

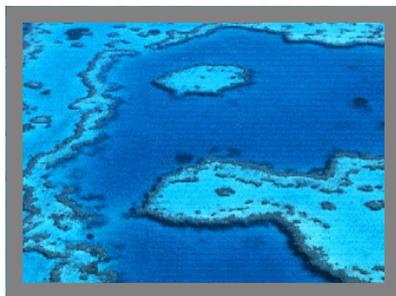


Asia Pacific Nanotechnology Forum 2nd Annual Conference

19-21 November 2003
The Hilton Cairns
Tropical Queensland
Australia

in collaboration with the
**Australian National
Nanotechnology Network**

"Oz Nano 03"



and
**International Nanotechnology
Showcasing Exhibition**





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A Message from

**The Honourable Minister Paul Lucas
Minister for Innovation and Information Economy
Queensland, Australia**



I'm delighted that Cairns is hosting this prestigious event for nanotechnology – which is an area of research that's providing the building blocks of the future.

Nanotechnology can provide us with applications such as bone tissue engineering to using to selectively separate gases such as hydrogen for use in fuel cells and environmental applications.

While we have world-class nanotechnology research and development, Queensland is also home to reefs and rainforests with unique mega-biodiversity which is also giving our science an edge.

The Queensland Government recognises the importance of nanotechnology research, and has committed up to \$20 million towards the \$60 million Australian Institute for Bioengineering and Nanotechnology at the University of Queensland.

The Honourable Minister Paul Lucas



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Note from the Asia Pacific Nanotechnology Forum Executive Director



The Asia Pacific Nanotechnology Forum evolved over a number of years from discussions with Nanotechnology Entrepreneurs and Thought Leaders in Nanotechnology in Industry, Government, and Academia. We have been approached and encouraged by many organizations across Asia Pacific, Europe, and USA to bring together major organizations and Thought Leaders in one place. With their encouragement and support, and by putting their nominated delegates in charge of helping with the formation of the Forum and organizing today's 2nd Annual APNF conference, the Asia Pacific Nanotechnology Forum has again become the center stage for Thought Leaders in Nanotechnology in Asia Pacific.

The commitment and encouragement of the following organizations, and their support in particular to nominate and send their delegates to participate in this year's conference and international Nanotechnology Showcasing Exhibition have made the Forum to one the most important Nanotechnology events in Australia in 2003:

Australian National Nanotechnology Network, Australia
Commonwealth Science & Industrial Research Organisation, Australia
National Research Council Canada, Canada
Chinese Academy of Sciences, China
Engineering Research Center of Nano Science and Technology, China
National Natural Science Foundation of China, China
European Commission, European Union
German Center of Competence in Nano-Scale Analysis, Germany
National Institute of Advanced Industrial Science and Technology, Japan
National Institute for Materials Science, Japan
MacDiarmid Institute for Advanced Materials & Nanotechnology, New Zealand
Industrial Technology Research Institute, Taiwan
National Science Council, Taiwan
National Science and Technology Development Agency, Thailand
APEC Center for Technology Foresight, Thailand
The Institute of Nanotechnology, United Kingdom
National Nanotechnology Initiative, USA
National Science Foundation, USA





My gratitude goes also to my personal friends and colleagues in government, industry, and academia who have been so supportive to make this event and Forum such an exciting gathering of Thought Leaders in Nanotechnology.

I'd like to thank the conference Executive Committee, Dr Vijoleta Braach-Maksvytis and Professor Max Lu for their initiative and strong leadership in making this event one of the most prominent international Nanotechnology events in Australia in 2003. We are proud to have had an excellent active Advisory Board, whose work will be most visible over the coming three days. I am in particular grateful to the co-organizer of APNF 2003 "Oz Nano 03", the Australian National Nanotechnology Network, who has been invaluable in bringing the many Australian research organizations together for this occasion.

The Asia Pacific Nanotechnology Forum is most grateful to the lead sponsors and their generous support throughout the preparation of this event:

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The ARC Special Research Centre for Applied Philosophy and Public Ethics (CAPPE)

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APNF 2003 "Oz Nano 03" Thought Network Sponsor

The Australian Technology Park (Innovations)

The International Nanotechnology Showcasing Exhibition at APNF 2003 "Oz Nano 03" received generous support through the Australian *Innovation Access Program* and the

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The Australian Department of Education Science & Technology

The Australian Department of Industry, Tourism, and Resources.

Dr Jurgen Schulte

Executive Director

Asia Pacific Nanotechnology Forum



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Nanotechnology in USA and an International Perspective

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Nanotechnology has opened an era of scientific convergence and technological integration with the promise of broad societal implications. The National Nanotechnology Initiative (NNI) is a long-term visionary program announced in January 2000 that coordinates 16 departments and independent agencies with a total budget of 0 million in fiscal year 2004. As government investments worldwide approach billion, expectations of nanotechnology R&D results, commercialization and other potential benefits are raised, and concerns about unexpected societal implications need to be answered to the public's satisfaction. Nanotechnology has evolved into a field of broad international interest, increasing collaboration and stimulating competition.

