008

9.30am	Grant Writing
9.30am	Alison Hadfield <i>Director of Research Services, Deakin University</i> How Do Research Offices Assist ECRs?'
10.00am	Rachel Webster <i>ARC College of Experts: Physics, Chemistry and Geosciences (PCG)</i> A Perspective from an ARC Panel Member'
10.30am	<i>Morning Tea (½ hour)</i>
11.00am	Peter Hodgson <i>Director of Research, Institute for Technology Research and Innovation, Deakin University, (Ex-ARC EE panel)</i> 'University/Industry Research Collaboration'
11.30am	Ian Mackinnon <i>ARC Executive Director</i> 'A Perspective on Careers in Materials'
12.00pm	ECR workshop activities: Coordinated by co-chairs: Bianca Haberl, Kevin Magniez, Barbara Fairchild, Chris Hutchinson
12.30pm	<i>Networking Lunch</i> <i>Lunch (1 hour)</i>
1.30pm	Industry Collaboration
1.30pm	Erol Harvey <i>Director, Minifab</i> 'Innovation for Increased Productivity for Australian Firms – The Minifab Story'
2.00pm	Ken King <i>CEO, Micronisers P/L</i> 'UV Protection Materials'
2.20pm	Bill Humphries <i>CSIRO Materials Science and Engineering, Geelong</i> 'Carbon Nanotube Sheets, Yarns and Fabrics'
2.40pm	Kerryn Caulfield <i>Technical Textile and Non-Woven Association (TTNA)</i> 'Career Futures in an Innovation Growth Sector'
3.00pm	Robert Bell <i>CTO, Clear Edge Filtration Technologies</i> 'The Global Clear Edge Group: Successful R&D Collaborations from Outside the Square'
3.20pm	Carla Gerbo <i>Future Materials</i> 'Connecting with Industry'
3.30pm	<i>Afternoon Tea (½ hour)</i>
4.00pm	Panel Discussion
4.00pm	Panel Discussion: Ian Mackinnon, Xungai Wang, Jim Williams, Bill Humphries, Ken King and Carla Gerbo
5.00pm	<i>Workshop Close</i>





Conference Program

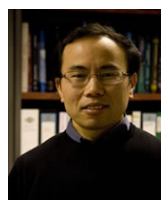
Plenary Presenters:



Mike Loretto

(University of Birmingham)

“Controlling the microstructure and properties of Ti and TiAl-based alloys”



Xungai Wang

(Deakin University)

“Multi-disciplinary research on fibres and fibrous materials”

Paul Meredith

(University of Queensland)

“Advanced Optoelectronic Materials for a Sustainable Future”



Rob Lamb

(Australian Synchrotron and University of Melbourne)

“The brightest light in the southern hemisphere”



Rob Short

(Mawson Institute, University of South Australia)

“Plasma Polymerisation and The Living Bandage”



Contributed Presenters:

Hasan Abdullah	Barbara Fairchild	Chih-Ling(Jenny) Lin	Rangam Rajkhowa	Bjorn Winther-Jensen
Nicholas Absalom	Javad Foroughi	Daniel Lin	Ranjan Rajoo	Chengtie Wu
Benjamin Adamson	Matthew Franklin	Klaus-Dieter Liss	Yogambha Ramaswamy	Yi Sun Wu
Tony Aitchison	Alison Funston	Ming Liu	Bernard Rolfe	Yueqin Wu
Mohammad Al Assadi	Kumaravelu Ganesan	Porun Liu	Nigel Ross	Zhigang Wu
Talukder Alam	Weimin Gao	Karen Livesey	Maksym Rybachuk	David Wyndham
Dominic Alexander	Ulf Garbe	Charles Loo Chin Moy	Aaron Südholz	Wanqiang Xu
Pasquale Aliberti	Alireza Ghaderi	Zhenhua Luo	Banchachit Saensunon	Yuhua Xue
Sima Aminorroaya-Yamini	Virginia Gill	Mykanth Mada	Noorasikin Samat	Kun Yan
Andrew Arulsamy	Ian Goon	Shokoufeh Malekjani	Bashir Samsam	Xiaoxia Yan
Alireza Asgari	Nathaniel Groothoff	Ross Marceau	Chee Howe See	Richard Yang
Avinash Baji	Yanan Guo	Adam Martin	Mary She	Min Yang
Aiden Beer	Daniel Haley	Mazlina Mat Darus	Cameron Shearer	Yimeng Yang
Oscar Borrero-Lopez	Xiaojing Hao	Peter Metaxas	Lisa Smith	Poh Hean Yap
Yang Cao	Karel Hartlieb	Jonathon Mitchell	Yong Heng So	Nima Yazdipour
Li Chang	Nur Farhana Hayazi	Alireza Moridi Farimani	Anna Sokolova	Suyun Ye
Dehong Chen	Rongliang He	Aniruddh Mukherji	Quansheng Song	Huaying Yin
Yiqing Chen	Rui Ping Hoo	Jelena Muric-Nesic	Philip Speck	Hua Yu
Shuk Yan Cheng	Christopher Hurren	Maryam Naebe	Zhongyuan Tan	Yang Yu
Sukfun Chin	Maizlinda Idris	Sina Naficy	Feng Tang	Akhmad Zaeni
Shulei Chou	Andreas Jahja	Dilip Nath	Yanwei Tang	Nan Zeng
Mohammad Choucair	Fei Jiang	Thai Nguyen	Eric Tavenner	Bo Zhang
Richard Clements	Abdullah-Al Kafi	Tich-Lam Nguyen	Ping-JU Tsai	Haimin Zhang
Kevin Cook	Zohreh Keshavarz	Haitao Niu	Wing Sze Tung	Hu Zhang
Darren Cram	Timothy Khoo	Nor Dalila Nor Affandi	Krasimir Vasilev	Jin Zhang
Pranesh Dayal	Kok Tee Lau	Aris Nugroho	Jinfeng Wang	Laichang Zhang
Ali Dehghan-Manshadi	Ya Ting Lee	Sam Ogden	Mingliang Wang	Mu Zhang
Hui Diao	Guiying Li	King Pang	Xin Wang	Sarah Zhang
Jessie Dilag	Hejie Li	Michael Pereira	Yanbo Wang	Yuebin Zhang
Marcus Doherty	Lihong Li	Steven Petinakis	Yichao Wang	Yan Zhao
Glenna Drisko	Puwang Li	Alokes Pramanik	Ian Watson	Yaqiong Zhou
Daniel Drumm	Sha Li	Daniel Pyke	Danny Wee	Jianli Zou
Xusheng Du	Yuncang Li	Qiao Yu Qiu	Matthias Weiss	
Yi Du	Peter Liddicoat	Reza Rafiee	Guiqing Wen	
Cameron Evans	May Lim	Kaveh Rahmzadeh	William Wen	

Day 1: Monday, 15th December 2008

Registration			
10:30	11:30	Session 1	Opening Remarks, Plenary 1
10:30	10:45	Opening Remarks: Xungai Wang/Jim Williams	
10:45	11:30	Paul Meredith (UQ) Advanced Optoelectronic Materials for a Sustainable Future	
11:30	12:50	Session 2 Electronic, Photonic, Magnetic 1	Session 3 Manufacturing 1
11:30	11:50	(02-1) Kevin Cook (USyd) Bragg gratings in photonic crystal fibres: Progress and applications	(03-1) Aiden Beer (Deakin) The Development of a New Magnesium Alloy for Extrusion
11:50	12:10	(02-2) Tich-Lam Nguyen (UMelb) Tunable light emission using quantum dot coated upconverters	(03-2) Huaying Yin (UNSW) Understanding and Minimizing Steel Oxidation in Direct Fired
12:10	12:30	(02-3) Alison Funston (UMelb) Plasmon Interactions of Closely-Spaced Au Nanoparticles	(03-3) Thai Nguyen (USyd) A development of a Grinding Wheel System for Coolant Minimisation
12:30	12:50	(02-4) Nan Zeng (CSIRO) Flash light illuminated gold nanoparticle cluster heat generation	(03-4) Jin Zhang (Deakin) Effect of processing conditions on fibre/matrix adhesion and fracture toughness of thermoplastic toughened CFRP composites
12:50	13:40	Lunch Break - 50 minutes	
13:40	16:00	Session 4 Electronic, Photonic, Magnetic 2	Session 5 Manufacturing 2
13:40	14:00	(04-1) Peter Metaxas (UWA) Domain wall pinning mediated by stray magnetic fields	(05-1) Yueqin Wu (UQ) Nanoscratch-induced Deformation of Single Crystal Silicon
14:00	14:20	(04-2) Virginia Gill (UMelb) Buried Electrically Conducting Structures in Diamond	(05-2) Yaqiong Zhou (Deakin) Structure and Properties of Nanofibre Yarns Prepared from Electrospun Nonwoven Strips
14:20	14:40	(04-3) Yi Du (UWollongong) Hydrothermal synthesis and physical properties of oxide multifunctional materials with controlled morphologies	(05-3) Kok Tee Lau (UNSW) Sedimentation of Titanium Powder in Organic Media
14:40	15:00	(04-4) Ranjan Rajoo (UNewcastle) Low-Temperature Embrittlement of Lead Free Solder Interconnections	(05-4) Lisa Smith (UMelb) Toward the Creation of Non-toxic Semiconductor Nanoparticle Systems for Bioapplications
15:00	15:20	(04-5) Bo Zhang (UNSW) Advances in the growth and characterization of multilayered Ge nanocrystals embedded in SiO ₂ matrix	(05-5) Jelena Muric-Nesic (ANU) Effect of vibrations on void content in composite materials
15:20	15:40	(04-6) Jonathon Mitchell (ANU) a-Si:H by Multi-layer PECVD to optimise mc-Si electronic surface passivation and heterostructures fabrication.	(05-6) Dilip Nath (UNSW) A correlation study of structure "property" interface of polypropylene-fly ash composites
15:40	16:00	(04-7) Karen Livesey (UWA) Effective medium method for multiferroic composite materials	(05-7) Poh Hean Yap (Deakin) Prediction of Wool Knitwear Pilling Propensity using Support Vector Machines
16:00	16:30	Afternoon Tea Break - 30 minutes	
16:30	17:30	Session 6	Short Presentation 1: Electronic <i>See detail at end of program.</i>
17:30	18:00	Poster Viewing - 30 minutes	
18:00	19:00	Session 7	Short Presentation 2: Manufacturing/Energy <i>See detail at end of program.</i>
19:00	19:30	Poster Viewing - 30 minutes	





Day 2: Tuesday, 16th December 2008

8:30	10:00	Session 8	Plenary Presentations 2
8:30	9:15	Mike Loretto (Birmingham) Controlling the microstructure and properties of Ti and TiAl-based alloys	
9:15	10:00	Rob Lamb (UMelb) The brightest light in the southern hemisphere	
10:00	10:30	Morning Tea Break - 30 minutes	
10:30	12:50	Session 9 Energy, Environmental And Biomaterials 1	Session 10 Structural And Functional 1
10:30	10:50	(09-1) Sina Naficy (UWollongong) Electrically controlled release of dexamethasone sodium phosphate from chitosan-carbon nanotubes films	(10-1) Tony Aitchison (Flinders) Carbon Nanotubes: Self-Alignment in Copolymer Thin Films
10:50	11:10	(09-2) Dominic Alexander (UQ) Development of Highly Active Catalysts for Methane Steam Reforming	(10-2) Li Chang (USyd) Visualization of the Percolating Networks in Multi-wall Carbon Nanotube (CNTs)/Epoxy Composites
11:10	11:30	(09-3) Shulei Chou (UWollongong) Lithium Metal Battery Using V ₂ O ₅ Nanomaterials Cathode and Room Temperature Ionic Liquid Electrolyte	(10-3) Yuhua Xue (Deakin) Fabrication of organic-inorganic hybrid nanofiber and nanotube arrays using POSS as building blocks
11:30	11:50	(09-4) Hua Yu (Griffith) An Organo-sol Modified TiO ₂ Nanoporous Electrode for Dye-Sensitized Solar Cells Applications	(10-4) Kaveh Rahmanzadeh Kabir (UNSW) Bending response of aluminium foam-cored sandwich panels
11:50	12:10	(09-5) Yong Heng So (UNSW) Investigation Of Quantum Confinement Effects In Tin Quantum Dot Materials For Photovoltaic Applications	(10-5) Maizlinda Idris (UNSW) Quasi-static and Impact Response of Carbon Fibre/Closed-Cell Aluminium Foam Sandwich Panel to Local Damage
12:10	12:30	(09-6) Xiaojing Hao (UNSW) Synthesis and characterization of nano P-N junction for all-Si tandem solar cells	(10-6) Laichang Zhang (UWollongong) High-Strength Ultrafine Grained Titanium Based Alloys With Bimodal Structure
12:30	12:50	(09-7) Dehong Chen (UMelb) Mesoporous spherical TiO ₂ as bifunctional material for high performance dye-sensitized solar cells	(10-7) Oscar Borrero-Lopez (UNSW) Strength Evolution in Brittle Thin Films
12:50	13:40	Lunch Break - 50 minutes	
13:40	16:00	Session 11 Energy, Environmental And Biomaterials 2	Session 12 Materials Characterisation 1
13:40	14:00	(11-1) Hasan Abdullah (UNSW) Effect of Ultraviolet Irradiation on Gel Oxidised Titanium in Simulated Body Fluid	(12-1) Peter Liddicoat (USyd) New hierarchy of solute architecture breaks strength ceiling in a nanocrystalline aluminium alloy
14:00	14:20	(11-2) Aniruddh Mukherji (UQ) Synthesis of highly efficient N-doped HTaWO ₆ photocatalyst highly active under visible light.	(12-2) Pranesh Dayal (UNSW) Microstructure and mechanical properties of multilayered Al/Pd thin films
14:20	14:40	(11-3) Ian Goon (UNSW) Fabrication and Dispersion of Gold Shell Protected Magnetite Nanoparticles for Biomedical and Environmental	(12-3) Sima Aminorroaya-Yamini (UQ) Effect of titanium addition to low carbon, low manganese steels on titanium nitride precipitation in cast slabs
14:40	15:00	(11-4) Chengtie Wu (USyd) Mesoporous Bioglass/PLGA Composites For Bone Tissue Engineering	(12-4) Alireza Asgari (Deakin) Modelling and Characterisation of Materials with Multiphase Microstructure
15:00	15:20	(11-5) Krasimir Vasilev (USouthAust) Amine plasma polymer films loaded with silver nanoparticles for antibacterial coatings	(12-5) Andreas Jahja (UNSW) Deformation Mechanisms in TiN-Based Thin Film Structures
15:20	15:40	(11-6) May Lim (UNSW) Cellular uptake of biocompatible polymer coated iron oxide nanoparticles	(12-6) Richard Clements (USyd) The Electronic and Crystal Structure of Lanthanide Zirconates
15:40	16:00	(11-7) Rangam Rajkhowa (Deakin) Silk particles reinforced macro-porous composite silk fibroin scaffolds for bone tissue engineering	(12-7) Pasquale Aliberti (UNSW) Preparation and mechanical properties of Ti-Nb alloy foams with different porosities and pore sizes
16:00	16:30	Afternoon Tea Break - 30 minutes	
16:30	17:30	Session 13	Short Presentation 3: Functional See detail at end of program.
17:30	18:00	Poster Viewing - 30 minutes	
18:00	19:00	Session 14	Short Presentation 4: Characterisation See detail at end of program.
19:00	19:30	Poster Viewing - 30 minutes	



Day 3: Wednesday, 17th December 2008

8:30	10:00	Session 15	Plenary Presentations 3
8:30	9:15	Xungai Wang (Deakin) Multi-disciplinary research on fibres and fibrous materials	
9:15	10:00	Rob Short (USouthAust) Plasma Polymerisation and The Living Bandage	
10:00	10:30	Morning Tea Break - 30 minutes	
10:30	12:50	Session 16 Materials Characterisation 2	Session 17 Structural And Functional 2
10:30	10:50	(16-1) Yang Cao (USyd) Severe Plastic Deformation Induced Phase Transformation in Duplex Stainless Steel	(17-1) Glenna Drisko (UMelb) One-pot synthesis of hierarchical metal oxide beads for the adsorption of uranyl
10:50	11:10	(16-2) Ming Liu (UQ) Initial film formed on the surface of intermetallic Al ₃ Mg ₂ in water	(17-2) Javad Foroughi (UWollongong) How artificial muscles can be improved using polypyrrole
11:10	11:30	(16-3) Yanbo Wang (USyd) Stacking Fault/Twin Boundary Effect on Grain Refinement in Cu-30wt.% Zn Processed by High Pressure Torsion	(17-3) Daniel Lin (USyd) Functionally Graded Dental Implant and its Effect on Bone Remodeling: A Numerical Approach
11:30	11:50	(16-4) Feng Tang (USyd) Study of nanocomposite Ti-Si-N film by pulsed laser atom probe (PLAP) tomography	(17-4) Maksym Rybachuk (QUT) Uncommon properties of common carbon coatings: surface modified coatings and hosts to basic polymers and carbyne.
11:50	12:10	(16-5) Yuncang Li (Deakin) Cytotoxicity Study of Titanium Alloying Elements Using Human Osteosarcoma Cells	(17-5) Jinfeng Wang (Deakin) Optimizing the UV Protection of textile with reduction of photocatalytic activity of ZnO
12:10	12:30	(16-6) Rui Ping Hoo (UNSW) Analysis of Elastic 'Viscous' Plastic Deformation Behaviour of Cortical Bone determined by Nanoindentation and Analytical	(17-6) Haimin Zhang (Griffith) Effect of pH on Photoelectrocatalysis Process at Nanostructured TiO ₂ Film Electrodes
12:30	12:50	(16-7) Talukder Alam (USyd) Investigation of IN718 in The Early Stages of Aging by Atom Probe Tomography	(17-7) Bjorn Winther-Jensen (Monash) Pt-free air electrode for battery and fuel-cells
12:50	13:40	Lunch Break - 50 minutes	
13:40	16:00	Session 18 Materials Characterisation 3	Session 19 Structural And Functional 3
13:40	14:00	(18-1) Daniel Haley (USyd) Evaporative Influence on Radial Distribution Functions in Atom Probe Tomography	(19-1) Ian Watson (ANSTO) Complementary In-situ Neutron and High-Energy X-Ray Powder Diffraction Analysis of the Phase Transformations in Titanium
14:00	14:20	(18-2) Ulf Garbe (ANSTO) New Instrument Concept for Local Texture Measurement with Neutron Radiation	(19-2) Bashir Samsam (UWA) Evaluation of thermo-mechanical behaviour of functionally graded structures based on classical and shear deformation theories
14:20	14:40	(18-3) Avinash Baji (USyd) Effect of fiber diameter on tensile properties of electrospun poly(ϵ -caprolactone)	(19-3) Qiao Yu Qiu (UNSW) Film thickness versus misfit strain phase diagrams for ultra-thin epitaxial ferroelectric films
14:40	15:00	(18-4) Kun Yan (ANSTO) From the single grain to texture	(19-4) Xiaoxia Yan (UQ) Nitrogen Doped Layered Tantalate and Niobate with Highly Visible Light Absorption
15:00	15:20	(18-5) Abdullah-Al Kafi (Deakin) Analysis of the effects of atmospheric helium plasma on the surface structure of jute fibers and resulting composite properties	(19-5) Fei Jiang (UWA) Effect of Aging Treatment on the Transformation and Mechanical Behaviour of Ti-50.9at.%Ni Alloy
15:20	15:40	(18-6) Anna Sokolova (ANSTO) Soy glycinin: from chemical solutions to real food powders. Influence of pH and ionic strength on the protein quaternary structure.	(19-6) Mazlina Mat Darus (UWA) Morphology Evolution of Silver/Carbon Hybrid Nanomaterials Synthesized via Hydrothermal Technique
15:40	16:00	(18-7) Eric Tavenner (USouthAust) X-ray Photoelectron Analysis of Ion Implanted and Ion Beam Mixed Polyetheretherketone	(19-7) Zhenhua Luo (UNSW) Damaged near electrode regions in Lead Zirconate Titanate (PZT) induced by electric fatigue





Day 1: Short Presentations

16:30	17:30	Session 6	Short Presentation 1: Electronic
(06-01)	Mohammad Al Assadi	(UNSW)	First-principles Calculations, Enhanced Ferromagnetism in Nitrogen codoped ZnO:Co
(06-02)	Andrew Arulsamy	(USyd)	Ionization energy dressed electron-phonon interaction applied to under-screened Kondo metal
(06-03)	Marcus Doherty	(UMelb)	Ab-initio determination of the electronic and optical properties of the nitrogen-vacancy centre in
(06-04)	Daniel Drumm	(UMelb)	Hybrid Density Functional Theory modelling of single atom defined nanostructures
(06-05)	Cameron Evans	(UWA)	A simple method towards self-assembled superparamagnetic quantum dots
(06-06)	Barbara Fairchild	(UMelb)	Towards a single mode waveguide in single crystal diamond
(06-07)	Javad Foroughi	(UWollongong)	Production of high performance polypyrrole fibres by wet spinning
(06-08)	Kumaravelu Ganesan	(UMelb)	Optical waveguide fabrication and characterization in single crystal diamonds
(06-09)	Nathaniel Groothoff	(USyd)	Time-resolved plasma density measurements in silica-based glasses exposed to IR femtosecond laser
(06-10)	Karel Hartlieb	(UWA)	Simple, "green" synthesis of small silver nanoparticles tailored by phosphonated calixarenes
(06-11)	Mykanth Mada	(UNSW)	Microstructure and Percolation threshold of Activated charcoal-PMMA nano composites.
(06-12)	Mykanth Mada	(UNSW)	Electrical conductivity of Activated charcoal-PMMA nano composites.
(06-13)	Alireza Moridi Farimani	(UNSW)	Study of the surface integrity of micro-abrasive jet machined surfaces on a synthetic quartz crystal
(06-14)	Sam Ogden	(Flinders)	Silane Functionalisation of Mechanochemically Prepared Iron Oxide Nanoparticles
(06-15)	Daniel Pyke	(ANU)	Strained Semiconductors Influencing Hydrogen Transport & Trapping For Wafer Cleaving
(06-16)	David Wyndham	(UWA)	An In-situ monitoring system for characterizing porous silicon growth
(06-17)	Min Yang	(Griffith)	Photoelectrocatalytic Activity of TiO ₂ /Carbon Nanotube Nanocomposite
(06-18)	Yuebin Zhang	(UNSW)	Hydrothermal epitaxy of ZnO:Co diluted magnetic semiconducting single crystalline films
18:00	19:00	Session 7	Short Presentation 2: Manufacturing/Energy
(07-01)	Yiqing Chen	(USyd)	Establishing the Polishing Map in Dynamic Friction Polishing of Polycrystalline Diamond Composites
(07-02)	Matthew Franklin	(UWollongong)	Short-term high-temperature oxidation of tubular-shaped metallic specimens using the Gleeble thermal-mechanical simulator
(07-03)	Christopher Hurren	(Deakin)	The Effect Of Ultrasonic Agitation In An Aqueous Environment On The Mechanical Properties Of Single Wool Fibres
(07-04)	Hejie Li	(UWollongong)	Analysis of the Surface Morphology of 6060 T5 Aluminum Plate in Uniaxial Compression
(07-05)	Porun Liu	(Griffith)	Hydrothermal Synthesis of Titanate Nanotubes via a Seeded-Growth Mechanism
(07-06)	Haitao Niu	(Deakin)	Needleless Electrospinning study using Cylinder and Disk Nozzles
(07-07)	King Pang	(UNSW)	Micromachining using Low Pressure Slurry Jet
(07-08)	Michael Pereira	(Deakin)	Contact Pressure Prediction in Sheet Metal Forming Using Finite Element Analysis
(07-09)	Reza Rafiee	(Deakin)	Contact Pressure Prediction In Sheet Metal Trimming/Blanking Process Using FEM
(07-10)	Bernard Rolfe	(Deakin)	Analysing variation in the manufacture of automotive structural members
(07-11)	Zhongyuan Tan	(Deakin)	Review on phase change materials and its applications
(07-12)	Xin Wang	(Deakin)	Needleless Electrospinning of Nanofibres with a Conical Wire Coil
(07-13)	Matthias Weiss	(Deakin)	Experimental and numerical investigation of tool wear in forming of Advanced High Strength Steels
(07-14)	Nima Yazdipour	(Deakin)	Recrystallization Simulation During and After Deformation through Cellular Automaton Approach
(07-15)	Rongliang He	(Deakin)	Synthesis and characterisation of blackberry-shaped ZnO nanoparticles
(07-16)	Timothy Khoo	(Monash)	Interfacial properties of Magnesium battery electrodes.
(07-17)	Ya Ting Lee	(UNSW)	Hydrogen Storage of CNTs with Microwave Treatment
(07-18)	Guiying Li	(Griffith)	Photoelectrocatalytic Oxidation of Uracil at Nanoparticulate TiO ₂ Photoanodes
(07-19)	Lihong Li	(Griffith)	Synergetic Photoelectrocatalytic Oxidation of Linear Aliphatic Acids at Nanoparticulate TiO ₂ Electrode
(07-20)	Puwang Li	(Deakin)	Preparation and characterization of chitosan nanoparticles for targeted drug delivery of 5-FU to colon
(07-21)	May Lim	(UNSW)	Preparation of silver doped TiO ₂ coating for bactericidal application
(07-22)	Aris Nugroho	(Curtin)	The Development Of Porous Ti-Nb-Ta-Zr Alloy By Powder Metallurgy
(07-23)	Steven Petinakis	(CSIRO)	The Fracture Morphology and Mechanical Properties of Biodegradable Polyester Composites
(07-24)	Yogambha Ramaswamy	(USyd)	Bioactive Spheene Ceramics: Potential material for Orthopedic Coating Applications
(07-25)	Chee Howe See	(USyd)	Towards integrated biorefineries
(07-26)	Quansheng Song	(UNSW)	Effects of Carbon Nanotubes in 3D Porous Nickel-Foam Electrodes for Rechargeable Nickel Batteries
(07-27)	Ping-JU Tsai	(UNSW)	Effects of Multiwalled Carbon Nanotubes on the Electrochemical Performance of AB5-based Ni-MH
(07-28)	Yanwei Tang	(Deakin)	3D Fibrous Tissue Scaffolds: Influence of Porosity on the Cell Culture Performance
(07-29)	Yichao Wang	(Deakin)	PLGA nanoparticles prepared by emulsion-solvent evaporation method: Optimization of process



Day 2: Short Presentations

16:30	17:30	Session 13	Short Presentation 3: Functional
(13-01)	Nicholas Absalom	(USouthAust)	An investigation into the effects on morphology, electrochromic response and conductivity of rapid-mixing wet chemical polymerisation and vapour phase polymerisation of polyaniline
(13-02)	Shuk Yan Cheng	(Monash)	Synthesis of Chitosan/ Jojoba Oil Microcapsules for Skin Caring Fibrous Materials and their
(13-03)	Shuk Yan Cheng	(Monash)	Investigation of Host-Guest Interactions on TiO ₂ Treated Fibrous Materials modified with Beta-
(13-04)	Sukfun Chin	(UWA)	Encapsulation of Superparamagnetic Magnetite Nanoparticles in Ultrathin Plasmonic Shells
(13-05)	Mohammad Choucair	(UNSW)	New Routes to Carbon Nanostructures
(13-06)	Darren Cram	(Monash)	Physically-based Modeling of the Dynamic Recrystallization of Metals
(13-07)	Ali Dehghan-Manshadi	(Wollongong)	Hot Deformation Characterization of Low Carbon, Low Manganese, Titanium added Pipeline Steels
(13-08)	Hui Diao	(QUT)	Analysis of Nanoindentation of Bulk Nanocrystalline and Amorphous Alloy
(13-09)	Jessirle Dilag	(Flinders)	Cadmium sulfide quantum dots in a chitosan matrix for latent fingerprint detection
(13-10)	Xusheng Du	(USyd)	Mechanochemical polymerization of polyaniline dendritic nanofibers and their electrochemical
(13-11)	Alireza Ghaderi	(Deakin)	Effect of grain size on deformation twinning behaviour of commercially pure titanium
(13-12)	Zohreh Keshavarz	(Deakin)	The Static Recrystallisation Behaviour of Magnesium Alloy AZ31
(13-13)	Adam Martin	(UWA)	Phosphonic Acid Functionalised Calixarenes
(13-14)	Cameron Shearer	(Flinders)	Vertically aligned single-walled carbon nanotube arrays on porous silicon
(13-15)	Philip Speck	(UNSW)	Metal Dusting of Nickel-Aluminium Alloys
(13-16)	Shokoufeh Malekjani	(ANU)	The effect of annealing time on the microstructural evolution and mechanical properties of an ultrafine
(13-17)	Wing Sze Tung	(Monash)	Photocatalytic Keratin Fibers
(13-18)	Wing Sze Tung	(Monash)	Photocatalytic Self-Cleaning Surface Functionalization of Keratins
(13-19)	Mingliang Wang	(UWA)	Electrochemical synthesis of metallic nanowires using porous anodized alumina template
(13-20)	Guiqing Wen	(Deakin)	The Effect of pH on Dye Sorption by Wool Powders
(13-21)	Zhigang Wu	(UWA)	Effects of solution treatments on the martensitic transformation and magnetic transition behaviours of Ni ₄₃ Co ₇ Mn ₃₉ Sn ₁₁ ferromagnetic shape memory alloy
(13-22)	Yimeng Yang	(UWA)	Effect of heat treatment on chemical composition and bonding configuration of PECVD SiN _x thin films for MEMS application
(13-23)	Suyun Ye	(UNSW)	Hydrogen storage properties of Mg-Pd multi-layer thin film prepared by magnetron sputtering
(13-24)	Yang Yu	(USouthAust)	Advanced Nanoscale Materials Fabricated from Diatomaceous Earth
(13-25)	Sarah Zhang	(UNSW)	FRP-An alternative reinforcement for reinforced concrete slabs
(13-26)	Yan Zhao	(Deakin)	Superhydrophobic modification of normally hydrophilic cotton fabrics
(13-27)	Jianli Zou	(UWA)	Synthesis of PVP-palladium hybrid nanoparticles under continuous flow
18:00	19:00	Session 14	Short Presentation 4: Characterisation
(14-01)	Benjamin Adamson	(Deakin)	A Fractography Analysis on Advanced Melded Joints.
(14-02)	Pasquale Aliberti	(UNSW)	Study Of Optical Properties Of Silicon Quantum Dots In A Silicon Dioxide Matrix For Energy Selective Contacts
(14-03)	Weimin Gao	(Deakin)	Thermodynamic and Kinetic Modelling Diffusion-controlled Phase Transformation during Hydrogenization of Titanium Particles
(14-04)	Yanan Guo	(UQ)	Phase Separation of Epitaxial InGaAs Ternary Nanowires
(14-05)	Nur Farhana Hayazi	(UNSW)	Effect of Oxide Inclusions on the Aging Behavior of Powder Metallurgy AA 2014
(14-06)	Sha Li	(USyd)	APT Characterisation of Solute Clustering in 6111 Al Alloy
(14-07)	Jenny Lin	(UQ)	Mechanical Properties of Human Femoral Cortical and Trabecular Bones Measured by Nanoindentation
(14-08)	Klaus-Dieter Liss	(ANSTO)	Become a Professional: Do It In Q-Space
(14-09)	Charles Loo Chin Moy	(USyd)	The microstructure and properties of cold gas dynamic spray (CGDS) Ti powder coatings
(14-10)	Ross Marceau	(USyd)	Understanding Solute Segregation to Dislocation Loops Formed During the Early Stages of Ageing of Al-Cu-Mg Alloys
(14-11)	Maryam Naebe	(Deakin)	Use of Plasma to Enhance the Shrinkproofing of Wool with a Silicone Polymer
(14-12)	Nor Dalila Nor Affandi	(CSIRO)	Effect of spinneret diameter on fibre morphology of electrospun membranes
(14-13)	Alokesh Pramanik	(USyd)	Deformation of metal matrix composites- A 3D FEM analysis
(14-14)	Nigel Ross	(Deakin)	Role of particles on mechanical properties in magnesium alloys
(14-15)	Aaron Südholz	(Monash)	On the Corrosion of Binary Magnesium-Rare Earth Alloys
(14-16)	Banchachit Saensunon	(UNSW)	Crystal field interaction at the Tm ³⁺ site in TmCr ₂ Si ₂
(14-17)	Noorasikin Samat	(UNSW)	Fatigue behaviour of PVC nanocomposites (CaCO ₃)
(14-18)	Mary She	(Deakin)	3-D Image Analysis Of Nanofiltration Membrane Porous Structure
(14-19)	Danny Wee	(UWA)	Characterisation of minority carrier diffusion length in Gallium Nitride using the Electron-Beam Induced Current technique
(14-20)	Matthias Weiss	(Deakin)	A new test routine for the characterization of roll forming materials
(14-21)	William Wen	(Griffith)	In-Situ Determination of Organic Adsorption at TiO ₂ Photocatalyst
(14-22)	Yi Sun Wu	(UMelb)	Diffraction analysis of nano-crystalline materials after severe plastic deformation
(14-23)	Wanqiang Xu	(UNSW)	A 3-D Study Of Nucleation Of Recrystallization In Cold Rolled IF Steel Using Fib-Ebsd Tomography
(14-24)	Richard Yang	(Deakin)	FE Mesh Generation for the Unit Cell Approach of Micro-structured Metals and Alloys
(14-25)	Akhmad Zaeni	(UNSW)	The effect of fly ash on mechanical and morphological properties of fly ash -polypropylene composite.
(14-26)	Hu Zhang	(Deakin)	The Photostability of Wool Doped with Photocatalytic Titanium Dioxide Nanoparticles



Paul Meredith

(University of Queensland)

Smart State Senior Fellow

University of Queensland School of Physical Sciences

Advanced Optoelectronic Materials for a Sustainable Future

The World is facing a serious energy crisis. Coupled with this, many believe the planet to be in the early stages of climate change caused by our consumption of fossil fuels and constant polluting activities. Even the most ardent environmentalist would concede that we cannot immediately stop using fossil fuels or instantaneously abandon current manufacturing processes. We must solve our energy problems and mitigate global warming by a progressive transition from fossil fuels to alternative, sustainable energy. A critical part of this process is the creation of environmentally friendly high tech materials to replace those currently used. For example, the formation and processing of silicon that is used in solar cells and many electronic applications is energy and dollar intensive and highly polluting.

In my talk I will cover recent progress in the field of sustainable optoelectronic materials. I will particularly focus on our work within the Centre for Organic Photonics & Electronics at the University of Queensland in application areas such as organic solar cells, coatings to boost solar energy conversion and organic chemi-sensors. The central theme of our research is establishing consistent structure-property relationships to guide materials design and I will also discuss a case example of a bio-organic optoelectronic material where this approach has yielded new insight and new materials.

Bragg gratings in photonic crystal fibres: Progress and applications

Kevin Cook
John Canning
Nathaniel Groothoff
John Holdsworth
Alexandre A P Pohl

We report some of our recent progress made in the area of Bragg grating inscription in photonic crystal fibres (PCFs) and discuss the potential applications. The inscription of Bragg gratings in microstructured fibres such as PCFs and Fresnel fibres is far from trivial. A number of challenges need to be circumvented. Of these, scattering by the air-structured cladding combined and a typically low-photosensitive core are the two main problems. Rotational variance of fibre symmetry, in contrast to conventional fibres, also hinders reproducibility. To overcome the scattering, an intense 193nm laser source is used together with rotational control to demonstrate the efficient writing of Bragg gratings in highly nonlinear PCF with a 12-ring cladding. Direct excitation of the germanosilicate core leads to the formation of a type I grating and, with continued exposure, a so-called type IIa grating. These gratings, however, are shown to exceed the performance of conventional type IIa gratings and can withstand temperatures up to 700°C. This high durability makes these kind of gratings highly suitable for nonlinear optics applications. In other work, we have demonstrated the fabrication of a distributed feed-back (DFB) laser in germanium-free, erbium-doped PCF with a narrow linewidth of <10kHz. In this case, the grating is formed by 2-photon absorption at the band-edge of the aluminosilicate core glass using 193nm radiation. The DFB is implemented in a ring cavity configuration, which ensures stable, single-mode, CW operation and overcomes the unwanted effect of self-pulsing. The applications of such a DFB to spectroscopic applications are discussed.



Presenting Author: **Dr Kevin Cook**
Postdoctoral research fellow

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AUSTRALIA

Research Activities:

My current research focusses on writing Bragg gratings into optical waveguides such as photonic crystal fibres. Gratings inscribed in such fibres can have many applications as sensors, spectroscopy and novel lasers sources.

Tunable light emission using quantum dot coated upconverters

Tich-Lam Nguyen

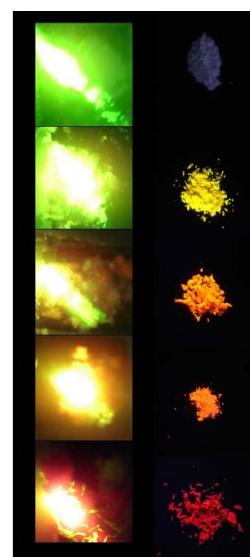
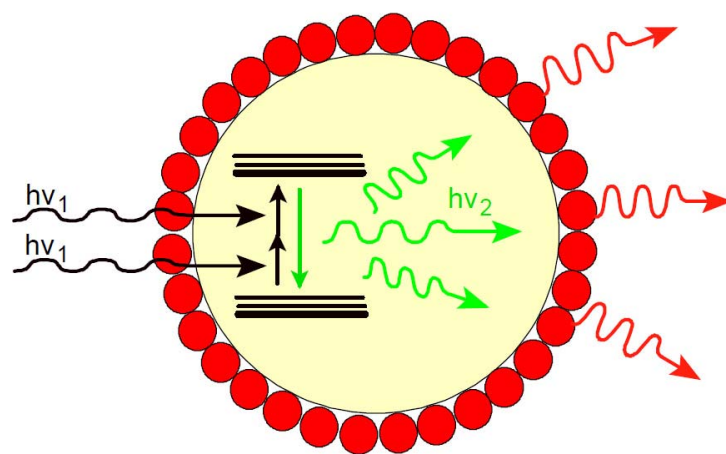
Paul Spizzirri

Gerry Wilson

Paul Mulvaney

Fluorescent upconverting crystals (UCs) typically consist of metal oxides doped with lanthanide ions. When excited in the near infrared (NIR), the ions upconvert either through a non-linear 2-photon absorption process or by sequential absorption of photons via the formation of a long lived intermediate state. Such upconverters have a variety of potential uses in solar energy conversion and optical labelling, however they are currently limited by the narrow range of emission wavelengths available. One solution to this problem is to use semiconducting nanocrystals or quantum dots (QDs) to tailor the UC emission characteristics. Quantum dots are well known for their size tunable emission properties. In principle the combination of strong up-converter absorption with tunable down-conversion from semiconducting QDs provides a method for creating tunable upconverters.

We demonstrate a simple method for encapsulating NIR upconverters such that they can emit at any tunable visible wavelength with a high emission quantum efficiency. By coating conventional NIR upconverters with multilayers of QDs, the upconverted emission is absorbed by the QD coating (i.e. radiative energy transfer) which then re-emits at its design (visible) wavelength, a feature that is not available with current lanthanide based upconverters. The resulting tunable fluorophores are extremely photostable and can be transferred into glassy or polymer matrices. This process cannot generally be exploited with molecular species such as dyes because of their smaller absorption cross-sections. Importantly, the absorption cross-section of the QDs is high enough that just a few monolayers on the UC surface are sufficient to ensure both a high yield of radiative energy transfer and emission efficiency.



IR excitation UV excitation

Presenting Author: Dr Tich-Lam Nguyen

Plasmon Interactions of Closely-Spaced Au Nanoparticles

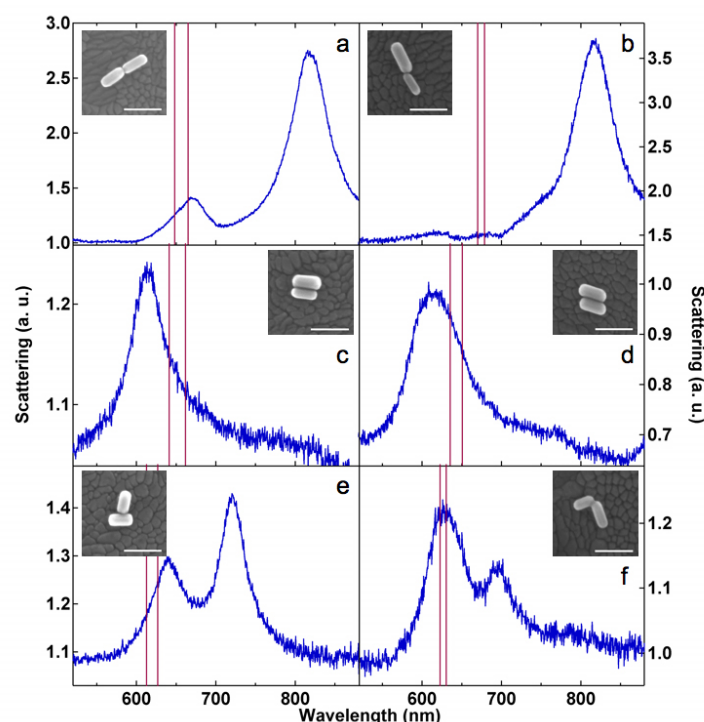
Alison M. Funston, Carolina Novo, Paul Mulvaney

Miniaturisation of metals to form nanoparticles results in the spatial confinement of conduction electrons within the particles. The collective oscillation of the conduction electrons gives rise to the localised surface plasmon resonance (LSPR) and the characteristic colours of metal nanoparticles. When two particles are located close to one another, the LSPRs of the two particles interact. Previous investigations into these interactions have predominantly utilised electron beam lithography (EBL). However, the resolution limit of modern EBL is about 10nm and experimental fabrication and investigation of particle pairs less than 2nm apart has remained a challenge.

