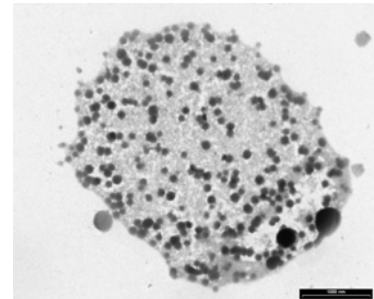
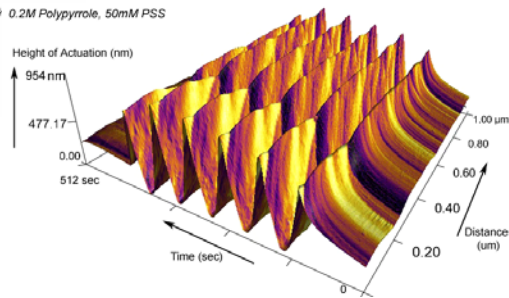
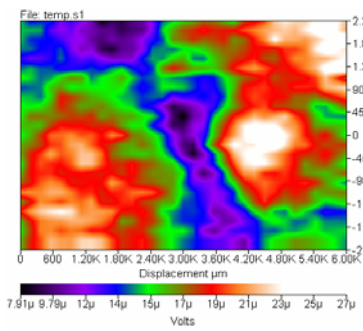
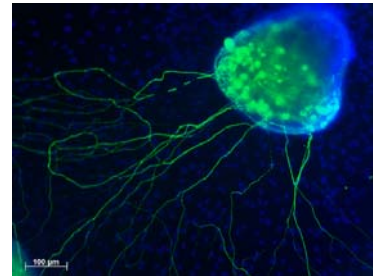
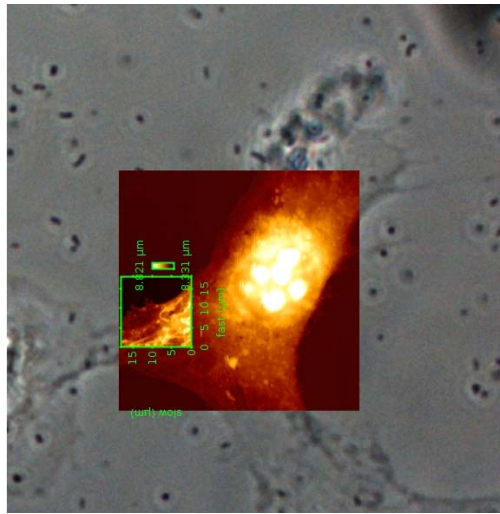
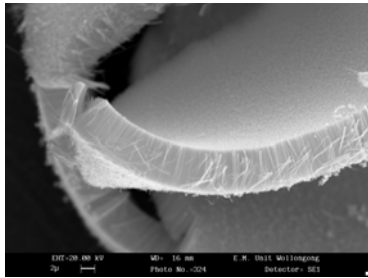


ACES Characterisation Facilities



ARC Centre of Excellence for
Electromaterials
Science

ACES Characterisation and Instrumentation Facilities

The purpose of this booklet is to raise awareness in the scientific community of the materials characterisation facilities available through users via ACES.

The equipment is located at:

University of Wollongong (A/Prof Peter Innis, innis@uow.edu.au, 02 4221 3600)
Monash (Patrick Howlett, Patrick.Howlett@eng.monash.edu.au, 03 9905 3247)
St Vincent's Hospital (A/Prof Rob Kapsa, rkapsa@bionicear.org, 03 9288 3341)

For general enquiries please contact A/Prof Peter Innis (Coordinator Characterisation Facilities and Training @ ACES).

For specific enquiries regarding specialist equipment a direct contact person has been listed.

An ACES training/workshop schedule is provided for 2008.

We look forward to working with you in utilising these world class facilities.

ACES
2008 Characterisation Training & Workshop Schedules

1. NMR Workshop : Solid State NMR and Diffusion

Training: Jenny Pringle, Andrew Whittaker, Maria Forsyth etc.

Date: February 19th 2008

Venue: Monash University

Contact: Maria Forsyth

Ph: (03) 9905 4939

2. Modelling

Training: Ekaterina Izgorodina, Mike Kuiper, Gursel Alisi, Keith Gordon

Date: 14th May 2008

Venue: Monash University

Contact: Ekaterina Izgorodina

Ph: (03) 9902 8639

3. Battery Fabrication and Testing

Training: Hua Liu etc.

Date: July 25th 2008

Venue: Wollongong University

Contact: Hua Liu

Ph: (02) 4221 4547

4. AFM Workshop

Training: Michael Higgins

Date: August 29th 2008

Venue: Wollongong University

Contact: Michael Higgins

Ph: (02) 4221 4872

5. ESR and EC ESR

Training: Peter Innis, Phil Barker (BlueScope)

Date: October 13th 2008

Venue: Wollongong University

Contact: Peter Innis

Ph: (02) 4221 3600

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Synthesis/Materials Characterisation Equipment

Instrument (Primary trainer, back-up trainer)

<http://www.uow.edu.au/science/research/ipri/equipment/index.html>

<http://www.chem.monash.edu.au/ionicliquids/equipment/index.html>

http://www.electromaterials.edu.au/Resources/BEI_stvincents.pdf

<http://www.uow.edu.au/eng/research/ISEM/equipment.html>

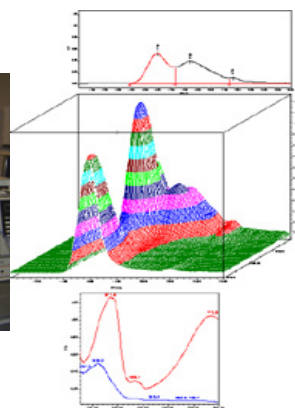
IPRI

<http://www.uow.edu.au/science/research/ipri/equipment/index.html>

Compositional Tools

Aqueous Gel Permeation Chromatography (GPC).

This system is available for determining the molecular weight distributions of water soluble polymers and macromolecular bimolecular systems. The system includes a Water Millennium 2000 quaternary pump HPLC system (10 mL/min maximum flow rate). Typical separation columns are dedicated Waters Ultrahydrogel columns for molecular weight determination and fractionation from 100 to 1,000,000 Da of water soluble polymers and biopolymers (cationic). Available detectors include RI, PDA, RALLS & capability of running two additional OEM detectors. It is highly recommended that users provide their own columns for their specific application due to incompatibility issues with different anionic/cationic polymer systems.