NNI scientific and engineering results achieved in academe and industry will be illustrated. The long-term NNI strategy for development of nanoscale science and engineering will be updated in 2004 based on the results obtained in the first three year. First, priorities are envisioned in exploratory research for nanomedicine, energy conversion, food and agriculture, realistic simulations at the nanoscale, molecular nanosystems, and improving human performance. Secondly, the transition from fundamental discoveries into technological innovation will be an area of focus in nanostructured materials, nanoelectronics, catalysts, and pharmaceuticals, development of tools. Thirdly, funding will emphasize broad societal goals such as education, health and sustainable development.



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Nanotechnology / Funding and R&D Activities in Japan

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The first part of the talk describes the R&D Policy of the Council of Science and Technology Policy, Japan (CSTP) with an emphasis on Nanotechnology, its research funding, several nanotechnology plans and projects running in METI, MEXT and other Ministries. New inter-ministry joint projects proposed towards 2004 FY are also touched upon. In the second part, recent R&D activities in National Institute of Advanced Industrial Science and Technology (AIST), METI, are presented, which will include CNT nanotechnology, spintronics, nano ink-jet technology, and MIRAI Project for LSI Road Map.



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The European Union's 6th Framework Programme : Research on Nanosciences and Nanotechnologies

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Key words: nanotechnology, nanosciences, nanotechnologies, European research, Sixth Framework Programme, international co-operation, industrial research, education, social acceptance, sustainable development

Abstract

For the past several years the European Commission (on behalf of the European Community) has supported a significant portfolio of nanosciences and nanotechnologies-related projects. Already in the 4th Framework Programme (1994 - 1998), some 80 projects involving nanotechnology were funded. In the 5th Framework Programme, (1998 - 2002) the estimated funding level rose to about 45 M€/year. The overall project portfolio is very wide in scope, encompassing for example nano-electronic devices, giant magneto-resistance, carbon nano-tubes, bio-sensors, molecular diagnostics, nano-composite materials and atomic force microscopes.

In the case of the current 6th Framework Programme (2003 - 2006), nanosciences and nanotechnologies are a priority. The role played by the Union's initiatives is of paramount importance with respect to the total public funding for nanotechnology activities in Europe. In broad terms, we can estimate the grand total for the European investment in nano-research being now of the order of almost 700M € per year. This presentation will give an outline of some of the thinking behind the current Framework Programme and its activities in the context of nanotechnologies and nanosciences.



Policy of nanotechnology in Japan

*Nanotechnology Researchers Network Center of Japan
National Institute of Materials Science (NIMS)*

Shunichi ARISAWA, Norio SHINYA and Tetsuji NODA



Today, the exotic-sounding word "nanotechnology" is fast becoming part of the common vocabulary. Both industry and science place high expectations on this technology. I believe that Australia and Japan are considered to be among the world's leaders.

In this talk, nanotechnology policy and strategy in Japan based on 5 years science & technology basic plan are introduced. The current national research programs promoted by ministries and funding agencies on nanoscience and nanotechnology are reviewed. Due to the importance of interdisciplinary alliance among researchers in different research fields, Nanotechnology Supporting Projects started and Nanotechnology Researchers Network Center, which is operated by National Institute for Materials Science (NIMS), was established. The activities toward constructing researcher and facility networks in nanotechnology are outlined.

NIMS also places the highest importance on nanotechnology. We have established Nanomaterials Laboratory as a specialized organization for nanomaterials. International Center for Young Scientists was established this year to promote interdisciplinary fields which are indispensable for nano related research. The approach of NIMS to nanotechnology and nanoscience is also reviewed.



Evaluating Nanotechnology Ethically

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What is the relationship between ethics and nanotechnology? I will begin by challenging a number of popular positions about the proper interaction between ethics and nanotechnology. The first is the nonresponsibility view which suggests that nanotechnology is value free and ethical considerations do not apply. The nanotechnologist produces items that can be used either for good or for evil, so the argument goes, and therefore the nanotechnologist cannot be held ethically responsible for his or her work. The second position is the scientific/technological moratorium view which is essentially the proposal offered by Bill Joy who suggests that we place a moratorium on frontier science and technology, such as nanotechnology, until we can understand the consequences of the enterprise. The third position is the ethical moratorium view that recommends that we first generate the technology, learn what the consequences of the new technology are, and only then open the discussion to ethical considerations. All three of these positions have some truth in them but all three are seriously misleading. I will develop a more realistic and defensible view about the relationship between ethics and nanotechnology that emphasizes a dynamic interaction between them. On this view ethics sometimes constrains what is permissible to do with nanotechnology but also raises the interesting possibility that the developments of nanotechnology, resulting in changes in human nature and culture, might ultimately impact ethical theory itself.