We report our investigation into the coupling between two discrete nanoparticles, specifically gold nanorods, with interparticle distances smaller than 2nm and with the pairs in different orientations. The particles were chemically synthesized and are single crystals. The investigation was carried out utilizing the recently reported Focussed Ion Beam Registration Method[1,2] allowing correlation of the SEM image of the particle pairs with their scattering spectrum. The scattering spectra and SEM images of particle pairs arranged side-to-side, end-to-end and at right angles were collected, (Figure 1) as well as some pairs arranged side-to-side but with a lateral displacement between the two particles. The observed spectra are compared with those calculated using the discrete dipole approximation (DDA) and discussed in terms of plasmon hybridization.

1) Novo, C., Funston, A. M., Pastoriza-Santos, I., Liz-Marzán, L. M., Mulvaney, P., *Angew. Chemie. Int. Ed.*, 2007, 46, 3517-3520.

2) Novo, C., Funston, A. M., Mulvaney, P., *Nature Nanotech.*, 2008, 3(10), 598-602.



Presenting Author: **Dr Alison May Funston**
Research Fellow

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Flemington Rd, The University of Melbourne, 3010

Research Activities:
Plasmonics, Solar Photovoltaics, Nanotechnology

Flash light illuminated gold nanoparticle cluster heat generation

Nan Zeng

Antony B. Murphy

Gold nanoparticles can absorb light and convert the electrical magnetic energy to heat through surface plasma resonance. The heat generated this way has great potential to be used in many areas, such as in photothermal therapy or making biosensors. Normally, to raise the temperature of a single gold nanoparticle sufficient high requires powerful lasers. In order to achieve the same effect with a less powerful light source, a cluster of nanoparticles can be used instead. This enhancement of heat generation is partly due to the light multi-scattering among nanoparticles, and partly due to the overall thermal energy generated by the cluster. Using T-matrix method and finite element method, we studied the temperature distribution of a cluster of nanoparticles embedded in a dielectric material under flash light illumination. Different configurations of the cluster were calculated and the results were discussed.

Presenting Author: **Dr. Nan Zeng**
Research Activities:
Nanoscale thermal transport

The Development of a New Magnesium Alloy for Extrusion

A.G. Beer
D. Atwell
M.R. Barnett
C.H.J. Davies
M. Easton

Due to environmental concerns, reducing the weight of vehicles for improved fuel efficiency is now a priority for the automotive industry. Magnesium is a potential material for a range of automotive applications due to its low density. The consumption of magnesium alloys by the automotive industry is primarily in the form of die castings. However, wrought magnesium products have the advantage of a higher strength and ductility than castings and can thus be applied to structural applications.

The current applications of wrought magnesium are relatively limited, which can be ascribed to the slow production speed of existing alloys, when compared to aluminium alloys, resulting in a more expensive final product. The main objective in developing a new magnesium extrusion alloy has been to increase the rate of extrusion whilst still retaining good mechanical properties.

The metallurgical principles which govern how fast a magnesium alloy can be extruded, and the resultant mechanical properties of the extrudate, were examined. The understanding gained led to the development of a new magnesium extrusion alloy, AM-EX1, which possesses similar extrusion rates as aluminium alloy AA6063 whilst maintaining comparable mechanical properties. AM-EX1 can also be extruded more than twice as fast as the commonly used magnesium alloy AZ31 whilst possessing a similar strength and a greatly enhanced ductility.

Presenting Author: **Dr Aiden G Beer**
Research Academic

Geelong Technology Precinct
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Research Activities:
Current research topics include the development of new magnesium alloys, the deformation and annealing of magnesium alloys, and in-situ annealing experiments combined with electron back scattering diffraction.

Understanding and Minimizing Steel Oxidation in Direct Fired Furnaces

Huaying Yin

Low carbon steel is often coated with zinc or an Al-Zn alloy for corrosion protection. As part of the process, steel strip is heated in a direct fired furnace before entering the molten coating metal. There is a risk of steel oxidation in the furnace when unexpected stoppages occur. In this work, steel oxidation kinetics were investigated at 800°C to 1100°C in $N_2-(6-x)H_2-xH_2O$ ($x=3,4,5$) gas mixtures. At 800°C, the kinetics followed a linear rate law, with a rate proportional to the partial pressure of water vapour. Varying the gas flow rate did not change the oxidation rate, indicating that the oxidation was controlled by a surface reaction. At 900 to 1000°C, parabolic kinetics were observed, with the oxidation process being controlled by solid-state diffusion in the oxide scale. The equilibrium oxygen partial pressure in the gas mixture was given by $p_{O_2} = \exp(-\frac{2\Delta G^\circ}{RT})$. Oxidation rates were correlated with the ratio p_{H_2O}/p_{H_2} and the absolute value of p_{H_2O} . At 1100°C, the kinetics followed a linear rate law, and the rate was proportional to the square root of gas flow rate, suggesting that gas phase mass transfer was the controlling step. Reaction kinetics are discussed in terms of oxide scale morphologies and phase constitutions as determined by scanning electron microscopy, cross-sectional metallography and X-ray diffraction.

Keywords: oxidation; linear rate; parabolic rate; wstite.

Presenting Author: **Ms Huaying Yin**
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Research Activities:

· High temperature corrosion of iron and steel, especially focus on metal dusting phenomenon. · Focus on metal dusting of iron and Fe-2.25Cr-1Mo

A development of a Grinding Wheel System for Coolant Minimisation

*Thai Nguyen
Liangchi Zhang*

This paper investigates the mechanical and thermal effectiveness of a new segmented grinding wheel system with controlled radial coolant supply. The applicability of the system was examined on the grinding forces, specific energy and ground surface integrity in plunge grinding of AISI 4140 steel. Compared with a standard grinding wheel, the new system enabled a much efficient coolant penetration into the grinding zone where specific energy was lower while less coolant could be used. It was found that the new grinding system could effectively maintain the sharpness of active cutting edges, evidenced by the minimisation of ploughing and rubbing deformation. The cleaning capacity of the wheel was much improved and chip loading on wheel surfaces was avoided. Meanwhile, the new wheel system generated better surface integrity without tensile residual stresses.

Presenting Author: **Dr Thai Hien Hoa Nguyen**
ARC APD

School of AMME
The University of Sydney
NSW 2006, Australia

Effect of processing conditions on fibre/matrix adhesion and fracture toughness of thermoplastic toughened CFRP composites

Jin Zhang and Bronwyn Fox

HexPly914 and T800H/3900-2 are both commercial thermoplastic toughened carbon epoxy composites; however, the toughening mechanisms are different. The HexPly914 has a semi-interpenetrating network (IPN) type of toughening, in which the thermoplastic is dispersed into the epoxy resin; the T800H/3900-2 utilizes thermoplastic interlayer toughening mechanism in which the thermoplastic particles are dispersed onto the surface of the carbon/epoxy lamina to achieve high fracture toughness. Two types of composites were fabricated by applying different heating rates. Double cantilever beam (DCB) test results showed an 86% increase in the average value of propagation mode I fracture toughness (GIC-PROP) for the HexPly914 and a 161% increase in the average GIC-PROP for the T800H/3900-2 cured with faster heating rate (10°C/min). The glass transition temperature (T_g) was 18% higher for the HexPly914 and 5% higher for the T800H/3900-2 cured with the faster heating rate. The fast heated out-of-autoclave process also resulted in a better fibre/matrix adhesion in these composites.



Presenting Author: **Dr Jin Zhang**
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Domain wall pinning mediated by stray magnetic fields

P.J. Metaxas (1,2)

P.J. Zermatten (3)

J.P. Jamet (2)

J. Ferre (2)

G. Gaudin (3)

B. Rodmacq (3)

A. Schuhl (3)

R.L. Stamps (1)

(1) School of Physics, University of Western Australia

(2) Laboratoire de Physique des Solides, Orsay, France

(3) SPINTEC/CEA, Grenoble, France

Control of magnetic domain wall pinning is an important issue for future generations of spintronic devices which depend upon reliable domain wall positioning. Current methods for pinning domain walls in magnetic film structures generally involve the creation of holes or notches in the film. However, this results in complex effects due to the associated film discontinuity. In this work, we have created a periodic pinning potential for domain walls moving in a continuous ferromagnetic [Pt/Co]₂ film without altering the structure of the film itself, thereby maintaining its intrinsic properties. This is achieved by patterning an array of 200nm wide ferromagnetic dots above the film. Similar to a classical bar magnet, a stray magnetic field surrounds each dot, penetrating the film and locally impeding domain wall motion.

Local pinning due to the dots' stray fields is evident in images of the domain structure obtained using Kerr microscopy. However, the domain walls are also pinned by structural inhomogeneities intrinsic to Pt/Co films which are known to result in a complex regime of wall motion referred to as creep. Indeed, we show that the energy barriers associated with creep motion are unchanged by the periodic potential. Instead, its effect is that of a uniform retarding field which works against the applied field and whose magnitude depends on the relative orientation of the applied field and the magnetisation of the dots. This is the first quantitative determination of the effect of a periodic pinning potential on domain wall dynamics.



Presenting Author: **Mr Peter Metaxas**
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Australia

Research Activities:

Magneto-optical investigations of domain wall dynamics in ultrathin magnetic film structures.

Buried Electrically Conducting Structures in Diamond

Virginia S. Gill

David N. Jamieson

MeV ions have long been used to characterise materials, but using the implanted ions themselves to make devices is a concept that has only recently been investigated in any detail. Diamond lends itself well to implantation by high energy ions because of its robustness. If implantation concentrations are kept below a critical threshold, the diamond above the implanted layer will anneal back to pure diamond. Alternatively, graphitic layers can be created by exceeding this critical dose at depth, then annealing to again return the region above the implant to pristine diamond.

This presentation reviews electrical structures created with different ion species, implantation energies and fluences. The resistivity, I-V characteristics, breakdown voltages and swelling of the diamond produced by these different implantation conditions are compared. Preliminary results from graphitic layers created by MeV ion implantation through a mask are also presented.

Presenting Author: **Miss Virginia Sue Gill**
PhD Student

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Research Activities:
Studying properties of diamond and fabricating structures within diamond.

Hydrothermal synthesis and physical properties of oxide multifunctional materials with controlled morphologies

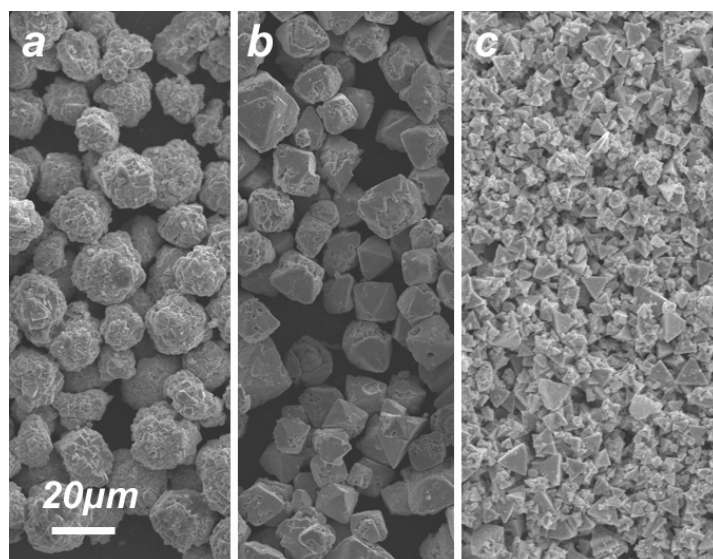
Y. Du
Z. X. Cheng
X. L. Wang
S. X. Dou

A series of bismuth iron oxides, including BiFeO_3 , $\text{BiFe}_{1-x}\text{Cr}_x\text{O}_3$ ($x=0, 0.025, 0.05, 0.075$, and 0.1), $\text{Bi}_{1-x}\text{La}_x\text{O}_3$ ($x=0.1, 0.2$, and 0.3), and $\text{Bi}_{25}\text{FeO}_{40}$, were prepared via a hydrothermal method. The shapes of particle can be tuned from spherical to octahedral and tetrahedral by different synthesis conditions. All the synthesized oxide materials were monodispersed in their dimensions. The concentration of mineralizer KOH and pH value of solutions were proved as the key factors to control micron morphologies. X-Ray Diffraction measurement shows that all of the obtained particles are pure phases. Ferroelectric measurement revealed that pure and Cr/ La doped BiFeO_3 were ferroelectric materials. The electrical leakage was decreasing with increasing Cr and La doping level. M-H loop, field cooled and zero field cooled magnetization measurement showed that $\text{Bi}_{25}\text{FeO}_{40}$ was ferromagnetic at low temperature. The valences and spin states of Fe ions will also be discussed

Acknowledgement

We would like to thank the funding support from the ARC, and Mr Yung Kent from UNSW for carrying out SEM experiments. Yi D. is thankful for IPRS and UPA for his PhD study.

Figure Caption: SEM images of (a) pure spherical BiFeO_3 , (b) octahedral $\text{BiFe}_{0.9}\text{Cr}_{0.1}\text{O}_3$, and (c) tetrahedral $\text{Bi}_{25}\text{FeO}_{40}$.



Presenting Author: **Mr. Yi Du**
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Low-Temperature Embrittlement of Lead Free Solder Interconnections

*Ranjan Rajoo,
E.H.Kisi,
D.J.O'Connor*

Portable electronic products are susceptible to drop impact failure. These failures are the result of the high strain rate deformation of the solder joints which occurs when the printed circuit board flexes. With the introduction of lead-free solder (which fails in a more brittle manner than the conventional lead solder) and the general trend towards miniaturisation of portable electronics (which translates to smaller, weaker solder joints), these failures have become more common. This is especially the case in harsh environments such as those with low temperatures. Material characterisation of the solder joints to determine the fracture loads, displacement and the interface where the failure occurs will aid in the designing for reliability of portable electronics.

Solder joint characterization at a range of low temperatures (-60°C to 10°C) has been carried out using the newly-developed 'micro-impactor'. This tester is capable of exerting a high-strain rate loading onto a solder joint and measuring both the dynamic impact force and the displacement during the entire event. Miniaturise test fixture with the use of liquid nitrogen was used to set the temperature of the specimens prior to testing. 4 different lead free solder alloys: Sn1%Ag0.5%Cu, Sn2%Ag0.5%Cu, Sn3%Ag0.5%Cu, Sn4%Ag0.5%Cu and 1 lead based Sn37%Pb solder alloy were tested. Solder alloys interconnections were formed and tested on 2 pad finishes : Electroless Nickel Immersion Gold & Organic Solderability Preservatives. Based on the results, the ductile-brittle transition temperature (DBTT) for each solder-pad finish system has been determined. 3 ~ 4% Ag have lower DBTT compared with 1 ~ 2% Ag contained solder alloys. OSP pad finishing is more robust compare to ENIG pad finishing at lower temperatures. This results will help designers pick the right solder material and finishing for their product, based on its working environment.

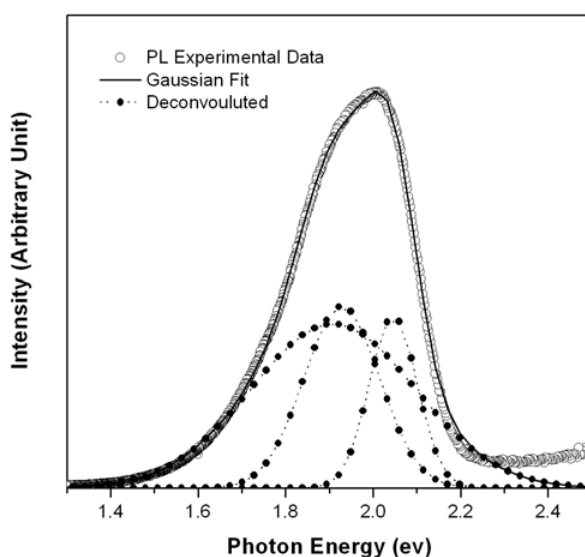
Presenting Author: **Mr Ranjan Rajoo**
Student

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Advances in the growth and characterization of multilayered Ge nanocrystals embedded in SiO₂ matrix

Bo Zhang, Santosh Shrestha, Fei Gao, Gavin Conibeer, Martin Green

Germanium (Ge) nanostructures have attracted much interest as a promising direction for the application of novel semiconductor devices. It has been predicted that the larger Bohr radius of bulk Ge (as compared to Silicon, Si) makes the quantum size effects more prominent. Furthermore the lower melting point of Ge implies that Ge nanostructures should be able to form at lower temperatures than Si. This is an important consideration both for processing compatibility and for long term process costs. In this study, we investigated the growth and properties of Ge nanocrystals embedded in a multiple bilayer structure of Ge-rich SiO₂ and GeO_x-rich SiO₂ films prepared by magnetron sputtering and subsequent thermal annealing. Transmission Electron Microscopy, X-ray Diffraction and Raman Spectroscopy indicated that Ge nanocrystals were successfully grown in the SiO₂ matrix at relatively low annealing temperatures down to 600°C. Optical absorption and photoluminescence measurements revealed a blue shift in absorption edges and photoluminescence peaks respectively. The corresponding changes in Ge band gap were tentatively attributed to the quantum confinement effect in Ge nanocrystals. Our initial work has indicated that Ge nanocrystals in a dielectric matrix may be a promising candidate, for engineering the band gap in thin film tandem solar cells.



Presenting Author: **Mr Bo Zhang**
Phd Candidate

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Research Activities:
Ge quantum dots in dielectric matrix, semiconductor processing and characterisation.

a-Si:H by Multi-layer PECVD to optimise mc-Si electronic surface passivation and heterostructures fabrication.

Jonathon Mitchell

A novel approach to electronic passivation across crystallographic defects found on multi-crystalline silicon (mc-Si) surfaces has been developed. Hydrogenated amorphous silicon (a-Si:H) with sub-nanometre thicknesses was successfully applied by multi-layer plasma-enhanced chemical vapour deposition (ML-PECVD) to form a continuous layer with a total thickness between 5 ? 10nm. This overcomes previous difficulties with standard depositions and permits even thinner passivating layers to be applied. Thinner thin-film layers have a reduced light-absorption by the inactive layer, allowing more light to reach the mc-Si wafer bulk where photogenerated charge occurs. Reduction in layer thickness reduces delamination resulting from mechanical stresses experienced when using thicker films. Further improvements were observed in silicon-hydrogen (SiH) bonding and thin-film microstructure. These improvements are particularly important as the overall thickness of the base silicon wafer can be reduced from 270 ?m to 100?m without compromising the passivation quality or increasing structural stresses. Reductions in the overall silicon required for applications are highly desirable in reducing costs associated with its use.

Furthermore, this new deposition technique has been shown to produce superior passivation for intrinsic inter-layers as part of an a-Si:H based heterostructure. Carrier lifetimes close to that of the bulk have been achieved consistently. Similar surface recombination velocities below 60cm/s were obtained on both n- and p-type mc-Si wafers. Open-circuit voltage measurements indicate that 627mV are obtainable and emitter current densities were measured below 100fA/cm² on both n- and p-type mc-Si wafers. These results represent a substantial improvement on measurements achievable with other materials and standard depositions.

Presenting Author: **Mr Jonathon Mitchell**
Postgraduate student

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Research Activities:
Amorphous silicon solar cells, nano-technology

Effective medium method for multiferroic composite materials

K L Livesey

R L Stamps

Multiferroic materials display multiple types of order, for example, magnetic, electric or elastic order. In recent years there has been a resurgence of interest in these materials because of the technological utility in being able to control magnetic properties with an electric field or vice versa. Even more recently, the design of multiphase materials that display a coupling between magnetic and electric order has begun and the control of magnetisation using an electric field has been demonstrated experimentally.

In this talk we detail an effective medium approach for modelling a superlattice comprised of alternating ferromagnetic and multiferroic layers. We assume a phenomenological coupling between the magnetisation and polarisation of the layers that is mediated by the microscopic strains at the interface. A frequency-dependent susceptibility for the superlattice is derived, which displays peaks where there are resonances in the system. The resonances have a mixed magnetic/electric nature and are often called electromagnons. We study the behaviour of the resonant frequencies as an electric field is applied. For large enough fields, the effective anisotropy in the ferromagnetic layers is reduced to zero so an infinitesimal applied magnetic field is required to reorientate the magnetisation in the superlattice. Hence the coupling to a multiferroic material enables the ferromagnet to be switched with lower energy costs.

We acknowledge the Australian Research Council, Seagate Technologies and the Hackett Student Fund at UWA for support.



Presenting Author: **Ms Karen L Livesey**
PhD student

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Research Activities:
Theoretical investigation of magnetic and multiferroic materials, in particular the high frequency dynamics of thin films and multilayers. I am interested in the design of multi-phase materials for technological applications, especially since the presence of interfaces may significantly alter the properties of materials.

Nanoscratch-induced Deformation of Single Crystal Silicon

Y.Q. Wu

H. Huang

J. Zou

Monocrystalline Si substrate, also named as Si wafer, is the most widely used semiconductor material in electronics industries. One of the stringent requirements for Si wafer machining is surface integrity. In most of the applications, a damage free subsurface is required. To achieve this, fundamental mechanisms of deformation and removal of silicon material involved in the machining process need to be explored.

Nanoscratching can be used to simulate an individual deformation and removal event in a nanogrinding process. In this work, the deformation characteristics of single crystal Si (100) under nanoscratching were systematically investigated by varying scratching load and tip radius. Conical tips of radii of 1 and 3 μm were used. Transmission electron microscopy (TEM) results demonstrated that no crack was observed from the nanoscratches generated under different loading conditions. The damaged layers induced by nanoscratching included an amorphous Si region and a damaged crystalline Si region. Only stacking faults were observed at the lowest load of 1 mN when the 3 μm tip was used. Dislocations along (111) planes started to nucleate when the load was over 2 mN. Interestingly, nanocrystals embedded in the amorphous Si were observed at the maximum load of 6 mN when the 1 μm tip was used. TEM and Raman revealed that the nanocrystals located in the middle of the scratch were Si-I particles re-crystallized from amorphous Si, but those observed at the end of the scratch were high pressure Si-XII/Si-III phases. The phase transformation routes are different from those reported from the nanoindentation studies.



Presenting Author: **Mr Yueqin Wu**
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Research Activities:
PhD Student in MEMS at UQ/UWA

Structure and Properties of Nanofibre Yarns Prepared from Electrospun Nonwoven Strips

Yaqiong Zhou

*Tong Lin**

Xungai Wang

Electrospinning is a promising technique to produce continuous fibres with diameters on nanometer scales. This technique involves stretching a polymer fluid under a strong electric field into fine filaments, which are deposited randomly on electrode collector forming a nonwoven nanofibre mat in most cases. Despite considerable efforts in exploring the applications of electrospun nanofibres, very limited work has been conducted on using this material to process mechanically robust nanofibre yarns.

Here we report on fabrication of nanofibre yarns using electrospun nonwoven strips, and the influences of processing parameters on fibre morphology and yarn tensile properties.

Poly(vinylidene fluoride-co-hexafluoropropylene) (PVdF-HFP) was used as a model polymer to prepare nanofibre mats. The nanofibre mats were then cut into ribbon form and underwent twisting process to form uniform yarns.

It was found twisting is crucial for yarn strength. A five-fold increase in tensile strength was observed in the twisted yarns. A slight decrease in fibre diameter and improved fibre alignment were observed under SEM. Differential Scanning Calorimetry (DSC), Dynamic Mechanical Thermal Analysis (DMTA), and wide angle X-ray scattering (WAXS) were also used to analyses how the process influences the polymer morphology. This method is feasible to produce a wide range of polymeric nanofibre yarns, which can be knitted to fabricate a new class of fibre-based materials. In addition, novel continuous composite fibrils can be fabricated by twisting different polymeric nanofibres.

Presenting Author: **Miss Yaqiong Zhou**
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Research Activities:
Electrospun nanofibre Carbon nanotube Conducting polymer

Sedimentation of Titanium Powder in Organic Media

*K.T. Lau 1,2
C.C. Sorrell 1*

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Electrophoretic deposition (EPD) is a simple, inexpensive, and rapid method for the production of thin and thick films of both metallic and nonmetallic coatings. However, prior to the EDP process, sedimentation studies normally are undertaken in order to provide information on the effects of the suspending medium, additives, and solids loading. In the present preliminary work, a basic sedimentation test was used to identify suitable suspension media for the EPD of titanium powder on metallic substrates.



Presenting Author: **Mr Kok Tee Lau**
PhD student

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Research Activities:

Explore the potential of applying more economical and flexible method combining Electrophoretic deposition and diffusion method to produce coating on high speed steel.

Toward the Creation of Non-toxic Semiconductor Nanoparticle Systems for Bioapplications

Lisa Smith

Particles which display bright, colour-tunable emission are greatly sought after in bioapplications such as medical imaging and diagnostics, where their potential to produce higher contrast images for faster analysis and to provide alternatives to invasive procedures would be of great advantage over current methods which can take days, weeks or even months to achieve results.

Presenting Author: **Lisa Smith**
PhD Student

Effect of vibrations on void content in composite materials

*J. Muric-Nesic,
P. Compston,
N. Noble,
Z.H. Stachurski*

A major research direction of the ANU advanced material research group is to develop new methods of improving manufacturing processes for composite materials.

This project is concerned with improving the quality of laminated composite structure by eliminating common defects such as voids, bubbles and poor adhesion at interfaces.

In order to improve mechanical properties experiments and analyses of the effect of vibrations on composite materials were conducted and will be presented here. Range of frequency of vibrations covered was from 2Hz to 8kHz. Samples were examined by microscopy to determine types and quantity of defects. Composites were also produced by specially made apparatus, similar to Quickstep method, for curing at elevated temperatures.

Theoretical analyses included propagation of acoustic waves and the effect on gas bubbles in the viscous fluid. Dissipation of mechanical wave energy leads to lowering of viscosity through temperature rise.

The results showed reduction in void content when vibrations were applied for longer period (such as 30 minutes), at low frequencies. Mechanical testing of vibration-assisted laminates is expected to show superior properties over static ones.



Presenting Author: **Mrs Jelena Muric-Nesic**
PhD student, Dept of Engineering, ANU

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A correlation study of structure "property" interface of polypropylene-fly ash composites

*Dilip CD Nath,
Sri Bandyopadhyay,
Aibing Yu,
Qinghua Zeng,
Tapas Das,
Darryl Blackburn and
Chris White*

Composites of isotactic semicrystalline polypropylene (PP) and Fly ash (particle size 5-60 μm) were prepared by injection moulding at 210°C incorporating 20, 45 and 60% by weight of FA. Tensile tests were carried out at 25, 50 and 70°C. WAXRD, DSC and SEM studies were also undertaken. Modulus of elasticity of composites at all temperatures was higher than that of the corresponding neat PP samples ? the gain ranged between 10-60%. The strength of the composites had a mixed trend. At 25°C, the composites suffered significant loss in strength, as much as 47%, whereas, at 50 and 70°C, there was up to 15% gain in strength. Strain to failure of the composite samples ranged from as low as 6% at 25°C to over 50% at 70°C. Whereas in the absence of ash the PP structure was composed of α -crystals, presence of fly ash induced ? -crystal nucleation in composites and the amount of ? increased to 15 % with 45 % fly ash. SEM studies indicated that the polymer had a distinctly high lamellar ductility and the interfacial interaction of PP chain and FA was observed in 20% FA composites at 50 and 70°C. Pukanszky interfacial interaction parameter is calculated using strength of the composites, shows a linear behavior with the modulus and strain to failure parameters for the composite materials. The -OH group on surface of fly ash particles is considered to be active to form a hydrogen bond with PP chain at elevated temperatures.

Presenting Author: **Dilip Nath**
Postgraduate study and research

Department of Material Science and Engineering
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Prediction of Wool Knitwear Pilling Propensity using Support Vector Machines

Poh Hean Yap,
Kok-Leong Ong,
Lijing Wang,
Xungai Wang.

Fabric pilling is perceived as a serious problem in wool knitwear industry. However, it is difficult to avoid pilling as surface abrasion happens during daily wear, laundering and drying. Hence much research has been carried out to identify the factors which contribute to wool knitwear pilling. These factors include the wool top, yarn and fabric properties which, together, affect the quality of an end product in a complex manner. This paper aims to predict the pilling propensity of wool knitwear using this combination of top, yarn and fabric properties. It examines, for the first time, the application of the support vector machines (SVM) data mining model to the pilling propensity prediction of wool knitwear using these properties as input attributes. The output of the model predicts the pilling propensity of wool knitwear in the form of pill ratings, where pill rating 1 represents worst pilling while pill rating 5 represents otherwise, as shown in Fig. 1. Through this model, we aim to be able to control and modify the properties of raw material before yarn or fabric is made in order to achieve desired pilling performance of wool knitwear. The results indicate that by using binary classification method and radial basis function (RBF) kernel function, SVM is able to give high prediction accuracy for pilling propensity of wool knitwear without data over-fitting, as shown in Fig. 2. The result shows that RBF achieved 65% to 90% prediction accuracy with an average of 80.25% for all pilling ratings in our experiments.

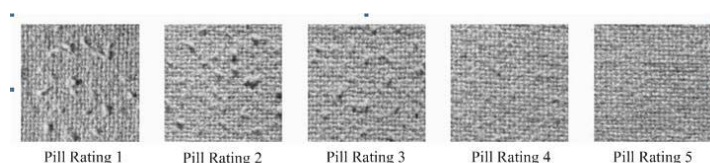


Fig. 1: Standard images for pill rating 1 (worst pilling) to pill rating 5 (no pilling)

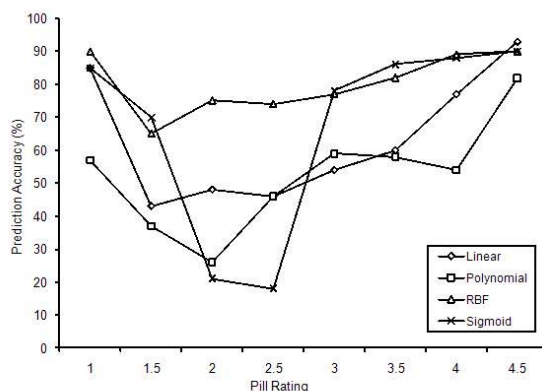


Fig. 2: Prediction accuracy for each pilling rating

Presenting Author: **Ms. Poh Hean Yap**
PhD Candidate

First-principles Calculations, Enhanced Ferromagnetism in Nitrogen codoped ZnO:Co

Mohammad H. N. ASSADI

Yuebin Zhang

Sean Li

Using first-principles calculations based on density functional theory, N codoped ZnO:Co has been demonstrated to be potentially a p-type diluted magnetic semiconductor. By investigating several different configurations, Co and N dopants are found to have a tendency towards staying close to each other with most stable -O-Co-N-Co-O- complexes. The dominant ferromagnetic interaction is due to the hybridization between N's 2p and Co's 3d states, which is strong enough to lead to hole-mediated ferromagnetism at room temperature. The ferromagnetic coupling strongly relies on the distance of N from Co.

Presenting Author: Mr mohammad Hussein Naseef AL ASSADI
Graduate Student

Ionization energy dressed electron-phonon interaction applied to under-screened Kondo metal

Andrew Das Arulsamy

One of the fundamental requirements from the electronic characterizations of materials is to understand what parameters effectively control the flow of electrons. But we do not have the authority to demand nor persuade the Nature to reveal its secret parameters. Adding to that, all electrons are the same, indistinguishable, we cannot distinguish one from another, be it in a metal or a wood. However, the energy that each or a group of electrons possess is different in different materials due to different types of atoms in a given material. This is also true for electrons in atoms due to different magnitudes of electron-nucleus Coulomb force. In view of this, we will employ a methodology that will make use of the atomic energy level difference, in order to reveal information about their electronic energies. In other words, this atomic ionization energy or the atomic energy-level difference can be used to theoretically predict the systematic changes to the conductivity, electron-phonon interaction and heat capacity with respect to different dopant in strongly correlated matter. These predictions are not only important for experimentalists to evaluate their data and design new materials, but also theoretically significant so as to understand what parameters influence the motion of electrons in strongly correlated matter. Therefore, we show here that the ionization-energy dressed electron-electron screened Coulomb potential is exactly the same as the ionization-energy dressed electron-phonon interaction potential. We prove this by means of the second-order time-independent perturbation theory with the heavier effective mass condition. Using this proof, we will re-evaluate the experimental data of conductivity, heat capacity and the Debye frequency as a function of ionization energy. We will also be able to understand why the Debye temperature and frequency change the way they do in alkali halide crystals and oxides (MgO, CaO and SrO). In addition, we can extend this analysis to study the under-screened Kondo metal ($\text{Fe}_{1-x}\text{Mn}_x\text{Si}$), namely, the systematic changes to its conductivity and specific heat with respect to Mn dopant. In doing so, we can have a deeper understanding on how a different element in a given compound will systematically influence the magnitudes of the conductivity, specific heat, Debye temperature and its frequency. In principle, we can use this theory to fine-tune the conductivity in the under-screened Kondo regime or the specific heat of $\text{Fe}_{1-x}\text{Mn}_x\text{Si}$ with elements other than Mn.

Presenting Author: **Mr Andrew Das Arulsamy**
PhD Student

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Research Activities:

- i) *IN PROGRESS* Theoretical studies on oxide Ferromagnets based on First-Principles calculations (computational).
- ii) *SUBMITTED* Charge and spin transport theory in ferromagnets using model hamiltonian (analytical).
- iii) *IN PREPARATION* Screening parameter, spin-orbit coupling, Zitterbewegung and energy level corrections due to relativity, QED and hyperfine splitting using model hamiltonian (Mathematical).
- iv) *PUBLISHED* Transport theory of High-Tc superconductors and polarization in ferroelectrics using ionization energy based Fermi-Dirac statistics (analytical).

Ab-initio determination of the electronic and optical properties of the nitrogen-vacancy centre in diamond

M.W. Doherty
F.M. Hossain
H.F. Wilson
L.C.L. Hollenberg

The nitrogen-vacancy (N-V) centre in diamond has promising applications in quantum information processing, including quantum key distribution and implementation as a spin qubit. Although, empirically the centre's electronic, optical and spin properties are consistently and extensively documented, the N-V centre is, in general, theoretically not well understood, with a number of outstanding issues regarding the properties of the centre still being contested. In order to aid future progress on these outstanding issues and design of potential quantum information processing devices utilising the centre, we demonstrate the application of group theoretical arguments to a set of modified molecular orbitals and produce the centre's electronic structure, optical transition dipole moments and optical polarisation anisotropy. Additionally, we report that our group theoretical results are supported by our numerical density functional theory calculations, which have accurately reproduced existing experimental observations.



Presenting Author: **Mr Marcus William Doherty**
PhD. Candidate

Research Activities:

Conducting research into theoretical models of defect centres in diamond and their application in imaging and quantum information devices.

Hybrid Density Functional Theory modelling of single atom defined nanostructures

*Daniel W. Drumm,
Faruque M. Hossain,
Richard P. Muller,
Salvy P. Russo,
and Lloyd C. L. Hollenberg*

The advent of STM based single atom fabrication techniques has opened up a new field of single-atom defined nanostructures. Predicting the behaviour of devices made using this technology is central to a number of applications in quantum information processing.

To further the understanding of these systems' behaviour, we used hybrid Density Functional Theory to undertake a range of ab initio studies of maximally δ -doped phosphorus in silicon structures. Systems considered include isolated P donors, δ -doped planes and δ -doped nanowires.

Presenting Author: **Mr Daniel Drumm**
PhD student

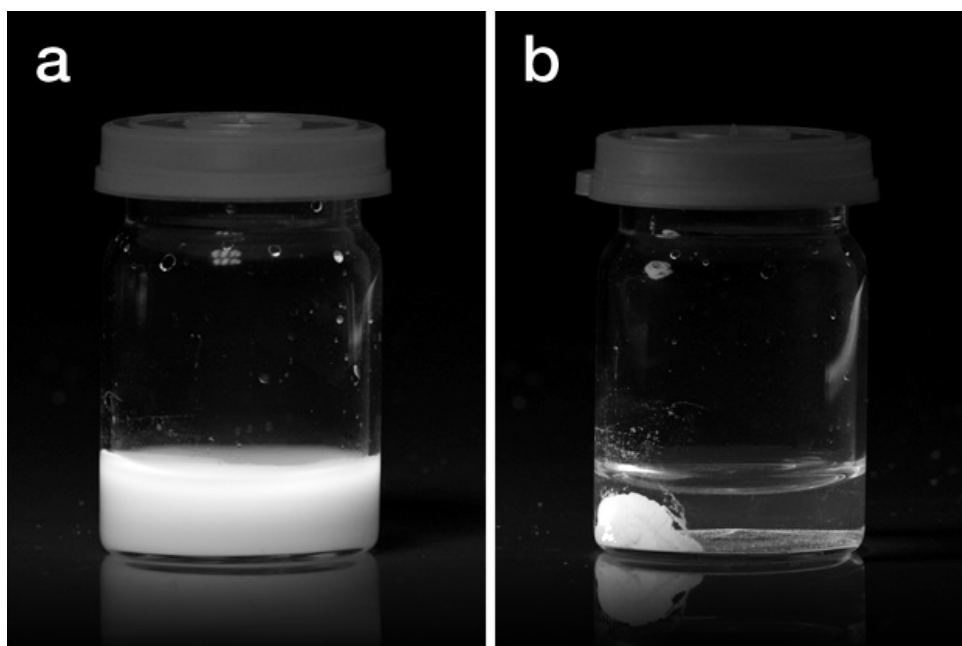
c/o The School of Physics
The University of Melbourne
Parkville VIC 3010

A simple method towards self-assembled superparamagnetic quantum dots

*Cameron W. Evans
Swaminathan Iyer
Colin L. Raston*

Given the disastrous consequences of neurotrauma, and controversy surrounding current treatments, we are investigating a new and novel approach to treatment using nanotechnology to improve the prospects of neurotrauma victims. In order to facilitate the recovery process by encouraging neural regeneration, we aim to deliver drugs to neurotrauma injury sites using nanoparticles, and to this end, we have prepared a composite nanomaterial incorporating cadmium telluride (CdTe) and magnetite (Fe₃O₄) nanoparticles. The luminescent properties of CdTe will be used to enable tracking in vitro and in vivo, while magnetic characteristics will facilitate spatial positioning of the delivery agent.

The aqueous synthesis of CdTe quantum dots was achieved using microwave energy, while Fe₃O₄ was prepared by aqueous co-precipitation. The combination of these materials to form the nanocomposite was performed in a simple manner via self-assembly. We find that this material combines the benefits of both its components: sharp emission spectra and high saturation magnetisation, and that the superparamagnetic properties of Fe₃O₄ are maintained in the composite. The suspended and magnetically collected material is shown in the attached graphic. We will present details on the preparation and properties of this material.



Presenting Author: **Cameron Evans**
PhD candidate

Towards a single mode waveguide in single crystal diamond

B.A. Fairchild
B. Gibson
A.D. Greentree
M. Draganski
E. Finkman
S. Rubanov
P. Olivero
J. C. McCallum
D.N. Jamieson
S. Prawer

Diamond has properties that make it highly attractive for quantum information processing in the solid-state [1]. These properties include low nuclear spin background, low electron concentration and low phonon scattering. Most interesting is the presence of optically active defect centres that can be engineered within the lattice. One in particular is the NV- centre which has a large dipole moment, and novel transition matrix elements that give rise to single photon emission, spin pumping, and single-spin readout. The challenges of harnessing NV centres for scalable quantum devices require the construction of optical structures to capture and guide emitted photons to effect long-range dipole-dipole coupling. This is the problem that we attack here. We have described a novel lift-off process [2, 3] to create a thin membrane from single crystal diamond using MeV ion-beam induced graphitisation, annealing, etching, and post-processing using focussed ion beam. We have used this method to construct a waveguide from a 1 micron layer formed from single crystal diamond. This is the thinnest such waveguide yet produced and is a significant step towards the generation of waveguides that are single-moded at the wavelength range of interest to NV-centre Zero Phonon Line transitions. The fabrication strategies can also be applied to other applications, including microfluidics and NEMS (Nano Electro Mechanical Systems).