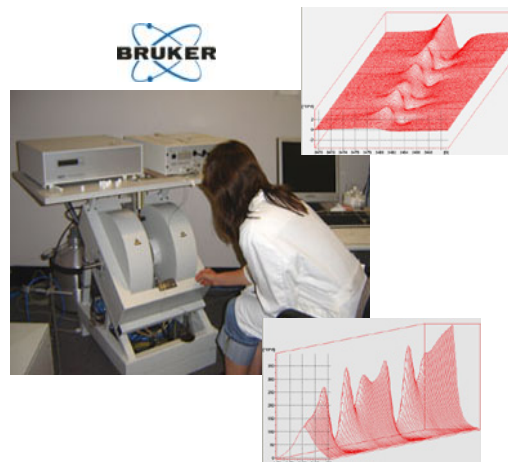


Peter Innis, innis@uow.edu.au, 4221 3600
Syed Ashraf, syed@uow.edu.au, 4221 5209

Structural / Physical Property Tools

Electrochemical Electron Spin Resonance Spectrometry (ESR).

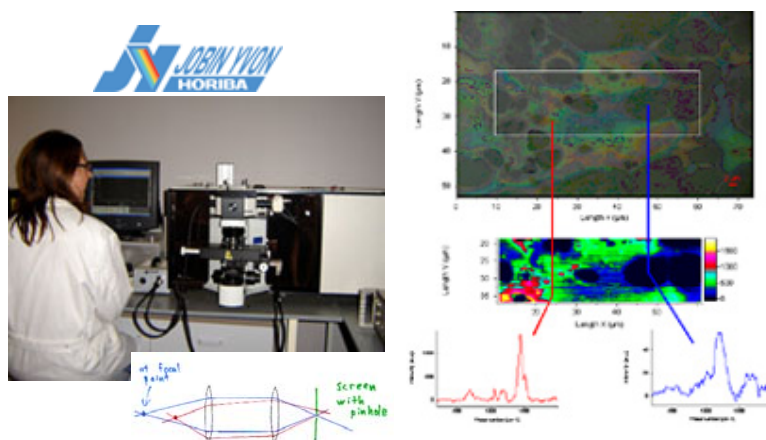
The Bruker EMX ESR (X-band) spectrometer is capable of detecting the presence of free radicals and non-spin paired electrons. The system has a 10cm 4.5T magnet, 9.8 GHz microwave bridge and cryostat (90 – 298K). The sample resonator is equipped with a photo illumination grid (suitable for photochemical investigations), an aqua-X flow cell for reproducible “lossy” solution based samples and an electrochemical flat-cell to probe the redox state of the materials under investigation.



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Raman (Electrochemical stage)

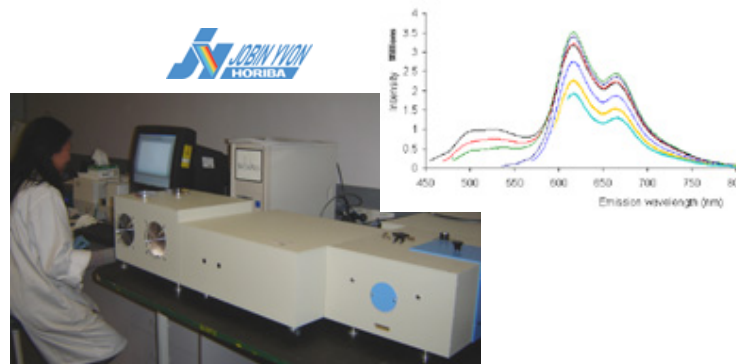
Raman spectroscopy can be carried out on the JY HR800 dispersive Raman spectrometer which currently has two excitation lines at 632.8 and 784.7nm (with an additional line at 1064nm to be added by mid 2008). The system is equipped with a confocal microscope with x10, x50, x100 standard objectives and x50 and x100 long distance objectives for electrochemical investigations. An automated x-y stage with automatic z-focus permits mapping and depth profile studies of surfaces that can be superimposed upon the optical image obtained via the microscope. Electroactive materials can also be studied via the use of a customized electrochemical stage.



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Fluorimeter

The JY Spex Fluorolog 22 is research grade fluorescence spectrometer with a double dispersion grating on the optics for the excitation light source and emission light providing excellent signal to noise, and 0.5nm band-pass, thereby permitting study of weakly fluorescent materials. The spectrometer is also capable of measuring solid state samples via a reflection attachment or an inbuilt front face optics system.



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Zeta Sizer Nano - Malvern

The ZetaSizer Nano series can perform a combination of three of the most important parameters for the colloid and polymer chemist, particle size analysis, zeta potential measurement, and molecular weight measurement.

Particle size analysis - enables measurements of particles and molecules from 0.6nm to 3 microns.

Zeta potential - enables accurate measurements of zeta potential in aqueous and non-aqueous dispersions.

Molecular weight - absolute molecular weight determination.

The Malvern ZetaSizer measures solution based nano particles from 0.6 to 3,000nm using a back scatter photon correlation spectroscopy



(173°) which permits analysis of highly coloured and opaque samples that would otherwise be impossible to measure at 90°. The advantage of this system is that “real” world samples can be analysed without the need for dilution which can affect particle size and aggregation.

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Scanning Vibrating Electrochemical Technique (SVET) and Localised Electrochemical Impedance spectroscopy (LEIS)

The Scanning Vibrating Probe (SVP) and Localised electrochemical Impedance Spectroscopy (LEIS) techniques operate with a non-intrusive scanning probe measuring and mapping the electric field generated above the surface of an electrochemically active sample.