Synthesis and characterization of nearly monodisperse CdSe quantum dots at lower temperature

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Abstract

Colloidal semiconductor nanocrystals, also known as quantum dots (QDs), are of tremendous fundamental and technical interest due to their applications as light-emitting devices, low-threshold lasers, and biological labels. Owing to their size-dependent photoluminescence (PL) tunable across the visible spectrum, CdSe nanocrystals have become the most extensively investigated QDs. A one-pot synthesis of high-quality quantum dots of CdSe was developed using cadmium acetate as cadmium precursor. This method was proposed as an alternative to the classical organometallic route based on highly toxic, expensive, and pyrophoric dimethylcadmium. The reaction conditions are mild and simple. The structures of the CdSe QDs were determined by X-ray powder diffraction and transmission electron micrograph. UV-Vis spectroscopy and photoluminescent spectroscopy were used to follow the reaction process and to characterize the optical properties of the resultant CdSe QDs. The obtained QDs exhibited a narrow PL band with reproducible room-temperature quantum yields as high as 60%. The emission color is tunable from green to red with increasing diameter of CdSe nanocrystals. This green-chemistry approach may also be used for time-resolved, in situ study of crystallization of the quantum dots. The scheme is reproducible and simple and thus can be readily scaled up for industrial production. General aspects of the nanocrystal nucleation and growth were also discussed.

One of the significant aspects of nanoparticle-based materials is the surface modification of nanoparticles, which can be utilized as a method of variation of their optical properties and as a tool for their spatial organization. The properties of the CdSe QDs modified with organic ligands such as PVP, phosphatide, phosphatidyl choline and 2-hydroxyl-4-n-octoxide-diphenyl ketone were also investigated in this report.



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Electronic Properties of Molecules Measured with Submicron-Gap Electrodes

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Electronic properties of molecules have been studied with electrodes sandwiching bulk crystals or thin films. Scanning probe techniques using conductive probes are also used to estimate local conductivity of molecular films, i.e. self-assembled monolayers, on metals with the nano-scale resolution. We can measure current-voltage characteristics of single molecules by embedding target molecules in insulative matrix molecular films like alkane thiols. For utilizing functional molecules as a component of electronic devices, however, electrodes separated by molecular scale gaps are required.

We examined field-induced conductance change of thin organic films using the trench-type electrodes, where the gate field is applied from the sidewall of the trench. We fabricated the electrodes, and observed field effects of a conductive self-assembled film and oligothiophene thin films. The electric field generated by the electrode structure was calculated by a two-dimensional finite element method. The gate field strength becomes weaker as the film thickness is reduced, while the fields generated by the source-drain potential increase. This result denies the 'normally-off' characteristics since a small source-drain voltage between the nano-gap could cause the conductance change corresponding to the large gate voltage (Mizutani et al., Jpn. J. Appl. Phys. 42 Part 1 (7A) 4535, 2003).

Recently, we demonstrated a high yield production scheme to fabricate sub-100 nm junctions without using electron beam lithography (Naitoh et al. e-J. Surf. Sci. Nanotech. 1, 41, 2003). We confirmed that the electrodes can be successfully used to measure the conductivity of molecules. Preliminary measurements of thiolated DNAs were conducted and the results will be discussed.





Tunable solid-state lasers incorporating dye-doped, polymer-nanoparticle gain media

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Abstract

Tunable laser action, in the visible spectrum, has been established using dye-doped, polymer-silica nanoparticle gain media for the first time. The silica nanoparticles, ranging from 9 to 12 nm in diameter, appear to be uniformly dispersed in the polymethyl methacrylate (PMMA) matrix, since the optical homogeneity of the gain medium, is maintained. Using rhodamine 6G dye and 30% weight-by-weight (w/w) silica nanoparticles, laser action was established in the 567–603 nm range. At the peak wavelength (580 nm) laser conversion efficiency is $\sim 63\%$ at a beam divergence of ~ 1.9 mrad. The new solid-state gain media also exhibits a reduction in | |.



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Diamond Quantum Dots: Fabrication and Applications.

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Recently there has been increased interest in the potential use of colour centers in diamond (specifically the N-V center) to be used either as single photon sources or as qubits in a quantum computer. One group has even demonstrated single spin detection in a diamond nanocrystal. This provides a strong motivation for the development of methods for the production of arrays of quantum dots of diamond. Ion Implantation has been found to be an extremely useful and flexible method for producing quantum dots of foreign atoms in an inert host. After annealing, the implanted species can form quantum dots of sizes ranging from 1-100nm. Using this method a wide range of quantum dots have been formed (eg Si, Ge, ZnS, CdS, PdS, and GaAs). However, due to the metastability of diamond, carbon implantation followed by annealing has not been successfully employed in the past to produce diamond.

We describe experiments which demonstrate that carbon atoms introduced into a fused-silica substrate by means of MeV ion-implantation can, after suitable annealing, form nanocrystalline diamond. Unlike other methods of creating diamond, the coalescence of the carbon into diamond nanocrystals occurs when the samples are heated in a conventional furnace and does not require the application of high external pressures, or any pre-existing diamond template. Following a dose of 5×10^{16} C/cm² into fused silica and after annealing in forming gas ($\sim 4\%$ hydrogen in argon), perfect cubic diamond crystallites of 5-7 nm diameter are formed. For higher doses, the same annealing treatments produce larger crystallites which are comprised of other varieties of solid carbon phases. We conclude that diamond is the stable form of carbon provided that the crystallite size is sufficiently small (i.e. less than 7 nm) and that the nanocrystallites are appropriately surface passivated.

Using the result of MD calculations we explain why diamond, rather than graphite forms under these conditions, and we show how this technique could be used for the controlled synthesis of arrays of diamond quantum dots for potential use in a quantum computer.