Presenting Author: **Ms Barbara Fairchild**
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Research Activities:
Micro machining in diamond

Production of high performance polypyrrole fibres by wet spinning

Javad Foroughi

Geoffrey Spinks

Joe Razal

Gordon Wallace

High molecular weight doped polypyrrole has been synthesized by the incorporation of the di(2-ethylhexyl) sulfosuccinate dopant anion which renders the polymer soluble in various organic solvents. The intrinsic viscosity of Ppy solutions show that the molecular weight of Ppy is very sensitive to the polymerization temperature. An increase in molecular weight of about three orders of magnitude was achieved by reducing the polymerization temperature from 0 °C to -15 °C. The resultant solutions were amenable to a wet-spinning process that produced continuous, doped polypyrrole fibres. The ultimate tensile strength, elastic modulus and elongation at break of the high molecular weight fibres were 136 MPa, 4.2 GPa and 5%, respectively. These values were 500%, 250% and 280% higher than obtained from the lower molecular weight fibers. X-ray diffraction showed that the low temperature Ppy powder exhibited higher crystallinity than the standard Ppy powder. UV and FT-IR spectroscopy showed that the conjugation length of Ppy could be increased significantly depending on the polymerization conditions. TGA, elemental analysis and SEM were carried out to investigate chemical and physical structure of Ppy powder and fibres. Cyclic voltammetry demonstrated the electroactivity of the polypyrrole fibres. These fibres are likely to be important for bionic, electronic textile, artificial muscles, battery and sensor applications.



Presenting Author: **Mr. Javad Foroughi**
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Research Activities:
conducting polymers

Optical waveguide fabrication and characterization in single crystal diamonds

Kumaravelu Ganesan

Mark P. Hiscocks

Brant C. Gibson

Shane T. Huntington

François Ladouceur

Steven Praver

All-diamond optical waveguide structures have been fabricated using a combination of 2MeV alpha particle implantation and subsequent photolithography, reactive ion etching (RIE) and focus ion beam milling (FIB). A Polydimethylsiloxane (PDMS) -based support structure for small diamond substrates was developed to obtain uniform photoresist coating without edge bead which prevents photolithography patterns at the edges. The propagation of light in the device was investigated by focusing $\lambda = 532$ nm laser light, with a long-distance optical objective, to a micrometer-sized spot at the input of the waveguide. Figure 1 shows an all-diamond waveguide with a multimode output in the top left corner of the image. This scalable process opens the door to the fabrication of a diamond-based optical chip integrating functional elements such as X-crossings, Y-junctions, evanescent couplers, Bragg reflectors/couplers and various interferometers.

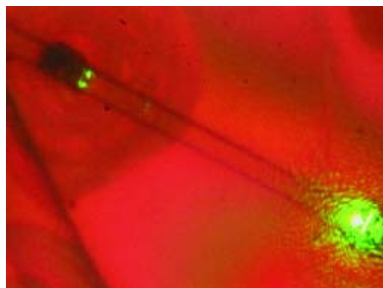


Fig1: Shows an 80 μm long waveguide with in the input in the bottom right of the image and the multimode output in top left corner of the image.



Presenting Author: **Dr Kumaravelu Ganesan**
Consultant

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Christchurch
New Zealand

Research Activities:

1. Wireless sensors using Surface Acoustic Wave devices. 2. Hydrogen sensors using Pd clusters. 3. Si Photovoltaics 4. Texturing using Reactive Ion Etching

Time-resolved plasma density measurements in silica-based glasses exposed to IR femtosecond laser

*Matthieu Lancry
Nathaniel Groothoff
Stephane Guizard
Bertrand Poumellec
John Canning*

Femtosecond lasers are finding ever increasing avenues in modifying and fabricating photonic based components in silica and doped silica glass. Current systems offer a myriad of material modifications in silica-based glasses, including surface machining, annealing, and refractive index modification (isotropic or anisotropic). Studies into femtosecond pulse interaction with glass material have resulted in other modification properties being discovered, including chirality, non-reciprocal writing, oxidation-reduction reactions, nano-cluster precipitation, shaping and distribution with sub wavelength resolution. The majority of changes in SiO₂ induced by femtosecond laser irradiation, result from non-linear absorption mechanisms. In particular, multiphoton absorption can lead to band-to-band electronic transitions, for example, irradiation with 800 nm in SiO₂ requires ~5 photons. Whilst the processes of laser absorption are known, the mechanisms of material changes, e.g. defect formation, is still not completely understood. To investigate femtosecond laser pulse and material interaction, a spectral frequency domain interferometry technique was applied to SiO₂ and Ge:SiO₂ samples using a Ti:Sapphire femtosecond laser. This permitted the direct in-situ observation of modifications to the dielectric function of the glass from the laser at various intensities. The conduction band electron density in SiO₂ was found to be 3 times larger than Ge:SiO₂ independent of the laser intensity. In addition, the conduction band electrons formed self-trapped-excitons and the trapping time in SiO₂ was found to be 60 fs longer ($\tau \sim 150$ fs), compared to Ge:SiO₂ ($\tau \sim 90$ fs). The shorter time in Ge:SiO₂ glass is believed to stem from Ge offering easily-ionizable states.

Presenting Author: **Mr Nathaniel Groothoff**
PhD Student

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Simple, "green" synthesis of small silver nanoparticles tailored by phosphonated calixarenes

Karel J. Hartlieb

Martin Saunders

Colin L. Raston

Silver nanoparticles have been synthesised by a simple and "green" chemical method using hydrogen and phosphonated calixarenes. We found that the calixarene acts as a template for silver nanoparticle nucleation and growth, and the ring size of the calixarene influences the final particle size and size distribution.

Calixarenes are a class of macrocycle formed by a condensation reaction between a para-substituted phenol and formaldehyde, and usually have a ring size between 4 and 8 monomer units. Replacing the p-substituents with phosphonato groups renders these molecules water soluble.

By heating a solution containing silver nitrate and phosphonated calix[n]arene (n = 4, 5, 6, 8) at alkaline conditions and bubbling hydrogen gas for 10 minutes small silver nanoparticles are formed. Phosphonated calixarenes with ring sizes of 4 or 5 give small particles with an average size ≤ 3.5 nm depending on the concentration of calixarene. Larger ring size calixarenes give larger particles and wider particle size distributions. We believe that the reason for these differences between calixarene ring sizes is due to the conformation adopted by the silver-calixarene complex.

Presenting Author: **Mr Karel Hartlieb**
PhD student

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School of Biomedical, Biomolecular and Chemical Sciences
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Microstructure and Percolation threshold of Activated charcoal-PMMA nano composites.

Mykanth Mada, University of New South Wales

Dr. Sri Bandyopadhyay, University of New South Wales

Electronic materials made up of polymers are getting much attention with their properties such as light weight, cost effective, and corrosion resistance. Electrical conductivity of this type of composites fell in the region between semi conducting and conducting properties. The present project is concentrated on the fabrication of cheap polymer composites based on activated charcoal and Poly methyl methacrylate (PMMA) which are already well known as a universal antidote and biomaterial respectively. This combination may help to fabricate a new type of bio-electronic materials in the near future. The circular disc shaped polymer nano composite samples are processed through cost effective melt-processing method. Addition of activated charcoal to the PMMA, electrical conductivity is shifted from 10-15 Siemens/meter to 20 Siemens/meter. This is a dramatic change due to the tunnelling of conducting fillers (Charcoal) in the non conducting medium (PMMA). These composites also showed good mechanical properties. The microhardness value of 20 wt% charcoal-PMMA is 100MPa and compressive stress is 30 MPa. The microstructures of the nano composites especially interface between the conducting filler and polymer matrix are studied. The activated charcoal-PMMA nano composite seems a promising electronic material.

Presenting Author: **Mr Mykanth Reddy Mada**
Research student

Mykanth Reddy Mada, Student ID:3167893, Materials Sc and Engg, Gate no.2, high street, University of New South Wales, Kensington, Sydney, NSW-2052.

Research Activities:

My main research activities are in CNT-polymer nanocomposites such as PMMA, PVA, and PEO based nanocomposites.

Electrical conductivity of Activated charcoal-PMMA nano composites.

Mykanth Mada, University of New South Wales

Dr. Sri Bandyopadhyay, University of New South Wales

Electronic materials made up of polymers are getting much attention with their properties such as light weight, cost effective, and corrosion resistance. Electrical conductivity of this type of composites fell in the region between semi conducting and conducting properties. The present project is concentrated on the fabrication of cheap polymer composites based on activated charcoal and Poly methyl methacrylate (PMMA) which are already well known as a universal antidote and biomaterial respectively. This combination may help to fabricate a new type of bio-electronic materials in the near future. The circular disc shaped polymer nano composite samples are processed through cost effective melt-processing method. Addition of activated charcoal to the PMMA, electrical conductivity is shifted from 10-15 Siemens/meter to 20 Siemens/meter. This is a dramatic change due to the tunnelling of conducting fillers (Charcoal) in the non conducting medium (PMMA). These composites also showed good mechanical properties. The microhardness and compressive stress showed 400% and 20% increment. The activated charcoal-PMMA nano composites seems to be the promising electronic materials.

Presenting Author: **Mr Mykanth Reddy Mada**
Research student

Mykanth Reddy Mada, Student ID:3167893, Materials Sc and Engg, Gate no.2, high street, University of New South Wales, Kensington, Sydney, NSW-2052.

Research Activities:

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Study of the surface integrity of micro-abrasive jet machined surfaces on a synthetic quartz crystal

Alireza MORIDI FARIMANI

Jun WANG

Abrasive jet machining (AJM) is an effective machining technology for machining of hard and brittle materials. However surface integrity is an important issue in machining of brittle materials. Removing chips from the surface of the material by impacting the abrasive particles can cause propagation of cracks, which change roughness and strength of workpiece material.

Synthetic quartz, which mainly use in photomask substrates for optical lithography, high temperature poly- Si TFT-LCDs and also as a precise source of electrical signal, has an increasing demand due to its unique electrical, optical and mechanical properties. The surface integrity of synthetic quartz crystals which micro-machined by micro-abrasive jet machining (MAJM) has been measured by a digital high resolution microscope and studied in this paper.

Presenting Author: **Mr. Alireza MORIDI FARIMANI**
Research Activities:
abrasive jet micro-machining

Silane Functionalisation of Mechanochemically Prepared Iron Oxide Nanoparticles

Sam G. Ogden

David Lewis

Joe G. Shapter

Silane encapsulated Magnetic Iron Oxide Nanoparticles (MIONs) were synthesised through a sequential approach. The MIONs were synthesised in both the solid-state form using a salt assisted reaction to form Fe₂O₃ particles with a sub-10nm size and via a coprecipitation method to form Fe₃O₄ particles with an average particle size of 10nm. MIONs were then coated via two different techniques with 3-glycidoxypentyltrimethoxysilane (GPTMS) to form core-shell type particles. Initially coating was attempted using a base catalysed sol-gel process involving the direct condensation of GPTMS onto the particle surface. The second coating approach used a ligand exchange technique. Elemental composition and crystal structure of the uncoated MIONs were determined by XRD. The coated particles were characterised with infra-red spectroscopy and energy dispersive x-ray spectroscopy to confirm the presence of silane on the particles. The functionality of the coated particles was also tested. TEM analysis and Scherrer broadening analysis of XRD were used to determine particle size and morphology of both coated and uncoated particles.

Presenting Author: **Mr Sam Ogden**
Honours Student

Research Activities:
Superparamagnetic Iron Oxide Nanoparticles

Strained Semiconductors Influencing Hydrogen Transport & Trapping For Wafer Cleaving

DJ Pyke
JC McCallum
RG Elliman

Strain's influence on materials can vary their mechanical, optical and electronic properties. Recent research has focused on its ability to produce higher carrier concentrations in heterojunctions for electronic devices. Its role in passivation or activation of defects and dopants within a material or structure has been demonstrated, but remains less well-investigated.

Hydrogen's use as a cleaving agent in ion-cut processes relies on ion implantation into a homogenous wafer, with its directional bias from the crystallographic plane, and is still a somewhat crude process. This study investigates strain modification as a method of having better control and possibly manipulating hydrogen-induced wafer slicing.

Semiconductors studied in this research include alloys of silicon and germanium produced epitaxially on (100) silicon, with either a constant concentration of Ge used to produce a uniform strain layer, or varying concentrations to induce a strain gradient within the alloy. The width over which these concentrations were added was also varied, to alter the magnitude of the strain gradients. These strained materials were contrasted with intrinsic Si and Ge wafers, and the hydrogen ion-implanted into the samples at a range of energies. Evolving hydrogen profiles within the materials were then examined with secondary ion mass spectroscopy (SIMS), Rutherford backscattering spectrometry (RBS), Raman spectroscopy and elastic recoil detection (ERD).

Findings suggesting novel trapping processes within the strain layers were observed, along with altered diffusion behaviour of the hydrogen, dependent upon implantation location and local direction of strain gradient.

Presenting Author: **Mr Daniel Pyke**
PhD Student

Department of Electronic Materials Engineering, Research School of Physical Sciences and Engineering,
Australian National University 0200

Research Activities:

Investigation Hydrogen implanted into Silicon, Germanium and III-V Semiconductors, crystallisation behaviour, defect formation, band structure modification, strain, solid phase epitaxy; elastic recoil detection, Raman scattering spectroscopy, Rutherford Backscattering Spectroscopy, Time Resolved Reflectivity, Double Crystal X-Ray Diffraction, Transmission Electron Microscopy

An In-situ monitoring system for characterizing porous silicon growth

David Wyndham

Tim James

Gia Parish

Charlie Musca

Adrian Keating

The production of high quality optical devices based on porous silicon relies on having precise control over the refractive index and thickness of each porous silicon layer. Until now this has been achieved by pre-calibrating each growth system and making sure that parameters such as wafer doping, electrolyte concentration and temperature are kept constant with each fabrication. As such, achieving growth reproducibility can be difficult.

The solution we have developed is based on in-situ monitoring during porous silicon growth. This process measures the optical interference between the porous silicon film and the back-side silicon surface. The optical light source comes from six coarse-wavelength-division-multiplexed lasers, with rapid switching between wavelengths achieved using a Microelectromechanical switch. The system permits rapid measurement (<1 sec) of the reflection spectra from all lasers, enabling real-time thickness and refractive index of each layer to be determined during growth. While only single layer growth is currently being used to optimize performance, our aim is to enable growth of high quality multi-layer films such as those required for Bragg Reflectors and high-Q Fabry-Perot micro-cavities.

The instrument and the numerical models developed to gather the measurements will briefly be discussed, and preliminary results gathered from this instrument during growth will be shown. The results show a good agreement with theoretical optical modelling, and also direct measurements of the porous silicon layers.



Presenting Author: **Mr David Alward Wyndham**
PhD Candidate

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Research Activities:
Porous Silicon

Photoelectrocatalytic Activity of TiO₂/Carbon Nanotube Nanocomposite

Min Yang
Shanqing Zhang
William Wen
Huijun Zhao

TiO₂ nanostructured electrodes have attracted much attention due to its strong oxidation power (e.g., +3.1V for anatase) under UV illumination. Carbon nanotube (CNT) possesses superior conductivity and attractive surface chemistry properties compared to TiO₂. This provides a great deal of incentive to synthesis TiO₂/CNTs composite as such type of composite could provide extra benefits enhancing photoelectrocatalytic activity.



In this work, we fabricated a new kind of TiO₂/CNT composite film electrodes. The resultant electrodes were systematically characterised and the photoelectrocatalytic activity was evaluated using potassium hydrogen phthalate (KHP) and glucose as the test compounds that represent strong and weak adsorbates, respectively.

Presenting Author: **Dr Min Yang**
Research Fellow

Australia Rivers Institute, Griffith School of Environment, Gold Coast Campus, Griffith University, Queensland 4222, Australia

Research Activities:

Fabrication TiO₂/carbon nanotube electrode for detecting organic compound in water

Hydrothermal epitaxy of ZnO:Co diluted magnetic semiconducting single crystalline films

Yuebin Zhang

Sean Li

Gregory Goh

ZnO:Co films with room-temperature ferromagnetism have been hydrothermally grown in water at 90 °C using a ZnO seed layer on MgAl₂O₄(111) substrates. High-resolution x-ray diffraction shows an epitaxial ZnO:Co single crystalline film with an out-of-plane orientation of ZnO:Co<001> || MgAl₂O₄<111> and an in-plane orientation of ZnO:Co[110] || MgAl₂O₄[-1-12] and ZnO:Co[-110] || MgAl₂O₄[-110]. A saturation magnetization of 0.83 emu/cm³ and a coercivity of 40 Oe were obtained for the epitaxial Zn_{0.98}Co_{0.02}O film at room temperature. Hydrogen unintentionally incorporated in the hydrothermal synthesis is suggested to contribute to the ferromagnetic properties in the diluted magnetic semiconductor by enhancing carrier concentration as a shallow donor.

Presenting Author: **Dr Yuebin Zhang**
ARC Postdoctoral Fellow

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Research Activities:
Colossal Magnetoresistance(CMR) Materials; Diluted Magnetic Semiconductors (DMS); Carbon Nanotubes (CNT)

Establishing the Polishing Map in Dynamic Friction Polishing of Polycrystalline Diamond Composites

Y. Chen and L. C. Zhang

Through a systematic experimental investigation into the polishing of polycrystalline diamond composites by the dynamic friction technique, this paper identified three major regimes of polishing conditions: the regime capable of a low material removal, that enabling a safe, high removal processing, and that of an unsafe but ultra-high material removal. The study concluded that a higher polishing pressure-speed combination results in a high material removal rate, but with a greater risk of workpiece cracking. At a too low pressure-speed combination, on the other hand, material removal may not take place. Based on the systematic experimental measurements, the paper established a polishing map to characterise the polishing conditions. It was found that using the polishing parameters determined by this polishing map, a quality surface finish can be obtained efficiently in duration about 10 times shorter than that of the abrasive polishing process currently used in industry.

Presenting Author: **Dr Yiqing Annie Chen**
Postdoctoral Research Fellow

School of Aerospace, Mechanical and Mechatronic Engineering
University of Sydney
NSW 2006 Australia

Research Activities:
Diamond and diamond related material

Short-term high-temperature oxidation of tubular-shaped metallic specimens using the Gleeble thermal-mechanical simulator

M.J Franklin

M. Reid

R. Dippenaar

A new experimental technique has been developed to study short-term high-temperature oxidation of metal alloys. The technique uses tubular-shaped specimens that are resistively heated using AC current via a Gleeble thermal-mechanical simulator. A controlled gas atmosphere can be passed through the sample hole during the thermal cycle. The outside wall of the sample can be cooled via water quench, or air flow. Axial and radial temperature gradients exist during the thermal cycle. During testing in a still air atmosphere, the maximum temperature occurs at the centre of the specimen length and on the inside wall of the specimen. Under such conditions and at this position it has been possible to melt part of the inside wall of a steel specimen without melting any of the outside wall. The microstructures of the oxide scale were determined using optical microscopy, and scanning electron microscopy (SEM) with energy dispersive spectroscopy (EDS). The initial results provide a reasonable simulation of part of the electric resistance welding process used to manufacture steel pipe.

Presenting Author: **Mr Matthew Franklin**
PhD student

THE EFFECT OF ULTRASONIC AGITATION IN AN AQUEOUS ENVIRONMENT ON THE MECHANICAL PROPERTIES OF SINGLE WOOL FIBRES

*Chris Hurren
Qing Li
Peter Lamb
Xungai Wang*

Ultrasonic agitation has been shown to provide significant improvement in the removal of grease and soil in conventional non-ionic detergent wool scouring. However, it has been found that when the wool fibre is subjected to ultrasonic scouring at a frequency of 35-45 kHz it undergoes some modification of the fibre scales. For the successful adoption of ultrasonics in the cleaning of wool it is important that the cleaning process has no significant impact on fibre properties. Here we report more extensive studies that have searched for reduced strength or abrasion resistance of the fibres after ultrasonic treatment. After scouring, at three different pH conditions, single fibres were assessed for tensile strength, fibre scale structure changes, bending abrasion and the mechanism of bending abrasion failure. Although ultrasonic agitation of the scouring bath causes micro-cracking of the scale structure and some rounding of the scale tip no significant changes to the tensile or bending abrasion properties of the fibre were observed



Presenting Author: **Mr Christopher James Hurren**
Postgraduate Student

Centre for Material and Fibre Innovation
Deakin University
Geelong, Victoria, 3217

Research Activities:

My PhD work is in the application of titanium oxide based sol-gel coatings for the self cleaning wool textiles and in the use of ultrasonic agitation for the cleaning of wool fibres. I am also involved in work including biological scaffolds and surface functionalisation using atmospheric glow discharge plasma treatment.

Analysis of the Surface Morphology of 6060 T5 Aluminum Plate in Uniaxial Compression

Hejie Li/Zhengyi Jiang/Dongbin Wei/Jingtao Han/A.K. Tieu

A finite element (FE) analysis of rate dependent crystal plasticity constitutive model with respect to latent hardening is carried out to simulate the uniaxial compression of 6060 T5 aluminium alloy. The surface morphology of samples before and after compression will be measured and analysed. To compare the influences of the different finite element models on simulation results, the Taylor-type and finite element polycrystalline models are respectively employed in ABAQUS to simulate the development of surface morphology and texture. Initial orientations measured by Electron Backscatter Diffraction (EBSD) are directly used in crystal plasticity finite element models. The two finite element polycrystalline models' surfaces are determined according to the initial surface roughness R_a measured by the surface profilometer directly. Comparison of the simulation results with the experimental results, it is shown that the technical parameters such as the strain and annealing temperature have an influence on the surface roughness. With an increase of strain, some slip systems activate and the deformation inhomogeneity becomes more and more significant in some surface areas. Therefore, the sample's surface tends to be rougher. With the rise of the annealing temperature, the grain sizes of samples are much more inhomogeneous. During the compression, the deformation and rotation of the inhomogeneous grains result in the inhomogeneity of stress and strain. As a result, the sample's surface becomes much rougher. On the other hand, the surface morphology from finite element polycrystalline model is much more close to the practical surface morphology of experimental sample than that of Taylor-type model.



Presenting Author: **Mr. Hejie Li**
PhD Student of Mechanical Engineering

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Wollongong,
NSW 2522,
Australia

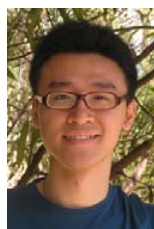
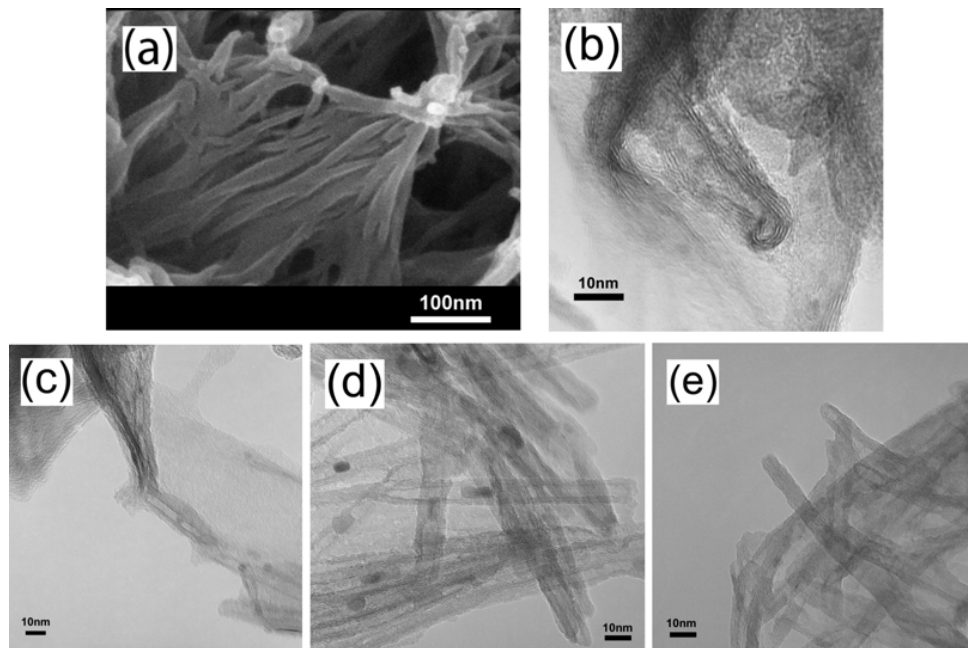
Research Activities:

Analyse the relationship between the microstructure and surface quality of metal products, observe the Microstructure and property (for example, Microstructure, texture and surface roughness etc) after and before the deformation, simulate the metal forming process by ABAQUS with Crystal plasticity finite element method (CPFEM), practice the control of surface quality of metal products during the practical metal forming process.

Hydrothermal Synthesis of Titanate Nanotubes via a Seeded-Growth Mechanism

Porun Liu, Haimin Zhang, Shanqing Zhang, Huijun Zhao*

Titanate nanotubes were synthesized using metal titanium as a raw material via an alkaline hydrothermal process. The formation mechanism of the nanotubes was investigated systematically using transmission electron microscope (TEM) and scanning electron microscope (SEM), and monitoring the gross Ti concentration change during the nanotube growth process. As the results revealed that nanotubular structure was formed via a seeded-growth mechanism that governed by the local Ti concentration. The tubular seeds were formed on titanate scaffold by warping the growing multilayered scaffold wall (see Figure 1. a, b) driven by the uneven surface tension distribution on different side of the scaffold wall. The formation of rolled hollow tubular structure initiated from the topmost part of the multilayered scaffold where the mass transfer and the crystal dissolution/precipitation rate were intensive (Figure 1. c). The multilayered scaffold wall rolled in different ways would result in different types of nanotubular seeds (Figure 1. d, e). Subsequent orientated titanate crystal growth took place as far as the solution Ti concentration could be maintained at a near saturation level. The findings in this study provide an alternative means to synthesize tuneable nanostructures via controlling Ti concentration under hydrothermal conditions.



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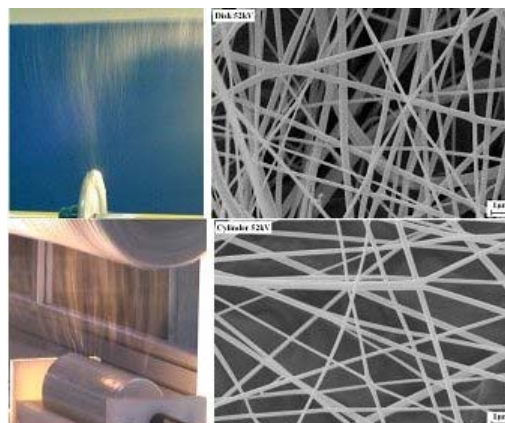
Research Activities:
Microstructure construction and control via hydrothermal approach Thin film process
and characterisation of semiconductors

Needleless Electrospinning study using Cylinder and Disk Nozzles

Haitao Niu
Tong Lin
Xungai Wang

In this paper we demonstrated the needleless electrospinning of polyvinyl alcohol (PVA) nanofibres using rotating disk and cylinder nozzles, and examined the effects of operating parameters on the electrospinning process and resultant fiber morphology.

With the same PVA solution, the critical voltage to generate nanofibres from the disk nozzle was lower than that from the cylinder of the same diameter; and the thin disk could produce nanofibres at a similar rate to the cylinder nozzle. Both electrospinning systems could produce uniform nanofibers; however fibers produced from the disk nozzle were finer than those from the cylinder when the same voltage was applied to both.



The finite element analysis of electric field profiles on the nozzles revealed concentrated electric field on the disk edges and cylinder ends, and much lower electric field intensity formed in the middle area of cylinder surface. These differences in electric field intensity profile could explain the difference in fineness and the rate of the nanofibres produced from these two nozzles. These findings will benefit the design and further development of large scale electrospinning systems for mass production of nanofibres for advanced applications.

Presenting Author: **Haitao Niu**
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Micromachining using Low Pressure Slurry Jet

*Pang, King
Nguyen, Thai
Wang, Jun*

The mechanics of micro-hole generation in brittle glasses using low pressure slurry jets were investigated. The effect of viscous flow of the jet caused the creation of a "W" shaped hole cross-section. The surface morphology featured three distinguished zones associated with the jet direct impact, viscous flow induced erosion and turbulent flow induced erosion, respectively. The surfaces generated were mostly smooth and without cracks, indicating a predominance of the ductile mode erosion mechanism. Based on the principles of fluid flow and coupling with the existing models of erosion in brittle and ductile materials, the effect of slurry jet properties on material removal was explored. A semi-analytical model was finally developed for predicting material volume removal rate. It was found that the model predictions were in good agreement with experimental data with a confidence level of 86%.

Presenting Author: **Mr King Lun Pang**

Contact Pressure Prediction in Sheet Metal Forming Using Finite Element Analysis

*Michael P Pereir*Wenyi Yan

Bernard F. Rolfe

Tool wear has become a significant issue associated with the forming of high strength sheet steels in the automotive industry. In order to combat this problem, recent research has been devoted to utilizing the contact results obtained from current sheet metal forming software predictions, in order to develop/apply tool wear models or tool material selection criteria for use in the stamping plant. This investigation aims to determine whether a specialized sheet metal forming software package can correctly capture the complex contact conditions that occur during a typical sheet metal stamping process. The contact pressure at the die radius was compared to results obtained using a general-purpose finite element software package, for a simple channel-forming process. Although some qualitative similarities between the two predictions were observed, it was found that significant differences in the magnitude and distribution of the contact pressure exists. The reasons for the discrepancies in results are discussed with respect to the simplifications and assumptions adopted in the finite element model definitions, and with regards to other results available in the literature.

Presenting Author: **Michael P Pereira**
Research Fellow

Contact Pressure Prediction In Sheet Metal Trimming/Blanking Process Using FEM

Reza Rafiee, Centre for Material and Fibre Innovation

Bernard Rolfe, School of Engineering and IT, Deakin University

Wenyi Yan, Department of Mechanical Engineering, Monash University

Peter Hodgson, Centre for Material and Fibre Innovation

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phodgson@deakin.edu.au*

Blanking and trimming process are the most usual applied process in sheet metal stamping. In all stamping parts either the initial blank is produced by blanking die or after drawing process, the panel is cut by trimming die. Automotive companies are increasingly using advanced high strength steels to achieve vehicle weight reduction without any effect on crashworthiness and performance. Forming and cutting components from these materials needs higher press loads, leaving the tools under very high pressures. The results have been a dramatic increase in tool wear leading to an increase in the tool maintenance and unscheduled stoppages in the plant. The tool profile of Trimming/Blanking sheet metal processes is exposed to strong tribological forces due to the high contact normal pressures and sliding distances. Accurate determination of the contact pressure distribution for a given sheet metal in a cutting process is an essential step towards the estimation of tool life. This study utilizes finite element analysis to simulate and explain the evolution and distribution of contact pressure over the punch and die radius, during the Trimming/Blanking process. It was highlighted that these contact pressure results may have a significant influence on the tool wear response.



Presenting Author: **Mr. Reza Rafiee**
Student

Research Activities:
Finite element simulation

Analysing variation in the manufacture of automotive structural members

Bernard F Rolfe
Tim de Souza

The sheet forming industry is plagued by inherent variations in its many input variables, making quality control and improvements a major hurdle. This is particularly poignant for Advanced High Strength Steels (AHSS), which exhibit a large degree of property variability. Current FE-based simulation packages are successful at predicting the manufacturability of a particular sheet metal components, however, due to their numerical deterministic nature are inherently unable to predict the performance of a real-life production process. Though they are now beginning to incorporate the stochastic nature of production in their codes. This work investigates the accuracy and precision of a current stochastic simulation package, AutoForm Sigma v4.1, by developing an experimental data set where all main sources of variation are captured through precise measurements and standard tensile tests. Using a Dual Phase 600Mpa grade steel a series of semi-cylindrical channels are formed at two Blank Holder Pressure levels where the response metric is the variation in springback determined by the flange angle. The process is replicated in AutoForm Sigma and an assessment of accuracy and precision of the predictions are performed.



Presenting Author: **Dr Bernard Rolfe**
 Senior Lecturer

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 Deakin University
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 Vic 3217

Research Activities:
 Investigating behaviour of Advanced High Strength Steels for automotive applications

Review on phase change materials and its applications

Zhongyuan Tan

Review on phase change materials and its applications

The study builds on and contributes to work in Phase Change Materials to control the temperature inside of the car. Although studies in PCMs for building area have examined by many researcher fellows, there has not been an application for vehicle. As such, this study provides additional insight into small space material for car using. I address this issue by demonstrating to control the temperature with a kind of material and no need the A/C or power or petrol.

Presenting Author: **Mr Zhongyuan Tan**
PHD

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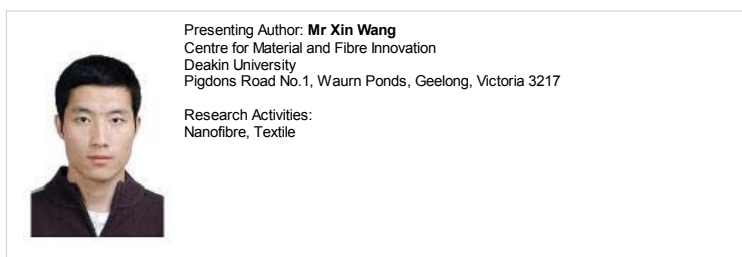
Research Activities:
Phase Change Materials

Needleless Electrospinning of Nanofibres with a Conical Wire Coil

*Xin Wang
Haitao Niu
Tong Lin
Xungai Wang*

In this study, we have demonstrated a novel needleless electrospinning of PVA nanofibers by using a conical metal wire-coil as spinneret. Multiple polymer jets were observed to generate on the coil surface. Up to 70 kV electric voltage can be applied to this needleless electrospinning nozzle without causing "corona discharge". Compared to conventional needle electrospinning, this needleless electrospinning system produced finer nanofibers on a much larger scale, and the fiber processing ability showed a much greater dependence on the applied voltage. Finite element calculation indicates that the electric field intensity profiles for the two systems are also quite different. This novel concept of using wire coil as the electrospinning nozzle will contribute to the further development of new large-scale needleless electrospinning system for nanofiber production.

FIG. 1. (a) Schematics of wire coil electrospinning setup. (b) Photo of the electrospinning process (Inset: multiple jets). (c) Illustration of jet formation on the coil surface.



Experimental and numerical investigation of tool wear in forming of Advanced High Strength Steels (AHSS)

Matthias Weiss

Tim Hilditch

Michael Pereira

Advanced high strength steels (AHSS) are increasingly used in the automobile industry due to their higher strength and improved crash performance compared to conventional steel. However, in stamping the enhanced material strength of AHSS leads to high forming contact stresses and through that to accelerated tool wear. Promising approaches to reduce tool wear in forming of AHSS steels are the application of dry lubricants, the modification of the die shape and the deposition of low-friction hard coatings on the critical tool surface regions. To enable the selection of the most appropriate and cost effective solutions it will be necessary to predict their performance in the forming of channel section components, which is where AHSS are most commonly used in the automobile industry. This work presents a novel routine consisting of a simple pin on disk test, a numerical model approach and a channel wear test that allows for the detailed and time efficient investigation of wear in forming of AHSS.

The presented set up will help in the determination of suitable and cost efficient solutions to reduce wear in the forming of AHSS for particular forming processes.

Presenting Author: **Dr Matthias Weiss**
Research Fellow

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Geelong Technology Precinct
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Geelong, Victoria, Australia, 3217

Research Activities:

- Investigation of tool wear in sheet forming of advanced high strength steels - experimental and numerical investigation of roll forming processes - Numerical and experimental investigation of the forming behavior of metal/polymer laminates - Advanced manufacturing

Recrystallization Simulation During and After Deformation through Cellular Automaton Approach

N. Yazdipour, C. H. J. Davies, P.D. Hodgson

Recrystallization during deformation (DRX) and after deformation (SRX-MDRX) was modeled by using a 2D cellular automaton (CA) approach. The CA approach was also used to simulate microstructure evolution during recrystallization. Initial microstructure features were used as the input data to the cellular automaton model and the dislocation density was employed as the energy criterion. Flow curve, recrystallization kinetics and final grain size were the simulation results. The final results of the DRX simulation at different deformation conditions were assumed as the input data to the post deformation softening simulations. To verify the proposed CA model, the simulation outcomes were compared with experimental data obtained from the hot torsion test of 304 austenitic stainless steel. The proposed model utilized thermomechanical parameters (e.g., temperature and strain rate) and predicted the final grain size as well as softening flow curve. It was shown that the cellular automaton approach can predict the final microstructure, softening kinetics and flow curve successfully in recrystallization phenomenon during and after deformation.



Presenting Author: **Mr Nima Yazdipour**
PhD student

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Deakin University, Waurn Ponds Campus
Pigdons Rd, Geelong, Victoria, Australia, 3217

Research Activities:

Modeling, Multi-Scale Simulation, Cellular Automaton Method Finite Element Analysis Thermo-mechanical Deformation processes

Synthesis and characterisation of blackberry-shaped ZnO nanoparticles

Rongliang He, Takuya Tsuzuki*

ZnO nanoparticles have a wide range of applications including transparent conductive oxides, UV-light absorbers and photocatalysts. In the past, ZnO nanoparticles having various morphologies were synthesized and their properties characterized by many groups [1]. It was found that the morphology strongly influences the properties of nanoparticles such as photocatalysis and photoluminescence [2].

In the present study, ZnO nanoparticles having a novel blackberry-like morphology was synthesized. Heat treatment of ZnCl₂ solutions in tetra-ethylene glycol at 140°C led to the formation of spherical ZnO nanoparticles consisting of uniform-sized small clusters inside of the particles. The particle size and morphology were characterized by transmission electron microscopy, dynamic light scattering, X-ray diffraction and Brunauer-Emmett-Teller gas absorption measurements. It was found that the average diameter of the particles was ~ 90 nm with a narrow size distribution width of ~ 34 nm. The clusters in the particles were single crystals of ~ 13 nm in diameter having the wurtzite structure. The specific surface area of the nanoparticles was 82.3 m²/g. Despite the large crystallite size, the bandgap energy measured by UV-Vis spectroscopy was ~3.47 eV, larger than that of bulk ZnO. Photocatalytic activity of the nanoparticles tested by degradation of Rhodamine B under simulated sunlight will be also discussed in the presentation. This new type of ZnO nanoparticles may have applications in the functional nano devices such as gas sensors or catalysts.

[1] L. Schmidt-Mende, J. L. MacManus-Driscoll, 2007, Mater. Today, 10[5], 40.

[2] A.C. Dodd, A. J. McKinley, T. Tsuzuki and M. Saunders, J. Nanoparticle Res., accepted for publication (18 May 2008)

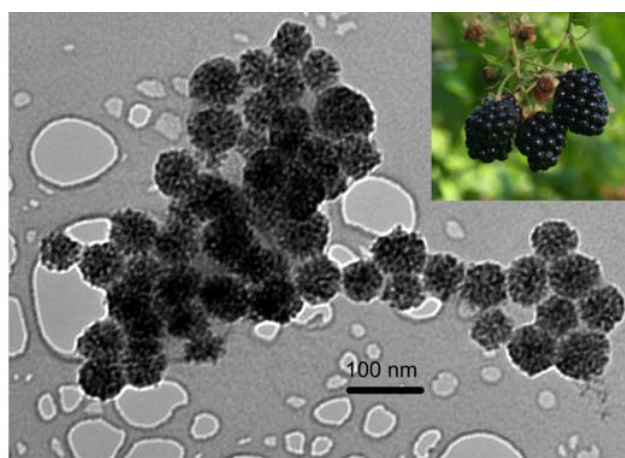


Fig. 1. Transmission electron micrograph of blackberry-shaped ZnO nanoparticles. The inset photograph shows natural blackberries.



Presenting Author: **Mr Rongliang He**
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Research Activities:
Nanoparticles synthesis, characterisation and applications

Interfacial properties of Magnesium battery electrodes.

*Timothy Khoo
Patrick Howlett
Bjorn Wither-Jensen
Maria Forsyth*

Magnesium has been considered as a suitable anode material for high energy density batteries. Its thermodynamic properties allow for higher energy density than common lead-acid and nickel-cadmium batteries. In comparison to lithium batteries, magnesium is considerably cheaper and safer to handle than lithium, as well as having a higher theoretical charge to volume ratio.

Magnesium is generally non-toxic, and disposal of magnesium batteries usually do not cause environmental concern.

Recent work in our group has realised the development of a biocompatible magnesium/air battery, formed from a magnesium anode and a cathode based on the conducting polymer poly(dioxyethylene thiophene) (PEDOT). Using highly saturated aqueous salts as an electrolyte, a stable battery can be constructed.

Measurements have indicated that the rate capability and lifetime of these batteries are limited by anodic reactions. This project aims to improve these devices by investigating the processes occurring at the metal/electrolyte interface.

A variety of electrolytes have been incorporated into the battery with varying success.

Electrochemical discharge of the batteries indicates an electrolyte comprising of a magnesium chloride-lithium chloride mixture presents the most stable voltage of approximately 1.5V for a lifetime of seven days. Novel surface characterisation techniques are being developed to characterise the magnesium anode surface after electrochemical testing.

It is the interfacial properties that will determine the performance and lifetime of the battery. Hence, understanding the morphology and properties of the interface is critical to further battery development.