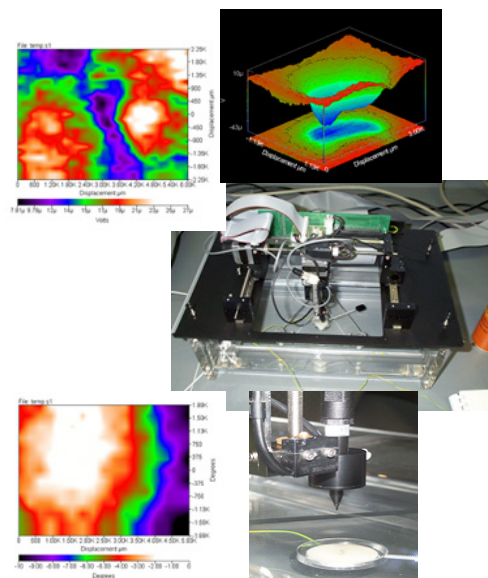
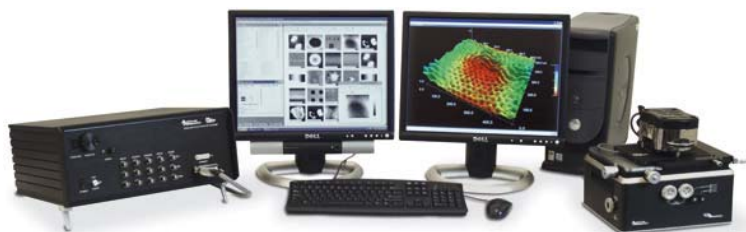
The SVET provides imaging of localised electrochemical events of less than $5\mu A/cm^2$. The probe vibration is controlled by a piezo-ceramic displacement device allowing vibration amplitudes from 1-60 μm (perpendicular to the sample surface). It is a pseudo AC technique, thus, high system sensitivity can be achieved via a differential electrometer in conjunction with a lock-in amplifier.

The LEIS allows spatially resolved impedance measurements to be made, combining established principles of EIS measurements with scanning probe technology similar to the SVET. The principles of LEIS are similar to bulk EIS, where a small electrochemical probe is scanned close to the surface while an AC potential or current is applied to the substrate and the resultant local respective AC current/potential response is measured the in the electrolyte by the microprobe.

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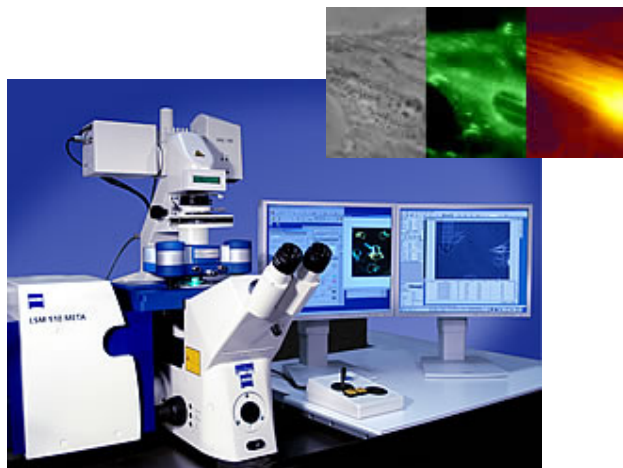
Atomic Force Microscopy (AFM) – JPK NanoWizard(II) BioAFM & Asylum MFP 3D

The Asylum MFP-3D is a stand alone AFM system ideally suited to surface topography and nano-mechanical surface analysis of samples providing 3 dimensional measurements at the nanometer scale. The MFP-3D-SA is ideal for many applications including physics, material science, polymers, chemistry, nanolithography, bioscience, and quantitative nanoscale measurements.



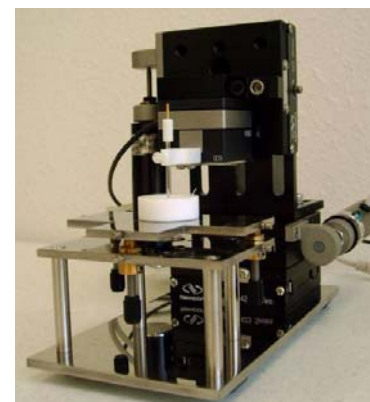
The JPK NanoWizard(II) BioAFM is a dedicated Biological AFM system which is mounted on a dedicated Nikon TE2000U Fluorescence microscope. The system is capable of imaging living biological systems, cells and interfaces overlaying with optical and fluorescence inverted microscopy images of the systems under investigation. The major advantage of this system is that living cells can be incubated and held under a controlled atmosphere within the AFM cell. The system is also capable of performing standard AFM analysis on the biological system of interest.

Michael Higgins, mhiggins@uow.edu.au, 4221 4872



Scanning Electrochemical Microscopy (SECM)- CH Instruments

SECM is based on the movement of a very small electrode (the tip) near the surface of a conductive or insulating substrate. A three-dimensional SECM image can be obtained by scanning the tip in the x-y plane and monitoring the tip. An advantage of SECM imaging is that the observed response can be interpreted in relation to theoretical models providing the capability estimate the tip-substrate distance based on the magnitude of the observed current. SECM can image the surfaces of different types of substrates, both conductors and insulators, immersed in solutions. The resolution attainable with SECM depends upon the tip radius.

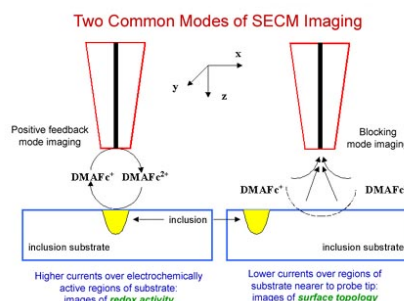


Applications

- Electrode surface studies
- Corrosion
- Biological samples
- Solid dissolution
- Liquid/liquid interfaces
- Membranes

Scanning Probe Techniques

- SECM Imaging (SECM) : constant height, constant current, potentiometric modes
- Probe Approach Curves (PAC)
- Probe Scan Curve (PSC) : amperometric, potentiometric and constant current modes
- Surface Patterned Conditioning (SPC)

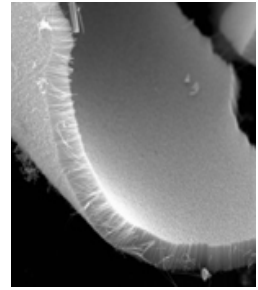


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Atomate Chemical Vapour Deposition (CVD)

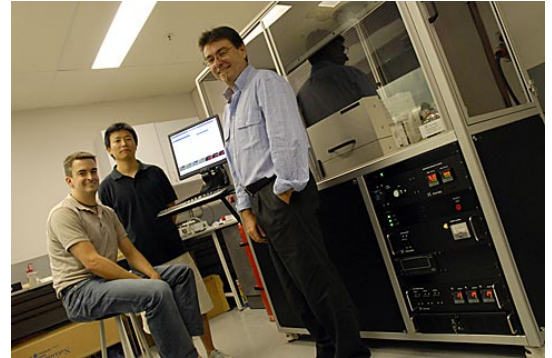
The Atomate is a fully integrated CVD system with precision computer control and state-of-the-art components, that gives excellent control and flexibility over the synthesis and growth of nanostructures. The Atomate CVD has a fully integrated 3-zone thermal CVD furnace and mass flow controllers and is suitable for most research applications that require synthesis of nanowires and nanotubes.