Nanoceramics In Biomedical Applications

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Abstract

An improved understanding of the interactions at the nanoscale level between the bioceramics in human implants and the hard or soft tissues could contribute significantly to the design of new generation prostheses and post-operative patient management strategies. Overall, the benefits of advanced ceramic materials in biomedical applications have been universally accepted, specifically in terms of their strength, biocompatibility, hydrophilicity, and wear resistance in articulating joints. The continuous development of new generation implants utilising nanocoatings with novel nanosensors and devices are pertinent for better compatibility, and improved well being and longevity for the patients. This presentation gives a short overview of bioceramics and re-examines key-issues of concern for processing and application of nanoceramics as biomaterials.

Keywords: Nanoceramics, biomaterials, implants



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Light emission from silicon nanocrystals –size does matter

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Silicon's pre-eminence in high-speed digital electronics does not generally extend to optoelectronics where the demand is for devices that can generate, guide, detect and process optical signals. However, the utility of this ubiquitous material has recently been extended by the observation that porous and nanocrystalline Si exhibit strong room-temperature luminescence. This strong emission is a direct consequence of the nano-scale dimensions of the material and can be tuned to different wavelengths by controlling the nanocrystal size distribution. As a consequence, Si nanocrystals offer an attractive basis for the full integration of electronic and optical functionality in Si-based devices and structures. This paper provides insight into the light emitting properties and applications of Si nanocrystals by briefly describing three current studies undertaken at the ANU, namely: a) improved emission efficiency by hydrogen passivation of non-radiative defects, b) control of emission by the use of optical microcavities, and c) carrier dynamics and the prospect for optical-gain and lasing in Si-based materials.



Formation of Anisotropic Silver Particles in N,N-dimethylformamide

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A novel procedure for the synthesis of anisotropic silver nanoparticles is described, based on the use of N,N-dimethylformamide (DMF) as a solvent and as a reducing agent, in the presence of a sufficiently high concentration of the polymer poly(vinylpyrrolidone) (PVP). The formation of spherical silver nanoparticles in DMF has been previously demonstrated, and the presence of different additives has been shown to lead to the formation of core-shell structures, such as Ag@SiO₂ or Ag@TiO₂. A detailed study was also recently carried out on the use of PVP to stabilize silver nanoparticles formed in DMF. However, in that study only low concentrations of both silver salt and polymer were employed, and therefore spherical particles were consistently observed. We have subsequently observed that at higher concentrations, there is a dramatic change in the shape of the particles (Figure 1), and in turn to the optical properties of the dispersions. The interest in anisotropic metal nanoparticles is based on the different resonance possibilities that arise for the conduction electrons. It has been found for instance that metal nanorods display two distinct dipole resonances due to transversal and longitudinal plasmon oscillations. A similar behaviour has been recently found for gold triangular prisms, while for silver prisms, the transversal dipole is not very strong, but quadrupole resonances are easily observed. The nanoprisms are also stable in other solvents like water and ethanol, and solvent exchange leads to strong shifts of the in-plane dipole plasmon band. We believe that shape control of silver and gold nanocrystals allows the creation of materials with tunable surface plasmon resonances.

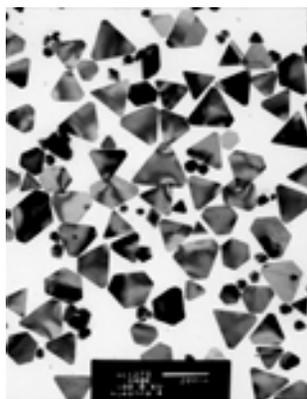


Figure 1. T.E.M. image of silver nanoprisms



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Science and Technology of Nanoparticle Systems

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The behavior of materials exhibiting structural components in the nanometer regime has been found to differ from that of conventional materials with structures in the micrometer range or larger. In many cases, such as the plasticity of metals and the electronic properties of materials, new mechanisms have been identified which do not occur in larger dimensions. The functionalization of nanostructures results in improved dispersibility in liquid and solid media. As a consequence of organic functional layers, dispersions of nanoparticles in aqueous and organic solvents can be stabilized for extended periods of time. This is only possible as the agglomeration is prevented almost completely due to the surface modification. Similarly, the organic shells around magnetic nanoparticles can be used to deposit ordered two- and three-dimensional arrays on surfaces. Additionally, three-dimensional packing of magnetic particles with excellent separation can be achieved and superparamagnetic properties can be established. Functionalization of inorganic nanomaterials occurs in natural systems as well. An example is found in the magnetic orientation system of the beak of the homing pigeon. The bio-mimicking of these functional bio-nanomaterials offers new opportunities for the basic understanding of the orientation system and for technological applications. The large potential given by the opportunities of designing materials with desired properties and property combinations by using nanotechnological approaches has resulted in a worldwide industrial interest. In the presentation several aspects of nanoparticulate systems will be described with special emphasis on the commercial aspects of the basic research.