Presenting Author: Mr Timothy Khoo

Hydrogen Storage of CNTs with Microwave Treatment

*Y.T. Lee,
P.J. Tsai,
K.S. Linb,
A.B. Yang,
S.L.I Chan*

This research aims to utilize microwave irradiations to introduce structural defects and morphological changes in the multi-walled carbon nanotubes (MWNTs). The defects in MWNTs are believed to affect the hydrogen storage ability significantly, with the creations of more surface area, as well as more hydrogenation/dehydrogenation paths in the MWNTs. In this work, MWNTs have been treated at different periods of time using microwave irradiations. The microwave treatment was found to increase the amount of structural defects and open ends in the MWNTs; the treatment also broke the MWNTs tubes into shorter sections. Morphological changes such as welding of tubes and amorphous structure formation after microwave irradiations have been identified using Transmission Electron Microscopy (TEM). The decreasing D-band to G-band ratio in the Raman Spectrum of the treated MWNTs suggests the formation of amorphous surface on MWNTs. Our BET also results show an increase in specific surface area in microwaved MWNTs, as compared to the as-received ones. Thus the BET and Raman results are consistent with the TEM observations.

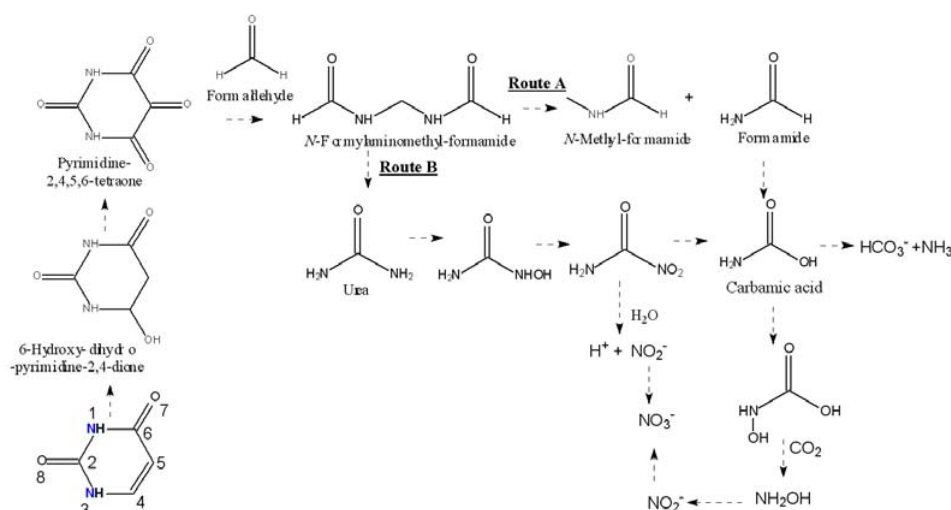
Hydrogen storage capacities of as-received and microwaved CNTs were acquired under He-reference method by Thermal Gravimetric Analysis (TGA). The TGA results show that the microwaved MWNTs have double the hydrogen storage capacity as compared to that in as-received MWNTs. Besides, it was found here that MWNTs with larger diameters (60 -100nm) have a higher hydrogen storage capacity than the ones with smaller diameter ones (20-40nm). This paper thus suggests a simple and cost-effective way to enhance the hydrogen storage capacity of MWNTs.

Presenting Author: Ms. Ya Ting Lee

Photoelectrocatalytic Oxidation of Uracil at Nanoparticulate TiO₂ Photoanodes

Guiying Li
Shanqing Zhang
Taicheng An
Huijun Zhao

In this work, the photoelectrocatalytic oxidation of uracil, a nucleic acid base, at nanoparticulate TiO₂ photoanodes was systematically investigated. The molecular orbital (MO) theory was employed to calculate the frontier electron density distributions among the atoms of the uracil molecule and the results were used to predict the initial mechanistic sequence(s). The degradation intermediates were examined using HPLC-PDA-MS. A photoelectrocatalytic degradation mechanism of uracil was proposed (see Scheme 1) by utilising the collective information obtained from photoelectrocatalytic experiments, HPLC-PDA-MS analysis of the reaction products and the MO calculations.



Scheme 1. Proposed photoelectrocatalytic degradation pathway for uracil.

Presenting Author: **Ms Guiying Li**
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Research Activities:
Reaction mechanisms and kinetics of photoelectrocatalytic degradation of organic and biological species

Synergetic Photoelectrocatalytic Oxidation of Linear Aliphatic Acids at Nanoparticulate TiO₂ Electrode

Lihong Li
Shanqing Zhang
*Huijun Zhao**

TiO₂ has been a dominant semiconductor photocatalyst due to its superior photocatalytic activity and strong oxidation power. Nanoparticulate TiO₂ thin-film electrodes have been used to degrade a variety of organic compounds. However, low degradation efficiency was observed during the photoelectrocatalytic oxidation of some short chain aliphatic acids, and the pollutants can cause adverse effects to skin and eyes. In this work, the photoelectrocatalytic degradation of a series of linear carboxylic acids (acetic acid, propanoic acid, butanoic acid) at the nanoparticulate TiO₂ electrode in a thin-layer photoelectrochemical cell was investigated. The experimental results show that these carboxylic acids cannot be fully mineralised by the direct photoelectrocatalytic oxidation at the TiO₂ electrode. It is also discovered that higher oxidation efficiency of these organic compounds can be achieved in the presence of some hydroxyl-containing organic compounds, such as glucose, namely synergetic photoelectrocatalytic oxidation. This synergetic effect can be used to improve the mineralisation efficiency of acetic acid, propanoic acid and butanoic acid. The results indicate that 100% mineralisation can be achieved via the synergetic approach.

Presenting Author: **Miss Lihong Li**
PhD student

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Gold Coast Campus,
Griffith University, QLD 4222

Preparation and characterization of chitosan nanoparticles for targeted drug delivery of 5-FU to colon

*Puwan Li,
Yichao Wang,
Lingxue Kong,*

Hydrophilic nanoparticle carriers have important potential applications for the administration of therapeutic molecules. The water-soluble anti-cancer drug, 5-fluorouracil (5-FU) is encapsulated into biodegradable chitosan (CS) nanoparticles by mixing a positively charged CS acetic acid solution and a negatively charged charged Tripolyphosphate (TPP). The parameters have been optimized for the preparation of 5-FU loaded nanoparticles. The nanoparticles are 120-160 nm in size and possess a spherical and smooth surface. The 5-FU loading capacity and encapsulation efficiency are 16.72% and 21.2%, respectively. The zeta potential of chitosan nanoparticles decrease when 5-FU loaded indicating the strong electrostatic interaction between 5-FU and chitosan.

Presenting Author: **Mr Puwan Li**
Research student

Preparation of silver doped TiO₂ coating for bactericidal application

Mega Ng
May Lim
Richard Kydd
Jason Scott
Rose Amal1

A novel dry, surfactant free deposition method was applied to the preparation of ultrafine silver deposits on the titanium dioxide surface. Titanium dioxide (Degussa P25) was first exposed to silver nitrate solution and then dried in a 60°C oven. The silver deposits were then formed by illuminating the TiO₂ particles under an 18 W blacklight or conventional fluorescent lamp. X-ray Photoelectron Spectroscopy showed that the surface silver species exist as Ag⁰ and Ag⁺, and the atomic ratio of silver to titanium dioxide range from 2.2 to 4.4. The presence of Ag⁰ was further confirmed by a plasmon peak at 490-530 nm in UV-Visible Reflectance Spectroscopy measurement. Transmission Electron Microscopy shows well-dispersed, uniform silver particles of approximately 5 nm in diameter. The oxidation state of the silver was shown to be an important factor in the bacteria killing properties of the coating.

Presenting Author: **Dr May Lim**
Research Activities:
Titanium Dioxide Magnetic Nanoparticles

THE DEVELOPMENT OF POROUS Ti-Nb-Ta-Zr ALLOY BY POWDER METALLURGY

Aris W. Nugroho
Garry Leadbeater
Ian J. Davies

The purpose of this study was to develop biocompatible porous titanium alloys produced from the alloying of titanium with β -stabilized elements, i.e., Nb, Ta and Zr, which are known to be relatively low in toxicity and also increase strength, fabricated by a novel powder metallurgy process based on the pressurised gas-induced expansion of pores (i.e., foaming). The manufacturing procedure involved: (i) blending elemental powders, (ii) pressurized argon gas infusion, (iii) powder compaction and sintering in a hot isostatic press (HIP) furnace, and (iv) expansion of the argon filled pores at elevated temperature under vacuum. Following manufacture, the allotropic phase transformations were examined by X-ray diffraction (XRD) whilst the pore size distributions of the HIP-ed and foamed alloys were determined by digital image analysis. Finally, the specimens were etched using Kroll's solution and examined by optical microscopy (OM) and scanning electron microscopy (SEM) in order to reveal the microstructure.



Presenting Author: **Mr Aris Widiyo Nugroho**
 Student

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Research Activities:
 Engineering and characterization porous titanium alloy for biomedical application

The Fracture Morphology and Mechanical Properties of Biodegradable Polyester Composites

Eustathios Petinakis^{1,2}

*Long Yu*¹,

*Katherine M Dean*¹,

*Graham Edward*²

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Polymers from renewable resources (PFRR) have attracted great interest in recent years due to two major reasons; firstly, environmental concerns and secondly the dwindling stocks of our petroleum resources. Like other petroleum-based polymers, many properties of PFRR can also be improved through blending and compositing techniques. These new blends and composites are extending the utilization of polymers from renewable resources into new value-added products. The focus of this work has been to investigate modification techniques for improving the interface in composites of poly(lactic acid) (PLA) and wood flour. The composites were prepared by melt compounding using a twin screw extruder, followed by injection molding. The microstructure, mechanical properties and fracture of the composites were studied by DMA, SEM, tensile and impact testing. The influence of filler content and the techniques of improving the interface between PLA and wood flour, such as the addition of an isocyanate and functional polyethylene as a toughening agent were systematically studied. Confocal Microscopy was employed to observe the dispersion and orientation of the wood flour particles in the PLA matrix. Characterisation of the interphase of the PLA composites was conducted to gain insight and provide evidence of chemical reactions between an isocyanate and the wood flour particles into PLA matrix.

Presenting Author: **Mr. Eustathios (Steven) Petinakis**
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Research Activities:
Development of biopolymer composites from natural resources materials characterisation

Bioactive Sphene Ceramics: Potential material for Orthopedic Coating Applications

Yogambha Ramaswamy
Chengtie Wu
Colin Dunstan
Benjamin Hewson
Gail Anderson
Hala Zreiqat

The success of orthopedic implants depends on strong anchorage of the device to skeletal tissue. The host response to titanium alloy (Ti-6Al-4V) is not favorable, as a fibrous layer may form at the skeletal tissue/device interface causing aseptic loosening. There is a need to develop new engineered surfaces that provide better implant osseointegration. Due to their bioactivity and biocompatibility, calcium silicate ceramics (CaSiO₃) have been used as coatings on Ti-6Al-4V. However, like hydroxyapatite (HAp), CaSiO₃ coatings have drawbacks. Recently, we developed a novel ceramic: Sphene (CaTiSiO₅) by incorporating Ti in Ca-Si system, which exhibited improved chemical stability. This study evaluates whether coating Ti-6Al-4V implants with sphene enhances anchorage to surrounding bone.

We investigated the in-vitro response of human osteoblast-like cells (HOB), human osteoclasts and human microvascular endothelial cells (HMEC) to sphene ceramics and determined the in-vivo osseointegration ability of sphene coated Ti-6Al-4V implants inserted in orthopedic relevant sheep model for 6 weeks.

In vitro: Sphene supported 1) HOB attachment, development of cytoskeletal structure, proliferation and differentiation; 2) Osteoclast maturation and functionality (formation of f-actin ring); and 3) HMEC growth.

In vivo: Sphene coated Ti-6Al-4V implants showed bone-implant contact comparable to that of HAp coatings. For both sphene and HAp, the new bone was in direct contact with the implants whereas fibrous tissue formed between the bone and implant with uncoated Ti-6Al-4V. The in-vivo assessment of sphene coated implants supports our in-vitro observation and suggests that they have the ability to recruit the osteogenic cells and support bone formation around the implants and enhance osseointegration.

Presenting Author: **Mrs Yogambha Ramaswamy**
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 Australia

Research Activities:
 Biomaterials for skeletal tissue engineering

Towards integrated biorefineries

*Chee Howe See
Thomas Maschmeyer
Brian S. Haynes*

Lignocellulose, the most abundant renewable source of stored solar energy, will supersede edible food crops in manufacturing biomaterials and biofuels via enzymatic or thermochemical methods. However, to fully utilise lignocelluloses, a paradigm shift in manufacturing practises would be required to valorise product streams, making use of the chemical structures already present, rather than simply gasifying biomass to produce syngas for subsequent Fischer-Tropsch processing. The key limitation to lignocellulose processing is the high cost involved in fractionation and hydrolysis via chemical means, e.g. acid and base hydrolysis, to obtain primary sugars for bioethanol production. However, alternative biofuels like 2, 5-dimethylfuran, which possesses higher energy densities, lower volatilities and hydrophobicity should be considered. Hydrothermal media are particularly interesting, encompassing promising processes ranging from lignocellulosic pretreatment, subcritical water hydrolysis and liquefaction, aqueous-phase reforming, hydrothermal upgrading and supercritical water gasification. Wet biomass can be directly processed to form the desired (immiscible) biofuels and biomaterials, which are easily separated. Energy recovery can be optimised by careful product staging and stream splits in an integrated hydrothermal biorefinery compared to the enzymatic route where the energy required in pretreatment is not amenable to recovery. Nevertheless, many engineering challenges remain in hydrothermal processing despite its high throughput, energy and separation efficiency, including unknown or largely uncharacterised reaction pathways and kinetics, reactor fouling and plugging issues arising from inadequate salt management, and a need for specialised materials to withstand the corrosive environments of hydrothermal media.

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PhD Candidate

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Research Activities:

Applications of fluidised bed technology in carbon nanotube synthesis – Parametric optimisation, large-scale synthesis, kinetic data analysis. Functionalised carbon nanotube materials for bioengineering, biomedicine, structural, energy storage and production.

Effects of Carbon Nanotubes in 3D Porous Nickel-Foam Electrodes for Rechargeable Nickel Batteries

Quansheng Song*,†

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S.L.I. Chan†

†School of Materials Science and Engineering, University of New South Wales, Sydney, NSW 2052, Australia.

Multi-walled carbon nanotubes (CNTs) were employed as a functional additive to improve the electrochemical performance of three-dimensional (3D) porous nickel-foam electrodes for rechargeable nickel-based batteries. The pasted nickel electrodes were prepared with a 3D porous nickel-foam as the substrate, spherical nickel hydroxide (β -Ni(OH)₂) powder as the active material, and various amounts of CNTs as additives. Galvanostatic charge/discharge cycling tests showed that in comparison with the electrode without CNTs, the nickel electrode with added CNTs exhibited better electrochemical properties in the chargeability, specific discharge capacity, active material utilisation, discharge voltage, high-rate capability and cycling stability. Meanwhile, the CNT addition also lowered the packing density of Ni(OH)₂ particles in the 3D porous nickel-foam substrate, which could lead to the decrease in the active material loading and discharge capacity of the electrode. Hence, the amount of CNTs added to Ni(OH)₂ should be optimised to obtain a high-performance nickel electrode, and an optimum amount of CNT addition was found to be 3 wt.%. The superior electrochemical performance of the nickel electrode with CNTs could be attributed to lower electrochemical impedance and less γ -NiOOH formed during charge/discharge cycling, as indicated by electrochemical impedance spectroscopy and X-ray diffraction analyses. Thus, it was an effective method to improve the electrochemical properties of 3D porous nickel-foam electrodes by adding an appropriate amount of CNTs to spherical Ni(OH)₂ as the active material.



Presenting Author: **Dr Quansheng Song**
Research Fellow

School of Materials Science and Engineering,
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Sydney, NSW 2052, Australia

Research Activities:

• Electrochemical Energy Storage & Conversion Technology. • Rechargeable Batteries and Supercapacitors. • Porous Electrodes for Electrochemical Devices. • Nanostructured Electrode Materials. • Carbon Materials for Electrochemical Systems. • Materials for Hydrogen Electrochemical Production and Storage.

Effects of Multiwalled Carbon Nanotubes on the Electrochemical Performance of AB5-based Ni-MH Battery

*P.J. Tsai,
Q Song,
Z.P. Guo,
S.L.I Chan*

Ni-MH battery's performance depends on the nature of the positive $\text{Ni}(\text{OH})_2$ electrode and the negative electrode. Negative electrode consists of hydrogen storage materials, Ni powder for enhanced conductivity and a binder. Most research on the improvement on the negative electrode concentrated on alloying modifications, crystal structure etc. Little work has been done on the Ni in the electrodes. The amount of Ni used has to be small in order to reduce the cost/weight of the electrode, yet to maintain a reasonably good conductivity. Here, a small amount of multiwalled carbon nanotubes (MWNTs) has been introduced into the negative electrode to partially replace the Ni, so as to achieve similar, or even better electrochemical properties of the electrodes, but with considerable weight/cost saving.

Electrode fabrication involves slurry pasting a mixture of 0.6g of AB5 powder hydrogen storage material with 0.06g (i.e. 10wt.% the weight of AB5) of Ni, and different amounts of MWNTs. For comparison purpose, electrodes with 0.6g of AB5 and 1.2g of Ni powder (i.e. 200% of the weight of AB5), were made. Our results reveal that for electrodes with only 0.06 g of Ni, the specific capacity has dropped to 130mAh/g, as compared with the electrodes with 1.2g of Ni (300mAh/g). Intriguingly, an addition of 0.03g (5wt.%) of MWNTs in such an electrode revived the capacity from 130 to 295mAh/g. Thus the MWNTs are very cost-effective and can be used to partially replace the Ni powder. Other electrochemical properties of MWNT-doped electrodes will be discussed in the presentation.

Presenting Author: Mr. Ping-JU Ben Tsai

3D Fibrous Tissue Scaffolds: Influence of Porosity on the Cell Culture Performance

Yanwei Tang, Cynthia Wong, Hongxia Wang, Alessandra Sutti, Tong Lin, Xungai Wang, Mark Kirkland, Andrew Parratt

Abstract: In this study, we explored the cell culture performances of a three-dimension (3D) fibrous matrix and examined the influence of matrix porosity on the cell growth behaviours. Four fibrous matrices having different porosities were prepared from polycaprolacton (PCL) fibres (diameter ~50 μ m) using a nonwoven technique. The matrix was characterised by SEM, Micro-CT and confocal microscope. The pores have very good interconnectivity with the size range between 100 micros and 700 micros.

Chinese Hamster Ovary (CHO) cells were seeded on the fibrous matrices and grew for 28 days. It was indicated that CHO cells attached, spread, and proliferated very well on the fibre surface insight the matrices. The cell number on the matrix showed significant difference after culture for 4 days and kept better after 28 days' culture period compared to that on 2D plastic Petri dish. Furthermore, the matrix with porosity of 81% resulted in the most effective one in entrapping CHO cells and providing anchorage.

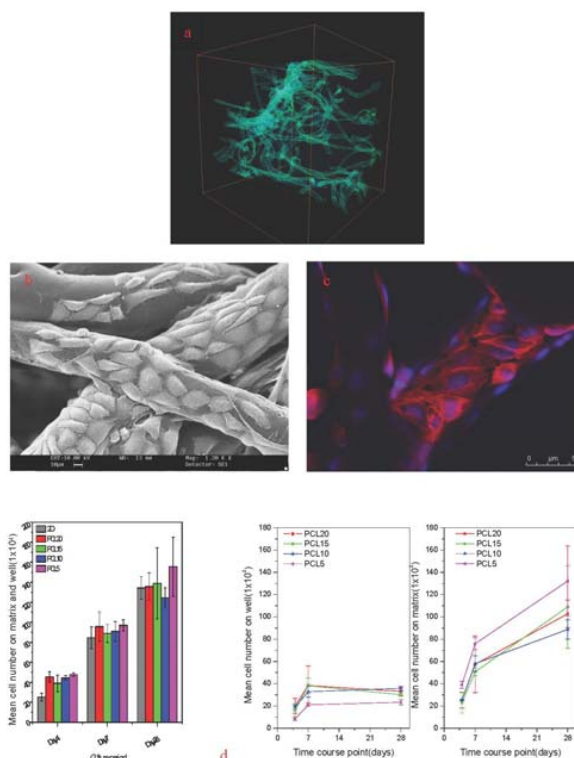


Figure 1: (a) Micro-CT photograph of a PCL fibre matrix, (b) SEM image of the matrix with CHO cells (culture 4 days), (c) confocal microscope image of CHO cells in PCL matrix, (d) cell growth after 28 days of culturing on different substrates.

Presenting Author: **Yanwei TANG**
PhD candidate

PLGA nanoparticles prepared by emulsion-solvent evaporation method: Optimization of process parameters to enhance encapsulation efficiency

Yichao Wang-Puwang Li-Juan Zhang-Mary Fenghua She-Lingxue Kong

The objective of this research is to optimize the processing parameters for poly (D, L-lactide-co-glycolide) (PLGA) microspheres of 5-Fluorouracil (5-FU). 5-FU is the standard treatment of colorectal cancer nowadays and would be a candidate to be delivered orally to the targeted area. The drugs are loaded inside PLGA nanoparticles by a modified emulsion-solvent evaporation method. The fabrication technique for preparation of nanoparticles suffers the drawback of poor incorporation of water soluble drugs. So in the experiment, various formulation parameters are assessed to enhance the entrapment of 5-FU into PLGA nanoparticles, such as the polymer concentration, kind of organic solvent, drug amounts, PVA concentration, pH of internal aqueous phase and external ones, etc. Factorial designs will be employed to study the effect of these factors to design a better scheme. Further research will also included drug distribution state in the microspheres and internal morphology, which have great effect on the following drug release characteristic.

Key words: 5-Fluorouracil, PLGA, microsphere, optimization



Presenting Author: **Mr Yichao Wang**
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Research Activities:
Drug delivery system

Formation mechanism of carbon spheres during hydrothermal process using sugar precursors

Mu Zhang, Hong Yang and Yinong Liu

Spherical colloidal carbon particles of uniform sizes were synthesized by a low temperature hydrothermal process from disaccharide (sucrose), fructose and glucose precursor materials. The synthesized carbon spheres were characterized by a variety of experimental techniques, including scanning electron microscopy (SEM), transmission electron microscopy (TEM) and Fourier transform infrared spectroscopy (FT-IR). SEM examination revealed that the carbon spheres synthesized using sucrose and fructose at ~150°C are of uniform sizes of ~300 nm. Increasing processing temperature was found to increase particle size of the carbon spheres. The surfaces of the spheres are granular. It was also found that massive carbonization of glucose does not occur at below 180°C. At this threshold temperature, much smaller carbon spheres of ~80 nm were synthesized from glucose. TEM examination revealed details of the granular surface features, which are of the order of xx nm in size. FT-IR analysis showed that the carbon spheres were composed of same chemical functional groups regardless of the starting material used, suggesting that carbon spheres created from all the three systems were formed by similar formation mechanism.

Keyword: carbon spheres; hydrothermal processing; sucrose; fructose; glucose;

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Research Activities:
hydrothermal synthesis of nanoparticulate materials and composites, micro-nano carbon spherules,
microemulsion systems

Mike Loretto

(University of Birmingham)



Controlling the microstructure and properties of Ti and TiAl-based alloys

M H Loretto, IRC in Materials, The University of Birmingham, Edgbaston, B15 2TT, UK

This talk will focus upon three topics; (i) The role of trace additions of carbon in controlling the microstructure of near beta Ti alloys through its influence on the precipitation of alpha during ageing. (ii) The development of microstructure during Hot Isostatic Pressing of Ti powders, which is becoming increasingly important with the application of Net shape HIPping to component manufacture and (iii) Microstructural control in cast TiAl-based alloys – driven by the decision by Rolls-Royce and GE to use cast blades in their next generation engines.



Rob Lamb

(Australian Synchrotron and the University of Melbourne)

The brightest light in the southern hemisphere

This is an overview giving an insight into what the fuss is all about regarding the Australian Synchrotron.

Electrically controlled release of dexamethasone sodium phosphate from chitosan-carbon nanotubes films

Sina Naficy

Geoffrey Spinks

Joe Razal

Gordon Wallace

Electrically controlled drug release using chitosan (CHIT) hydrogels and single walled carbon nanotubes (CNT) as the matrix for Dexamethasone disodium phosphate (Dex) as a model drug was investigated. Solution-casting method was employed to prepare drug loaded CHIT/ CNT hydrogels on carbon paper substrates. Passive release and electrically stimulated release of Dex was studied in phosphate buffer saline (PBS) solution at pH 7.4. The effects on the drug release of external electrical stimulus, electric field strength, electrode polarity, and CNT content were determined. UV-Visible spectroscopy was used to analyse the amounts of drug released into the surrounding buffer solution. The effect of electrical stimulation was evaluated by applying a constant electric potential from -800 mV to +150 mV (versus Ag/AgCl reference electrode). It was found that CNTs slow down the release of DEX during passive release (no applied potential). In addition, the CNTs can accelerate or retard the release of DEX by controlling the charge on the CNT surface and thereby manipulating the electrostatic interactions between the CNTs and the DEX. The performance of CHIT-CNT films for DEX release is compared to previously described methods.



Presenting Author: **Mr Sina Naficy**
PhD Student

Intelligent Polymer Research Institute, AIM Facility, Innovation Campus, University of Wollongong, Squires Way, Fairy Meadow, 2519

Research Activities:
Controlled Drug Release, Toughened Hydrogel Fibers

Development of Highly Active Catalysts for Methane Steam Reforming

D.T. Alexander

A.L. Dicks

A class of novel bi-metallic catalysts having extremely high activity for methane steam reforming has been reported recently (Miyata et al, Catal. Comm. 2007, 8, 447-451). The catalysts are prepared from Mg-Al hydrotalcite precursors, exploiting the so-called 'memory-effect' of hydrotalcite derived periclase mixed oxide to incorporate the active metals (Nickel and Ruthenium). Very high activity and stability has been recorded with extremely low Ru loading (c.f. 0.05 to 0.1% w/w). This investigation is concerned with the development and optimization of this class of catalysts.

Presenting Author: **Mr Dominic Alexander**
PhD Student

Research Activities:
Development of a Compact Integrated Microchannel Reformer for the production of Hydrogen and Synthesis Gas from Methane

Lithium Metal Battery Using V₂O₅ Nanomaterials Cathode and Room Temperature Ionic Liquid Electrolyte

Shu-Lei Chou
Jia-Zhao Wang
Jia-Zeng Sun
David Wexler
Maria Forsyth
Hua-Kun Liu
Douglas R. MacFarlane
Shi-Xue Dou

The lithium metal battery is one of the most promising high energy density storage devices due to the most negative potential of the Li⁺/Li couple and its high theoretical capacity (more than 3860 mAh g⁻¹). [1] To achieve a safe and practical high-energy-density rechargeable lithium battery requires selection of an optimum electrolyte and a compatible and high-capacity cathode material. Electrolyte materials currently used in lithium ion batteries present significant safety issues for lithium metal batteries due to the use of flammable organic electrolytes and the formation of lithium dendrites. Room temperature ionic liquids (RTILs), on the other hand are, in some cases, flame resistant, non-volatile, electrochemical stable, and able to effectively prevent the formation of lithium dendrites, showing potential as the safe electrolytes for use in lithium battery systems. [2]

Here, V₂O₅ nanomaterials were prepared by an ultrasonic assistant hydrothermal method followed by a post annealing process. The porous V₂O₅ nanoribbons with dimensions of about 5 μm in length, 500 nm in width, and approximately 20 nm in thickness shows the highest capacity of 430 mAh g⁻¹ for initial discharge, the best cyclability (270 mAh g⁻¹ for the 50th cycle) and good high-rate performance (119 mAh g⁻¹ at 2 C current density) in RTIL electrolytes. The TGA results show that the RTIL can prevent the dissolution of V₂O₅ during charge and discharge. The rechargeable lithium battery presented here using porous V₂O₅ nanoribbons as cathode materials and RTIL ([C₃mpyr][NTf₂] containing 1M LiNTf₂) as electrolyte could be the next generation lithium battery with high capacity, safety and long cycle life.

Reference

- [1] T. B. Reddy, S. Hossain, (Eds: D. Linden, T. B. Reddy), in Handbook of batteries, 3rd Edition, McGraw-Hill, New York, 2002, Ch. 34.
[2] a) M. Galinski, A. Lewandowski, I. Stepniak, *Electrochimica Acta* 2006, 51, 5567; b) D. R. MacFarlane, M. Forsyth, P. C. Howlett, J. M. Pringle, J. Z. Sun, G. Annat, W. Neil, E. I. Izgorodina, *Acc. Chem. Res.* 2007, 40, 1165; c) N. Byrne, P. C. Howlett, D. R. MacFarlane, M. Forsyth, *Adv. Mater.* 2005, 17, 2497.



Presenting Author: **Mr. Shulei Chou**
PhD Student

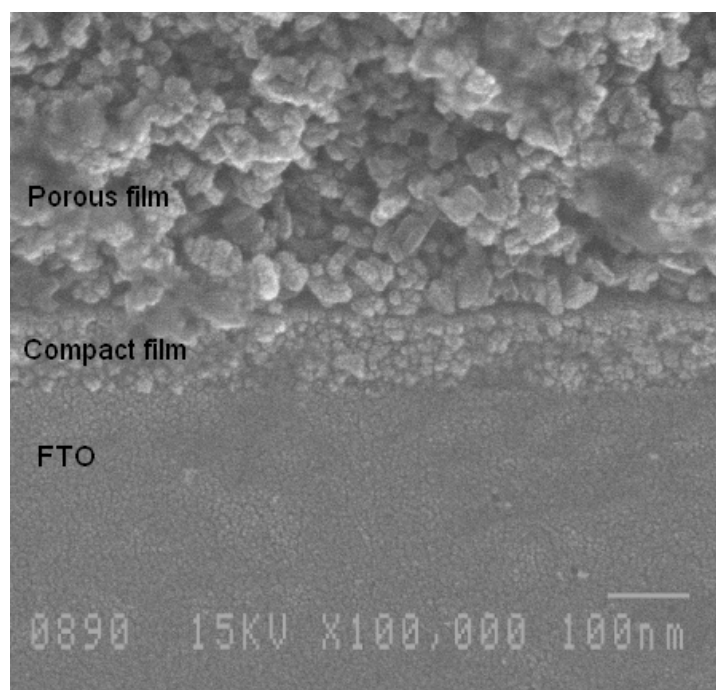
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Research Activities:
Nanomaterials Energy materials

An Organo-sol Modified TiO₂ Nanoporous Electrode for Dye-Sensitized Solar Cells Applications

Hua Yu
Shanqing Zhang
Huijun Zhao

A TiO₂ organo-sol was synthesised and used to create a compact TiO₂ layer on fluorine-doped tin oxide (FTO) glass by a dip-coating technique. The resultant thin film was used as the base for the fabrication of dye-sensitized solar cells (DSSCs). The compact layer has a typical thickness of ca. 110nm as indicated by its SEM, and consists of anatase as confirmed by the XRD pattern. Compared with the traditional DSSCs without compact layer, the solar energy-to-electricity conversion efficiency, short circuit current and open circuit potential of the DSSCs with the compact layer were improved by 33.3%, 20.3%, and 10.2%, respectively. This can be attributed to the merits brought by the compact layer. It improves the adherence of TiO₂ to FTO surface and enhances the TiO₂/FTO contact area. The improved performance may also be attributed to the reduced electron leakage at the exposed FTO surface as a result of compact layer formation on the FTO surface.



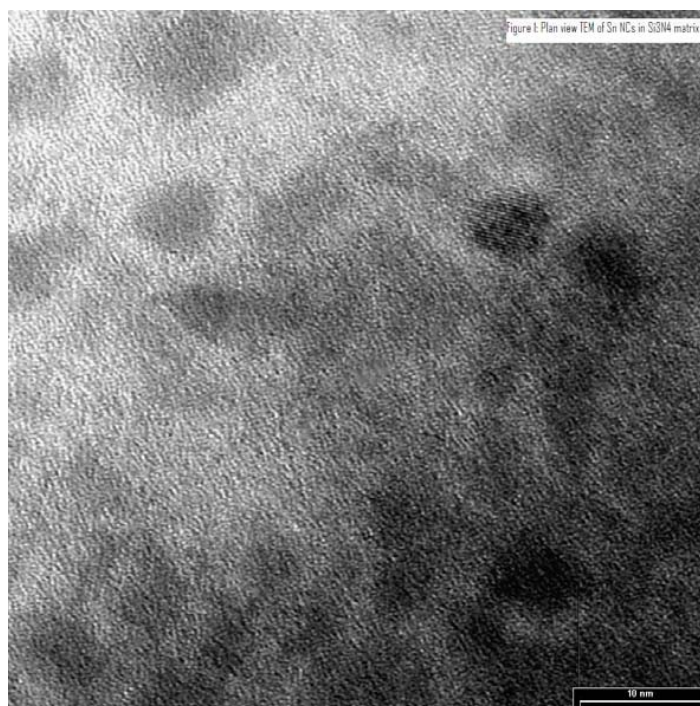
Presenting Author: **Mr HUAYU**
PhD

Research Activities:
Fabrication of nanostructured materials for dye-sensitized solar cell

Investigation Of Quantum Confinement Effects In Tin Quantum Dot Materials For Photovoltaic Applications

Yong Heng So, Shujuan Huang, Gavin Conibeer, Martin A. Green

Recently, other group IV elements other than Si, such as tin (Sn) have been implemented as quantum dots (QDs) in a dielectric matrix. Sn nanostructure materials have attracted growing interest due to low process temperatures and possible band gap flexibility. Sn nanocrystals (NCs) embedded in a Si₃N₄ matrix have been prepared by co-sputtering of Sn and Si₃N₄ at different substrate temperatures. Formation of Sn NCs in Si₃N₄ matrix was observed by using Transmission Electron Microscopy (TEM) and Glancing Incidence X-ray Diffraction (GIXRD). Our results showed that Sn NCs of sizes 5.2-0.5nm and 6.7-1.2nm were formed at substrate temperatures of 50°C and 100°C respectively, as observed by TEM. This indicates that with the employment of substrate heating during deposition, post-annealing can be avoided for the formation of Sn NCs in Si₃N₄. Moreover, the size of Sn NCs was found to be decreasing with decreased substrate temperature. This occurs as with certain substrate temperature, there is a critical size for the particle in the cluster beam where only if the incident cluster size is smaller than the critical size, the particle will melt upon deposition and coagulate to form larger cluster which will then solidify and stop further coagulation. Therefore, substrate temperature should be as low as possible to obtain smaller size NCs, which is in good agreement with the results of TEM and GIXRD. Lowering the substrate temperature during deposition enabled the formation of smaller Sn QDs. The control of NC size this enables is essential in studying and investigating the quantum confinement effect in Sn QDs material.



Presenting Author: **Mr Yong Heng So**
PhD Research Student

Synthesis and characterization of nano P-N junction for all-Si tandem solar cells

*Xiaojing Hao
Ivan Perez Wurfl
Eunchel Cho
Yansong Shen
Gavin Conibeer
Martin A Green*

The Si quantum dot (QD)-based ?all-Si? tandem solar cell, shown in Figure 1, is proposed as a way of improving solar cell performance [1]. The efficiency advantage of the tandem cell structure arises from the higher voltage output of the large bandgap cells in the structure. The bandgap can be tuned by taking advantage of quantum confinement effect in Si. In this work, nano P-N junction, similar to the conventional P-N junction, was synthesised and its properties were investigated. Silicon QD superlattices is the basic structure, which is synthesised by a co-sputtering multi-targets technique. P- and N-type Si QD superlattices was realized with introducing boron and phosphorus, respectively, during the sputtering process. By using this superlattice, Si quantum dot size can be well controlled [3]. The QD p-n and p-i-n junction devices of Figure 2 have been successfully fabricated, as could be used in the upper cells of Figure 1. Transmission electron microscopy confirmed that Si quantum dots 4 nm in diameter were obtained. Optical measurement suggests an optical bandgap of 1.5 eV. Electrical I-V measurement indicates that we obtained the QD junction. A progress has been achieved in improving the open-circuit voltage (Voc), the most critical parameter for device (shown in Figure 3)

References

- [1] M.A. Green, et al., in: Proc. 20th European Photovoltaic Solar Energy Conference, 2005, Barcelona, Spain, pp. 3.
- [2] S.C. Erwin, L.J. Zu, et al., Nature 436 (2005) 91.
- [3] X.J. Hao, M.A. Green, et al., Nanotechnology 19 (2008) 424019.

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University of New South Wales
UNSW SYDNEY NSW 2052

Research Activities:
Silicon quantum dots in oxide matrix All-silicon tandem solar cell

Mesoporous spherical TiO₂ as bifunctional material for high performance dye-sensitized solar cells

Dehong Chen,

Fuzhi Huang,

Rachel A. Caruso

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Yi-Bing Cheng

Department of Materials Engineering, Monash University, Vic 3800, Australia

The effectiveness of materials in applications can be enhanced by control of the structural architecture of a material. For a variety of practical applications, the fabrication of desired morphologies and textures is important as well as control in crystallinity, porosity and composition. In this report, mesoporous anatase titania beads with specific surface areas up to 108.0 m²/g and tunable pore sizes (from 14.0 to 22.6 nm) have been prepared through a facile combination of sol-gel and solvothermal processes. High resolution SEM and XRD measurements show that the resulting mesoporous titania beads have a diameter of ~ 830 nm and are composed of anatase titania nanocrystals. These titania beads have been used to prepare the working electrodes for dye-sensitized solar cells and an overall photon-to-current conversion efficiency of 7.20% has been achieved by using these mesoporous titania beads as electrodes, significantly higher than that derived from standard Degussa P25 titania electrodes of similar thickness (5.66%). Due to the submicron-sized particle diameters and high specific surface areas, the mesoporous TiO₂ beads can enhance the light harvesting within the electrodes without sacrificing the accessible surface for dye loading, thereby increasing the photon-to-current conversion efficiency compared to P25 nanoparticles.

Presenting Author: **Dr Dehong Chen**

Research Activities:

Templated synthesis of porous materials, Sol-gel dip coating approach for films, Hydrothermal synthesis of nanocrystallines, Dye-sensitized solar cells, Photocatalysis

Carbon Nanotubes: Self-Alignment in Copolymer Thin Films

Tony Aitchison

Milena Ginic-Markovic

Stephen Clarke

Janis Matison

Forming a uniformly dispersed carbon nanotube material has long been sought after to increase the mechanical properties of the resulting nanocomposite [1]. Many chemical techniques have been employed to increase such dispersions [2], however the orientation of carbon nanotubes in a polymer matrix has not been greatly studied and is often ignored.

In this work, homopolymer brushes of polystyrene on multi-walled carbon nanotubes are produced by living free radical polymerisation. As they are living polymers, the chain lengths are controlled by reaction time and hence, tailor made polystyrene coverage on carbon nanotubes has been achieved. The T_g increased by 190°C relative to commercial polystyrene with 60% polymer coverage on the nanotubes.

Self-alignment of carbon nanotubes in PS-*b*-PMMA copolymer micro-domains is achieved due to the affinity of these brushes towards the polystyrene phases giving uniform nanotube orientation. A thin film of a cylindrical copolymer has been explored and studied in further applications.

[1] (a) Deng, J.; Zhang, X.; Wang, K.; Zou, H.; Zhang, Q.; Fu, Q. *J. Mem. Sci.* 2007, 288, 261-267.

(b) Gao, J.; Itkis, M. E.; Yu, A.; Bekyarova, E.; Zhao, B.; Haddon, R. C. *J. Am. Chem. Soc.* 2005, 127, 3847-3854.

[2] Blake, R.; Gun?ko, Y. K.; Coleman, J.; Cadek, M.; Fonseca, A.; Nagy, J. B.; Blau, W. J. *J. Am. Chem. Soc.* 2004, 126, 10226-10227.



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Research Activities:
highly orientated structures on silicon surfaces with encapsulated carbon nanotube nanofillers

Visualization of the Percolating Networks in Multi-wall Carbon Nanotube (CNTs)/Epoxy Composites

Li Chang

Klaus Friedrich

Liangchi Zhang

In the present work, epoxy-based nanocomposites consisting multi-wall carbon nanotubes (CNTs) are produced by a calendaring approach. The electrical property of these composites is investigated as a function of CNT content. The experimental conductivity is found to obey a percolation-like power law with a very low percolation threshold below 0.05 vol.%. The electrical conductivity can be enhanced by more than six orders with the addition of 0.6 vol.%, suggesting the formation of network of CNTs in insulating polymer matrix.

To comprehensively study the morphology of CNTs in epoxy matrix, different microscopy techniques such as atomic force microscopy (AFM), transmission electron microscopy (TEM) and scanning electron microscopy (SEM) have been applied. It was found that the application of charge contrast imaging in SEM allows visualization of the overall CNT status at micro-scale, as well as the identification of bundled CNTs at nano-scale. On the basis of micro-observation, the influence of CNTs morphology on electrical percolation is further discussed.