Specifications - Low Pressure CVD System - 50mm

- 50mm diameter x 600mm 3-zone reaction chamber
- 4 mass flow controllers [MKS brand]
- Vacuum: 10^{-3} torr max with pressure control
- Computer control and 17" LCD monitor with advanced graphical user interface software

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 Atomate

Thermogravimetric Analysis - TGA

The TGA (Thermal Gravimetric Analyser) measures the mass of a sample as it is heated at a constant rate in a controlled atmosphere. The atmosphere is typically oxidizing (eg. compressed air) or inert (eg. high purity nitrogen).

TGA is routinely used in research for measurement of:

- Thermal stability
- Composition
- Oxidative stability
- Decomposition kinetics
- Estimated lifetime
- Moisture and/or volatile contents

The specifications of the TGA at IPRI are:

- TA Instruments Q500
- 16 sample auto sampler
- 0.1 μg sensitivity
- 30 – 1000°C temperature range
- Maximum sample mass 1 g, typical sample mass 5 mg.
- 0.1 – 100°C/min heating rate range.

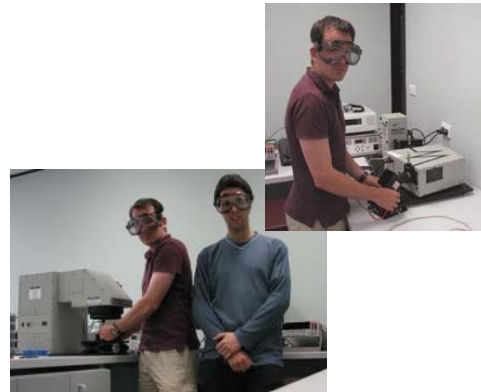


Phil Whitten, whitten@uow.edu.au, 4221 5209

Solar Simulator

The Solar Cells Characterization Facility consists of three key instruments.

i) The Solar Simulator - Current-Voltage Measurement setup uses an Oriel 1000 W Solar Simulator equipped with Air Mass (AM) 0, AM 1.5 Global or AM 1.5 Direct filters, capable of delivering up to 2.5 SUN (250 mW cm^{-2}) collimated light to a 4 inch by 4 inch area. The current voltage curves are recorded using a source-measure unit and controlled using home-built Labview software. The light output from the solar simulator is constantly monitored and regulated providing very accurate and reproducible characterization of white light power conversion efficiency of solar cells fabricated in our lab.



ii) The incident photon to collected electron (IPCE) setup gives access to the monochromatic photon to electron conversion efficiency, which is fundamental to the development of new photo-sensitizers and light absorbing polymers better matching the sun spectrum. It uses a 300 W Oriel Xe lamp and a 3-grating monochromator. The current response of the solar cells is recorded at various monochromatic wavelengths and the photon to electron conversion efficiency is calculated using a calibration standard. The output from the monochromator is focused into an optical fibre which makes the alignment and calibration a very simple and reliable process.

iii) The Step-Light Induced Measurements of Photocurrent and Photovoltage (SLIM-PC/PV) determines the electron lifetime and diffusion coefficient, two important parameters governing charge collection efficiency, in dye sensitized photo-electrochemical solar cells. by measuring the photovoltage or photocurrent decay, respectively. The output from a 630 nm laser diode is stepped down using a function generator. The resulting photo-current or photo-voltage response is recorded using a digitizing oscilloscope, and by fitting the decay curves and the diffusion coefficient and electron lifetime are calculated using a home-built Labview driver, respectively.

Attila Mozer, attila@uow.edu.au, 4221 4252

Goniometer – Data Physics

A goniometer is an instrument that either measures angles or allows an object to be rotated to a precise angular position. This tool provides a precise and reliable method for evaluating surface energy forces of surfaces and solid-liquid-air interfaces via a statistical error analysis of the drop contours of a liquid on a surface. The contact angle is the angle at which a liquid/vapor interface meets the solid surface. The contact angle is specific for any given system and is determined by the interactions across the three interfaces. Most often the concept is illustrated with a small liquid droplet resting on a flat horizontal solid surface. The shape of the droplet is determined by the Young-Laplace equation. The contact angle plays the role of a boundary condition.

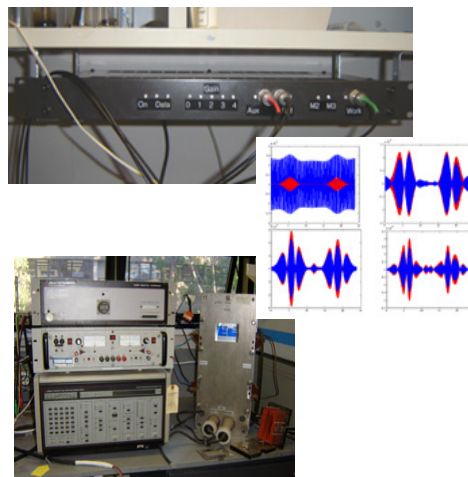


Kerry Gilmore, kerryg@uow.edu.au, 4221 5159

Other Routine Characterisation Systems

Electrochemistry

- **(Chart/echem/Scope)**
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- **Electrochemical Impedance Spectroscopy**
Simon Moulton, smoulton@uow.edu.au, 4221 5159
Peter Innis, innis@uow.edu.au, 4221 3600
- **Fourier Transform AC Voltametry**
Mark Imisides, marki@uow.edu.au, 4221 5473
Andrew Minett, aminett@uow.edu.au, 4221 3319
- **Electrochemical Quartz Crystal Microbalance**
Phil Whitten, whitten@uow.edu.au, 4221 5209
Carol Lynam, lynam@uow.edu.au, 4221 4351



UV-Visible Wavelength Spectrometer

Jakub Mazurkiewicz,
Scott McGovern, stm06@uow.edu.au, 4221 3475

Sputter Coater

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Jun Chen, junc@uow.edu.au, 4221 3781

Spin Coater

Jun Chen, junc@uow.edu.au, 4221 3781
Jakub Mazurkiewicz), jakub@uow.edu.au, 4221 3685

Circular Dichroism

Leon Kane-Maguire, leon_kane-maguire@uow.edu.au, 4221 3559
Peter Innis, innis@uow.edu.au, 4221 3600

Battery Testing

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Jun Chen, junc@uow.edu.au, 4221 3781

Viscometer

Binbin Xi, binbin@uow.edu.au, 4221 3475
Scott McGovern, stm06@uow.edu.au, 4221 3475