Crystallization as a Model for Controlling Self-Assembly and Structural Ordering at the Nanoscale

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Nanoscience underpins the tailoring of the properties of solid-state materials through the control of particle size and porosity on the nano-scale. In particular, the focus is increasingly on approaches that build structures by "bottom up", rather than "top down" methodologies. Thus, rather than preparing high purity single crystals and then mechanically or chemically machining them into desired shapes and sizes, nanoscience strategies generate particles of the desired morphology and size distribution and then control the assembly of these components into complex structures. Because of the generally highly metastable nature of nanoparticles with respect to the supersaturated solutions from which they can be generated, controlling their production and subsequent ordered assembly in the liquid phase can be quite difficult. Accordingly, alternative strategies, such as the production of nanoparticles by solid state reaction, the control of assembly through the use of templates, etc, are being successfully pursued.

As a complement to these strategies, this paper will explore the opportunities that are becoming available to generate controlled nanostructures through sophisticated solution crystallization, by the application of a combination of state of the art computational chemistry, synthetic organic chemistry and in situ nano-characterisation. Thus, through rational design, additives can be tailor-made to achieve control of particle size and morphology through site-specific binding to crystal faces. The resulting structures can be discrete nanocrystals, nanoporous "single" crystals, or other, less topologically well defined structures.

Examples will be given of the effects of additives based on simple molecules, supramolecular structures, and polymers. Parallels will be drawn with the exquisite control achieved by Nature in biomineralisation, and opportunities to develop novel additives for nanostructural control through biomimetic chemistry.





Multiphoton fluorescence imaging and spectroscopy of nanocrystal quantum dots

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Abstract

Quantum dot nanocrystals have recently received much attention for its interesting physical properties such as emission wavelength tunability and single electron confinement. This so-called "quantum size effect" can be understood with the energy level structures of the quantum dots, and the multiphoton spectroscopy has already proven to be a powerful technique for probing energy levels of quantum dots [1]. The research at the Centre for Micro-Photonics (CMP) has been focusing on the multiphoton imaging and spectroscopy of individual nanocrystal under near-field and far-field illuminations. Recently, the CMP has developed a novel near-field scanning fluorescence microscopy called scanning total internal reflection fluorescence microscopy (STIRFM), which utilizes a focused ring-beam illumination and a high numerical-aperture objective ($NA = 1.65$) to produce highly confined evanescent focus. The high-level confinement of the evanescent field could induce nonlinear processes such as multiphoton excitation. The images of nanocrystals under near-field illumination using STIRFM revealed that the two-photon excitation of nanocrystals is three dimensionally isotropic, leading to the characteristic double-lobed image shapes [2]. The two-photon and three-photon excitation cross sections of nanocrystals are also measured, which reveal the energy level structure of nanocrystals. In this talk, we will present the recent research results of multiphoton excitation of nanocrystals at the CMP. The research into multiphoton excitation of nanocrystals will open up a whole new possibility in development of new photonic devices based on quantum dot nanocrystals such as optical data storage and display devices.

References

1. M. E. Schmidt et. al., Phys. Rev. B 53, 12629 (1996).
2. J. W. M. Chon et. al., Opt. Lett., 28, 1930 (2003),



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Frontiers of phase formation and control in nanoparticles by in-situ TEM

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In situ transmission electron microscopy is one of useful methods to characterize and fabricate structures in nanosystems. We revealed that in binary alloy systems in which the heat of mixing is negative, a rapid solid-state reaction of solute atoms in nanoparticles kept at room or reduced temperatures occurs to form alloys or compounds easily. The phenomenon, named spontaneous alloying, is a peculiar example of the atom displacement processes in solids, and the reaction successively proceeds toward minimizing the chemical free energy in the system to self-organize the structure. Recently, we have found atom demixing driven by alteration of electronic states induced by electronic excitations in compound nanoparticles. In the present paper, new research field by in-situ TEM regarding the control of phase formation utilizing nonlinear responses of the structural changes induced by both self-organization and electronic excitation in nanoparticles will be introduced.



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Low-Temperature Formation of SiGe Nano-crystals by Metal-induced Lateral Crystallization

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Low temperature ($\leq 500^\circ\text{C}$) formation of SiGe heterostructures on insulating films has been expected to realize advanced three-dimensional (3-D) ULSI and system-in-display. To achieve this, we examined metal induced lateral crystallization (MILC) of a-SiGe/SiO₂. In the experiment, a-Si_{1-x}Ge_x layers (50 nm thickness, $0 \leq x \leq 1.0$) were deposited on SiO₂ films by using a MBE system. Subsequently, Ni films (5 nm thickness) were deposited on top of a-Si_{1-x}Ge_x and then patterned by using photolithography. Finally, they were annealed at 450-600°C in a nitrogen ambient. Crystallization of a-SiGe with plane morphology was found around the Ni-patterns for samples with low Ge-fractions ($x \leq 0.3$). Lateral growth-velocity could be enhanced by 60% by increasing Ge fraction from 0 to 0.3, which was attributed to enhanced Ni-migration in locally strained a-SiGe films. As a result, poly-Si_{0.7}Ge_{0.3} with large grains (15 μm) was obtained after annealing at 500°C(20hr). Raman spectroscopy measurements showed that grown layers were completely strain free. Application to 3-D ULSI and system-in-display is expected. On the other hand, dendrite growth was found for samples with intermediate Ge-fractions ($0.35 \leq x \leq 0.65$), and no crystallization was detected for samples with high Ge-fractions ($x \geq 0.7$). Growth velocity of dendrite was very high (30 $\mu\text{m/hr}$), and significant long growth-length (60 μm) was obtained at 500°C. The width of dendrite regions became narrower and the growth direction became straight with increasing Ge fraction and decreasing annealing temperature. By optimizing the growth conditions (Ge fraction: 0.5, annealing: 450°C, 20hr), very sharp nanowire crystals (width: 0.03 μm , length: 15 μm) were obtained. This should be used for novel devices such as 1-D quantum wires.