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Research Activities:

Solid Mechanics: Nano-mechanics and contact mechanics. Tribology: Wear and friction of polymer composites, two-body and three-body abrasive wear.

Nanotechnology: Materials characterisation using advanced nano-techniques, e.g. nano-triboindenter, Transmission Electron Microscopy (TEM) and Atomic Force Microscopy (AFM) Materials Science: Structure-property relationships in polymer composite, manufacturing techniques for high performance polymer composites, design with composites, polymer nanocomposites

Fabrication of organic-inorganic hybrid nanofiber and nanotube arrays using POSS as building blocks

*Yuhua Xue,
Tong Lin,
Lianfang Feng,
Xungai Wang*

Free-standing organic-inorganic hybrid nanofiber and nanotube arrays were fabricated via AAO template using polyhedral oligomeric silsesquioxane (POSS) as building blocks. Two kinds of POSS, mercaptan functional POSS (OmpPOSS) and epoxy functional POSS (epoxy-POSS), were used in this report. The nanofibers and nanotubes were prepared by in-situ polymerization and sol-gel method respectively. The resulted arrays were characterized by SEM, TEM, FTIR, XRD, DSC, TGA. FTIR indicates that OmpPOSS and epoxy-POSS were completely reacted in the AAO pores. POSS were uniformly dispersed in the hybrid nanofibers and nanotubes. The free-standing, vertical and ordered arrays were formed via freeze-drying removal of the environmental liquid. POSS nanofibers and nanotubes show high glass transition temperature (T_g) and thermal stability. The POSS hybrid nanofibers and nanotubes might find applications in catalysis, nanodevices, chemical/biological separation and sensing.

Presenting Author: **Yuhua Xue**
PHD student

Bending response of aluminium foam-cored sandwich panels

Kaveh R. Kabir
T. Vodenitcharova
M. Hoffman

The structural response of both monolithic foam and foam-cored sandwich panels subjected to static three-point bend loading was investigated in this study. The analysis employed foam panels of two thicknesses, 6 and 12 mm, made of a commercial closed-cell aluminium foam with an approximate cell size of 2.5 mm and an average density of 0.25 g/cc. The foam panels were laminated with 0.3 mm thick sheets of both high and low yield strength aluminium alloy. The load-displacement curves of the specimens under different span lengths were recorded, and the deformation behaviour, failure modes, and the load bearing capacity of the panels were investigated. The dependence of the failure modes on the core thickness, reinforcing face sheet and span length was also revealed. Modified models found to predict the load bearing capacity of the panels failed by different failure modes which were consistent with the experimental results.

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Research Activities:
Mechanical properties of sandwich structures and foams

Quasi-static and Impact Response of Carbon Fibre/Closed-Cell Aluminium Foam Sandwich Panel to Local Damage

Maizlinda Izwana Idris

Tania Vodenitcharova

Mark Hoffman

A key motivation for using light metal foams as the core material in a sandwich construction is not only the advantageous strength/weight ratio but also their exhibition of very good impact energy absorption. In this research, sandwich composite materials are fabricated with a carbon fibre skin and closed-cell aluminium foam core. During their service life, sandwich composites can undergo localised damage from impact of dropped tools, striking birds, hailstones or runaway debris. Although this impact may not cause failure of the structure, the localised damage will dramatically reduce the strength of the composite structure.

In this work, contact damage is simulated experimentally using spherical indenters into the surface of the sandwich by quasi-static and impact loading. Quasi-static indentation at a constant low-velocity of 0.5mm/min is carried out, and the induced contact damage was found to be dependent only of the indenter diameter, but independent of the sample thickness. On the contrary, the impact test indicated velocity-dependence of the failure mode of the sandwich panel (i.e. skin breakage or punch through) which could be found from the load-displacement curves. Of particular interest is the remnant bending strength of the panels when locally damaged but having no skin failure. The remnant strength is determined by carrying out four-point bending strength tests. The local damage has been located on either the compressive or on the tensile side of the sandwich panels. The results reveal that there is a correlation between contact damage and remnant strength and that the use of metal foam cores leads to high contact damage resilience of the metal foam-based composite structures.

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Research Activities:
Structural Integrity of Sandwich Composites

High-Strength Ultrafine Grained Titanium Based Alloys With Bimodel Structure

Dr. Laichang Zhang, Faculty of Engineering, University of Wollongong, NSW2500, Wollongong, Australia

Prof. Elena V. Pereloma, Faculty of Engineering, University of Wollongong, NSW2500, Wollongong, Australia

Prof. Juergen Eckert, Institute for Complex Materials, Leibniz Institute for Solid State and Materials Research (IFW) Dresden, D-01187, Dresden, Germany

Nowadays, the improvement of the strength and the room temperature plasticity of nano-/ultrafine-grained metallic materials has become a key topic in the development of advanced structural materials. Compared with other metallic materials, titanium alloys are one of the best lightweight engineering materials for many industrial applications due to their excellent mechanical properties and good corrosion resistance. However, the improvement of the mechanical properties balance for titanium alloys is limited. We report on the formation of ultrafine-grained Ti-Fe-Sn and Ti-Fe-Ta alloys with a combination of high strength of about 2350-2650 MPa and large plasticity. All the as-cast Ti alloys exhibit a bimodel microstructure consisting of primary FeTi or beta-Ti phases and a (beta-Ti+FeTi) eutectic matrix. The excellent mechanical properties are associated with the following combined microstructural features: (i) the refinement and the volume fraction of the phase constituents, (ii) the compatibility of the phase structures, and (iii) the structural short-range order and the lattice strain of the beta-Ti phase. These work have been published in Applied Physics Letters and Scripta Materialia.



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Research Activities:

Dr Laichang Zhang's main research interests are in alloy design and processing-microstructure-property relationships of advanced high-strength metallic materials (especially titanium alloys, TRIP steels). He has conducted extensive researches on the tailoring of microstructure and mechanical behaviour in advanced titanium alloys using x-ray diffraction, transmission electron microscopy, scanning electron microscopy as well as mechanical testing as main research tools.

Strength Evolution in Brittle Thin Films

Oscar Borrero-Lopez

Mark Hoffman

Avi Bendavid

Phil J. Martin

We have investigated the fracture strength variability of brittle thin films (thickness $< 1 \mu\text{m}$) utilising a simple test methodology. Nanoindentation of as-deposited films on silicon substrates followed by cross-sectional examination of the damage with a Focused Ion Beam (FIB) Miller allows the occurrence of cracking to be assessed in comparison with discontinuities (pop-ins) in the load-displacement curves. Strength is determined from the critical loads at which cracking occurs using the theory of plates on a compliant foundation. This method has been applied to tetrahedral amorphous carbon (ta-C) and Ti-Si-N nanocomposite films, in order to investigate microstructural and size effects on fracture strength. This is of great relevance, since the fracture strength of brittle films and other small-scale systems ultimately controls their reliable use in a broad range of functional applications, such as micro- and nanoelectromechanical systems.

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Postdoctoral Research Associate, UNSW

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Research Activities:
Thin films, Tribology, Contact Mechanics

Effect of Ultraviolet Irradiation on Gel Oxidised Titanium in Simulated Body Fluid

Hasan Zuhudi Abdullah

Charles Christopher Sorrell

The gel oxidation method was used to produce titania films on titanium substrates. This method involves subjecting the metallic substrate to surface gelation by immersion in a 5.0 M NaOH solution for 24 h at 60°C, followed by oxidation (heating at 300°C/h and soaking for 1 h at 400°, 600°, or 800°C). The resultant anatase or rutile thick films were soaked in simulated body fluid (SBF, Kokubo solution) for 24 h and irradiated with ultraviolet (UV) light for a total time of 12 h (in 15 minute segments with alternating on and off radiation [for maintenance of consistent temperature of $\pm 0.5^\circ\text{C}$] over 24 h). The microstructures, phases present, thicknesses, adhesive strengths, and surface roughnesses of the films were determined using field emission scanning electron microscopy (FESEM), glancing-angle X-ray diffraction (GAXRD), focussed ion beam (FIB) milling, scratch testing, and surface profilometry, respectively. Bonelike apatite formation was observed after 24 h soaking in SBF, with the rate and amount of formation increasing under UV irradiation. The films of anatase, which formed after soaking at 400°C, showed a greater amount of apatite formation compared to those of rutile (600° and 800°C). These data demonstrate that rapid apatite formation is enhanced with the use of anatase and UV irradiation, probably as a result of the photocatalytic effect of titania.

Presenting Author: **Mr Hasan Zuhudi Abdullah**
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Research Activities:
Titanium Dioxide Biomaterials

Synthesis of highly efficient N-doped HTaWO₆ photocatalyst highly active under visible light.

*Aniruddh Mukherji,
Gang Liua,
Chenghua Sun,
Lianzhou Wang,
Gao Qing Lua*

In this work report a novel Nitrogen doped layered HTaWO₆ photocatalyst prepared by an innovative doping strategy which demonstrates excellent visible light absorption and high photocatalytic activity. The protonated form of the layered Tungstanate material with homogeneous nitrogen doping showed drastically enhanced visible-light absorption and photocatalytic activity as tested in Rhodamine G decomposition under visible light, compared to that of nitrogen doped benchmark photocatalyst P25. The photocatalysts also appeared to be very stable and retained well over a number of cycles. The high activity was attributed to the unique structural characteristics and the novel synthesis procedure of the material.

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Research Activities:
Presently enrolled as a P.hd student and working on visible light driven photocatalysts for Hydrogen production

Fabrication and Dispersion of Gold Shell Protected Magnetite Nanoparticles for Biomedical and Environmental Applications

Ian Y. Goon

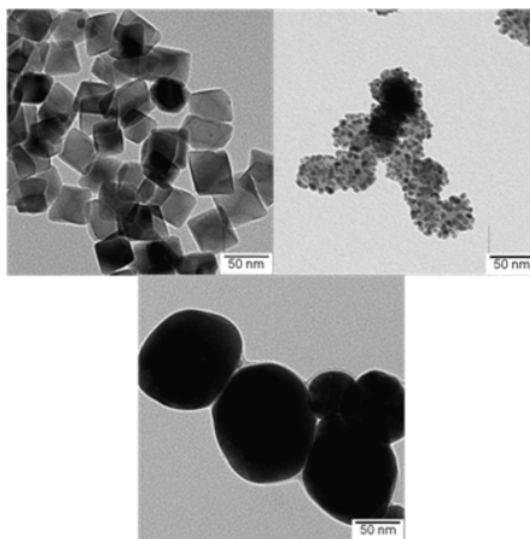
Leo M.H. Lai

May Lim

J. Justin Gooding

Rose Amal

Presented in this paper is a detailed study of the aqueous synthesis of composite 100 - 200 nm magnetite-gold core-shell nanoparticles with the ability to engineer the coverage of gold on the magnetite particle surface. This method utilizes polyethyleneimine for the dual functions of attaching 2 nm gold nanoparticle seeds onto magnetite particles as well as preventing the formation of large aggregates. Saturation of the magnetite surface with gold seeds facilitates the subsequent overlaying of gold to form magnetically responsive core-shell particles, which exhibit surface plasmon resonance. In-depth characterization and quantification of the gold shell formation process was performed using transmission electron microscopy, X-ray photoelectron spectroscopy, energy dispersive spectroscopy and inductively coupled plasma optical emission spectroscopy. Dynamic light scattering studies also showed that PEI coating of synthesized particles served as an excellent barrier against aggregation. The ability of the gold shell to protect the magnetite cores was tested by subjecting the particles to a magnetite-specific dissolution procedure. Elemental analysis of dissolved species revealed that the gold coating of magnetite cores imparts remarkable resistance to iron dissolution. The ability to engineer gold coverage on particle surfaces allows for controlled bio-functionalization, while their resistance to dissolution ensures applicability in harsh environments.



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Research Activities:

My work focuses on developing a robust method for the synthesis of tailored composite nanoparticles consisting of a magnetic iron-oxide core and a shell of gold. These composite particles possess the desirable magnetic character of the magnetite core and allow for predictable functionalisation of the gold shell. Such properties make the particles highly suited for potential use in protein separation, targeted drug delivery and biological monitoring. A major aim of this project is to develop a simple and versatile method to produce particles with well-controlled properties and to test these particles in a range of applications.

Mesoporous Bioglass/PLGA Composites For Bone Tissue Engineering

Chengtie Wu

Yogambaha Ramaswamy

Hala Zreiqat

Introduction: Poly (lactic-co-glycolic acid) (PLGA) is widely used in tissue engineering. However, it's poor bioactivity and the release of acidic degradation byproducts from PLGA can lead to inflammatory responses. Mesoporous bioglass, with regularly arranged 3D pores (range 2-50nm) and large surface area showed superior bone-forming bioactivity compared to normal bioglass.

Therefore it is expected that combination of bioactive mesoporous bioglass with PLGA will result in a composite with improved physico-chemical and biological properties compared to non-mesoporous bioglass. The aim of this study is to incorporate mesoporous bioglass into PLGA and optimize their physico-chemical and biological properties for bone tissue engineering application.

Results: Mesoporous bioglass with a highly ordered structure was prepared with surface area and pore volume of 400 m²/g and 0.5 cm³/g, respectively, compared to only 57 m²/g and 0.09 cm³ /g for the non-mesoporous bioglass. The pore size of the mesoporous bioglass is about 5 nm.

With the increase of the contents of mesoporous bioglass, the surface hydrophilicity, ions release ability, and apatite-formation ability of the composite films improved. Compared to non-mesoporous bioglass, mesoporous bioglass/PLGA composite had a significantly enhanced hydrophilicity, ions release ability, pH stability, apatite-formation ability and cellular bioactivity, suggesting improved chemical and biological properties.

Conclusions: The incorporation of mesoporous bioglass in PLGA significantly enhanced its physics, chemical and biological properties. Mesoporous/PLGA composites can be used for bone tissue engineering application.



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Research Activities:
Biomaterials, Tissue Engineering, Bone regeneration

Amine plasma polymer films loaded with silver nanoparticles for antibacterial coatings

Krasimir Vasilev, Rob Short and Hans Griesser

Bacterial infections continue to be a tremendous problem even in the 21st century. [1-4] In addition, bacteria colonization and biofilm formation have been recognized as serious issues in areas such as medicine, food processing, marine vessels, heat exchangers, etc.

In medicinal and other applications, one possible solution to the problem of bacterial infection is to coat the device with an antibacterial coating. Thus, there has been a strong drive in recent years on the development of antibacterial coatings suitable for biomedical applications. Among these, silver coatings have enjoyed the highest popularity and visibility. Silver has been known since ancient Greek times to have antimicrobial properties but has been neglected after the discovery of penicillin.

In this contribution I will present our recent research on development of antibacterial coatings based on amine functional plasma polymer films loaded with silver nanoparticles. Silver nanoparticles were synthesized directly into plasma polymer films from n-heptylamine and allylamine. A fast, simple and convenient procedure was developed to first load plasma polymer films with silver ions, which were subsequently reduced to silver nanoparticles. Varying parameters such as time of reduction, time of silver loading and thickness of the plasma polymer film gave us a versatile tool of for controlling the amount of silver nanoparticles loaded in the films. Bacterial tests showed excellent results as our films have a double effect: reduce bacterial adhesion and kill bacteria.

We also demonstrate that we can control the rate of release of silver atoms from the films which is very important when extended time of action is required.

References:

- [1] Hoffman, L. R.; D'Argenio, D. A.; MacCoss, M. J.; Zhang, Z. Y.; Jones, R. A.; Miller, S. I. *Nature* 2005, 436, 1171.
- [2] Mah, T. F.; Pitts, B.; Pellock, B.; Walker, G. C.; Stewart, P. S.; O'Toole, G. A. *Nature* 2003, 426, 306.
- [3] Costerton, J. W.; Stewart, P. S.; Greenberg, E. P. *Science* 1999, 284, 1318.
- [4] Furno, F.; Morley, K. S.; Wong, B.; Sharp, B. L.; Arnold, P. L.; Howdle, S. M.; Bayston, R.; Brown, P. D.; Winship, P. D.; Reid, H. J. *J. Antimicrob. Chemother.* 2004, 54, 1019.

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Research Activities:
Biointerfaces Nanostructured materials Functional materials Plasma polymerization Surface science

Cellular uptake of biocompatible polymer coated iron oxide nanoparticles

*Maria Arsianti,
John Chng,
May Lim,
Chris Marquis,
Rose Amal*

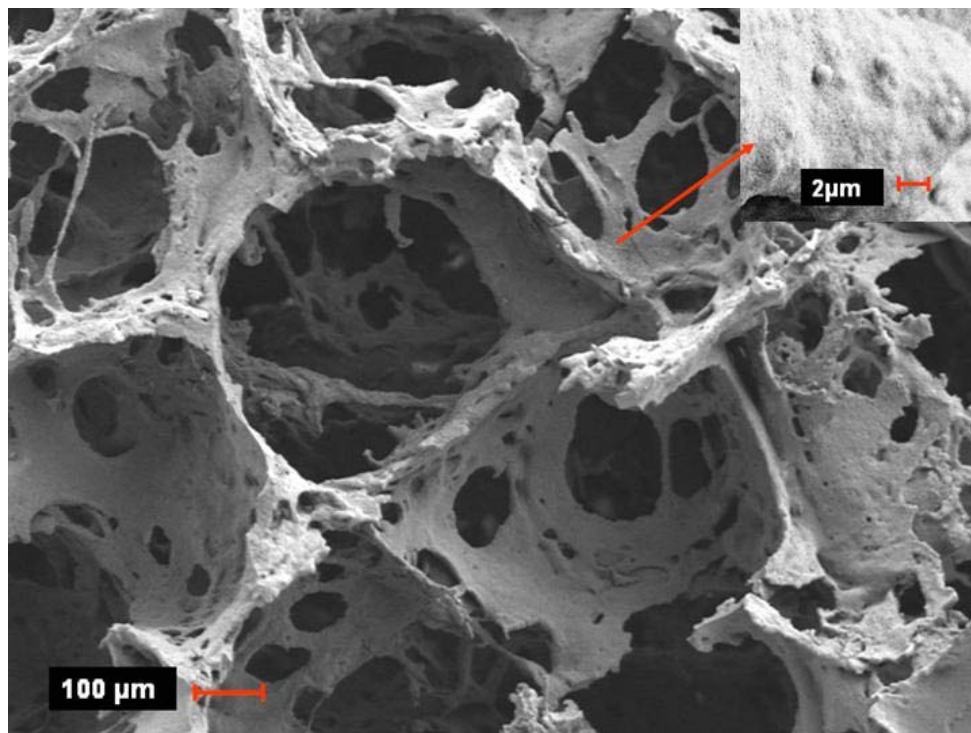
The cellular uptake of plasmid DNA conjugated to iron oxide nanoparticles was investigated in the present work. Coating the nanoparticles with polyethylenimines (PEI) was shown to improve the nanoparticle size dispersion, biocompatibility, and conjugation with an enhanced green fluorescent protein-encoding plasmid DNA. Picogreen assay was used to assess the quantity of DNA bound on the nanoparticles and we found that up to 10-folds enhancement of DNA binding were achieved using PEI coated nanoparticles compared to bare nanoparticles in the range of nanoparticles amount studied. The amount of nanoparticles cellular uptake was determined by Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) and was shown to increase with increased nanoparticles loading. The internalisation and trafficking of the nanoparticles/DNA conjugates in the mammalian cell was also examined using fluorescence microscopy. The use of magnetic field to physically direct the magnetic nanoparticles (MNPs) towards the mammalian cell in culture was also investigated. We found that the uptake of the MNPs/DNA conjugates coupled with lipofectamine, a cationic lipid based transfection agent, under the exposure of magnetic field for 60 minutes was as efficient as conventional 24 hours transfection. Whereas in the absence of lipofectamine, we demonstrated that the MNPs/DNA cellular uptake in magnetic field for 60 minutes was higher than conventional 24 hours transfection, suggesting that the magnetic field was essential when cationic transfection agent was absent. Toxicity of the MNPs/DNA conjugates towards the cells was also studied using Alamar Blue assay which evaluate the extent of metabolically active cell, and we showed that increased uptake of PEI coated MNPs almost had no effect to cell toxicity.

Presenting Author: **Dr May Lim**
Research Activities:
Titanium Dioxide Magnetic Nanoparticles

Silk particles reinforced macro-porous composite silk fibroin scaffolds for bone tissue engineering

Rangam Rajkhowa, Eun Seok Gil, Aneta Mieszawska, Lijing Wang, Xungai Wang, David L. Kaplan

Macro-porous scaffolds of silk fibroin are ideal potential materials for bone tissue engineering due to their good biocompatibility, cell supporting ability and slow biodegradability. However, their mechanical properties are inadequate for this type of application. To improve stiffness and compressive strength and maintain advantages of silk protein, silk composite scaffolds were prepared by incorporating mechanically fabricated silk particles of different sizes and shapes in a regenerated porous silk fibroin matrix. The effects of various types of silk particles on mechanical properties have been discussed. In vitro assessment of silk particles used on differentiation behaviour of human bone marrow mesenchymal stem cells (hMSCs) was made in a 2D matrix. The osteogenic differentiation of stem cells has been investigated through quantification of DNA as well as gene expression markers such as Collagen type I, elevated alkaline phosphatase (ALP), and bone sialoprotein based on real time PCR.



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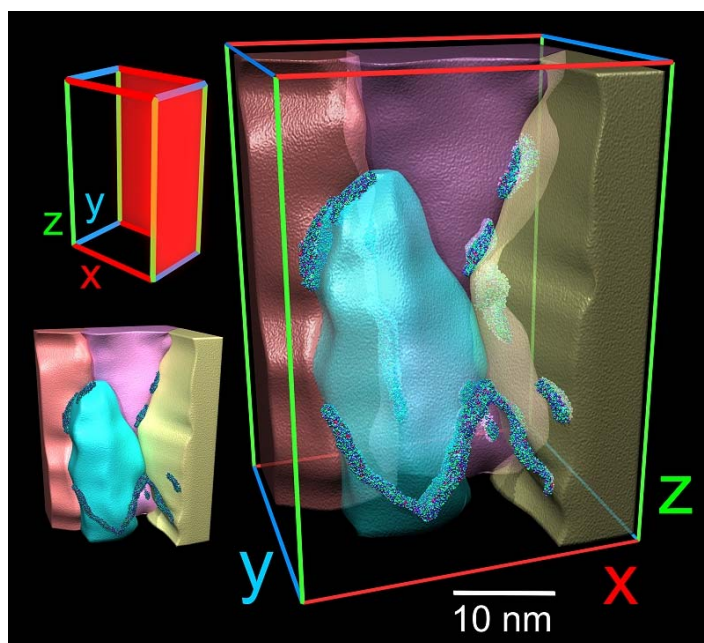
Research Activities:
Fibre Powder and application

New hierarchy of solute architecture breaks strength ceiling in a nanocrystalline aluminium alloy

Peter V Liddicoat

Simon P Ringer

In recent years, the pursuit of higher strength metals and alloys has led researchers to nanometer scale grain refinement. New nanocrystalline engineering techniques have successfully increased properties for a wide range of materials. There appears, however, to be a ceiling above which strength cannot be reached. Here we report a new hierarchy of solute architecture that breaks the strength ceiling in a nanocrystalline 7075 alloy processed by high-pressure torsion. Specifically, the alloy has a yield strength in excess of 1 GPa and a total elongation to failure of 10%. The new hierarchy of solute architecture was discovered through high-resolution characterisation featuring novel techniques we have developed in atom probe tomography. Our results indicate that nanometer-scale engineering of solid solutions by severe plastic deformation could offer a pathway towards a new generation of super-strong alloys that hold promise for creating entirely new regimes of property-performance space.



Presenting Author: **Mr Peter Liddicoat**
Student

Microstructure and mechanical properties of multilayered Al/Pd thin films

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Nick Savvides

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Mark Hoffman

School of Materials Science and Engineering, The University of New South Wales, Sydney, NSW 2052, Australia

Multilayered Al/Pd thin films with nanoscale layer thickness are expected to show significant enhancement of mechanical properties if the Al and Pd nanolayers have an epitaxial crystallographic relationship [J.S. Koehler, Phys. Rev.B, 1970, 547-551]. Multilayered Al/Pd thin films, with individual layer thickness varying from 1 to 40 nm, and monolayers of Al and Pd were deposited at room temperature from the physical vapour phase using DC magnetron sputtering of Al and Pd targets. The films were deposited onto single crystal Si(111) substrates, and had a total thickness of ~1micron. Nanoindentation tests on the films revealed that the mechanical strength of the Al/Pd multilayers is much higher compared to the same of pure aluminium. With just 6.5 % (v/v) Pd an enhancement of hardness ~200 % was observed for nanolayered Al/Pd compared to the hardness of pure Al film. A maximum hardness enhancement of up to 350 % was observed for nanolayered Al/Pd samples compared to the hardness of pure Al film when the bilayer thickness was 2 nm and Pd was 50 % (v/v). Modulus enhancement was also observed for the nanolayered thin films.

To understand this extraordinary enhancement in mechanical strength, the films were examined using X-ray diffraction (XRD) and cross-sectional transmission electron microscopy (XTEM) techniques. Samples for XTEM were prepared by focused ion beam (FIB) milling. The XRD spectra show almost perfect epitaxial grown Al(111)/Pd(111) thin films while XTEM shows sharp Al/Pd interfaces and the deformation of the layers directly below the compression zone produced by the Berkovich nanoindenter.

	Presenting Author: Mr. Pranesh Dayal Postgraduate Student Pranesh Dayal, Postgraduate Student, School of Materials Science and Engineering, The University of New South Wales (UNSW), Sydney, NSW 2052, Australia
Research Activities: Currently working on "Deformation of nanolayered light metals".	

Effect of titanium addition to low carbon, low manganese steels on titanium nitride precipitation in cast slabs

Sima Aminorroaya

Rian Dippenaar

Controlled rolling of steels requires the reheating of slabs and soaking at 1200-1250°C to increase the homogeneity of austenite while its grain size is controlled by precipitates which are stable at the soaking temperature. In the present study, two low carbon, low manganese steels, containing 0.008 and 0.024 wt% titanium, supplied in the form of as-cast, industrially cast slab, were used to investigate the effect of titanium addition on the size and distribution of titanium nitrides. Specimens were selected from the centreline and edge of the slabs perpendicular to the casting direction. Carbon replica techniques employed to study the precipitates by TEM analysis.

A few hundreds nanometers in size TiN formed on the surface of sulphide precipitates. More of these large TiN particles were observed in the steel containing lower titanium. Moreover, automated inclusion analysis revealed that a few micrometers TiN formed in the steel containing 0.024 wt % Ti but were not, or very seldom observed in the other steel. Decreasing of titanium content from 0.024 to 0.008 wt% results in smaller TiN in size and higher in number. Following cooling, when the solubility of titanium and nitrogen in the matrix is decreased, titanium and nitrogen diffuse towards the existing titanium nitrides but there is a competition between long range diffusion to grow existing TiN and to nucleate new TiN particles. The presence of a large number of small cubic (70-100 nm) titanium nitrides in the steel containing 0.024 wt% Ti indicates that nucleation might be dominant in this steel.



Presenting Author: **Dr. Sima Aminorroaya- Yamini**
Post-doc Research fellow

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Modelling and Characterisation of Materials with Multiphase Microstructure

*S. A. Asgari¹, P. D. Hodgson, V. Lemiale, and
B. F. Rolfe*

This paper investigates the simulation methods that can be used to model metallic materials with complex multiphase microstructure. The significant opportunity with these types of materials is to fine tune and tailor their mechanical properties with respect to stress states required in any application. However, prediction of the mechanical properties is often not a suitable task for conventional modelling methods. Instead, specialised multiscale methods are necessary to be able to include the microstructural effects at a larger macro scale model.

This paper uses a recently developed method called Multiscale Particle-In-Cell (MPIC), which is a combination of particle-based approach with computational homogenisation technique. Some recent results from the MPIC models have shown that this method could be a suitable one for the microstructural modelling of multiphase materials such as Advanced High Strength Steels. Although the method is still incapable of handling large size coupled multiscale models, it has shown that prediction of residual stress distribution in the constituent phases could provide valuable insight into deformation mechanism of the material. Future extension to this method could be enhancements to the 3D requirements, as well as application of realistic microstructural models.

Presenting Author: **Mr. Alireza Asgari**
PhD Student

Research Activities:
Multiscale modelling of TRIP steel

Deformation Mechanisms in TiN-Based Thin Film Structures

Andreas Jahja

Paul Munroe

A range of sub-micron thick TiN coatings were deposited on a H13 hot worked tool steel substrate via pulsed laser deposition as a function of processing conditions. The coatings were subject to detailed microstructural characterization, including FIB and cross-sectional TEM studies. Coatings prepared at high substrate temperatures (450°C) and reactive gas conditions exhibited very fine nanoscale grain sizes, whilst slightly coarser structures were prepared in inert environments. Mechanical behaviour was assessed through nanoindentation using a spherical indenter. The coatings exhibited high hardness values and significant resistance to cracking, even at high loads. Examination of the indented layers revealed intercolumnar cracks within the TiN coatings, together with shear steps at the coating-substrate interface, whilst inclined cracks were observed at the periphery of the indentations.



Presenting Author: **Mr Andreas Jahja**
phD student

Research Activities:
Surface Engineering

The Electronic and Crystal Structure of Lanthanide Zirconates

Clements, Richard

Kennedy, Brendan

Ling, Chris

Stampfl, Anton P.J.

The lanthanide zirconates are of interest for potential use in inert matrix fuels and nuclear wasteforms. To determine the suitability of a material as an inert matrix or wasteform, the material's structure must be resistant to radiation damage and its thermal, thermodynamic and mechanical properties must be known. The structure's ability to incorporate an actinide host into the lattice vacancy must also be known. These properties may be better understood by investigating the f-electronic structure, which has historically proved difficult to model.

We have undertaken a synthesis of the full range of lanthanide zirconate series using solid state techniques. We have performed the following measurements on a selection of the series using synchrotron radiation: powder X-ray diffraction, VUV photoluminescence spectra, X-ray photoemission spectroscopy (XPS) and X-ray absorption near edge spectroscopy (XANES). These results will be presented, along with details of the analysis and synthetic techniques used.



Presenting Author: **Richard Clements**
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Room 434
The School of Chemistry, F11
THE UNIVERSITY OF SYDNEY
NSW 2006
Australia

Research Activities:

Structural and electronic characterisation of rare earth pyrochlores.

Preparation and mechanical properties of Ti-Nb alloy foams with different porosities and pore sizes

Yang An,
Jianyu Xiong,
Peter Hodgson
Cui'e Wen

Abstract

Recently, metal foams and other highly porous metal materials with a cellular structure are known to have a interesting combination of physical and mechanical properties, such as high stiffness in conjunction with very high specific strength, and high gas permeability combined with high thermal conductivity [1]. Cellular solids and their properties have been described in much detail by many researchers [2-3].

In the present study, Ti-Nb alloy foams with different porosities and pore sizes were fabricated by powder metallurgy. The porous structure of the foams was studied by scanning electron microscopy (SEM). The mechanical properties of the Ti-Nb alloy foams were investigated using compressive test. Results indicate that the mechanical properties of the Ti-Nb foam samples are influenced by the foam porosity and pore size. The yield stresses, plateau stresses of the foams under compression increase with the decrease of their porosities. In particular, the pore size also affects the mechanical properties. The relationship between the porosity, pore size and the mechanical properties were analyzed.

Key words: Metal foam, porosity, pore size, mechanical property

Reference

- [1] John Banhart, Manufacture, characterisation and application of cellular metals and metal foams, Progress in Materials Science 46 (2001) 559-632
- [2] Lorna J. Gibson, Michael F. Ashby, Cellular solids Structure and properties-Second edition
- [3] Jianyu Xiong, Yuncang Li, Yasuo Yamada, Peter Hodgson, Cui'e Wen, Processing and Mechanical Properties of Porous Titanium-Niobium Shape Memory Alloy for Biomedical Applications, Materials Science Forum Vols. 561-565 (2007) pp. 1689-1692

Presenting Author: **Mr Pasquale Aliberti**
PhD Student

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Research Activities:

Third Generation Photovoltaics. Silicon quantum dots in silicon Dioxide matrixes for Selective Energy Contacts.

An investigation into the effects on morphology, electrochromic response and conductivity of rapid-mixing wet chemical polymerisation and vapour phase polymerisation of polyaniline

*Nicholas Absalom
Dr. Rick Fabretto
Dr. Peter Murphy
Prof. Hans Griesser*

Polyaniline (PANI) was produced using rapid mixing wet chemical oxidation polymerisation and vapour phase polymerisation (VPP). Specifically, for the wet chemical technique the impact of various oxidant to monomer ratios as well as stirred versus non-stirred polymerisation was investigated. Stirring was found to have a dramatic affect on the morphology of PANI, ranging from thin and thick thread-like structures to small particle agglomerates. Varying the oxidant to monomer ratio changed the size distribution from bimodal at low ratios to a single smaller size distribution at high ratios. Two unique polymerisation processes have been put forward to explain this phenomenon. A maximum conductivity and electrochromic response was obtained at an oxidant to monomer ratio of 30%. In all cases, stirring was found to increase both the conductivity and optical switching of PANI compared to non-stirred PANI synthesis.

Use of the VPP technique for PANI synthesis has been limited and problematic. However, initial problems have been resolved and the technique has been successfully utilised to produce PANI directly onto donor substrates. Compared to the two-step process of synthesis followed by deposition (i.e. spray coating) when using the wet chemical oxidation technique, the one-step VPP method offers inherent advantages. Superior film quality is achieved leading to improved conductivity, increased electrochromic switching, optical transparency and increased mechanical robustness.

Presenting Author: **Mr Nicholas Peter Absalom**
PhD student
Mawson Lakes, South Australia

Synthesis of Chitosan/ Jojoba Oil Microcapsules for Skin Caring Fibrous Materials and their Characterisation

S.Y. Cheng
C.W.M. Yuen
W. A. Daoud
C.W. Kan
K.K.L. Cheuk
J.C.O. Tang

Chitosan encapsulated Jojoba oil microcapsules were synthesised using coacervation technique for the development of skin caring fibrous materials. Aqueous chitosan solution was intermixed with Jojoba oil by means of high mechanical shearing to produce fine and stable emulsion without coalescence followed by the addition of sodium hydroxide for precipitation. The chitosan microcapsules formed were then dispersed using Polyoxyethylene sorbitan monostearate (Tween 60) to prevent agglomeration. Characterisation of chitosan microcapsules was conducted by optical microscopy, scanning electron microscopy, particle size analysis as well as fourier transform infrared spectrophotometry. A colorimetric MTS [3-(4,5-dimethylthiazol-2-y)-5-(3-carboxymethoxyphenyl)-2-(4-sulfophenyl)-2H-tetrazolium, inner salt] assay was utilised to determine the cytotoxicity of the chitosan microcapsules with different concentrations. The optical microscopy and scanning electron microscopy images demonstrated that the microcapsules developed were in the form of core-shell spheres with the particle size ranging from 2 to 10µm. The FTIR results indicated the presence of chitosan and Jojoba oil in the microcapsules. The mean particle size of microcapsules was 2.89µm with the zeta potential at 56.91mV, illustrating a very good stability of microcapsules dispersion. The cytotoxicity test results illustrated that the microcapsules were non-toxic to the fibroblast cell lines (NIH 3T3). Chitosan microcapsules were then successfully grafted into fibrous materials without bursting using textile fabrication techniques.

Presenting Author: **Miss SHUK YAN CHENG**
Research Student

West House 8, Room 3, Monash University, Gippsland Campus, Australia 3842

Research Activities:
Development of Cosmetic Textiles for Body Care with Biological Benefits

Investigation of Host-Guest Interactions on TiO₂Treated Fibrous Materials modified with Beta-cyclodextrin

S.Y. Cheng
W.A. Daoud
C.W.M. Yuen
C.W. Kan
K.K.L. Cheuk
J.C.O Tang

Surface modification of nanocrystalline TiO₂ fibrous materials with beta-cyclodextrin for accommodating various kinds of essential oil complex was investigated. The as-prepared sols were used to prepare TiO₂ thin coatings on fibrous materials by a dip-pad-dry cure process. Functionalised fibrous materials were prepared by immersing the TiO₂ treated fibrous materials in a methanolic solution of beta-cyclodextrin. The insertion of guest was performed by immersing the functionalised fibrous materials into the fragrance solution. The rate of release of essential oils from the fibrous materials was measured by the UV-Visible spectrophotometer. The fibrous materials concerned were immersed into appropriate solvent for a certain period of time and the rate of release of essential oils in terms of the intensity of the characteristic peaks observed at different time intervals under UV spectrum was investigated. Subjective odour evaluation was conducted to investigate the presence of fragrance on fibrous materials against time. A panel of judges was invited to indicate their choice on the strength of fragrance with the scale of 0-5 which denotes no scent, very faint, faint, noticeable, strong and very strong respectively.

Presenting Author: **Miss SHUK YAN CHENG**
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Research Activities:
Development of Cosmetic Textiles for Body Care with Biological Benefits

Encapsulation of Superparamagnetic Magnetite Nanoparticles in Ultrathin Plasmonic Shells

Suk Fun Chin, K. Swaminathan Iyer and Colin L. Raston

Superparamagnetic magnetite nanoparticles are coated with a homogeneous gold shell and heterogeneous silver shell impregnated with gold nano-particles using a simple aqueous based method at room temperature with dopamine as a surfactant. Nanoparticles of Au in the range 2 - 3 nm are attached to amine functionalized Fe₃O₄ nanoparticles, acting as seed for the growth of ultrathin Au or Ag shells. The monodispersed core-shell nanoparticles Fe₃O₄@Au and Fe₃O₄@Ag, have a particle size range of 10-13 nm with a shell thickness of approximately 2-3 nm. They are magnetically purified and are superparamagnetic at 300 K with saturated magnetization values of 41 and 35 emug⁻¹, respectively.

Presenting Author: **Miss Sukfun Chin**
PhD student

The University of Western Australia

The University of Western Australia
School of Biomedical & Chemical Sciences
35 Stirling Highway
Crawley WA 6009 Australia

Research Activities:

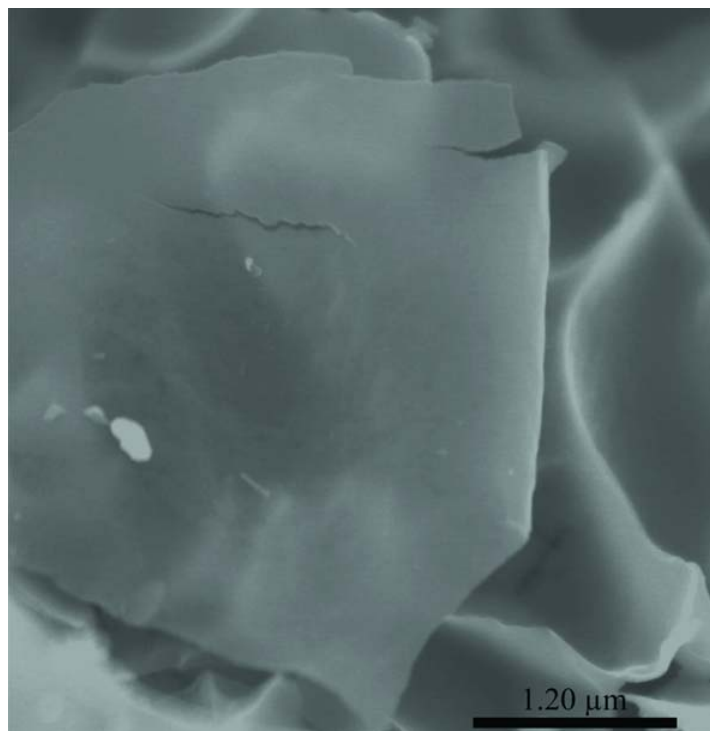
Synthesis and Characterization of Magnetic Nanoparticles for Biomedical Application

New Routes to Carbon Nanostructures

Mohammad Choucair

Human life depends so much on what our modern world has provided, with nanotechnology and the notion of carbon based nanostructures making today's technology seem obsolete. The understanding of chemical processes, and the synthesis of novel materials allow an intricate overlay to extend to many applications which affect the public on a generic scale. With science and its application in technology reaching the atomic scale, research in chemistry has allowed an interdependence in the development of devices and components across all fields of science.

Through a patented solvothermal technique, graphene-based nanostructures can now be obtained by a bottom-up wet chemical approach with complete control over morphology through a low cost, industrial scale, feasible pathway. The chemical synthesis of graphene has been shown to be truly atomistic, governed by the thermodynamic processes occurring upon carbon nucleation; consequently, the dependence of carbon morphology lies in the power involved in the transformation of the carbon precursor. The realisation of the additional dependence of time, as well as energy, in the formation of graphene-based nanostructures has allowed the synthesis of a multitude of novel morphologies including: sheets, rods, ribbons, tubes and spheres.