Actuator Dual Lever System

Binbin Xi, binbin@uow.edu.au, 4221 3475
Richard Wu, yanzhe@uow.edu.au, 4221 3478

Snow Cleaner

Attila Mozer, attila@uow.edu.au, 4221 4252

Sonicators (x3)

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Simon Molton, smoulton@uow.edu.au, 4221 5159

Karl Fisher

Jakub Mazurkiewicz, jakub@uow.edu.au, 4221 3685

Glove Boxes

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Smart Motor

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Peter Innis, innis@uow.edu.au, 4221 3600

Electrospinning

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Lui Yong, y1160@uow.edu.au, 4221 3782

UV-vis

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ISEM

<http://www.uow.edu.au/eng/research/ISEM/equipment.html>

Materials Processing

Muffle and tube furnaces

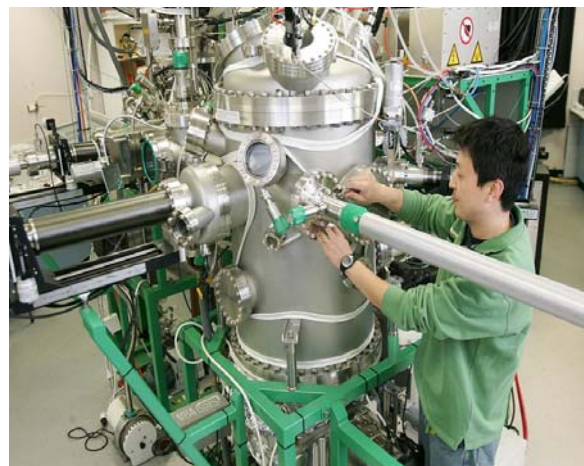
Our large variety of tube and muffle furnaces are designed to bring the best possible outcomes in sample preparation. We have designated three zone furnaces for thin film processing and metal-organic chemical deposition. Our high temperature furnaces can reach up to 1600 °C allowing us to prepare phases and materials that are difficult to form under normal conditions. For superconducting materials, we have designed and are operating furnaces with vacuum caps. We are also utilizing a set of vacuum dry ovens for intermediate sample preparation, which is crucial for processing of materials used in batteries.



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Ultra high vacuum electron beam evaporation (EBE) and DC magnetron sputtering system

The ultra high vacuum electron beam evaporation unit combined with DC magnetron sputtering is state-of-the-art equipment for the preparation of thin film samples. Ultra high-vacuum, reaching 10^{-11} Torr ensures highest possible safety against contamination during deposition. The EBE can be used for deposition of both ceramic and metallic samples. The availability of 4 deposition pockets provides opportunity to fabricate multilayered samples without any delay. The single crystal analyzer gives precise information on the deposition rates and thickness of the samples. The DC magnetron sputtering system can produce large scale thin film samples for industrial applications.



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A. V. Pan, pan@uow.edu.au, 4221 4729

Ultra high vacuum pulsed laser deposition system (PLD)

Ultra high vacuum (UHV) multi-purpose pulsed laser deposition (PLD) chamber with an incorporated ion gun for ion-beam assisted deposition (IBAD) and a possibility to carry out inclined substrate deposition (ISD) process. It is also equipped with a multi-target holder and large rotating substrate/sample heater/holder. The control instrument rack for automated control of the PLD chamber is situated next to it. The inbuilt system for rotation of the targets ensures easy and straightforward exchange between targets. Ultra high vacuum, up to 10^{-9} Torr, helps to avoid any contamination of the deposition chamber, which is very important for preparation of high quality samples. Recently we have also purchased a second PLD system, meaning that more samples can be made and the waiting list can be shortened.



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Planetary ball milling facility

Our new planetary ball milling facility can be used for pharmaceuticals, mechanical alloying, metallurgy, ceramics, materials research, geology and mineralogy, chemistry, biology. The grinding bowls sunk into the disc make revolutionary rotation speeds of up to 1100 rpm possible. This allows the PULVERISETTE 7 to achieve sensational centrifugal accelerations up to 95 times Earth gravity. The resulting energy application is roughly 150% greater than classic planetary mills. The result: significantly shorter milling processes and fineness levels down to the nano range. The practical advantage: Work more efficiently by preparing more samples in the same amount of time.



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Structural / Physical Property Tools

X-ray diffraction equipment (GBC Scientific, MAC Science, Philips)

ISEM has acquired a range of x-ray diffraction facilities for fast and precise control of sample quality. These three diffraction systems can be utilized to analyze bulk, thin film and single crystal samples. The newest product from GBC Scientific is very efficient as it has a special design, which enables us to switch between analysis of bulk and thin film samples in no time. All equipment contains safety locks and safeguards making them safe and easy to operate.



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Scanning Electron Microscope with EDS function

The JEOL SEM/EBL is a high-performance, scanning electron microscope with a high resolution of 3.0nm. Its asynchronous five-axis mechanically eucentric stage with compeucentric rotation and tilt can accommodate a specimen of up to 8-inches in diameter (12-inches loadable). Standard automated features include Auto Focus/Auto Stigmator, Auto Gun (saturation, bias and alignment), and Automatic Contrast and Brightness. The EDS option provides powerful tool to analyse the elemental composition of the samples with point analysis, mapping and other features.



The features include:

Fast, unattended data acquisition, smart settings for common samples, streamlined design, Compact footprint, customized toolbars for repetitive functions, enhanced SE imaging, super conical lens, can be field upgraded for Low Vacuum, large specimen chamber.

K. Konstantinov, innis@uow.edu.au, 4221 5765

Inductively Coupled Plasma (ICP-OES) spectrometer

The Varian made ICP-OES system is highly accurate to determine chemical composition of samples.

The Vista-MPX is ideal for environmental, chemical and industrial laboratories, offering a host of benefits including:

The productivity of simultaneous measurement of all elements from parts per billion to percent levels with the



unique megapixel CCD array detector. Simple 'one step' analysis that saves you time and argon costs. The optimized plasma viewing systems of the Vista-MPX means that, unlike dual view systems, you don't have to analyse the sample twice. Rapid instrument set-up, operator training and method development from our powerful ICP-Expert™ software which is versatile and easy to learn. Fast optimization and hands-free operation, from full PC control of all instrument parameters. Confidence to analyse any sample type with Varian's robust free running 40 MHz RF generators; the highest reliability from no moving parts optics and RF generator designs.