Nanostructures in Photovoltaics

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Present commercial solar cells are predominantly silicon wafer-based devices with features of micron scale and the next generation will use micron-scale thin films. However, there are several proposed and actual devices that incorporate nanostructures. These include cells formed from dye-coated titanium-dioxide nanocrystals, organic cells using interpenetrating networks of two polymers, impurity band cells with alternating quantum dots, quantum well and quantum dot cells, quantum dot luminescent solar concentrators and nanoscale antennas.

Two other proposals, being actively pursued at UNSW are all-silicon tandem cells and hot carrier cells. Tandem cells are stacks of individual cells, each collecting energy from a different spectral range. We aim to engineer a new silicon-based material to form a top cell above a silicon cell, able to respond more efficiently than silicon to short wavelengths, using silicon quantum dots or quantum wells embedded between oxides, nitrides or carbides of silicon, thereby producing benign, affordable and efficient tandems. So far, we have shown clear photoluminescence evidence of quantisation in Si/SiO₂ quantum wells free of the usual dominance of interface states and have formed silicon nanodots in annealed layers of silicon-rich oxide.

Hot carrier solar cells are intended to avoid one of the major cell loss mechanisms by collecting, through mono-energetic contacts, charge carriers resulting from the absorption of short-wavelength light before they can relax thermally. There are two principal problems: firstly the need to either collect the carriers rapidly or slow their relaxation and, secondly, to restrict the energy of carriers transported through each contact to a narrow range. The first problem may be addressed by nanoscale phononic engineering to suppress phonon interaction and/or enhanced absorption, together with short collection dimensions. The second problem, on which we are more advanced, will likely involve resonant tunnelling either intraband through quantum dots or even single atoms or interband through tunnel junctions.



Optical properties of Inorganically Surface-Passivated PbS Quantum Dots

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Strong photoluminescent emission has been obtained from 3 nm PbS nanocrystals in aqueous colloidal solution, following treatment with CdS precursors¹. The observed emission usually displays a peak near 1.95 eV which we attribute to band-edge exciton recombination. However, significant emission can also be obtained from above the nanocrystals band-edge extending into the near-ultraviolet. We find that both the band-edge and above-band-edge components are strongly polarised, but display distinctly different behaviours. The two types of behaviour are shown to be incompatible, enabling us to identify two distinct types of surface passivated PbS nanocrystal². In both cases, the observation of polarised emission from bulk solutions of colloidal nanocrystals is a phenomenon that is rarely observed. Of the two types of polarisation behaviour, the polarisation of the above-band-edge component represents a new and intriguing type of polarisation memory.

Surface passivated PbS nanocrystal solutions exhibiting strong band-edge emission can also possess atomic-like discrete emission lines. Polarisation resolved two-photon spectroscopy is used to show that the emission depends on the excited state parity. Both the parity dependence and polarisation of the emission lines indicate that the states must be populated by radiative relaxation from the initial excited state. Such radiative intraband relaxation is only possible from ideal zero-dimensional semiconductors. These results are discussed in terms of the type and quality of the surface passivation used for nanocrystals and in particular may be useful in explaining the apparent lack of a phonon-bottleneck found in recent experiments on PbSe nanocrystals.

References

1. M. J. Fernée, A. Watt, J. Warner, S. Cooper, N. Heckenberg, H. Rubinsztein-Dunlop, *Nanotechnology* 14, 991 (2003).
2. M. J. Fernée, J. Warner, A. Watt, S. Cooper, N. Heckenberg, H. Rubinsztein-Dunlop, *Nanotechnology* in press.





Nanoscale Defect Characterization via Positron Annihilation Lifetime

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Positron annihilation lifetime spectroscopy (PALS) is a non-destructive defect sensitive technique used as a characterization tool for materials. Positrons and ortho-positronium (oPs) trap in unoccupied space in materials, for example vacancies in ordered solids, pores in mesoporous materials, and free volume in polymers. The annihilation characteristics give information on the type of trap (mono, di- vacancy, cluster, pore) and its size. The lifetime of the localized ortho-positronium (oPs) atom acts as a measure of the pore size and allows derivation of pore size distributions. The relative statistical weight or intensity of the oPs component can be correlated with specific surface area and numerical concentration of pores. In mesoporous materials such as VYCOR glass, zeolites, and silica gels, PALS is used to characterize the pore size distribution. Additional information on the nature of the pores (open or closed) and the contents of the pores can be gained from PALS studies of mesoporous materials. In nanoporous polymeric materials, the nanospace between and along polymer chains has dimensions of order 0.1 nm to a few nm. This unoccupied volume has static and dynamic components, both of which are critical to the transport of gas and vapour molecules and ions through the polymer. Alterations of the nanospace by less than 0.1nm can cause two orders of magnitude variation in flux. The oPs annihilation characteristics are used to measure the effect of variations in materials chemistry on the nanospace through which the ions and molecules move. This lecture will present an overview of the technique applied to a range of materials.