Presenting Author: **Mr Mohammad Choucair**
PhD Student

School of Chemistry, The University of New South Wales, Sydney, Australia 2052

Research Activities:

Novel synthesis techniques to carbon nanostructures, namely that of Graphene.

Physically-based Modeling of the Dynamic Recrystallization of Metals

Darren Cram

Christopher Hutchinson

Grain refinement is one of the most effective methods to enhance the mechanical properties of metals. In particular, it is the only method that simultaneously increases both the strength and the toughness, which are two of the key engineering properties of metals.

The fabrication of many wrought metals occurs at elevated temperature using deformation processing (i.e. thermo-mechanical processing (TMP)) such as rolling, extrusion or forging. Under many conditions of TMP new, defect-free, grains nucleate and grow into the deformed matrix. This process is known as 'dynamic recrystallization' and is one of the primary industrial means of refining the grain sizes of metals. However, the phenomena controlling DRX are complex and coupled, and a physically-based quantitative description still does not exist.

The objective of this research is to model the fundamental phenomena that control the evolution of microstructure during DRX as a function of applied strain-rate and temperature. Pure Cu system has been chosen as a model system and the coupled interactions between plasticity (work hardening) and the subsequent nucleation and growth of recrystallized grains is described quantitatively. The ultimate objective is to use such a model to identify new alloys and processing schedules that allow for significant reductions in recrystallized grain sizes using conventional processing infrastructure.



Presenting Author: **Mr Darren Geoffrey Cram**
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Monash University, Clayton, 3800, Vic

Research Activities:
Dynamic Recrystallization

Hot Deformation Characterization of Low Carbon, Low Manganese, Titanium added Pipeline Steels

Ali Dehghan-Manshadi

Rian Dippenaar

The effect of small titanium addition on hot deformation and dynamic recrystallization of low C, low Mn steel has been studied using a Gleeble thermo-mechanical simulator. The initial and deformed microstructures were also analyzed using TEM to study the effect of size and distribution of small particles on mechanical properties and microstructural characteristics. The results showed a considerable effect of Ti content on mechanical properties, austenite grain size as well as precipitate size. However, there was not a direct relationship between Ti content and improvement in the mechanical properties and/or recrystallization rate. It has been determined that the ratio of Ti/N has an important role on those parameters and a ratio of smaller than the stoichiometric value showed the best improvement in the mechanical properties. After re-heating of different steels to high temperature, steel with Ti/N ratio of 2.0 showed the smallest size of TiN particles as well as finest austenite grain size.

Presenting Author: **Dr Ali Dehghan-Manshadi**
Research Fellow

Faculty of Engineering
University of Wollongong

Research Activities:
Hot deformation Phase Transformation Microstructure Characterization

Analysis of Nanoindentation of Bulk Nanocrystalline and Amorphous Alloy

Hui Diao¹
Cheng Yan
John Bell

The mechanical properties of bulk nanocrystalline (nc) Mg-5%wt Al alloy and Z-based metallic glass (Zr_{41.25}Ti_{13.75}Ni₁₀Cu_{12.5}Be_{21.5}) were investigated using instrumented nanoindentation with Berkovich indenter at different strain rates. The results showed that the plastic deformation of the nc Mg alloy was sensitive to the strain rate. The hardness was marginally higher for smaller indentation penetration (<2 mm), especially at low strain rates. Significant displacement excursions (pop-in) in the load-penetration (P-h) curve during loading were observed in the Zr_{41.25}Ti_{13.75}Ni₁₀Cu_{12.5}Be_{21.5} bulk metallic glass. These displacement discontinuities were dependent on the strain rate; lower strain rates seem to promote more pop-ins.

Presenting Author: Hui Diao

Cadmium sulfide quantum dots in a chitosan matrix for latent fingerprint detection

Jessirie Dilag

Amanda Ellis

Hilton Kobus

Fingerprints that are invisible to the eye - termed latent fingerprints, are of most concern in forensic investigations. They are left behind as sweat deposits on the friction ridges, and are hence composed of amino acids, proteins, salts and fats. Here we present work using cadmium sulfide (CdS) quantum dots (QDs) in a chitosan matrix for latent fingerprint detection. CdS QDs possess the advantage of tuneable size, and intrinsic fluorescence and give rise to materials brighter than materials used conventional fingerprinting methods.

Chitosan, a natural biopolymer, is chelated to the cadmium ions followed by the reduction of the cadmium ions with sodium sulfide to produced CdS QDs within chitosan. The size of CdS according to precursor concentration was investigated using Ultra-Violet Visible (UV-Vis) spectrophotometry and was imaged with Transmission Electron Microscopy (TEM). Fluorescence spectrophotometry at an excitation of 450 nm showed a sharp emission at 531 nm and a broad emission (600 nm to 850 nm), with a maximum at 715 nm. The interaction between the CdS and chitosan was investigated with Fourier Transform Infra-Red (FTIR) spectroscopy.

Dusting the latent fingerprints on aluminium foil with a freeze-dried powder of CdS-Chitosan in a detergent-surfactant solution, Tergitol, produced visible fingerprints. These were visualised under a an excitation of 450 nm (Polilight source), and photographed with barrier filters (550 nm and 565 nm).

	Presenting Author: Miss Jessirie Dilag Honours Student
	Research Activities: Hounours Student Project: Snythesis of Cadmium Sulfide Quantum Dots in Chitosan for Latent Fingerprint Identification

Mechanochemical polymerization of polyaniline dendritic nanofibers and their electrochemical properties

*Du, Xu-Sheng
Zhou, Cui-Feng
Mai, Yiu-Wing*

Since conductive polymers were discovered in the last century, a tremendous amount of research has been carried out in this field. Among the large family of conductive polymers, polyaniline is one of the most remarkable since it is stable, commercially cheap, and easy to change its phase by doping. It has a great variety of applications, such as anti-corrosion coatings, batteries, sensors, and antistatic coatings. The classical chemical synthesis of polyaniline is carried out in solution using aniline, an oxidant, and a strong doping acid with either aqueous or organic solvents. As the liquid monomer aniline forms solid salts with doping acids, room-temperature solid-state polymerization of aniline is possible. Different from previously reported interface polymerization, rapid mixing polymerization, hard template or surfactant-assist synthesis methods, we recently developed a facile solid-state mechano-chemical route for polyaniline nanomaterials. Microscopy observations show that the products are novel branched polyaniline nanofibers. XRD confirms the good crystallinity of the product, and FTIR UV indicates the product is in the conductive emeraldine salt phase. The electrochemical properties of nanostructured polyaniline dendrites were characterized and it showed to be a good electrochemically active materials.

Presenting Author: **Dr Xusheng Du**
School of Aerospace, Mechanical and Mechatronic Engineering J07
University of Sydney
Sydney, NSW 2006

Effect of grain size on deformation twinning behaviour of commercially pure titanium

A. Ghaderi
M.R. Barnett

Mechanical properties and deformation twinning behaviour in commercially pure titanium was investigated. In order to generate different grain sizes, the samples were subjected to cold rolling followed by annealing. Tensile tests were carried out on the range of different grain sizes (10-120 μm) at room temperature. This study reveals the grain size influence on deformation twinning behaviour in terms of volume fraction and number of twins per grain.

	Presenting Author: Mr. ALIREZA GHADERI PhD student
	Institute for Technology Research and Innovation Deakin University Pigdons Rd, Geelong VIC 3217, Australia
	Research Activities: -Mechanical properties of light metals -Wear behaviour of metals and alloys, especially steel and cast iron

The Static Recrystallisation Behaviour of Magnesium Alloy AZ31

Keshavarz, Z.

Barnett, M. R.

Beer, A. G.

The present work examines the microstructural evolution during the annealing of cold worked magnesium alloy AZ31. The roles of deformation strain, annealing temperature and annealing time are explored. Results show that recrystallisation is enhanced with a higher deformation strain and annealing temperature. Hardness testing is used to establish the kinetics of recrystallisation, whilst microstructural analysis provides insight into the mechanisms by which this material recrystallises during annealing after room temperature deformation.



Presenting Author: **Miss Zohreh Keshavarz**
Postdoctoral

Centre for Material and Fibre Innovation
Geelong Technology Precinct
Deakin University
Pigdons Rd, Geelong
VIC 3217, Australia

Research Activities:

Investigation of Deformation Modes in Magnesium and Its Alloys In-situ Investigation of Dynamic Recrystallization Effect of Hydrogen on Texture of CP-Ti

Phosphonic Acid Functionalised Calixarenes

Adam D Martin

Phosphonic acid functionalised calixarenes are of interest due to their potential role in biological processes and their binding abilities towards metals, nutrients and drugs.

The synthesis of p-phosphonic acid calixarenes functionalised at their lower rim with long alkyl chains are intriguing due to their ability to form fibres, vesicles and other structures by the variation of the alkyl chain length on the calixarene. The fibrous structures could be used as a support for tissue networks and cell growth and proliferation.

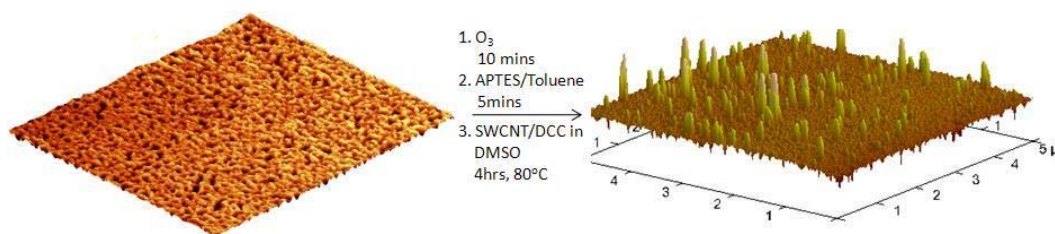
They are also attractive due to their more simple synthesis, with acetylation steps unnecessary, and investigations are being carried out into whether a cyclisation reaction involving p-phosphonic acid functionalised phenol would indeed afford the phosphonic acid calixarene in one step. This would dramatically enhance the potential of the calixarenes in gaining access to new materials with novel function.

Presenting Author: **Mr Adam David Martin**

Vertically aligned single-walled carbon nanotube arrays on porous silicon

Cameron James Shearer
Kristina Teresa Constantopoulos
Nicolas Hans Voelcker
Joseph George Shapter
Amanda Vera Ellis

Chemically shortened single-walled carbon nanotubes (SWCNT) have been chemically attached to porous silicon (pSi) by four different attachment methods. All methods utilise the carboxylic acid groups that are formed at the ends of the shortened SWCNT during treatment with concentrated acid and the silanol groups that are formed on the pSi surface when treated with ozone. SWCNT arrays were formed on pSi with different pore size regimes, ranging from 10-100nm. Surfaces were imaged with atomic force microscopy, scanning electron microscopy and confocal Raman microscopy. Arrays of vertically aligned SWCNTs were observed with surface coverage depending upon attachment method, pore size and attachment reaction time.



Presenting Author: **Mr Cameron Shearer**
 PhD student

Research Activities:
 Attaching Carbon Nanotubes to surfaces Using Carbon Nanotubes to filter water Carbon Nanotube based field emission devices

Metal Dusting of Nickel-Aluminium Alloys

P. Speck

D. Young

Metal Dusting corrosion of four model binary nickel-aluminium alloys was investigated. Alloys of γ -Ni(Al), γ - γ' Ni(Al)-Ni₃Al, γ' -Ni₃Al and β -NiAl were exposed in 1 h cycles to carbon supersaturated ($a_C=36.7$, $p_{O_2}=2.83 \cdot 10^{-26}$ atm) CO-H₂-H₂O gas mixture at 650°C and an overall pressure of 1 atm. The reacted samples were examined using X-Ray diffraction, scanning electron microscopy, transmission electron microscopy, energy dispersive spectroscopy and light optical microscopy.

Weight gain and metal wastage rates were slowed with increasing aluminium content for the single-phase alloys. The γ - γ' two phase alloy had the overall highest metal loss rate.

It was found that all alloys except β -NiAl had been attacked by metal dusting, leaving a layered structure of nickel particles, graphite and catalytically grown nano-sized carbon filaments as the corrosion product. Surface morphologies reflected homogenous attack for the γ and γ - γ' alloys, whereas on γ' a pitting type of attack was observed. Al₂O₃ formation was identified on the surfaces of γ - γ' , γ' and β , and is thought to be the major factor providing protection against dusting attack.

Presenting Author: Philip Johann Speck

The effect of annealing time on the microstructural evolution and mechanical properties of an ultrafine steel

Shokoufeh Malekjani

Ilana Timokhina

Ilchat Sabirov

Peter Damian Hodgson

Starting microstructure of martensite was subjected to cold rolling followed by annealing at 550C for different times. The resulting microstructure was an ultrafine substructure with mainly low angle grain boundaries. The effect of different annealing time on the microstructural evolution and mechanical properties was investigated. The results obtained from tensile test showed reduction of strength and ductility with increasing annealing time. The results obtained from TEM study on the undeformed and deformed microstructure will be discussed.

Presenting Author: **Ms Shokoufeh Malekjani**
PhD student

Center for Material and Fiber Innovation, Deakin University,
Waurmponds, VIC, 3217

Research Activities:
mechanical properties of ultrafine grained materials

Photocatalytic Keratin Fibers

Wing Sze Tung

Walid A. Daoud

Self-cleaning keratins are functional fibrous materials, capable of performing self-cleaning and antimicrobial functions by use of sunlight, so that resources such as water, detergent and energy can be saved. It is envisaged that the development and use of self-cleaning fibrous materials will help in improving the ecology of our society. Hence, this research is aimed at investigating a compatible approach toward the formation of self-cleaning keratin fibres using the concepts of photocatalysis and bottom-up nanotechnology in an attempt to extend the utilization of this new technology to naturally occurring protein fibres.

Presenting Author: **Miss Wing Sze Tung**
PhD Student

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Australia

Research Activities:
Application of Self-cleaning Surface Functionalization on Keratin Fibers Development of Visible Light
Nanostructured Photocatalysts

Photocatalytic Self-Cleaning Surface Functionalization of Keratins

Wing Sze Tung

Walid A. Daoud

Nanocrystalline titanium dioxide has aroused great scientific attention universally for recent decades. In view of its fascinating physical and chemical properties, titanium dioxide is close to be an ideal photocatalytic material. Using simple sol-gel method, anatase titanium dioxide nanocrystalline was successfully nucleated at low preparation temperature so as to extend its utilization to substrates with low thermal resistance. A novel concept of incorporating anatase nanoparticles into fibre substrates in order to produce photocatalytic fibrous materials has been recently introduced. In this contribution, we devised a photocatalytic self-cleaning sol-gel formulation that can effectively be deposited on wool fibers with good compatibility and significant photocatalytic self-cleaning activity. It is anticipated that successful self-cleaning functionalization of keratin fibers shows potential in extending the application to other protein materials, and the implementation of self-cleaning functionalization treatment becomes more practical and feasible towards industrialization and commercialization.

Presenting Author: **Miss Wing Sze Tung**
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Churchill, VIC 3842,
Australia

Research Activities:

Application of Self-cleaning Surface Functionalization on Keratin Fibers Development of Visible Light Nanostructured Photocatalysts

Electrochemical synthesis of metallic nanowires using porous anodized alumina template

Mingliang Wang, (PhD student)

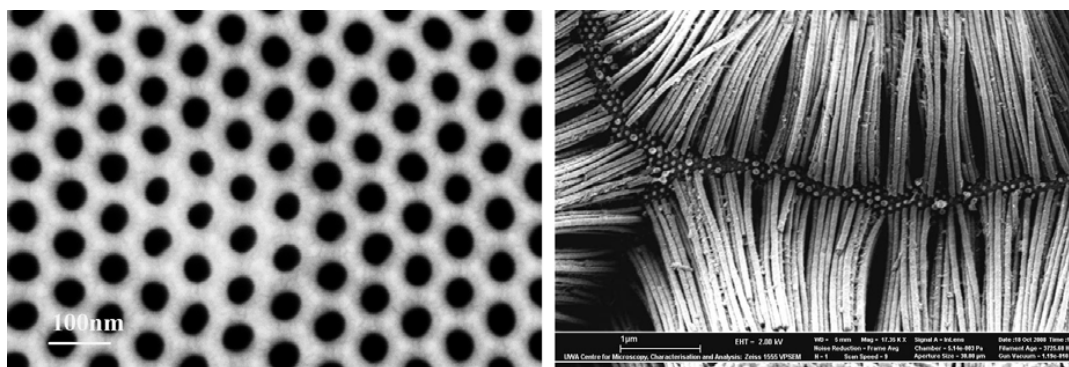
Yinong Liu, (Professor)

Hong Yang, (Senior Lecture)

School of Mechanical Engineering

The University of Western Australia

Co and Ni nanowire arrays have been fabricated by means of electrochemical deposition into confined nanochannels of porous anodized alumina templates. The size of the nanochannels in the template can be controlled between 40 and 90 nm by chemical etching using 5wt% H₃PO₄ aqueous solution, as shown in Figure 1. Metallic nanowires are grown by means of electrochemical deposition. The length of the nanowires can be controlled by controlling the deposition time, typically ranging between 50 nm and 20 μ m, as shown in Figures 2. The synthesized nanowire arrays are characterized by means of scanning electron microscopy, transmission electron microscopy and x-ray diffraction. The nanowire arrays are found to have high wire packing densities and are polycrystalline. Mild anneal in controlled atmosphere may convert the metallic nanowires into their corresponding metal-oxide nanowires for different functional properties.



Presenting Author: **Mr Mingliang Wang**
Ph.D Student

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Research Activities:
1. Metallic nanowire 2. Shape Memory Alloy

The Effect of pH on Dye Sorption by Wool Powders

*Guiqing Wen,
John.A. Rippon,
Xin Liu,
Peter G. Cookson*

The sorption behaviour of wool powders for two acid dyes, C.I. Acid Red 88 (AR88) and C.I. Acid Red 18 (AR18), and the cationic dye, Methylene Blue (MB), have been investigated. When the levels of dye uptake were examined at different pH values over the range 2-10, different behaviours were observed (Figure 1). Uptake of AR88 was relatively high over the entire pH range, sorption of AR18 fell off dramatically as the pH was increased, and uptake of MB increased slightly as the pH was raised. These contrasting characteristics are explicable in terms of the electrostatic and hydrophobic forces responsible for the adsorption of dye, the chemical structures of the dyes, especially as they relate to the balance between their hydrophilic and hydrophobic characteristics, and the charges on the wool substrates in water, as measured by zeta potentials.

Differences in the behaviour of 'untreated' wool powder, and the corresponding 'chlorinated' substrate (which was chemically treated prior to the final milling operation) are explicable in terms of the relatively high concentration of cysteic acid residues on the surface of the chlorinated product.

Presenting Author: **Mrs. Guiqing Wen**
Ph. D Candidate

Research Activities:
to produce and characterize wool powder; to investigate the sorption capacity of wool powder for dyestuffs, metals and some gases.

Effects of solution treatments on the martensitic transformation and magnetic transition behaviours of Ni₄₃Co₇Mn₃₉Sn₁₁ ferromagnetic shape memory alloy

Zhigang Wu, Yinong Liu, Zhuhong Liu

The martensitic transformation and magnetic transition behaviours of a Ni₄₃Co₇Mn₃₉Sn₁₁ polycrystalline alloy fabricated by arc-melting method are investigated in this study. It is found that the as-cast alloy ingot exhibits severe chemical segregations, both microscopic in its dendritic structure and macroscopic along the solidification direction. The as-cast alloy showed multiple phases from the solidification, and exhibits neither martensite transformation nor magnetic Curie transition. Anneal at 923 K is identified the threshold temperature condition to eliminate the microscopic dendritic segregation whereas anneal at higher temperatures up to 1273 K is effective in inducing the martensite transformation. The sample annealed at 1273 K for 24 hours shows three thermal peaks, suggesting three martensitic transformations. The phenomenon is attributed to the formation of compositional homogeneity of local areas with the slightly different compositions from each other. The long-range macroscopic segregation requires longer annealing times up to 72 hours at 1273 K to be eliminated to achieve a single-phase microstructure. The homogenised single phase structure displays L21-10M martensite transformation and clear magnetic Curie transition.

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Research Activities:
shape memory alloys, magnetic materials, functional actuation materials

Effect of heat treatment on chemical composition and bonding configuration of PECVD SiNx thin films for MEMS application

Yimeng Yang

Yinong Liu

John Dell

Silicon nitride thin films deposited at 200°C by plasma enhanced chemical vapor deposition (PECVD) on Si substrates were heat treated in air at elevated temperatures up to 700°C. The composition and chemical bonding structures of the annealed samples were analyzed by means of x-ray photoelectron spectroscopy and Fourier transform infrared spectroscopy. SiNx thin films synthesized under this condition are hydrogenous. Heating to elevated temperatures in air causes changes in chemical composition of the PECVD SiNx films, including depletion of N and H and intake of O. Whereas the depletion of N and H is expected to occur uniformly throughout the thickness of the films, oxidation occurs on the free surface and penetrating through into the depth of the films. The oxygen penetration depth was found to increase with increasing annealing temperature, which accords with internal stress relaxation of the films. The films are found to be severely Si-rich, as compared to the stoichiometry of Si₃N₄, implying the existence of Si-H bonds or free Si crystals in the thin films.

Presenting Author: **Ms. Yimeng Yang**
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Research Activities:

PECVD SiNx thin films: environmental stability of the materials chemical and microstructures, properties, deposition conditions, nanoindentation

Hydrogen storage properties of Mg-Pd multi-layer thin film prepared by magnetron sputtering

S.Y.Ye, C. Y. V. Li, H.W.Dong, M. Zhu, S.L.I.Chan

Abstract: The hydrogen storage properties of Mg-Pd multi-layer thin films have been studied in this work. The films were deposited on (001) Si wafer by RF magnetron sputtering with dual targets. Before hydrogenation, X-ray diffraction (XRD) and scanning electron microscopy (SEM) analysis revealed that the Mg-Pd multi-layer thin film is composed of fine-crystalline Pd layers and Mg layers. The film was activated twice under 473K and 3.4MPa hydrogen pressure. Hydrogenation and dehydrogenation of the thin film were performed in an automatic gas reaction controller, using different temperatures (305, 373, 473 and 323K) in each cycle. The hydrogen absorption-desorption cycles of the thin film showed that with increasing temperature, the maximum hydrogen absorption capacity was increased from 2.5wt.% at 305K to 2.7wt.% at 473K. Thus the composite film showed a hydrogen absorption capacity close to the theoretical value of 2.8wt% for Mg₆Pd, even at a relatively low temperature. The thin film was able to desorb hydrogen reversibly in the first two cycles. However, some of the hydrogen was retained in the film when dehydrogenated at 473K. After annealing at 473K for 2 hours and then lowered to 323K for another hydrogenation cycle, complete desorption of hydrogen was observed. The film undergone the first cycle was analyzed by XRD, the result shows that there were two new phases of Mg₆Pd and Mg₅Pd₂ formed, with the disappearing of Mg and Pd peaks. The X-ray result suggests that during the hydrogenation reaction, Pd and Mg reacted to form Mg₆Pd. This reaction occurred at a much lower reacting temperature than predicted by the peritectic reaction at 973 K. Subsequently Mg₆Pd was decomposed into Mg₅Pd₂ and magnesium hydride, which is a reversible disproportion hydrogenation. It is believed that additional interfacial free energy stored at the Mg and Pd layers interface; as well as the catalytic effect of Pd, can be accounted for the low temperature hydrogen absorption-desorption cycles.

Presenting Author: Ms Suyun Ye

Advanced Nanoscale Materials Fabricated from Diatomaceous Earth

Yang Yu
Jonas Addai-Mensah
Dusan Losic

The unique structural properties of nano-colloidal silica-based diatomaceous material formed by diatoms (single-cell algae), derived from the sharp sizes, shapes, distinctive patterns, and mesoporous structure of their silica skeletons (frustules), have been recognized as an attractive natural substrate for the development of new nanomaterials. The large source of diatom silica comes from diatomite (diatomaceous earth, DE), fossilized sediments that have remained silica skeletons intact for over 1 million years. DE possesses a great potential to transfer its valuable properties into new materials and significantly improve existing and gain new applications. This project proposes research toward the transformation of this inexpensive natural mineral, into advanced nanoscale materials. To address the purity issue of natural DE material, several purification and separation processes has been explored to prepare a ultra-high purity nanoporous silica material. The synthetic concept based on diatom templates, has been investigated for fabrication of microscale 3-d gold and polymeric structures with biologically-derived shapes and nanoscale features. The chemical composition and morphological characteristics of DE silica and their replicas was examined by range of characterization techniques that includes: Nano Zeta Sizer, XPS, ToF SIMS, SEM, EDAX, TEM and XRD.



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Research Activities:
Advanced Nanoscale Materials Engineered from Diatomaceous Earth

FRP-An alternative reinforcement for reinforced concrete slabs

Zhang, Y.X. (Sarah)

Due to its superior characteristics of fibre-reinforced polymers (FRP), such as high corrosion resistance, high strength-to-weight ratio, and advantageous fatigue resistance, significant progress on the use of internal FRP reinforcements as an alternative material of conventional steel bar has been observed. FRP-reinforced slabs find widespread use in many important engineering structures, especially concrete slabs. The application of FRP as an internal reinforcement of concrete slabs will be reviewed in this presentation, and the structural behavior of the concrete slabs with FRP reinforcements and its steel counterpart will be compared based on an advanced nonlinear finite element modeling technique. The investigation of different effects of a series of parameters on structural behavior of FRP-reinforced concrete slabs, such as different ratio of reinforcement in tension and compression regions and different reinforcement material types on the structural behaviors are presented.

Presenting Author: **Dr Y. X. (Sarah) Zhang**
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Research Activities:

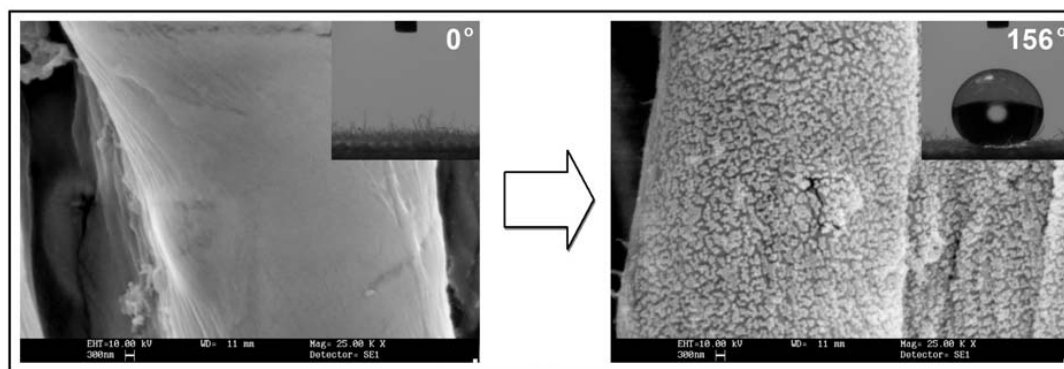
• Composite materials and structures • Computational solid mechanics • Structural performance of innovative engineering structures • Civil/Structural engineering structures, Aerospace structures, Biomechanical structures

Superhydrophobic modification of normally hydrophilic cotton fabrics

Yan Zhao, Tong Lin*, Xungai Wang

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Cotton is an abundant, inexpensive and biodegradable raw material for textile and clothing products, but is also water-absorbing and easily stained due to surface hydroxyl groups. In nature, the unusual superhydrophobicity of lotus leaves with water contact angles larger than 150°C is known to originate from micro- and nanoscale structures and low surface energy materials. Inspired by this, normally hydrophilic cotton fabrics were transformed into superhydrophobic surfaces via the controlled electrostatic assembly of silica nanoparticles followed with fluoroalkylsilane (FAS) treatment. In brief, negatively charged cotton fabrics were produced by grafting of poly(acrylic acid) (PAA) via esterification reaction between carboxyl groups of PAA and hydroxyl groups on the fibre surface. The charged fabrics were then used as substrates for layer-by-layer electrostatic assembly of negative silica nanoparticles and positive poly(allylamine hydrochloride) (PAH). The surface morphology of the resulting coatings can be easily tailored by controlling the number of assembly cycles. Further modification with FAS led to the generation of superhydrophobic surface with both advancing and receding contact angles larger than 150°C , which is practically nonwetable and self-cleaning.



Presenting Author: **Dr. Yan Zhao**
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Research Activities:

Developing functional polymer-based interface materials via surface chemistry and micro-/nano-structures;
Effects of surface chemistry and topography on surface wetting properties; Various applications of coatings with special wetting and self-cleaning properties

Synthesis of PVP-palladium hybrid nanoparticles under continuous flow

JIANLI ZOU,
S. IYER,
C. L. RASTON

Palladium polymer hybrid nano- or micro-particles are mostly synthesized by a two step method [1-3], that is, fabrication of polymer spheres (or from commercial polymer spheres) followed by the reduction of palladium precursor solution on the surface or inside of the polymer material. Here we report a facile and green (aqueous solution) method to synthesize palladium-PVP [poly(vinyl pyrrolidone)] hybrid nanoparticles, which contain 5-9 nm palladium nanoparticles, using spinning disk processor with scalable size control. We can adjust the size of hybrid nanoparticles from 40 nm to 200 nm by changing the molar ratio of palladium to PVP, speed of the disc and the molecular weight of PVP. These uniform and stable hybrid nanomaterials are potential candidates for Heck and Suzuki catalytic reactions.

[1] Gao, Yuan; Chen, Chien-An; Gau, Han-Mou; Bailey, James A.; Akhadev, Elshan; Williams, Darrick; Wang, Hsing-Lin. *Chemistry of Materials* (2008), 20(8), 2839-2844.

[2] Naka, Kensuke; Sato, Masahide; Chujo, Yoshiki. *Langmuir* (2008), 24(6), 2719-2726.

[3] Mei, Yu; Lu, Yan; Polzer, Frank; Ballauff, Matthias; Drechsler, Markus. *Chemistry of Materials* (2007), 19(5), 1062-1069

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Performance Analysis of Novel Merged Joints in Epoxy Composites

B.P.Adamson

M. Forrest

B.L.Fox

Composite manufacturing industries channel large amounts of resources into reducing the part count, processes and processing time required to produce each part. Melding is a process similar to co-curing in that the epoxy in a pre-preg is used as the adhesive, rather than mechanical fasteners or adhesive films. The process has the ability to leave flanges of a part with minimal advancement in cure and to be co-cured at a later stage. This can substantially decrease the part count of large assemblies and enable the manufacture of complex composite structures.

The patented melding process utilises a heat transfer fluid to allow the selective cure of pre-preg composite materials. Melding is a novel out of autoclave process aimed at reducing the manufacturing costs and processes required with adhesives and mechanical fasteners. Melding requires no surface treatments like co-curing and adhesive films.

Melding enables unconventional joint designs, like interleaved joints, to be manufactured resulting in greater resistance to crack propagation through the joint. Several joint types have been investigated, these include single lap, stepped lap, double stepped lap and interleaved joints. A performance analysis is being completed on the above mentioned joint designs with varied geometries. The adhesion of the joints are evaluated by means of tensile testing with optical analysis.

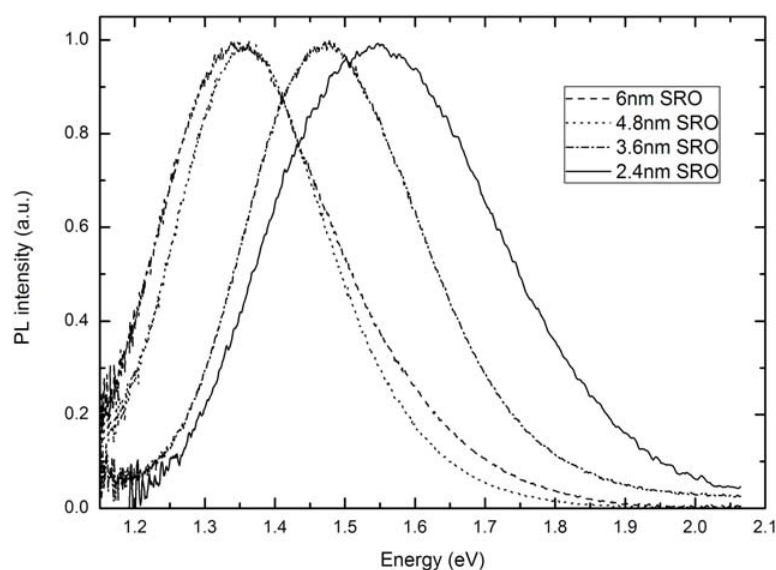


Presenting Author: **Mr Benjamin Paul Adamson**
Postgraduate Student

Study Of Optical Properties Of Silicon Quantum Dots In A Silicon Dioxide Matrix For Energy Selective Contacts

Pasquale Aliberti, Santosh K Shrestha, Gavin J Conibeer, Martin A Green

Structures consisting of silicon quantum dots in silicon dioxide matrix represent a promising approach to implement selective energy contacts for Hot Carriers Solar Cells; the double barrier resonant tunnelling effect can be utilized to realize the energy selection of the hot carriers. In this study several double barrier structures have been realized using RF-magnetron co-sputtering of silicon and quartz targets. All the structures consist of a stack of three layers (silicon dioxide - silicon rich oxide - silicon dioxide) deposited on both conductive silicon substrates and quartz substrates; an annealing step at 1100°C is then performed in order to obtain silicon quantum dots in the silicon dioxide matrix. Photoluminescence and absorption measurements have been conducted to investigate how the thickness of the silicon rich oxide layer and the annealing time of the structures can influence the size distribution of the silicon nanoparticles embedded in the matrix and the quantum confinement properties of the device itself. A blue-shift of the photoluminescence spectrum has been observed with the decrease of the thickness of the silicon rich oxide layer. This is attributed to the decrease of quantum dots size which is also confirmed by transmission electronic microscope measurements. Even though the blue-shift is in accordance with a simple effective mass approximation quantum confinement model, this model itself can't be used to explain the phenomena since the peak shift does not show a quadratic behaviour. Absorption coefficient studies show that the nucleation of silicon nanoparticles embedded in the matrix take place at the early stage of the annealing process, typically in the first fifteen minutes, after which the absorption properties show a saturated behaviour.



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Research Activities:
Third Generation Photovoltaics. Silicon quantum dots in silicon Dioxide matrixes for Selective Energy Contacts.

Thermodynamic and Kinetic Modelling Diffusion-controlled Phase Transformation during Hydrogenization of Titanium Particles

Weimin Gao

Wei Qi Li

Peter Hodgson

The manufacturing of titanium-based products is characterized by high production costs. The direct powder rolling process, among other competitive methods, has the potential of becoming a cost-effective method of manufacturing strip products from a variety of powder metallurgy alloys, multilayer structures, and composite materials. A potential method that could further reduce the manufacturing costs of the direct powder rolling process is the introduction of hydrogen to reduce the hardness of titanium particles and the degradation of hydrogen to restore the performance of the products, because the mechanical properties of titanium alloys can be remarkably improved by charging with a certain level of hydrogen. The characteristics of titanium with different hydrogen concentrations and the structures and properties of different titanium-hydrogen phases have been investigated. However, the instantaneous process of hydrogen diffusion and phase transformation during hydrogenization or dehydrogenization has rarely been reported due to the experiment difficulties.

This paper studied the hydrogen diffusion process and the phase transformation during hydrogenation and dehydrogenation of a titanium particle. The work was performed based on the thermodynamics and kinetics. The free energy was calculated from thermodynamic data. A mobility database was developed for the hydrogen and titanium system based on previous experimental works on the diffusion coefficient of hydrogen reported in literature and a fundamental analysis of diffusion. By combining the mobility database and the fundamental of diffusion, the hydrogen diffusion process in a titanium particle was computationally simulated to analyze the mechanism of hydrogen diffusion in different phases (α -Ti, β -Ti and TiH_x) and the phase transformation in the particle.

Presenting Author: **Dr Weimin Gao**
Research Fellow

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Phase Separation of Epitaxial InGaAs Ternary Nanowires

Yanan Guo

Jin Zou

Mohanchand Paladugu

Xin Zhang

Graeme Auchterlonie

Hannah J. Joyce

Qiang Gao

Han Hoe Tan

Chennupati Jagadish

Yong Kim

We report a novel phase separation phenomenon during the growth of ternary InGaAs nanowires by using metalorganic chemical vapor deposition. Advanced transmission electron microscopy investigations show that, at low indium content case, a GaAs nanowire core is actually grown by catalytic growth, an InGaAs shell is grown by lateral growth. At high indium content case, as the indium concentration in the vapor exceeds a threshold (somewhere between 15% and 20%), a ternary InGaAs nanowire can be formed. We explain this phenomenon by accounting the different affinity of indium and gallium with the gold particle during the growth. This phenomenon opens a new way to engineer binary-ternary core-shell nanowire heterostructure.



Presenting Author: **Mr. Yanan Guo**
PhD student

Research Activities:

Using advanced microscopy (SEM and TEM) to characterize one-dimensional semiconductor nanostructure (nanowires), so as to develop the key mechanism for fabricating those materials.

Effect of Oxide Inclusions on the Aging Behavior of Powder Metallurgy AA 2014

N. F. Hayazi

Y. C. Kang

S. L. I. Chan

Aluminum Alloy 2014 has been widely used for heavy-duty forgings, aircraft fittings and truck frames. Although the aging behavior of powder metallurgy (P/M) aluminum alloy and its composites has been studied to some extent, the effects of oxide inclusion contents and its morphology on aging require further study. This work employed differential scanning calorimeter (DSC) and transmission electron microscopy (TEM) to investigate the effect of oxide inclusions on the aging in a P/M AA 2014. Different amounts of oxide inclusions were introduced into the alloy by pre-treatment process before sintering the powder in different atmospheres. Small oxide inclusions were obviously found where the amounts of inclusions increased with the oxygen content increased. We have observed that the oxide inclusions could change the precipitation sequences of the AA 2014. The λ' precipitation would be retarded due to absorption of vacancies at dislocations and interfaces between oxide inclusions and the matrix. While the θ' formation was facilitated by the increase in the matrix dislocation density due to coefficient of thermal expansion mismatch. The DSC results also show that the rates of the precipitation formation and dissolution reactions were accelerated in the (P/M) aluminum alloy. The degree of accelerated aging increases with the oxide inclusion content. However, it was also observed that the reduction in peak matrix hardness in the aluminum alloy with the highest oxide content studied. The change of precipitation sequence due to the presence of oxide inclusions has been confirmed by TEM observations.

Presenting Author: Miss Nur Farhana Hayazi

APT Characterisation of Solute Clustering in 6111 Al Alloy

*S. Li,
G. Sha,
R.K.W. Marceau
S.P. Ringer*

There have been strong demands for development of light weight vehicle with better fuel efficiency and less environment impact over the last ten years. A6111 alloy as light weight materials are showing strong potentials for automobile applications especially as car body panel materials. Bake hardening response of the alloy is extremely important. Strong research interests have been focused on the relationship between microstructure and mechanical properties. It is known that the formation of clusters prior to the strengthening β phase have a significant effect on the strength of the material after two-stage ageing treatment. It is important to understand solute clustering during ageing treatment.

In this investigation, samples were treated by various ageing temperature ranged from room temperature to 180°C to obtain a similar yield strength about 140-180 MPa. Atom probe characterisations have been performed on the materials to get quantitative information about cluster size, number density, volume fraction and the spacing between clusters in two dimensions. The information from this research will help to obtain a better understanding about how the clustering process occurs and to evaluate their strengthening effect.

Presenting Author: **Ms Sha Li**
Research student

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Mechanical Properties of Human Femoral Cortical and Trabecular Bones Measured by Nanoindentation

Chih-Ling, Lin
Han Huang
Bronwen W. Cribb
Anthony Russell

Osteoporosis is characterized by increasing incidence of fragility bone fracture, especially in the elderly and postmenopausal women. A comprehensive understanding of mechanical properties of human bones at the microstructural level may assist in discovering the etiology and pathogenesis of osteoporosis. The overall aim of this study was to characterize at the microstructure level the mechanical properties of human bone. Using nanoindentation combined with atomic force microscopy (AFM), the elastic modulus and hardness were measured from femoral head specimens taken from eleven patients (seven female/four male) were collected at the time of hip replacement surgery. ANOVA was used to compare differences in (i) cortical versus trabecular bone (ii) force applied in the longitudinal versus transverse direction and (iii) age and gender. The elastic modulus of cortical bones measured in longitudinal direction was significantly greater than that measured in transverse direction, whereas the elastic modulus of trabecular tissue was not affected by the loading direction. The modulus of the trabecular bone was smaller than that of the cortical bone tissue measured in the longitudinal direction, but greater than that measured in the transverse direction. No correlates were found between mechanical properties of the bone and age or gender of the patient. The elastic properties of cortical bone at the femoral head varied according to the direction in which the force was applied. These characteristics were not present in trabecular bone. Further analyses of energy dispersive spectroscopy and micromechanical testing are required to determine the reasons for these differences.