K. Konstantinov, konstan@uow.edu.au, 4221 5765

Sample density analysis - pycnometer

To analyze density of our samples, which is crucial for battery and superconducting materials, recently, we have purchased high quality pycnometer. This is an ultimate instrument for measuring the true volume and density of powders, foams and bulk solids.

The Pentapycnometer permits up to five samples to be loaded and then purged simultaneously. Each of the five samples is then automatically analyzed in sequence with no operator involvement. Adjustable flow rates for each cell provide maximum flexibility of operation.



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Physical Property Measurement System (PPMS)

The Quantum Design PPMS represents a unique concept in laboratory equipment: an open architecture, variable temperature-field system, designed to perform a variety of automated measurements. Sample environment controls include fields up to ± 16 Tesla and temperature range of 1.9 - 400 K.

Features include:

Sealed sample chamber with 2.6 cm diameter sample access; novel sample mounts couple easily to the 12 electrical leads built into the cryostat insert; the Model 6000 is a self contained microprocessor-controlled device, eliminating the need to use or purchase external bridges, continuous Low-Temperature Control - maintains temperature below 4.2 K for indefinite periods of time and offers smooth temperature transitions when warming and cooling through the 4.2 K



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Magnetic Property Measurement System



Utilizing Superconducting Quantum Interference Device (SQUID) technology, combined with patented enhancements, the MPMS-XL sample magnetometer achieves superior measurement sensitivity, dynamic range, and reproducibility otherwise unattainable.

The MPMS-XL provides solutions for a unique class of sensitive magnetic measurements in key areas such as high-temperature superconductivity, biochemistry, and magnetic recording media.

The modular MPMS design integrates a SQUID detection system, a precision temperature control unit residing in the bore of a high-field superconducting magnet, and a

sophisticated computer operating system. The unit can measure magnetic properties in a temperature range from 5 to 340 K and applied magnetic field in a range of ± 5 T. The sensitivity of the equipment is staggering – 10^{-8} Oe at 0 T.

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B.

Thermogravimetric Analysis – TGA/DSC

The heart of a TGA is the balance cell. This TGA instrument uses the world's best micro and ultra-micro balances. By using one of the three removable sensor types the TGA/DSC1 simultaneously measures heat flow in addition to weight change. Thanks to its modular design, the TGA/DSC1 is the ideal instrument for manual or automated operation in production and quality assurance through to research and development.

TGA is routinely used in research for measurement of: Thermal stability, composition, oxidative stability, decomposition kinetics, estimated lifetime, moisture and/or volatile contents

Specifications - Thermogravimetric Analyzer
TGA/DSC1:

Temperature range: RT ... 1100 °C or 1600 °C

Heating: RT ... 1000 °C 2°C/min

Cooling: 1100 ... 60 °C 8.8°C/min



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Other Routine Characterisation Systems

Electrochemistry

- **Cyclic Voltammograph, BAS CV-27**

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G. X. Wang, gwang@uow.edu.au, 4221 5726

- **Impedance Analyser, M6310**
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G. X. Wang, gwang@uow.edu.au, 4221 5726
- **Four Channels Data Collection System, MacLab/4e**
Z. P. Guo, zguo@uow.edu.au, 4221 5727
J. Z. Wang, jjazhao@uow.edu.au, 4221 5722
- **Scanning Potentiostat, M362; Potentiostat, M363**
G. X. Wang, gwang@uow.edu.au, 4221 5726
Z. P. Guo, zguo@uow.edu.au, 4221 5727
- **CHI 660B Electrochemical Workstation**
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G. X. Wang, gwang@uow.edu.au, 4221 5726
- **Arbin MSTAT8000 Electrochemical Workstation**
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Z. P. Guo, zguo@uow.edu.au, 4221 5727
- **Automatic PCT Measuring System**
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UV-Visible Wavelength Spectrometer

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Dip Coater

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Spin Coater

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Ferroelectric, dielectric constant measurements

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Battery Testing

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Profilometer

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Particle Size Analyzer

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Spray-dry pyrolysis

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Multi-purpose wire bonder

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Magneto-optical imaging

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Glove Boxes

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Terahertz facilities

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Wire drawing facilities

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Monash

<http://www.chem.monash.edu.au/ionicliquids/equipment/>

Electrochemical Impedance Spectroscopy (EIS),

HP 4284A & Solartron DI 1296

The electronic properties of a system can be defined in terms of its ability to store and transfer charge (i.e. its capacitance and conductance). The use of electrochemical impedance spectroscopy (EIS) records the response of the system to a small applied perturbation (i.e. AC signal), over a pre-determined frequency range. The applied AC voltage and the resultant AC current are measured and the impedance calculated ($Z^* = V / I$). The technique is non-destructive and is particularly sensitive to small changes in the system.

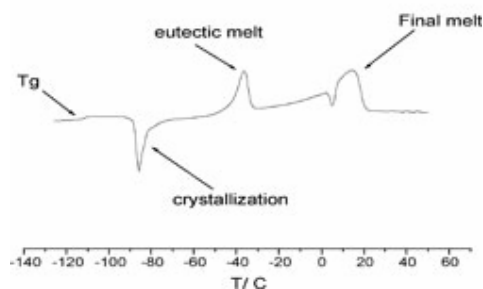


of

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Differential Scanning Calorimetry (DSC), Perkin Elmer

Differential scanning calorimetry is a thermal analytical technique in which the differences in heat flow (energy) into a substance and reference are measured as a function of temperature while the two are subjected to a controlled temperature program.



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Ion Selective Electrodes (ISE) Cl-, I- & Br-

An Ion-selective electrode (ISE) is a transducer (sensor) which converts the activity of a specific ion dissolved in a solution into an electrical potential which can be measured by a voltmeter or pH meter. The voltage is theoretically dependent on the logarithm of the ionic activity, according to the Nernst equation.

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Differential Scanning Calorimetry (DSC), TA

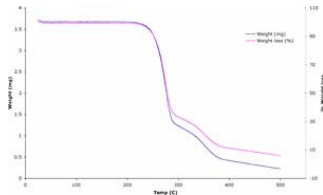
In addition, Monash has available a TA DSC for studying thermal events.

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Thermogravimetric Analysis (TGA)

TGA is a thermal analytical technique in which the mass of a sample in a controlled atmosphere is continuously recorded as a function of temperature for a controlled temperature program.



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Densitometer DMA 5000

Density is the relationship "mass per unit volume" of a substance. The most commonly derived reading from density is specific gravity, which, though dependent on temperature and reference material, can be loosely defined as the measured density divided by the density of water. Various concentrations can be calculated from the density and specific gravity.