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A Mechanism for Gold Nanorod Formation

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The factors affecting the nucleation and growth of gold nanorods have been investigated. It is shown that the size and the aspect ratio can be controlled through the use of different sized seed particles (Figure 1). The length of the rod can be tuned from 25-170 nm and the width was kept constant ca. 25 nm. The formation of rods requires the presence of CTAB. Lower temperature favours the rod formation, although this reduces the CTAB solubility. The addition of chloride ions or the use of DTAB leads to shorter aspect rods. Au(III) and Au(I) are shown to be quantitatively bound to the CTAB micelles. This leads us to propose a new electrochemical mechanism for rod formation, in which the flux of Au(I) bound to cationic micelles is maximised at the rod termini.

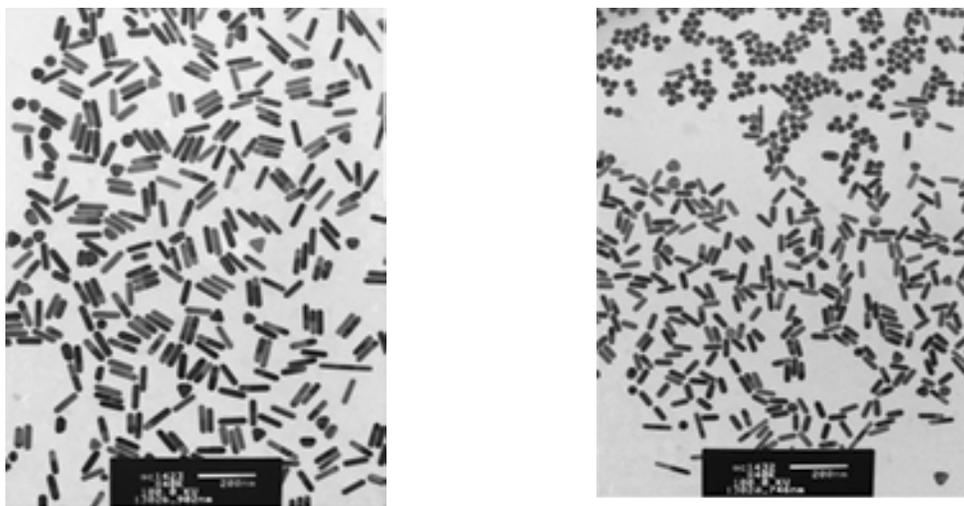


Figure 1. T.E.M. images of gold nanorods with different aspect ratios: 4.05 ± 0.52 (left) and 2.81 ± 0.42 (right).

Jana, N. R.; Gearheart, L.; Murphy, C. J. *J. Phys. Chem. B* 2001, 105, 4065.



The precautionary principle in nanotechnology

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Abstract

The precautionary principle is widely adopted and thought by many to be a useful strategy for action, especially in the environmental and health areas. A recent report by Greenpeace extends the scope of the principle to include nanotechnology, artificial intelligence and robotics. But despite its wide acceptance and intuitive appeal, it is not without its strong critics. This paper will first examine the principle to understand better both what it means and whether it is useful, and then explore the view that it should be applied to Nanotechnology.

Various statements of the precautionary principle have been formulated:

Where an activity raises threats of harm to the environment or human health, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically [Wingspread Statement].

Where there are significant risks of damage to the public health, we should be prepared to take action even when the scientific knowledge is not conclusive, if the balance of likely costs and benefits justifies it [Douglass L. Weed].

These and other formulations will be examined and criticised.

The next part of the paper will attempt to see if the principle has any role to play in nanotechnology. The argument here will be that while it may not be possible or even desirable to halt certain research and developments, the mere existence of the precautionary principle in the field of nanotechnology may help to make researchers, developers and policy makers more careful, by shifting the burden of proof. Advocates of new technology would be required to show that it (the new technology) does not cause serious or irreversible damage. What constitutes "serious or irreversible damage" of course requires further explanation, as will the standards used in assessing the evidence for this damage being caused.





Exploiting the Properties of Carbon and Boron Nitride Nanomaterials for Nanotechnology

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Abstract:

Carbon and boron nitride form sp^2 -bonded networks which can be configured as nanotubes, nanococoons, and other unique nanostructures. The constructs often display thermal, electronic, optical, and mechanical properties that are advantageous for nanotechnological applications, including sensors, field emission sources, and NEMS (nanoelectromechanical systems). I will describe some of the fascinating fundamental science aspects as well as the near-term technology associated with nanotube and nanoparticle materials.