Presenting Author: **Miss Chih-Ling(Jenny) Lin**
 MPhil student

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Research Activities:

A fracture in bone is a particular manifestation resulted from osteoporosis and also a process that depends on the geometrical arrangement of bone, the mechanical properties of bone and the applied loads. Therefore, a fracture in bone contributes to the loss of mechanical stability of bone. In order to study the bone fracture, nanoindentation is used to measure mechanical properties (elastic modulus and hardness) in different microstructural bones (cortical and cancellous bones). Additionally, to systematically study bone structures by characterizing their mechanical properties and mineral densities at the microscope scales using the specimens collected from the highly potential "osteoporosis" patients.

The microstructure and properties of cold gas dynamic spray (CGDS) Ti powder coatings

Charles Moy^{1,2,3}, Mahnaz Jahedi⁴, Gianluca Ranzi^{1,2,3} and Simon Ringer^{1,2}

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2 ARC Centre of Excellence for Design in Light Metals, The University of Sydney, Sydney, NSW, 2006, Australia

3 School of Civil Engineering, The University of Sydney, Sydney, NSW, 2006, Australia

4 CSIRO Materials Science and Engineering, Clayton, Victoria 3168, Australia

Examples of potential application of Ti coating include corrosion protection and bio-implants. A study of the microstructure of cold sprayed Ti powder onto an Aluminium alloy substrate has been undertaken. The influence of the process on the deformation of the particles and grain morphology was of particular interest. These were investigated using light microscopy, SEM and TEM techniques. A three-dimensional slicing reconstruction using the FEI Nova Nanolab 200 Dualbeam FIB was also performed to examine the interaction of the coating and the substrate at the impact region.

In addition to microstructural characterisation, a compositional study was carried out using XRD, EDS and XPS. The XPS confirmed a probable N capture during the process indicating a small amount of TiN within the coating.

Presenting Author: **Mr Charles Kwet Shin Loo Chin Moy**
PhD Student

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Research Activities:
Research related to light metal study

Understanding Solute Segregation to Dislocation Loops Formed During the Early Stages of Ageing of Al-Cu-Mg Alloys

Ross K.W. Marceau

Gang Sha

Simon P. Ringer

The change in dispersion of solute atoms during the early stages of ageing in Al-Cu-Mg alloys is studied by quantitatively assessing the role of dislocation loops to adsorb both vacancies and solute atoms. This is carried out by measuring the change in loop size and density with 60 s ageing at 150°C from the as-quenched condition, and the results of which are input into a method for calculating the balance of solute in the matrix and that adsorbed to dislocation loops. Large-angle convergent beam electron diffraction (LACBED) has been employed to study the quenched-in dislocation loops and identify their Burgers vector and habit plane, which are necessary parameters in the process of calculating the solute distribution. The implications of the balance of solute atoms at loops compared with solute atoms residual in the matrix, i.e. the likelihood of dislocation-locking versus solute clustering, is then discussed in the context of the rapid hardening phenomenon (RHP).

Presenting Author: **Dr Ross Kevin William Marceau**
Research Associate

Australian Key Centre for Microscopy & Microanalysis
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The University of Sydney NSW 2006

Use of Plasma to Enhance the Shrinkproofing of Wool with a Silicone Polymer

Maryam Naebe
Eva Hakansson
Qing Li
Peter Cookson

Treatment of wool fabric with plasma has virtually no impact on shrinkproofing. Although the silicone polymer, SM 8709, is an effective shrinkproofing agent for wool, the relatively high levels of polymer add-on required lead to a serious impairment of fabric handle. The use of a short-exposure plasma treatment, in combination with 5% of the silicone polymer emulsion, produced a synergistic effect whereby the fabric was effectively shrinkproofed, with no deterioration in handle.

X-ray photoelectron spectroscopy investigations showed that with a plasma treatment time of only three seconds, the covalently-bound F-layer was largely removed from the surface of the wool fibre. In addition, the wettability of the fibre was increased significantly. Polymer was applied to fabric by a pad-dry operation, during which solid polymer was deposited around and between fibres. Confocal microscopy of surface fibres gave a strong indication that polymer was spread more uniformly on plasma-treated fibres. Scanning electron microscopy revealed high levels of inter-fibre polymer bonding when both untreated and polymer-treated fabrics were used, but significantly more polymer encapsulation of fibres with the plasma treatment.

It is postulated that the plasma treatment has a significant impact on the manner in which polymer is attached to the fibre, with shrinkproofing enhanced though fibre encapsulation that masks the scale edges, and also by the formation of a higher concentration of inter-fibres bonds that restricts the migration of adjacent fibres.

Presenting Author: **Ms Maryam Naebe**
PhD student

CMFI, GTP, Deakin University, Waurn Ponds, Geelong, 3217, Vic

Research Activities:
Plasma Treatment

Effect of spinneret diameter on fibre morphology and wettability of electrospun membranes

Nor Dalila Nor Affandi (1,2)

Yen Bach Truong (1)

Ilias Louis Kyratzis (1)

Rajiv Padhye (2)

Lyndon Arnold (2)

1. CMSE, CSIRO

2. RMIT University

Five different polymers (PAN, PVDF, Nylon-6, PU and PVA) have been characterized with respect to their ability to produce electrospun fibre membranes. The effect of spinneret size on the average fibre diameter was examined using different spinneret diameters under optimum electrospinning conditions. Results have shown that smaller diameter spinnerets produce thinner and more uniform fibre. Increasing the spinneret diameter produced fibres with imperfections such as beads and droplets and a higher degree of variation in fibre diameter. The wettability of the electrospun membranes, measured by contact angle (θ) with deionized water, was found to be hydrophilic for PVA and Nylon-6, whilst PVDF, PU and PAN exhibited good hydrophobicity. Electrospun membranes produced using different internal spinneret diameters also influenced surface wettability and membrane thickness for all cases.

Presenting Author: **Miss Nor Dalila Nor Affandi**
Research Activities:
Advanced materials

Deformation of metal matrix composites- A 3D FEM analysis

A. Pramanik

L. C. Zhang

J. A. Arsecularatne

Metal matrix composites (MMCs) have a high strength to weight ratio and wear resistance, and therefore are increasingly used in automotive and aerospace structures. While the reinforcement induces superior physical properties to MMC, the reinforcement particles also bring about very high tool wear and inferior surface finish when machining MMCs. Thus, in manufacturing, difficulties associated with precision and efficient machining of MMCs have become an important issue. In order to exploit MMCs, a deeper understanding of their deformation behavior and the interaction between reinforcements and matrix is required. Investigation of micro-indentation is an effective and simple means to understand the performance and deformation of MMCs. With the increasing trend to use particle reinforced MMCs in a wide range of applications, the micro-indentation response with particle-matrix interaction and plastic deformation characteristics of these composites is of great practical interest. However, it was found that most of the investigations on the properties of MMCs were experimental and did not provide detailed analyses of the deformation during loading/unloading for different particle-matrix-indenter arrangements.

Because of the complexity of deformation of an MMC and the interaction in the vicinity of contact zone between the indenter and work material, an analytical or experimental method is unable to predict the detailed deformation process. This paper investigates the inhomogeneous behavior of MMCs subjected to micro-indentation by a spherical indenter using 3D finite element analysis, including the effects of volume percentage of reinforced particles and indenter-to-particle diameter-ratio on hardness. It was found that the increase of volume percentage of reinforced particles and indenter-to-particle diameter-ratio increased the resistance to deformation of MMC. Hardness of MMC varied in a complex way in four stages with the variation of load and it was explained by the development of strain fields. Hardness increased with the increase of volume percentage of reinforced particles and decrease of indenter-to-particle diameter-ratio. Inhomogeneous deformation of matrix was also noted which is dependent on locations of indentation relative to particles.

Presenting Author: **Mr Alokesh Pramanik**
Postgraduate student

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Role of particles on mechanical properties in magnesium alloys

Nigel Ross

Increasing fuel prices and concerns for the environment are driving manufacturers to lighter, more efficient vehicles. This has led to an increase in the consumption of magnesium in vehicles as it is the lightest engineering metal.

Magnesium can be used for structural components, however due to its hcp crystal structure, it suffers from low ductility and strength. This metal can be alloyed and heat treated to improve strength and ductility through solid solution and precipitation strengthening.

In recent times there has been growing interest in the presence of particles that precipitate in magnesium alloys, particularly those with an icosahedral crystal structure. The combination of this structure with improved coherence with the magnesium matrix has been reported to improve both ductility and strength.

The focus of the current research is to understand the formation of precipitated particles in Mg-Zn-RE (RE= Y and Gd) alloys and their effect on mechanical properties. These alloys were chosen because of their likelihood to produce icosahedral structured precipitates. The role of alloy content and heat treating regime on the development of particles will be investigated. The subsequent influence of different particles on mechanical properties, in particular strength and ductility, will be examined.

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Research Activities:
Precipitation in magnesium alloys

On the Corrosion of Binary Magnesium-Rare Earth Alloys

Aaron Sudholz

Nick Birbilis

Mark Easton

Suming Zhu

Mark Gibson

Magnesium is the lightest of all structural metallic materials with good strength/weight ratio and castability. However its application has been severely limited by its relatively poor resistance to corrosion. Unlike most passivating metallic materials which develop their own protective surface oxide, magnesium suffers from continued dissolution in neutral chloride solutions. A number of studies have focused on the corrosion behaviour of already heavily alloyed Mg-based systems currently in use, such as AZ91; however there remains limited information in literature regarding the microstructural features, and ensuing corrosion behaviour, of many binary Mg alloys.

This work investigates high-pressure die cast (HPDC) magnesium-rare earth (RE) based binary alloys with carefully controlled additions of Ce, La and Nd up to a nominal 6wt% in commercially pure Mg. A combination of electrochemical techniques and electron microscopy were used to reveal the corrosion performance response to microstructural features. It was found that the intermetallic phases formed in the eutectic were Mg₁₂Ce, Mg₁₂La and Mg₃Nd respectively. The corrosion properties of these alloys were found to vary significantly with volume percent of their respective intermetallic. This work aims to reveal the corrosion behaviour of some binary Mg-RE alloys and elucidate how the introduction of various amounts of alloying additions can influence the corrosion rate, with the intention of aiding future alloy design.



Presenting Author: **Mr Aaron D. Sudholz**
PhD Student

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Research Activities:

Mr Sudholz's postgraduate research interests include the corrosion resistance of Magnesium and Magnesium-based light alloys. Currently investigations are underway into the corrosion characteristics of Magnesium-based light alloys and possible thermodynamic and kinetic means of hinder the corrosion process of these alloys. The aim of this research is to better understand the dynamics of Magnesium corrosion and ultimately assess the viability a "stainless" Magnesium alloy.

Crystal field interaction at the Tm³⁺ site in TmCr₂Si₂

B. Saensunon

G. A. Stewart

K. Nishimura

A systematic investigation of the crystal field interaction at the rare earth R site has already been conducted for the intermetallic compound series RT₂Si₂ with T = Cu, Ni, Fe and Co and R = Er, Gd and Tm [1, 2]. These compounds have been classified as Pauli paramagnets where only the rare earth sub-lattice orders magnetically at low cryogenic temperatures. This investigation is being extended to include the T = Cr and Mn members of the series whose the transition metal sub-lattices shown to order anti-ferromagnetically well above room temperature [3, 4]. In this poster we present the results for TmCr₂Si₂ study using ¹⁶⁹Tm-Mössbauer spectroscopy and specific heat measurements. The fitted crystal field parameters are consistent with those determined elsewhere for isostructural HoCr₂Si₂ and indicate a deviation of the rank 6 parameters from the trend observed so far for the series RT₂Si₂ (R = rare earth, T = Fe, Co, Ni, Cu).

[1] Harker, S.J., et al., J. Alloys Compd., 2005. 402: p. 17-20.

[2] Harker, S.J., et al., J. Phys. Condens. Matter, 2002. 14: p. 2705-2714.

[3] Szytula, A. and I. Szott, Solid State Commun., 1981. 40: p. 199-202.

[4] Moze, O., et al., Eur. Phys. J. B, 2003. 36: p. 511-518.



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at the Australian Defence Force Academy
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Research Activities:
Crystal interactions in rare-earth intermetallic compounds

Fatigue behaviour of PVC nanocomposites (CaCO₃)

Noorasikin Samat

Robert Burford

Alan Whittle and

Mark Hoffman

The use of rigid fillers to toughen polymers has received considerable attention in recent years. The fatigue behavior and crack propagation mechanisms of a series of polyvinyl chloride composites was investigated to determine the influence of addition of nano- calcium carbonate particles to the polymers in concentrations ranging from 3-20 pphr . In general, the fatigue resistance was not significantly improved with the addition of nano-particles. However, the fatigue fractographic observations revealed that addition of nanoparticles changed the fatigue crack propagation mechanism, from crazing to new mechanisms such as particle debonding and matrix yielding; and these were associated with the particle content and the stress amplitude. The addition of the coupling agent does improve the dispersion of the particles but its effect on fatigue behavior is only minor.

Presenting Author: **Mrs Noorasikin Samat**
PhD Student

School of Materials Science & Engineering
University of New South Wales
Sydney NSW 2052
Australia

Research Activities:
Fatigue of PVC pipe

3-D Image Analysis Of Nanofiltration Membrane Porous Structure

She, Mary Fenghua

Hong, Hanyu

Kong, L. X.

Gao, W. M.

Hodgson, P.D

Water is the scarcest resource in Australia. Water recycling and desalination will be more widely practiced in Australia evidenced from the installation of desalination plants in all major mainland states. Membrane technology not only has the ability to produce water of exceptional purity but also of consistent quality regardless of the source. Nanofiltration membrane (NFM), in particular, is acknowledged as the most effective pre-process in wastewater treatment and desalination. However, the quality of yielded water and efficiency of filtration greatly depend on membrane's porous structure, which varies in 3-dimensional (3D) space and has remarkable influences on permeate volumetric flux, solute rejection, and fouling potentials. Knowledge of the 3D nanoporous structure is thus vital to understanding and predicting the performance of NF membrane.

In this study, we developed 3D image acquisition protocol based on 3D transmission electronic microtomography (TEM) and 3D image analysis algorithms to quantify nanofiltration membrane's porous structure at nano scale reconstructed images by extracting several geometrical and topological properties in 3-D space, including pore size distribution of nanopores, and global porosity, pore connectivity, tortuosity, coordination number (Z) and genus (G), which are very useful to understand the filtration performance of membrane. The algorithms developed in this project include 3D image enhancement, filtering, image segmentation, thinning and morphological operations.

The results obtained in this project will lead to in-depth understanding and accurate prediction of filtration performance. They will also provide a unique foundation to evaluate fouling phenomena and to design more efficient NF membranes. The outcomes will significantly benefit membrane scientists, membrane designers and membrane manufacturing industry as well as membrane users, such as water and specially, wastewater treatment and desalination industries.

Presenting Author: **Dr Mary Fenghua She**
Research Fellow

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Deakin University
Waurin Ponds, VIC 3217

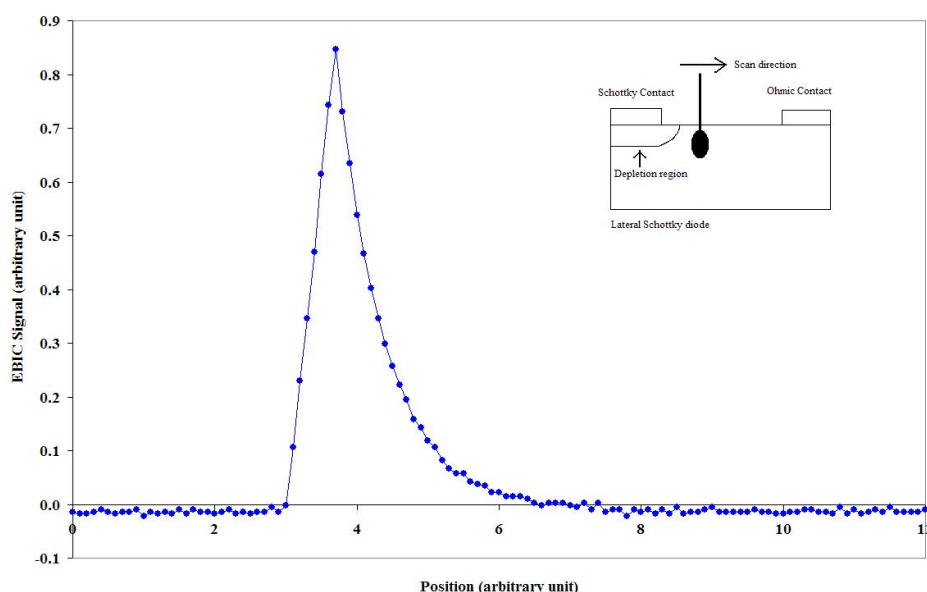
Characterisation of minority carrier diffusion length in Gallium Nitride using the Electron-Beam Induced Current technique

Danny Wee, Gia Parish, Brett Nener

Minority carrier transport properties such as diffusion length, L and recombination lifetime, τ are critical parameters that affect the operating characteristics of semiconductor devices. In this work, the diffusion length of Gallium Nitride (GaN) is characterised using the Electron-Beam Induced Current (EBIC) technique. The sample used for characterisation is a lateral Schottky diode and L is extracted from the EBIC signal (see graphic attached) using the model developed by Chan et al [1]. Additionally, 2-D simulation of EBIC is carried out using Sentaurus to investigate the effects of short L on the results obtained from the model. The diffusion length of GaN can be very short ($<100\text{nm}$) and therefore comparable to, if not less than the dimensions of the generation volume in GaN, thus requiring additional consideration and analysis. The generation volume created in the material is obtained using CASINO v2.42 [2], a Monte Carlo SEM interaction simulation software. This is a more realistic representation of the generation volume compared to using point or Gaussian sources. The effects of electron beam properties such as beam width and energy on EBIC signal are investigated.

[1] D.S.H. Chan, V.K.S. Ong & J.C.H. Phang, 'A Direct Method for the Extraction of Diffusion Length and Surface Recombination Velocity from an EBIC Line Scan: Planar Junction Configuration', IEEE Trans. Electron. Devices, vol. 42, no. 5, pp.963-968, 1995.

[2] D. Drouin, A.R. Couture, R. Gauvin, P. Hovington, P. Horny, and H. Demers, Monte Carlo Simulation of Electron Trajectories in Solids (CASINO) v.2.42, University of Sherbrooke, 2002.



Presenting Author: **Mr Danny Kang Woon Wee**
Postgraduate Student

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Research Activities:
Characterisation of minority carrier properties in Gallium Nitride

A new test routine for the characterization of roll forming materials

*Eva Hemmerich
Matthias Weiss
Bernard Rolfe
John Duncan*

Roll forming is characterized by a large number of deformations with often very small strains per pass. Current roll pass design is largely based on experience with basic analytical and numerical tools. Greater customer demands for new products and shorter lead times require increased virtual engineering at the roll pass design. There are a number of challenges, particularly in representing the material behavior due to residual stress gradients and the need to accurately model both low and large strain behavior. In this work a novel bend test routine is presented that allows the bending and re-bending of roll forming material. The test set up is validated by experimental tests performed on copper and aluminum and the comparison with numerical model predictions.

The presented test routine will give valuable data on the effect of residual surface stresses due to skin passing on the bending behavior of roll forming material. It further enables the detailed investigation of the Bauschinger effect in bending and re-bending of sheet material.

Presenting Author: **Dr Matthias Weiss**
Research Fellow

Centre for Material and Fibre Innovation
Geelong Technology Precinct
Deakin University
Geelong, Victoria, Australia, 3217

Research Activities:

- Investigation of tool wear in sheet forming of advanced high strength steels - experimental and numerical
investigation of roll forming processes - Numerical and experimental investigation of the forming behavior of
metal/polymer laminates - Advanced manufacturing

In-Situ Determination of Organic Adsorption at TiO₂ Photocatalyst

William Wen,
Shanqing Zhang,
Min Yang
Huijun Zhao*

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Abstract

Adsorption of organic species at TiO₂ photocatalyst surface is one of the decisive steps that significantly influence the overall efficiency of the photocatalytic process. In this work, we demonstrated a characterisation method that can be used to in-situ study the adsorption behaviour of organics at nanoparticulate TiO₂ photocatalyst surface. The proposed method is based on a photoelectrochemical principle in which the adsorbed organics can be quantitatively mineralised at the TiO₂ via a photocatalysis process. The amount of charges originated from photocatalytic mineralisation of the adsorbed organics can be readily measured and used to quantify the adsorption amount in accordance with Faraday's law. The method is simple, rapid and effective. It can also be used to study the kinetic aspects of the adsorption process. The method is applicable for studying the adsorption behaviours of a weakly adsorbed species such as methanol, which an ex-situ method is ineffective. Phthalic acid and methanol were chosen as the model compounds to represent strong and weak adsorbates, respectively.

Presenting Author: Mr William Wen

Diffraction analysis of nano-crystalline materials after severe plastic deformation

Yi Sun Wu

Kenong Xia

Nanostructural materials are those have grain sizes ranging from several to few hundreds nanometers and each grain contain only about few hundred atoms. As the grain size is so small in comparison to conventional materials, there is a significant increase in the density of grain boundaries or interfaces. This characteristic strongly enhanced the mechanical properties of the material including the strength and microhardness.

Recently, BP-ECA consolidation has been found to be a promising process to produce ultrafine-grained nanostructure bulk materials from micro-sized pure Al powders. In addition, there is also considerable interest in the generation of other nanocrystalline and amorphous alumina structures to which the attained remarkable high strength and microhardness are also attributed. The existence of these are detected by X-ray diffraction technique and are believed to be formed through oxidation and crystallization processes due to subsequent particle reactions with the entrapped oxygen induced by the severe plastic deformation during the BP-ECA consolidation process.

Presenting Author: **Mr Yi Sun Wu**
PhD - Mechanical & Material Engineering

Research Activities:
Analysis of nano-crystalline materials after severe plastic deformation using Diffraction techniques.

A 3-D Study Of Nucleation Of Recrystallization In Cold Rolled IF Steel Using FIB-EBSD Tomography

W. Xu

M. Ferry

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FIB-EBSD tomography was used to analyze the structure and crystallography of the nucleation processes in 3-D space during annealing of a cold rolled IF steel. It was found that the structure of a given nucleus at the initial formation stage can be divided into two parts: (1) nucleation core, containing a dislocation substructure, mainly bounded by low angle grain boundaries (LAGB) with the surrounding deformation substructure, and (2) newly-grown region, having a dislocation-free structure, and mainly bounded by high angle grain boundaries (HAGB), and forms by consuming surrounding high store energy deformation substructure. It is shown that the origin and orientation of each nucleus is the nucleation core which is a subgrain within in deformation structure. These nuclei also tend to grow heterogeneously into the surrounding high stored energy deformation substructure, such as grain boundaries and shear bands by the process of orientation pinning.

Presenting Author: **Dr. Wanqiang XU**
Research Fellow

School of Materials, the University of New South Wales, Sydney, NSW 2052

Research Activities:

the relationship of microstructure, composition and properties of metallic materials; the texture evolution during thermal mechanical processing; the orientation distribution of crystalline materials in three dimensional space using FIB-EBSD tomography.

FE Mesh Generation for the Unit Cell Approach of Micro-structured Metals and Alloys

Chunhui Yang
Marine Tort
Peter D. Hodgson
Cuie Wen
Bernard F. Rolfe

Keywords: Multi-scale Modelling, Unit Cell Approach, Multiple-phase Microstructures, Finite Element Mesh, Metals and Alloys.

Abstract

Nanostructured and ultra-fine grained metals have higher strength but extremely limited ductility compared to coarse grained metals. However, their ductility can be greatly improved by introducing a specific range of grain sizes in the microstructures. For material design's point of view, a finite element-based multiscale unit cell approach (UCA) has been developed and applied to predict the averaged stress-strain relations of such multi-scale microstructure metals. These unit cell models are multiple-phase structured at different length scales in nano-meter and micro-meter with different volume fractions and periodic boundary conditions. However, it is not easy to generate the appropriate two- or three-dimensional FE meshes for such complex micro-structured metals and alloys.

In this paper, we use Matlab Language to create basic information of elements and nodes in FE models and then apply GMESH to generate the relevant meshes. The phases are shaped as circular or sphere for 2-D or 3-D cases with various geometrical configurations and volume fractions, respectively. They are generated through the sphere growth approach and thus their size distribution can be freely chosen. All the FE meshes are finally transferred in the form of Abaqus input files for further simulation in Abaqus. As one of the application in practical, the developed Matlab codes have been employed to generate the FE models for the foamed metals.

References:

- Yang, C.H., Sabirov, I., Mullins, J., Yazdipour, N., Asgari, S.A. and Hodgson, P.D. (2007) 'Structure-properties relations of metallic materials with multiscale microstructures', *Material Forum*, Vol. 31, 177-185.
- Yang C.H., Sabirov I., Mullins J. and Hodgson P.D. (2008) 'Analytic Prediction of Structural Stress-strain Relations of Microstructured Metal', *Advanced Materials Research*, Vol. 32, 83-86.

Presenting Author: **Dr Chunhui (Richard) Yang**
Lecturer

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Faculty of Science and Technology
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Warrnambool, Geelong, VIC3217, Australia

Research Activities:

C Yang currently is working on the multiscale modelling of metal microstructure engineering, including crack initiation and fatigue crack growth using the coupled molecular dynamics method, dislocation dynamics method and finite element method in the appropriate scales, respectively. One of his activities on multi-scale modelling is that he extensively developed a micromechanically-based unit cell approach to successfully predict the material properties of microstructured metal-matrix composites. His activities also include the investigation of stress-induced shear bands in metallic glass Cu₄₆Zr₅₄ and the effects of pores using Molecular Dynamics (MD). He is also working in the research area of foamed metals with the study on and development of automatic generation of 2-/3-D micro-structured models using Python Code and Matlab Language with the mixtures of inclusions to simulate metal matrix composites.

The effect of fly ash on mechanical and morphological properties of fly ash -polypropylene composite.

A. Zaeni,
Sri Bandyopadhyay,
C. S. Sorrell,
Aibing Yu,
D. Blackburn
C. White,
Greg Heness
Norman Booth

The mechanical and thermal properties of fly ash filled polypropylene composite such as tensile, modulus, impact, crystallizing point, and crystallinity, were determined as a function of fly ash content and fly ash particle size. Polypropylene composites were prepared by mixing the fly ashes with polypropylene and then processed using injection molding. Fly ashes from Tarong coal fired power plant with an average particle size of 85.9, 21.2, 9.0 and 8.3 microns were used as filler.

The modulus and impact strength of composites increased with increasing fly ash content, whilst the tensile strength decreased. However, smaller particle size fly ash appears to improve the tensile strength, as well as increase modulus. Figure 1 shows a graph of close to 2.5 times increase in modulus with fly ash concentration.

Also, fly ash with a wider particle distribution was stronger and more rigid, because the small particles could fill in the interstitial space between closely packed large particles [,]

Thermal analysis using DSC showed that the crystallinity of the polymer in the resulting composites reduced as a function of the filler content; however, this had apparently a beneficial effect on the impact properties due to the increase in amorphous (rubbery) ductile phase content of the polymer matrix, as shown in Figure 2 for 9.0 microns fly ash.

Presenting Author: **Mr Akhmad Zaeni**
Student

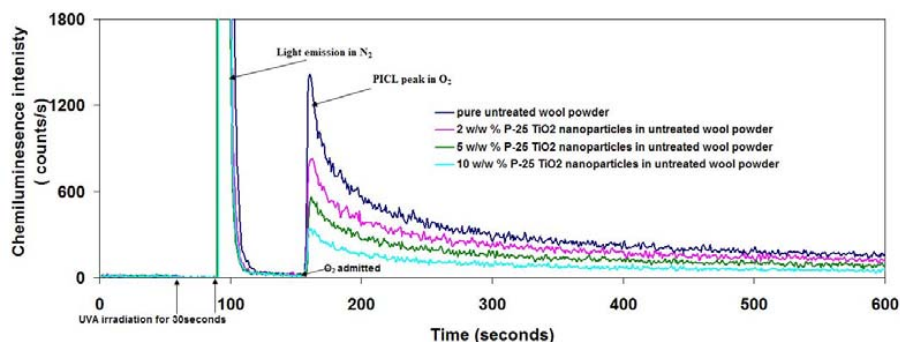
The School of Materials Science and Engineering,
The University of New South Wales,
Sydney 2052, Australia

Research Activities:
Recycling of plastics by compounding with Fly-ash

The Photostability of Wool Doped with Photocatalytic Titanium Dioxide Nanoparticles

Zhang, Hu
Millington, Keith
Wang, Xungai

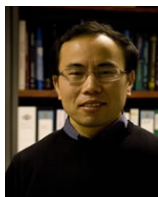
Photoyellowing of wool is a serious problem for the wool industry. This study assessed the role of photocatalytic nanocrystalline titanium dioxide (P-25) as a potential antagonist or catalyst in the photoyellowing of wool. Untreated, bleached and bleached and fluorescent-whitened wool slivers were processed into fine wool powders for the purpose of even and intimate mixing with the TiO₂ nanoparticles in the solid state. Pure wool and wool / TiO₂ mixtures were then compressed into solid discs for a photoyellowing study under simulated sunlight and under UVB and UVC radiation. Yellowness and photo induced chemiluminescence (PICL) measurements showed that nanocrystalline TiO₂ could effectively reduce the rate of photoyellowing by inhibiting free radical generation in doped wool, and that a higher concentration of TiO₂ contributed to a lower rate of photooxidation and reduced photoyellowing. Hence nanocrystalline TiO₂ acts primarily as a UV absorber on wool in dry conditions and not as a photocatalyst.



Presenting Author: Miss Hu Zhang
PhD student

Centre for Material and Fibre Innovation
Faculty of Science and Technology
Geelong Victoria
3217 Australia

Research Activities:
Wool research



Xungai Wang
(Deakin University)

Multi-disciplinary research on fibres and fibrous materials

In this presentation, I will introduce the vast applications of fibres and fibrous materials. I will talk about our recent research into different types of fibres: from micro to nano, and from natural to manufactured. Different ways of functionalising fibrous materials and new ways of processing fibres, including fibre powdering, will also be discussed.

Rob Short

(Mawson Institute, University of South Australia)

**Plasma Polymerisation and The Living Bandage**

Within two decades over 25% of the population in Australia will be 65 years or older. Because of lifestyle and other factors, the population is not ageing in a healthy-fashion. This brings new challenges and places an increasing-burden on the health care system. Engineering solutions, based upon the use of advanced materials, offers some solutions in mitigating some of the problems. Rob is going to talk about developing low cost cell therapies for treating some of the conditions that arising from unhealthy ageing. Non-healing (chronic) wounds arise as a consequence of diabetes and of poor circulation. These wounds can be healed by the repeated delivery of healthy skin cells to the wound bed. This has been achieved by the development of a polymer sheet that carries cells from the lab to the clinic. The polymer sheet (bandage) incorporates a plasma polymerised coating that allows cell expansion and, when required, cell release. It took about eight years to develop and perfect (1996-2004) and was first approved in Europe for treatment of burns and scalds in 2004 and for chronic wounds the following year. The underlying technology can be used in a number of other indications (e.g. to resurface the cornea after injury).

Severe Plastic Deformation Induced Phase Transformation in Duplex Stainless Steel

Y. Cao,
Y. B. Wang,
X. Z. Liao,

DP3W duplex stainless steel disks were severely deformed using high pressure torsion (HPT) at room temperature and a low strain rate. X-ray diffraction, optical microscopy and transmission electron microscopy were used to characterize the microstructural evolution process of the HPT disks. The body centered cubic "alpha" phase and the face centered cubic "gamma" phase co-exist in the as-received sample. After a HPT process for 5 revolutions, the two phases still exist but with slightly increased lattice parameters due to the strain caused by the severe plastic deformation and the grains in the two phases are significantly refined to the nanometer regime. Further HPT process mixes the two phases and results in compositional redistribution. The original "alpha" and "gamma" phases finally transforms to a new "gamma" phase with a reduced lattice parameter. The mechanism of the phase transformation will be discussed in detailed.

Presenting Author: **Mr. Yang Leo Cao**
Master Student

Research Activities:
by means of various instruments to study and analyse the nanostructure and mechanical properties of metallic materials.

Initial film formed on the surface of intermetallic Al₃Mg₂ in water

*Ming Liu
Sandrine Zanna
Helene Ardelean
Antoine Seyeux
Patrik Schmutz
MingChun Zhao
Andrej Atrons
Philippe Marcus*

The oxide film formed on the surface of intermetallic Al₃Mg₂ immersed in distilled water or 0.01M Na₂SO₄ with different pH value have been investigated by X-ray photoelectron spectroscopy (XPS) and time of flight secondary ion mass spectrometry (ToF-SIMS). The electrochemical experiment indicated that the corrosion behavior of Al₃Mg₂ is domain by Al or Mg depends on the environment pH. High resolution XPS spectra revealed there was preferential dissolution of magnesium in the mechanically ground surface and during aqueous immersion. After immersion, there was a stable film on the mechanically graded surface; the film is a Al Mg oxy-hydroxide mixture. The layer distribution measured by ToF-SIMS shows inside the oxide layer there are metallic islands existed while the surface of those island is enrich of Al.



Presenting Author: **Mr Ming Liu**
PhD student

Materials Engineering, The University of Queensland, Brisbane, Qld, Australia 4072

Stacking Fault/Twin Boundary Effect on Grain Refinement in Cu-30wt.% Zn Processed by High Pressure Torsion

Y.B. Wang

X.Z. Liao

Stacking Fault/Twin Boundary Effect on Grain Refinement in Cu-30wt.% Zn Processed by High Pressure Torsion

Y.B. Wang, X.Z. Liao*

School of Aerospace, Mechanical and Mechatronic Engineering, The University of Sydney, Sydney, NSW 2006, Australia

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Abstract

The microstructural evolution process of face-centered cubic Cu-30wt.%Zn, which has very low stacking fault (SF) energy of only 14mJ/m², processed by high-pressure torsion was investigated using transmission electron microscopy. Results reveal that deformation SFs/twin boundaries play the key role in the grain refinement process from ultrafine grains to nano grains and that the smallest achievable grain size is determined by the highest SF/twin density that the system can produce. Equiaxed ultrafine grains with grain sizes of hundreds nanometers were refined through the formation of high density of SFs and twins, resulting in elongated grains with high aspect ratios of length to width. With the accumulation of high density of dislocations at SF/twin boundaries, the originally atomic flat coherent SFs/twin boundaries evolved into curved large angle grain boundaries from which secondary SFs/twins were emitted. The emission of secondary SFs/twins further refined grains and transformed elongated grains into equiaxed grains with grain size of ~ 10 nm. The observed grain refinement mechanism is significantly different from those of materials with medium to high SF energies in which full dislocation activities play a key role for grain refinement. Amorphization of grain boundaries in the final structure was also observed and discussed.

Presenting Author: **Dr. Yanbo Wang**
Research Associate (Postdoc)

Building J07, School of Amme
The University of Sydney

Research Activities:

Electron microscopy characterization of advanced structural and functional materials, materials structure-property relationship, nanomaterials

Study of nanocomposite Ti-Si-N film by pulsed laser atom probe (PLAP) tomography

*Feng Zai Tang,
Baptiste Gault,
Phil Martin,
Avi Bendavid,
Simon Ringer,
Julie M Cairney*

Nanocomposite Ti-Si-N film has prospective applications in machining industry due to its high hardness. A model in which nano-sized TiN crystals are encapsulated by amorphous Si₃N₄ monolayer has been proposed to correlate to its largest hardness. Despite a variety of analytical techniques such as transmission electron microscopy (TEM), x-ray diffraction (XRD) and x-ray photoelectron spectroscopy (XPS) having been used to study the microstructure of these films, no concrete evidence has been obtained to date to directly show the amorphous interfacial phase. The replacement of pulsed voltage by pulsed laser in atom probe tomography (APT) has extended the application of APT beyond the realm of conducting materials, and investigations of semiconductor materials with low electric conductivity by pulsed laser atom probe (PLAP) are now being rapidly reported. In this study, we have investigated nanocomposite Ti-Si-N film by PLAP with the assistant of a dual beam (FIB/SEM) instrument for specimen preparation. FIB/SEM has been used to site-specifically prepare APT tips, which has an end curvature radius less than 100 nm with the coated film retained on its apex. Analysis conditions for the study of Ti-Si-N film have been optimised, and reconstructed 3D microstructures from PLAP can be correlated to results obtained from high resolution TEM.

Presenting Author: **Dr Feng Zai Tang**
Postdoctoral research associate

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Australian Microscopy & Microanalysis Research Facility (AMMRF)
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The University of Sydney

Research Activities:
Materials characterization

Cytotoxicity Study of Titanium Alloying Elements Using Human Osteosarcoma Cells

Y.C. Li
C.S. Wong
P.D. Hodgson
C.E. Wen

Abstract: Titanium alloys possess high strength to weight ratio, lower elastic modulus, superior biocompatibility, and enhanced corrosion resistance compared to more conventional stainless steel and Co-Cr alloys and can be widely used as loading-bearing implant materials. Titanium (Ti), tantalum (Ta), niobium (Nb), zirconium (Zr), molybdenum (Mo), tin (Sn), and silicon (Si) are the most commonly used Ti alloying elements for implant materials. In the present study, the cytotoxicity of Ti, Ti alloying elements and binary Ti alloys was assessed to determine their suitability for biomaterials and biomaterial components. The cytotoxicity assessment on Ti, Ti alloying elements in both their powdered forms and solid forms was carried out by cell culture of human osteosarcoma (SaOS-2) osteoblast-like cells using an extract method. The cell morphology and adhesion on the surfaces of the solid alloying elemental metals after cell culture were observed by confocal microscopy. Results indicated that, the elemental metal powders of Ta, Zr and Sn show a good biocompatibility; the metal powders of Nb and Ti show a certain level of cytotoxicity; and the metal powders of Mo and Si show a relatively strong cytotoxicity. On the other hand, in the solid form of the elemental metals, Ti, Ta, Nb and Zr show an excellent biocompatibility; Sn shows a moderate biocompatibility; and Mo and Si show a substantial cytotoxicity. It was found that the ion concentrations of the metals affected the biocompatibility of the elemental metals significantly. The powdered metals display a good biocompatibility when the metal ion concentration was lower than 15.5, 172.0, 8.5 and 37,000µg/l for Ti, Nb, Mo and Si, respectively. The results of the present study provide fundamental information and new insights for future design and development of new biocompatible titanium alloys for implant materials.

Key words: cytotoxicity, titanium alloying elements, in vitro test, osteoblast-like cells

Presenting Author: **Dr Yuncang Li**
Research Fellow

Centre for Material and Fibre Innovation
Geelong Technology Precinct
Deakin University, Geelong, Victoria, Australia, 3217

Analysis of Elastic 'Viscous' Plastic Deformation Behaviour of Cortical Bone determined by Nanoindentation and Analytical Modelling

Rui Ping Hoo

William Robert Walsh

Mark John Hoffman

Cortical bone has a complex hierarchical structure, which deforms uniquely under various loading modes and conditions. Nanoindentation experiments were performed on the longitudinal direction of the bovine cortical bone using two spherical tips (5 μ m and 20 μ m) to a maximum load of 50mN at three different loading and unloading rates (0.05mN/s, 0.5mN/s and 5mN/s) with a 100s holding time at maximum load. An analytical model was developed describing elastic-plastic and time-dependent deformation behaviour of cortical bone under spherical indentation. The analytical model employs elastic (spring), viscous (dashpot) and plastic (slider) mechanical elements arranged in either series or parallel, analogous to the Maxwell and Kelvin-Voigt models, for loading, holding and unloading conditions. Experimental and analytically-predicted load-depth behaviour are found to be comparable. The analytical model also provides material parameters related to elastic modulus, hardness and viscosity coefficient. The predicted reduced modulus of the cortical bone ranges from 13-25GPa, which is in good agreement with previous studies. Deformation mechanisms have been suggested based upon a staggered configuration of mineral and collagen phases where irreversible deformation is proposed to be contributed by extensive shear deformation between the mineral platelets in the collagen matrix. This study well predicts the deformation behaviour of cortical bone at the micro- to nano-scale under compression loading, which is essential to understand the post-yield deformation prior to bone fracture.

Presenting Author: **Miss Rui Ping Hoo**
PhD student

Research Activities:

Multi-scale design of bone biomechanics Analytical modelling on deformation of cortical bone under indentation
Finite element analysis of dental tooth from X-ray determined structure

Investigation of IN718 in The Early Stages of Aging by Atom Probe Tomography

Talukder Alam

Julie Cairney

Electron Microscope Unit, University of Sydney

Nickel-based superalloys are the key material used for turbine blades and the hot section components of turbine engines. Inconel 718 (IN718) is an alloy of this group, which combines excellent high temperature properties and good weldability [1]. Minor elements present in the alloy play an important role in determining the mechanical properties and the microstructure of IN718 [1,2]. The purpose of this project is to investigate the effect of minor elements like carbon, phosphorus and boron on the formation of the main strengthening precipitates of IN718, γ' and γ'' , and on the grain boundaries in IN718.