The MacFarlane group have recently purchased an Anton Parr DMA5000 series density meter. This instrument allows you to measure in the temp range of 10-90oC and is fully automated

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Viscometer, Anton Paar

Viscosity is the degree to which a fluid resists flow under an applied force. It describes the internal friction of a moving fluid.

The MacFarlane group have recently purchased a high quality viscosity meter. The AMVn supplied by Anton Parr determines the dynamic and kinematic viscosity of transparent and opaque liquids fully automatically. It is based on the rolling/falling ball principle (DIN 53015 and ISO 12058) and ideal for the measurement of low viscosity substances.

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Karl Fischer, MEP

Karl Fischer titration is a widely used analytical method for quantifying water content in a variety of products. The fundamental principle behind it is based on the Bunsen reaction between iodine and sulfur dioxide in an aqueous medium. Karl Fischer discovered that this reaction could be modified to be used for the determination of water in a non-aqueous system containing an excess of sulfur dioxide. He used a primary alcohol (methanol) as the solvent, and a base (pyridine) as the buffering agent.

How does it work?

Water and iodine are consumed in a 1:1 ratio in the above reaction. Once all of the water present is consumed, the presence of excess iodine is detected voltametrically by the titrator's indicator electrode. That signals the end-point of the titration. The amount of water present in the sample is calculated based on the concentration of iodine in the Karl Fisher titrating reagent (i.e., titer) and the amount of Karl Fisher reagent consumed in the titration.

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Solid State/Diffusion NMR, Bruker

Solid state Nuclear Magnetic Resonance Spectroscopy (NMR) is a technique that allows study of certain elements, such as Carbon, Fluorine, Phosphorus and Silicon, within solid materials. The material is placed in a small rotor and spun inside the magnetic field of the spectrometer, and this technique can then be used to get structural information about the solid material relating to the element being studied e.g. the different types of carbon species present.

This technique is extremely valuable for getting structural information for solid samples. For example we can study samples such as polymers, cement, functionalized nanoparticles, inorganic or organic materials.

The NMR at Monash also has a diffusion probe. Diffusion NMR is a very valuable but rare technique that allows measurement of the diffusion rate of ions with samples. For example, we can measure the diffusion rate of lithium ions in materials such as ionic liquids or plastic crystals.

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Quartz Crystal Microbalance

The QCM allows measurements of changes of mass the 10ng range on thin films. The QCM is connected the VMP Potentiostat making it possible to measure weight changes under changing electrochemical conditions.

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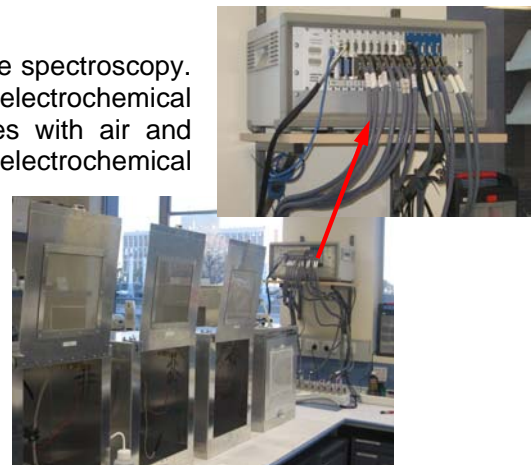
in
to

VMP2/Z multichannel Potentiostat , PAR

The VMP is a 14-channel potentiostat with build-in impedance spectroscopy. The equipment is a general tool for corrosion and electrochemical experiments. 12 channels are equipped with faraday cages with air and nitrogen supply, one channel is reserved for a Microcapillary electrochemical cell set-up and one channel is connected to the Ar drybox.

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Argon Electrochemical Drybox.

Features oxygen, water and nitrogen free environment especially suitable for handling reactive metals (e.g. lithium) and ionic liquids. The drybox is connected to a channel from the VMP allowing electrochemical tests inside the drybox.

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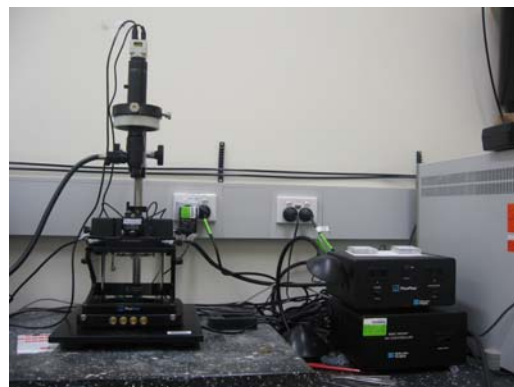


AFM, Molecular Imaging

The Atomic Force Microscope (AFM) uses the interactions between a tip and a sample to be imaged to create a topographic illustration of the surface of the sample. Gives an accurate height measurement of the surface features, with a resolution in the nm range. Excellent for imaging organic compounds on inorganic substrates.

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FTIR microscope

Standard FTIR facility extended with a FTIR Microscope and single reflection ATR. The FTIR Microscope allows measurements on areas in the 100 μm^2 range and with the ATR measurements on thin-films down to 100nm is possible.

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4-point Conductivity Probe, Jandel

The four point conductivity probe allows the conductivity or resistivity of solid samples to be determined. There are four tips, with the probes arranged in either a square or linear array. This apparatus is ideal for measuring the conductivity of small solid samples, powders pressed into pellets, or materials coated onto substrates e.g. conducting polymers coated onto plastic.

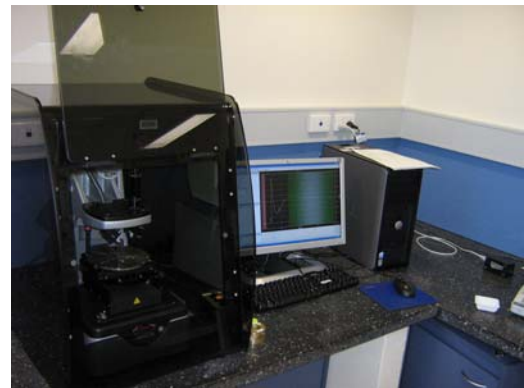
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Profilometer Veeco 150

The 150 is able to give very detailed information about the profile of a materials surface, allowing thickness measurements down to several nanometers to be easily obtained. The stated resolution of this machine is 6Å. It can accommodate samples with overall dimensions of up to 150mm in diameter and 100mm thick. The stylus system will provide a good response at forces as low as 1mg. This equipment is user friendly and can be learnt in a short space of time.

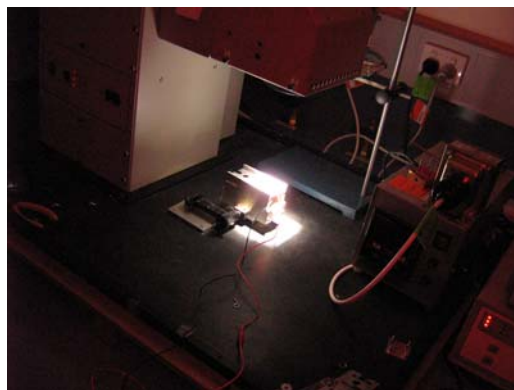
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Sun Simulator, Oriel

The solar simulator testing equipment at Monash is based around an Oriel sun simulator with a 1000W Xe source and an AM1.5 filter. This is connected to a Keithly 2400 source meter, controlled by 'home brew' code written in lab view. The set up includes a filter wheel in order to test at different light intensities, as well as a heating block for elevated temperature testing. Testing software includes I-V curve measurements, decay testing and stability testing.

Our IPCE (incident photon to electron conversion efficiency) set up is based on a spectra physics monochromator, connected to another Keithly, once again run on 'home brew' code in labview software, and can be used for tests ranging from 330 up to 1000nm.



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Nitrogen Gloveboxes

Storage , Handling of moisture or air sensitive compounds. Used for preparation of ionic liquids.



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Microcapillary electrochemical cell

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Con-focal Microscope, Leica



St Vincent's Hospital/Bionic Ear Institute

http://www.electromaterials.edu.au/Resources/BEI_stvincents.pdf

arrayWoRx and Codelink Gene Chip Microarray Expression System

Microarray analysis allows detection and measurement of gene activation in response to environmental stimuli. The Codelink 60k system that we use simultaneously measures the expression status of 60,000 gene sequences, which represents the entire known genome. The process involves exposure of cells/tissues to specific conditions (eg polymers), extracting and labelling the mRNA from the cells, and hybridising the labelled probe nucleic acid to oligonucleotide sequences representative of all of the genes in the cells and arranged in spots of 3um in diameter on a microscope slide. After development, the slide is read through a arrayWoRx slide scanner which collects the data and facilitates processing via software to establish which genes' expression had been primarily involved in the cells' response to the conditions imposed on the cells. This technology can be used to "ask" cells what they "think" of any particular stimulus, and to tailor environments to achieve specific molecular responses in cells. This analysis can be performed on even a single cell.

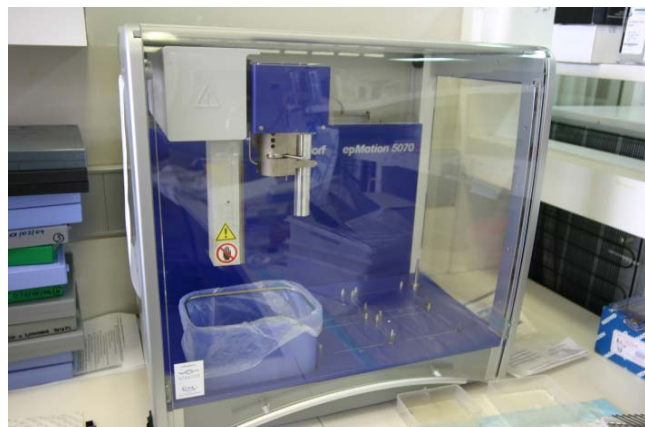
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Eppendorf epMotion-5070 Automated Liquid Handling

The EP5070 liquid handler allows the rapid and error-free preparation of high throughput, high volume experiments that require the dispensation of small volumes of reagents (ul to ml). The EP5070 also facilitates the production of 300 spot arrays (on nitrocellulose) containing cloned DNA of specific genes that may be of interest in measuring or defining specific cellular phenotypic characteristics. As such, the EP5070 complements our gene expression analysis activities by providing an inexpensive way to evaluate the response (via 300 genes) of cells to contact with specific environmental factors.

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Realplex⁴ epGradient-S Real Time PCR Thermal Cycler

The epGradient-S RT-PCR thermal cycler allows accurate quantification of small amounts of nucleic acid (DNA or RNA) by using the nucleic acid amplification capacity of the Polymerase Chain Reaction (2^n copies of template where n = number of cycles). The process works by incorporation of a fluorescent probe into the reaction whilst the DNA is being amplified by PCR. The fluor is either incorporated into the amplified DNA product or is "chased off" the template nucleic acid by the thermostable polymerase as it tracks along the template NA during amplification. The fluorescent signal is then recorded and graphed in real time to provide accurate data relating to the amount of template DNA or RNA that is present in the reaction mixture.



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Histology and Immunohistology facilities

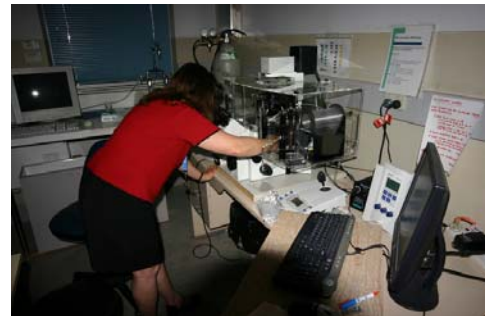
Full histology facilities enable the cutting (frozen or paraffin-embedded) of sections, fixation of tissues and immunohistochemical, histochemical and biochemical staining.



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Olympus IX70 Fluorescence Microscope:

The Olympus IX70 inverted microscope is equipped with full fluorescence capability for the visualization of fluorescently-labelled probes on cells and tissues. The system facilitates Vis-spectrum light microscopy to be done on cell cultures in a thermal-controlled humidifier chamber that facilitates continuous time-lapse photomicrography to observe cell behavior in "real time". The system is also equipped with full micro-manipulation and injection facilities via the Eppendorf femtojet microinjector system that allows the injection of proteins, nucleic acids and other substances into the cells' cytoplasm.



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Tucker-Davis Electrophysiology Stimulation and Recording Equipment

The Tucker-Davis 16 channel electrical stimulation/signalrecording system is housed in an acoustically shielded Faraday Room equipped with Stereotaxic Frames for neurosurgery in CNS and Spinal Cord (Mouse and Rat). This system allows the recording (16 channels) of electrical activity in regions of the CNS and peripheral nerves.

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