Extensive study of IN718 in last few decades has mainly focused on samples that have a history of multiple heat treatments for many hours or on samples prepared from in-service components in operation for thousands of hours. In the present study, Atom Probe Tomography (APT) is used to understand the evolution of the microstructure in the very early stages of aging in WE91, which is a variation of IN718 with B and P additions to improve the creep properties. Based on a Vickers hardness curve obtained, various annealing times were chosen to carry out APT to study the precipitation and pre-precipitation clustering in WE91. Our study has shown that, while no precipitates are observed after 120 seconds, both γ' and γ'' precipitates form within 500 seconds of aging.

[1] Ping, Gu, Cui, Harada Materials Science And Engineering A 456 (2007) 99?102

[2] Benhadad, Richards, and Chaturvedi Metallurgical and Materials Transactions A Volume 33a, July 2002?2005

Presenting Author: **Mr. Talukder Mahbub-UI- Alam**
Ph.D Student, EMU, Uni of Sydney

Research Activities:
Grain boundary study of Ni-based superalloy Inconel 718

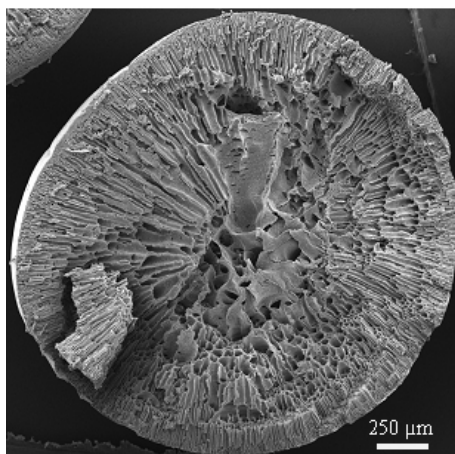
One-pot synthesis of hierarchical metal oxide beads for the adsorption of uranyl

Glenna L. Drisko
Maryline Chee Kimling
Nicholas Scales
Vittorio Luca
Rachel A. Caruso

Porous beads have an application in the areas of environmental clean up, separations and catalysis. Granules are desirable for commercial column chromatography and filtration. However, there are few examples of spherical porous metal oxides and fewer still have been produced in an industrially feasible process.

In this work we demonstrate the feasibility of producing hierarchical porous zirconium titanium oxides beads via an engineering-friendly one-pot process. The phase separation of polyacrylonitrile (PAN) created macroporosity and a non-ionic surfactant influenced the mesophase. The presence of Pluronic F127 increased the mechanical integrity of the calcined oxide beads and increased the mean mesopore diameter. PAN/F127 templated zirconium titanium oxide beads had surface areas of 150 m²/g, mesopore diameters of 4-23 nm and large macropores of up to 100 μ m.

The materials were characterized with SEM, TEM, XRD and gas sorption and then were tested for the adsorption of uranyl. The adsorption results were compared to beads produced by templating pre-formed PAN beads with F127 in a two-step process. Kinetic studies, which are heavily influenced by the pore size, structure and connectivity, showed comparable adsorption rates between the one-pot and two-pot beads. Both synthesis procedures produced beads with hierarchical porosity with medium sized mesopores (~10 nm) and a high degree of inter-connection, thus leading to similar kinetics. However, the adsorption capacity was slightly lower for the one-pot beads, which has been attributed to the lower surface area. The one-pot beads have produced in a simple one-pot process and have shown sufficient performance for the uptake of uranyl.



Presenting Author: **Miss Glenna Lynn Drisko**
Ph.D. student University of Melbourne

Research Activities:
Template synthesis for the construction of hierarchically porous titania and zirconia. These materials have been used for the adsorption of heavy metals.

How artificial muscles can be improved using polypyrrole

Javad Foroughi

Prof. Geoffrey M. Spinks

Prof. Gordon G. Wallace

To develop artificial muscles polypyrrole(Ppy) has been fabricated for the first time in to fibres and Ppy cast films from chemically polymerized of pyrrole. Their use in a range of electrochemical configurations including electronic-textiles and artificial muscle nano-structures has been evaluated. Also a comparison of chemically prepared and electrochemically prepared polypyrrole films and fibres for artificial muscles were carried out.



Presenting Author: **Mr. Javad Foroughi**
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Wollongong NSW 2500

Research Activities:
conducting polymers

Functionally Graded Dental Implant and its Effect on Bone Remodeling: A Numerical Approach

Daniel Lin, Qing Li, Wei Li, Michael Swain

For many decades titanium dental implants have been the mainstream product on the dental implant market, due to advantages such as corrosion resistance, high mechanical strength, and superior bio-compatibility. However, in more recent times, as functionally graded material (FGM) gradually gains popularity and research interests. FGM is being considered as the potential replacement material for future implant design, due to the common speculation of improved osseointegration into the surrounding bones. The concept of using FGM implant is such the properties are to be tailored at different regions in accordance with the biomechanical needs, to accommodate its hosting bone tissues. Thus in principle creating a better integration between the implant and bone interface. However, whether FGM can meet this speculation remains to be a topic under investigation. This study aims to explore this critical issue by the implementation of computational bone remodeling simulation based on finite element method. The research procedure involves the construction of computational models, consisting of a 3D maxillary model created from CT scans, and a single unit implant design using FGM. The entire model was analyzed by using ABAQUS software from Dassault Systems, and a user routine program, coded using Python scripting language was designed to perform the bone remodeling calculations. The bone remodeling simulation was performed over a 4 year period. Comparisons were made between titanium implants and various FGM implant settings, where the results were further examined through resonance frequency analysis. The study forms the foundations for futuristic design optimization of FGM dental implants.

Presenting Author: **Mr. Daniel Lin**
PhD student

School of Aerospace, Mechanical and Mechatronic Engineering, The University of Sydney, Sydney, NSW 2006, Australia

Research Activities:
Computational biomechanics research

Uncommon properties of common carbon coatings: surface modified coatings and hosts to basic polymers and carbyne.

M. Rybachuk (1,2)

J. M. Bell (2)

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(2) Faculty of Built Environment and Engineering, Queensland University of Technology, 2 George St., Brisbane, Queensland 4001, Australia

Functional carbon coatings that include soft and hard amorphous carbon films, and amorphous diamond-like (DLC) films are known to contain significant fraction of carbon atoms organised in sp³ configuration. These films are unique due to their valuable mechanical properties and tuneable opto - electronic properties which can be modified becoming either graphite-like or similar to natural diamond. Films synthesised out of a hydrogenated medium occasionally contain trans-polyacetylene and carbyne, these very inclusions while perceived of being ineffectual, have been difficult to identify and quantify.

This talk will present the experimental work investigating inclusions of basic π - conjugated polymers (trans-polyacetylene and poly(p-phenylene vinylene)) and carbyne (polyynes) in hydrogenated carbon films. We will also assess the potential for use of in situ or ex situ modification of carbon surfaces by ultra-fast (femto-second) laser radiation and determine whether inclusions of such basic polymeric chains could warrant novel opto ? electronic applications.

The analytical focus of the talk will be on the use of Raman and resonant Raman scattering (NIR $\rightarrow$ vis $\rightarrow$ UV range) for amorphous carbons, while X-ray photoelectron and infra - red spectroscopy techniques will also be discussed. The presentation will conclude highlighting possible new directions in applied research on carbon coatings.

Presenting Author: **Mr Maksym Rybachuk**
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Research Activities:

Investigation of properties of diamond like carbon (DLC) thin films in application to opto-electronics. An open Ar:CH₄ plasma source and a bimodal ion beam sputtering deposition are used to fabricate the films.

Optimizing the UV Protection of textile with reduction of photocatalytic activity of ZnO

Jinfeng Wang, Takuya Tsuzuki, Lu Sun*

Oral Presentation at ARNAM 2008

Optimizing the UV Protection of textile with reduction of photocatalytic activity of ZnO

Jinfeng Wang, Takuya Tsuzuki, Lu Sun*

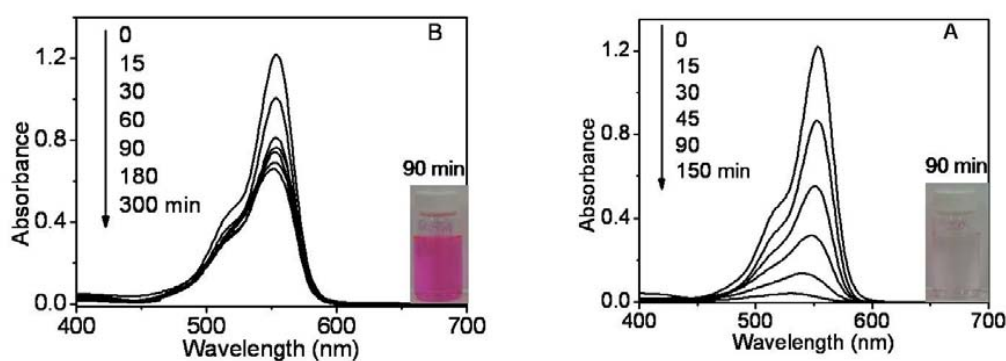
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The useful life of many outdoor textile products is limited due to their degradation caused by ultra violet (UV) rays. The degradation results in fading of colours and loss of physical properties, such as tear strength and abrasion resistance. The degradation can be prevented by blocking UV light using UV absorbers such as zinc oxide (ZnO). ZnO is expected to provide an effective UV protection over a much longer period than organic UV absorbers owing to the superior stability to UV light. However, our past work has revealed that direct application of ZnO nanoparticles on dyed polyester fabric could not always prevent colour fading because of the photocatalytic activity.

In this presentation, we will report a facile and efficient synthesis technique for the preparation of ZnO-core/SiO₂-shell hybrid nanoparticles to reduce the photocatalytic activity of ZnO. Monodispersed wurtzite-type ZnO nanoparticles were prepared and SiO₂ coating was applied to the particles via the Stober method. ZnO particles before and after coating experiment were investigated by X-ray diffraction, transmission electron microscopy, dynamic light scattering, infrared and UV-Vis absorption spectroscopy, and x-ray photoelectron spectroscopy. The UV-Vis results implied that the aggregation of ZnO was significantly reduced by the presence of SiO₂ on the surface. Rhodamine B (RhB) was used as a probe to evaluate the photocatalytic performance of SiO₂/ZnO nanocomposites under UV light irradiation. It was found that the photocatalytic activity was considerably suppressed by the silica shells on ZnO nanoparticles. This hybrid material would give a much better protection against colour fading on fabric.

Fig. 1 Time dependent absorption spectra of RhB solution during UV light irradiation in the presence of Zn dispersion (a) and SiO₂/ZnO dispersion (b) irradiated at pH=6. Insets are photographs of RhB solution irradiated for 90 min in the presence of ZnO (a) and SiO₂/ZnO (b), respectively.



Presenting Author: Miss Jinfeng Wang
Centre for Material and Fibre Innovation
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Deakin University, Geelong Victoria Australia 3217

Research Activities:
Effective UV Blocking Materials

Effect of pH on Photoelectrocatalysis Process at Nanostructured TiO₂ Film Electrodes

Haimin Zhang
 Porun Liu
 Shanqing Zhang
 Huijun Zhao

It is well known that the photocatalysis process at nanostructured TiO₂ can be strongly influenced by the solution pH via the band edge potentials changes. To date, the majority investigations on the effect of pH on photocatalysis processes were carried out using particle suspension systems, while very limited information is known regarding the effect of pH on the photoelectrocatalysis processes at an immobilised film electrode. In this work, two types of nanostructured TiO₂ film electrodes, TiO₂ nanotubular and nanoparticulate film electrodes were prepared via electrochemical anodization and sol-gel methods, respectively. The effect of solution pH on the photoelectrocatalysis processes was investigated. The effect of pH on the photoelectrocatalysis processes at the nanotubular and the nanoparticulate film electrodes were found to be similar, indicating the pH influence is determined by the nature of the material rather than its physical appearance. The determined onset potentials were found to follow the Nernstian-type pH dependence when pH is below 4 or greater than 10. Within these pH regions, the obtained photocurrent-potential curves exhibit a single-wave characteristic suggesting the photoelectrons were drawn from a single electron energy state (the conduction band). The measured onset potentials were found to be insensitive to pH changes and deviated from Nernstian-type pH dependence behaviour within the pH range of 4 to 10. Within such a pH region, double-wave shaped photocurrent-potential curves were observed, implying photoelectrons were drained out from two different electron energy states, which could be explained by the proposed band edges shift model.

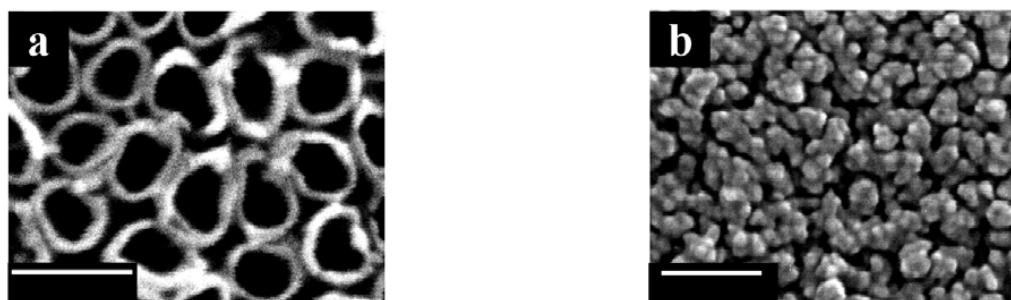


Figure 1. TiO₂ nanotube electrode annealing at 450°C for 3h (a) and TiO₂ nanoparticle film electrode annealing at 700°C for 16h (b).

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 Australia

Research Activities:
 Visiting Research Fellow

Pt-free air electrode for battery and fuel-cells

B. Winther-Jensen
Orawan Winther-Jensen
Maria Forsyth
Douglas MacFarlane

The oxygen reduction is of broad significance such as fuel-cells and metal/air batteries. The most commonly used electrode for this process employs a Pt catalyst to enhance the reaction rate. This adds significant cost to the electrode and potential poisoning by CO by-products in some applications. Further, it is a well known phenomena that drift of platinum and other catalytic centres causes loss of efficiency during operation. Here we describe an electrode based on a porous material coated with a base inhibited chemically polymerised poly (3,4-ethylenedioxythiophene) (PEDOT), which acts as a high rate oxygen reduction catalyst. Continuous operation for 3 weeks has been demonstrated without sign of degradation or deterioration of the performance. O₂ conversion rates for the PEDOT electrode are comparable with Pt base electrodes with same geometry. The PEDOT appears to cycle its oxidation state during the oxygen reduction reaction. This has been demonstrated in two different modes 1) as an air electrode operating at ambient pressure and 2) as a dissolved oxygen electrode operating in aqueous solutions.



Presenting Author: **Dr Bjorn Winther-Jensen**
Research Fellow

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Evaporative Influence on Radial Distribution Functions in Atom Probe Tomography

Daniel Haley, Tim Petersen, Geoff Barton, Simon Ringer

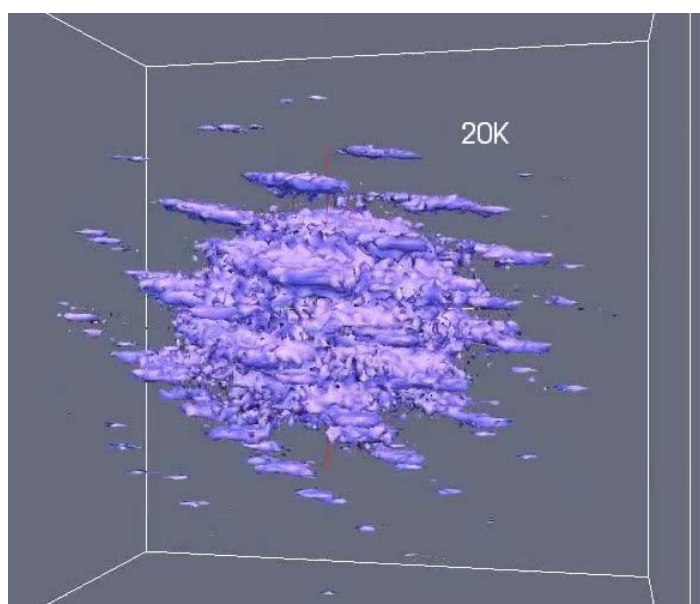
Atom Probe Tomography of metallic glasses has been utilised as a method of extracting fine-scale chemical decomposition phenomena, which are difficult to examine directly using techniques such as Transmission Electron Microscopy. Similarly structural information in the case of crystalline alloys has previously been shown to be possible in atom probe reconstructions.

Typical structural refinement methods include diffraction and simulation, the former is limited by the complex interaction behaviour and difference in scattering cross-section, and the latter limited by computing resource & experimental constraints. As APT represents a point source data with chemical identity, the possibility of obtaining structural information is appealing.

Experiments have been conducted on Mg₆₅Cu₂₅Y₁₀ and Pd₄₀Cu₃₀Ni₁₀P₂₀ glasses to obtain Radial Distribution Functions (RDFs), using optimal computational methods. These APT results have been compared with non-chemically resolved correlations obtained via TEM diffraction and shown to have no structural information.

Through high-performance computing based statistical analysis of images at the detector surface, the lack of observed correlation has been shown to be a result of the observed field evaporation phenomena.

The field evaporation behaviour of these observed metallic glasses undermines a fundamental assumption in the generation of the tomographic data in APT, limiting the observable structural information in APT amorphous datasets, highlighting the need for a re-examination of the reconstruction methods.



Presenting Author: **Mr Daniel Haley**
PhD Student

Australian Key Centre for Microscopy & Microanalysis
The University of Sydney
NSW 2006 Australia

Research Activities:
Structural identification of amorphous materials using Atom Probe Tomography and TEM.

New Instrument Concept for Local Texture Measurement with Neutron Radiation

*U. Garbe
O. Kirstein
K.-D. Liss*

The knowledge of the local variation of texture, e.g. by inhomogeneous deformation, is important, due to the coherence between texture and the physical and mechanical properties of materials. The Materials Science Diffractometer KOWARI at ANSTO is designed to be applied to residual stress analyses. As first experiments have shown, however, for local texture applications it is also feasible with further optimisation on neutron flux and sample positioning. This will be achieved by improving sample manipulation, neutron optics and neutron detection efficiency by increasing the detector area.

The existing Eulerian cradle, which is limited in sample size and translation, will be replaced by a more flexible robotic system. The robot is proposed to be used simultaneously for automatic sample manipulation and sample change. It will also allow faster alignment and positioning of larger samples. In order to enhance the flux on the sample and improve the definition of small gauge volumes down to $1 \times 1 \times 1 \text{ mm}^3$, a parabolic neutron guide between the monochromator and the sample will be used. The possibility to take data with two or three position sensitive detectors was calculated. These calculations show that in comparison with the existing setup it is possible to reduce the number of measured orientations more than three times. The combination of the focusing neutron guide with three area detectors and the robotic system enables 3-D texture mapping in acceptable timescales.

Presenting Author: **Dr Ulf Garbe**
Postdoc

PMB 1,
Menai NSW 2234

Research Activities:
- Neutron and synchrotron in-situ diffraction - Strain and Texture measurement

Effect of fiber diameter on tensile properties of electrospun poly(ϵ -caprolactone)

Avinash Baji
Yiu-Wing Mai
Shing-Chung Wong

Little is understood on mechanisms used by nature in designing materials with high strength and toughness from weaker constituents. Nanostructured materials found in nature such as bones, nacre and teeth are composites of proteins and bio-minerals and are found to possess superior mechanical properties in comparison to its constituent phases. The hierarchical arrangement of organic-inorganic nanoparticles at the structural level provides superior strength and toughness to the composite. The mechanisms used by these materials help in providing the guidelines for the design of biomimetic materials with optimized strength and toughness.

Electrospinning method was used in this study to produce polymer nanofibers to mimic the structure of extracellular matrix (ECM). The tensile properties of these fibers have not been widely investigated due to the difficulties in handling nanofibers and measuring low load for deformation. In this study, the effect of dimensional confinement on free standing biodegradable poly(ϵ -caprolactone) (PCL) is investigated using electrospinning-enabled techniques and a nanoforce tensile tester. The structural properties of the spun fibers are examined using wide angle X-ray diffraction (WAXD). The structural properties of fibers are enhanced when the diameter of fibers is reduced, resulting in improved mechanical strength and stiffness. It is evident that PCL fibers with decreasing fiber diameter exhibit an abrupt shift in tensile performance in comparison to those derived from non-spun systems. The abrupt shift in tensile properties of electrospun PCL fibers occurs at around 700 nm in diameter and illustrates the importance of studying the mechanical behavior of the nanofibers.

Presenting Author: **Mr. Avinash Baji**
Postdoctoral Fellow

12 Hercules Street
Ashfield, NSW-2131

Research Activities:
Characterisation the deformation behavior of electrospun fibers; Investigating the effect of diameters on the tensile properties of the electrospun fibers

From the single grain to texture

Kun Yan
Klaus-Dieter Liss
Rian Dippenaar

By high energy synchrotron X ray diffraction, the evolution of microstructure was tracked during axial compression deformation for a cold rolled copper following annealing treatment. The grain refinement and mosaic spread of sub-grain were observed dynamically from the movie of 2D diffraction patterns as well as the diffraction profile broadening and the anisotropic grain orientations were obtained with numerical analysis. Complementary neutron diffraction was employed for the ex-situ texture measurement. The results fulfill the understanding of the grain orientation evolution and plastic slip mechanism during compressive deformation.

Presenting Author: **Miss Kun Yan**
PHD Candidate

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New Illawarra Road, Lucas Heights

Research Activities:
In-situ analysing the microstructure evolution of metal by high energy x ray and neutron diffraction technology

Analysis of the effects of atmospheric helium plasma on the surface structure of jute fibers and resulting composite properties

Abdullah A. Kafi

Christopher J. Hurren

Bronwyn L. Fox

This work investigates the mechanisms involved in the improvement of flexural strength of a jute/polyester composite when the reinforcement material has been atmospherically plasma treated using a helium gas. Surface characterization techniques including atomic force microscopy (AFM), surface wetting rate, and X-ray Photoelectron Spectroscopy combined with fabric surface co-efficient of friction (COF), fabric tensile strength, composite flexural strength and composite mode-I properties have been used to quantify the effects of plasma modification. AFM analysis showed that the surface roughness of the fibre decreased as the plasma treatment time increased. The COF and surface wetting rate both increased with number of plasma treatments. Fabric strength initially improved with increased treatment time but started to decrease after 25 passes of the fabric through the plasma zone. Flexural strength followed the same trend as fabric strength. These results showed that flexural strength improvement achieved by atmospheric plasma treatment was due to the improvement in fabric strength. Fabric strength was improved because an increase in fibre to fibre friction made it harder for fibres to pull past each other in the yarn during fabric strain. Over treatment by plasma causes fibre damage related strength losses in the fabric which outweigh the friction related improvements after 25 passes.



Presenting Author: **Mr Abdullah-Al Kafi**
student

Abdullah-Al-Kafi
PhD candidate
Centre for Material and Fibre Innovation
Deakin University Geelong Victoria 3217 Australia.

Research Activities:
surface modification and development of fabrication process

Soy glycinin: from chemical solutions to real food powders. Influence of pH and ionic strength on the protein quaternary structure.

Anna Sokolova, Agata Rekas, Catherine S Kealley, Elliot P Gilbert

Presented work describes performed modeling of real structure of 11S soy glycinin in wet and dry states at various conditions. We investigated the molecule' structural changes as a function of pH and anion type by gaining a greater understanding of the structural changes occurring in the protein under different solution conditions prior to freeze-drying. This enables to make further advances in the use of glycinin as a food additive. Glycinin is typically used in the solid state and often following free-drying from solution, so our challenge was to investigate to what extent solution scattering can be used to describe the structure of the native material in the solid state.

Glycinin is hexameric protein contains randomly distributed five types of subunits. Structure of two constructed monohexameric mutants was determined by x-ray diffraction technique. Recently published results show structural features of glycinin obtained by small angle x-ray scattering (SAXS) in dry state at different values of moisture content.

A combination of rigid body refinement as well as pair distribution functions analysis (ATSAS 2.2 <http://www.embl-hamburg.de/ExternalInfo/Research/Sax/software.html>) of SAXS data supported by data obtained by CD and DLS techniques have been used for structure changes modelling under the influence of variable pH and presence of salts.

Getting scattering from dry glycinin at the same conditions (i.e. pH and salts) as dissolved one we've sought to reconstruct the low resolution structure of the freeze-dried powder by simultaneous analysis of a series of scattering data from glycinin in solution and in dry state.

Presenting Author: **Dr Anna Sokolova**
PostDoctoral fellow

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X-ray Photoelectron Analysis of Ion Implanted and Ion Beam Mixed Polyetheretherketone

E. Tavenner, Ian Wark Research Institute, Adelaide, SA
B. Wood, University of Queensland, Brisbane, Qld.
M. Curry, Missouri State University, Springfield, MO, USA
R.E. Geidd, Missouri State University, Springfield, MO

Ion implantation is one of the few techniques that can change the characteristics of a material by non-equilibrium conditions. This allows materials to be modified in such a way that is near impossible by other techniques. The ion treatment of inorganic materials is well understood. However, due to the complexities of elucidating the processes that occur during ion implantation and the difficulties in characterising implanted materials, the understanding of the modifications that occur with the ion implantation of polymers has not advanced to the same level. Hence, the ability to tailor the ion implantation procedure to a specific polymer to achieve desired characteristics is only attainable through trial and error.

The aim of this study is to understand the changes that occur during the ion implantation and ion beam mixing of polyetheretherketone. The presented work looks at the XPS analysis of polyetheretherketone implanted by three different, but complimentary, techniques: nitrogen ion implantation, tin ion implantation and finally nitrogen ion beam mixing of thin tin films into the polymer.

It was found that graphitic-like structures were produced within the implanted region. This is evident through the XPS C 1s peak low energy broadening and through the changing of the valence band to a graphitic line shape.

Because of this, the C 1s line shape of graphite was used in the analysis of the implanted PEEK spectra, and it was discovered that all implanted samples had developed these structures. It was also seen that carbon-tin bonds were being formed during ion implantation.

Presenting Author: **Dr. Eric Tavenner**
 Surface Scientist

Ian Wark Research Institute
 University of South Australia
 Mawson Lakes Campus
 Mawson Lakes, SA 5095

Research Activities:
 Ion beam modified polymers for electronic applications

Complementary In-situ Neutron and High-Energy X-Ray Powder Diffraction Analysis of the Phase Transformations in Titanium Aluminides

Ian Watson
Klaus-Dieter Liss
Helmut Clemens
Arno Bartels
Wilfried Wallgram
LaReine Yeoh
Thomas Hansen
Thomas Buslaps

Titanium Aluminides are light intermetallic compounds with good mechanical properties and oxidation resistance at elevated temperatures and therefore bear a high potential for applications in the aerospace and transport industries. The complicated phase diagram and multitude of microstructures, however, need a detailed understanding of the transitions involved. We present in-situ synchrotron high energy X-ray diffraction and in-situ neutron diffraction obtained during different heating and cooling ramps. While X-rays are mostly sensitive to the overall phase composition, neutrons reveal the atomic order / disorder in each phase.

Anomalies in thermal expansion, phase transformations, order / disorder and undercooling effects have been observed and are correlated to each other. Also, on temperature ramping, the sequence of the phase transformations order-disorder in α -Ti₃Al and the appearance-disappearance of γ -TiAl seem to be inverted between heating and cooling. The results lead us to speculate, that the α to γ transformation, which is essentially a transformation from a near-hcp to a near-fcc structure, is triggered by the atomic ordering process of the component elements and shine a new light onto the understanding of phase transformations out of thermodynamic equilibrium.

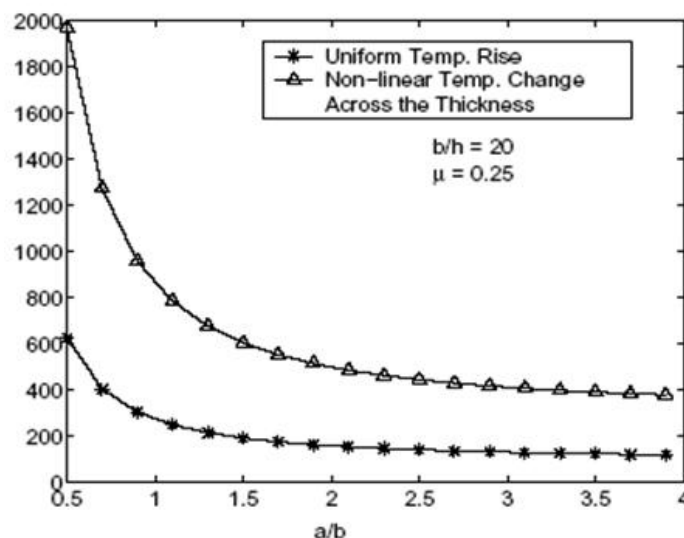
Presenting Author: **Mr Ian James Watson**
Student

Evaluation of thermo-mechanical behaviour of functionally graded structures based on classical and shear deformation theories

Bashir Samsam

Many investigations are carried out on the subject of mechanical and thermal buckling of structures. However, development of new materials, such as functionally graded materials (FGM's), has necessitated more research in this area. Functionally graded materials are new materials with heterogeneous/isotropic properties mainly designed to withstand high thermal stresses.

Mechanical and thermal stability analysis of rectangular functionally graded plates is investigated in this study. It is assumed that the non-homogeneous mechanical properties vary linearly through the thickness of the plate. The plate is assumed to be separately under three types of mechanical loading, namely; uniaxial compression, biaxial compression, and biaxial compression and tension and two types of thermal loadings, namely; the uniform temperature rise and nonlinear temperature gradient through the thickness. The equilibrium, stability, and compatibility equations are derived using the higher order shear deformation plate theory. Resulting equations are employed to obtain the closed-form solution for the critical buckling load for each loading case. It is indicated that the buckling load values are affected by the material and geometrical properties of the plate, especially imperfections. The perfect plate has a symmetric pitchfork bifurcation at the buckling load; however, the imperfect plate develops an asymmetric secondary path by means of a saddle-node bifurcation at the higher load value. This behaviour exists in the case of both mechanical and thermal loading. The present study confirms this phenomenon for the functionally graded plates. The results based on different theories are compared and the most accurate theory is proposed.



Presenting Author: **Mr Bashir Samsam**
PhD student

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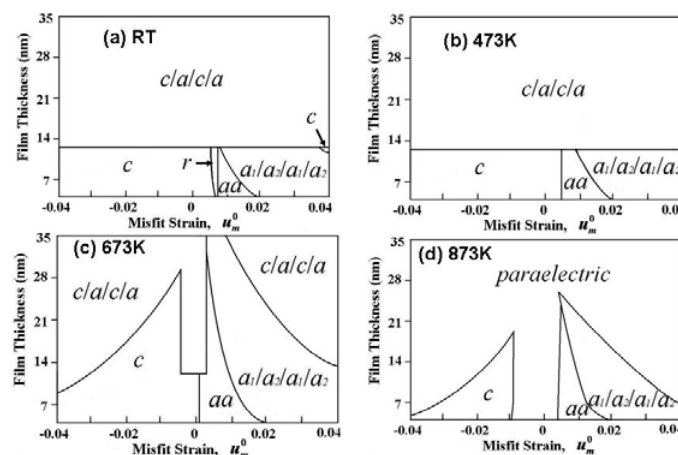
Research Activities:
Shape memory alloys, Thermo-mechanical behaviour of structures, Stability analysis

Film thickness versus misfit strain phase diagrams for ultra-thin epitaxial ferroelectric films

Qiao Yu Qiu
Nagarajan Valanoor
Pamir Alpay

The question of size-effect in ultra-thin ferroelectrics and strain-engineering of ferroelectric thin films has now become an intensely debated topic. Despite the various contradicting results and theoretical approaches, there is unanimous consent that mechanical and electrical boundary conditions control the ultimate phase stability in epitaxial ferroelectric thin films. Distinctly, the theoretical models reported so far treat these boundary and the system's geometric conditions as almost independent parameters with no one work that takes into account the entire possible parameters. We present a full-scale non-linear thermodynamic model based on a Landau-Ginzburg-Devonshire formalism and the theory of dense polydomain structures in a multi-parameter space to predict the phase stability of (001) oriented $\text{PbZr}_{1-x}\text{Ti}_x\text{O}_3$ epitaxial thin films as a function of film thickness and epitaxial strain. The developed methodology, which accounts for electrostatic boundary conditions as well as the formation of misfit dislocations and polydomain structures, produces a thickness-strain phase stability diagram where it finds that the rotational phases (the so called *r*- and *ac*-phases) in epitaxial PZT films are possible only in a much smaller window than the previous predictions. Subsequently the high dielectric and piezoelectric coefficients that are associated with the rotational polar domains exist only in this very small window of phase stability. We find that for experimentally used thickness or strains (or both) that often fall outside this window, the film is in the *c* or *c/a/c/a* polydomain state.

Computed Misfit-strain vs. Thickness Phase Diagrams For Various Temperatures



Presenting Author: Mr Qiao Yu Qiu

Nitrogen Doped Layered Tantalate and Niobate with Highly Visible Light Absorption

Xiaoxia Yan
Lianzhou Wang
Gaoqing (Max) Lu

Semiconducting photocatalysis has been extensively explored over the three decades since the pioneer work of Honda and Fujishima. For most semiconductor photocatalysts, the photocatalytic reaction is difficult to process under the irradiation of visible light (>400 nm) which is the main part (43 %) of solar energy due to the large bandgap of the materials. Non-metal doping (e.g. doped with C, N, S, I, and F, et al.) has been proved to be an efficient method to narrow the bandgap of the semiconductors and subsequently attain visible light adsorption. In the work, two kinds of important semiconductors (Nb and Ta-based compounds) doped with nitrogen dopant were successfully prepared. The resultant nitrogen doped niobate and tantalate compounds exhibit intriguing visible light absorption.. More importantly, the enhanced visible light absorption is originated from the band-to-band activation instead of merely a commonly observed shoulder absorption. XRD, XPS, UV-vis, SEM, TEM, et al were employed to understand the photocatalysts with high band-to-band visible light absorption. To investigate their visible light photocatalytic activity, terephthalic acid as fluorescence probe was used by trapping generated $\cdot\text{OH}$ radicals under visible light illumination (420~770 nm) compared with the undoped photocatalysts.



Presenting Author: **Miss Xiaoxia Yan**
 The University of Queensland

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 Australia

Effect of Aging Treatment on the Transformation and Mechanical Behaviour of Ti-50.9at.%Ni Alloy

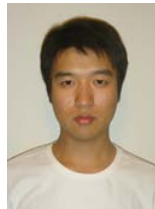
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NiTi is an advanced functional material used in a wide range of innovative applications in medicine, engineering and consumer goods products. This study investigated the effect of ageing treatment on the transformation and mechanical behaviour of a Ti-50.9 at.%Ni alloy. Ageing at 473-873 K was found to induce several different transformation sequences, including (I) $A \rightarrow M_0$, (II) $A \rightarrow R$, (III) $A \rightarrow R \rightarrow M_1$, (IV) $A \rightarrow R \rightarrow M_1$ and $A \rightarrow M_2$, and (V) $A \rightarrow M_2$. Ageing at below 573 K was found to suppress the original $A \rightarrow M$ transformation. This effect is ascribed to the lowering of B2 ordering of the matrix caused by the formation of GP zones as a pre-phenomenon for precipitation. Ageing at between 573-813 K resulted in complex multiple-stream transformations. These complex transformation behaviours are attributed to long-range heterogeneity of precipitation structure between grain boundaries and grain interior, and short-range heterogeneity caused by partial dissolution of coherent precipitates and formation of incoherent precipitates. Meanwhile, the alloy ageing between 673 and 833 K, exhibits pseudoelasticity within a certainly temperature window or stress window. This window narrows with increasing ageing temperature between 673 K and 833 K, with the sample aged at 673 K for 3.6 ks exhibiting the maximum temperature window of ~40 K for pseudoelasticity. Based on the tensile experimental results, mechanically induced transformation sequence is different from the thermally induced transformation sequence, implying that mechanical behaviour of the alloy cannot be predicted from the knowledge of the thermally induced transformations base don the Clausius-Clapeyron correlation between stress and temperature. Ageing at above 833 K led to a single-stage $A \rightarrow M$ transformation, which indicates total dissolution of coherent Ti_3Ni_4 .



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Research Activities:
Shape memory alloys: Effect of Aging Treatment on the Transformation and Mechanical Behaviour and transformation characterism of TiNi Alloy

Morphology Evolution of Silver/Carbon Hybrid Nanomaterials Synthesized via Hydrothermal Technique

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This study investigated the synthesis of silver/carbon hybrid nanomaterials by using a hydrothermal technique. The hydrothermal process uses silver nitrate (AgNO_3) as the precursor material and starch as a reducing agent to cause reduction reaction of silver at elevated temperatures. The morphology of the solid Ag formed is found to be sensitive to starch concentration. At low starch/ AgNO_3 molar ratios of 0.3~1.2, silver is formed in predominantly equiaxial morphologies of quasi spherical nanoparticles and shaped microcrystals, e.g., pyramids, cubes and hexagons. On the other hand, at high starch/ AgNO_3 molar ratios of 2.4~5, Ag is formed in dominantly anisotropic shapes of nanocables with small amount of bundle-like structures. In these samples, large number of carbon spheres are also formed apparently related to the excess carbon in the system. The optimum precursor molar ratio to impede the formation of free carbon spheres is estimated to be 1.2. Starch, a polysaccharide, undergoes hydrothermal hydrolysis in an autoclave to produce glucose. During the hydrothermal process, silver reduction and glucose carbonization occurred simultaneously, leading to the formation of silver core - carbon shell hybrid materials and free carbon spheres when excess of starch is present. X-ray diffraction analysis confirmed the metal phase formed is pure Ag in fcc structure.

Keywords: hydrothermal synthesis, nanoparticles, nanomaterials, nanocables, starch, silver



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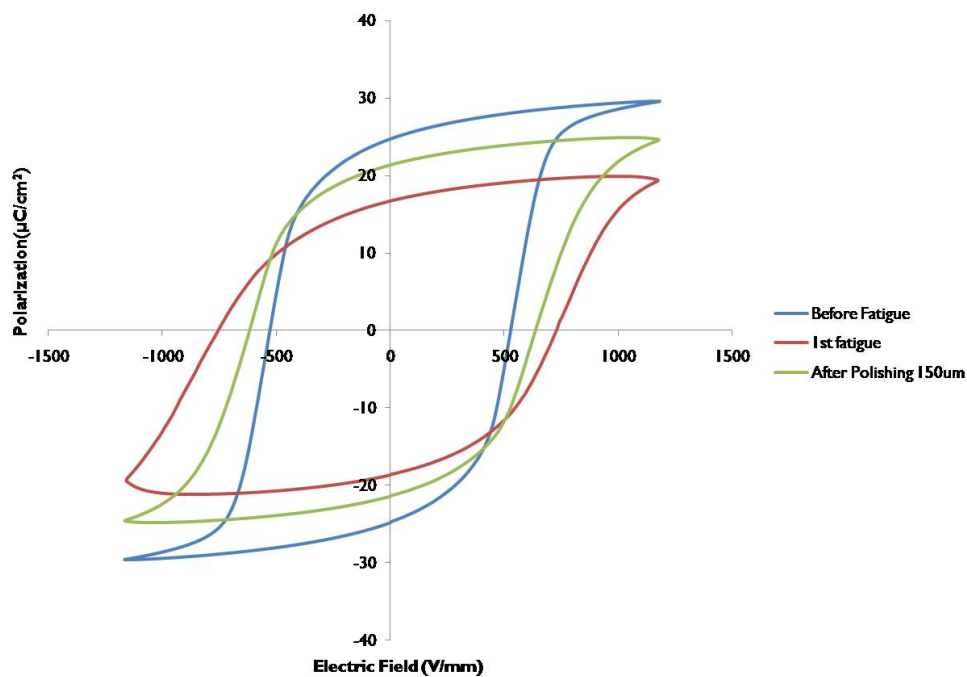
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Research Activities:
Nanotechnology, Nanomaterials

Damaged near electrode regions in Lead Zirconate Titanate (PZT) induced by electric fatigue

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Cyclic electric loading on Lead Zirconate Titanate (PZT) leads to electric fatigue of the material. The changes in near electrode regions of PZT in the course of electric fatigue are investigated. It is found that those regions attributed significantly to the loss of ferroelectricity after electric fatigue. By removing near electrode regions, the loss of polarization can be restored. The characteristics of those regions are observed to be changed significantly compared to the bulk, including generation of microcrack, loss of domain structure, chemical segregation and possible phase changes. Those changes of microscopic properties in near electrode regions affect the macroscopic behaviours of PZT materials, such as decrease of polarization and increase of coercive field. The damaged near electrode regions are believed to cause most of the polarization loss during electric fatigue, as the effective electric field applied on the PZT bulk is reduced by the screening from damaged regions. The results indicate the importance of near electrode region attributed to the ferroelectric behaviours of PZT, and further improve the understanding of the causes in electric fatigue of PZT. The study on the damage mechanism in near electrode regions provides potentials in preventing electric fatigue of ferroelectric material.



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Fatigue of Lead Zirconate Titanate



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