Electrochemical Characteristics of Ordered Mesoporous Carbon as Electrode



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Material in Li-ion Battery

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Ordered mesoporous carbon CMK-5 was comprehensively tested for the first time as electrode material in Lithium ion battery. The surface morphology, pore structure and crystal structure were characterized by Scanning Electronic Microscopy (SEM), N₂ adsorption technique and X-ray diffraction (XRD) respectively. Electrochemical properties of CMK-5 were studied by galvanostatic cycling and cyclic voltammetry, and compared with conventional anode material graphite. Results show that the reversible capacity of CMK-5 was 525 mAh/g at the third charge-discharge cycle and that CMK-5 was more compatible for quick charge-discharge cycling because of its special mesoporous structure. Of special interest is that the CMK-5 gave no peak on its positive sweep of the cyclic voltammetry, which was different from other known anode materials. Besides, X-ray photoelectron spectroscopy (XPS) and XRD were also used to investigate the charge-discharge characteristics of CMK-5.

Table 1 Surface properties of CMK-5 and graphite^a

samples	BET (m ² /g)	Total pore volume (cm ³ /g)	Average pore diameter (nm)	HK micropore volume (cm ³ /g)
Graphite	8.2	0.06	---	----
CMK-5	1674	1.39	3.29	0.63

^a Graphite particles were around 10 mm according to SEM observation.

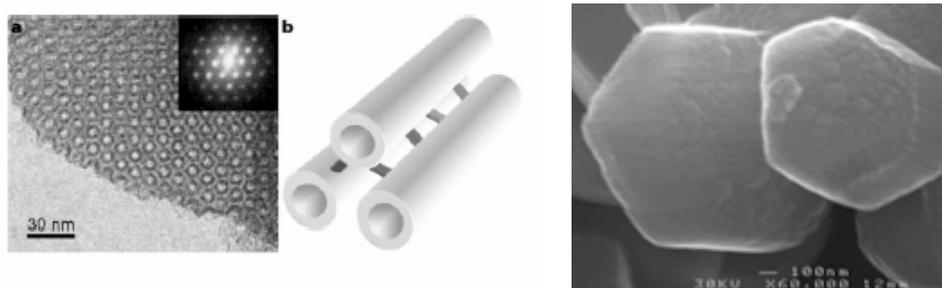


Fig 1. (a) TEM micrograph of CMK-5 carbon[11] (b) SEM micrograph of CMK-5

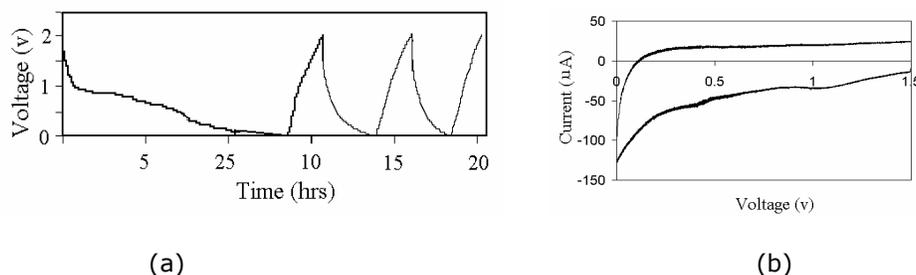


Fig. 2 Electrochemical characteristics of mesoporous carbon CMK-5, (a) First three charge-discharge cycles of CMK-5; (b) Cyclic voltammograms of CMK-5 after three cycles. Scan rate 1 mV s^{-1} .

4. Conclusion

Mesoporous carbon CMK-5 was synthesized and applied as electrode material for the first time in the lithium ion battery. XRD study reveals that the synthesized CMK-5 possessed periodical mesoporous structure and that it consisted of tiny carbon crystallite with much larger graphene layer spacing than graphite. Galvanostatic cycling tests showed that the discharge and charge curves of CMK-5 did not exhibit obvious potential plateau at the low voltage below 0.3 volts, which was due to the disordered carbon structure of the CMK-5 material. The reversible charge capacity of CMK-5 reached 525 mAh/g in the third charge-discharge cycle. Of especially interest is that CMK-5 gave no peak on its positive sweep of the cyclic voltammetry, possibly due to its unique ordered mesopores structure. This indicates that lithium ion possibly redistribute to the different sites with various energy levels through the nanopores or tiny carbon crystallites after intercalating into CMK-5. Besides, high current cycle tests demonstrated that CMK-5 was more compatible for quick cycling operations because it can maintain very high capacity under this condition. This property was expected to derive from its unique mesoporous structure. Quick cycling compatibility will make this carbon material very promising in some applications such as supercapacitors.

References

- [1] Z. H. Yang, H. Q. Wu, B. Simard. Charge-discharge characteristics of raw acid-oxidized carbon nanotubes. *Electrochemistry Communications*, 4 (2002) 574~578.
- [2] Z. H. Yang, H. Q. Wu. Electrochemical intercalation of lithium into carbon nanotubes. *Solid State Ionics*, 143 (2001) 173~180.
- [3] B. Gao, A. Kleinhammes, X. P. Tang, C. Bower, L. Fleming, Y. Wu, O. Zhou. Electrochemical intercalation of single-walled carbon nanotubes with lithium. *Chemical Physics Letters*, 307 (1999) 153~157.
- [4] H. Take, H. Kajii, K. Yoshino. Electrochemical properties of macroporous carbon for electrodes of lithium-ion batteries. *Synthetic metals*, 121 (2001) 1313~1314.
- [5] G. T. K. Fey, K. L. Chen, Y. C. Chang. Effects of surface modification on the electrochemical performance of pyrolyzed sugar carbons as anode materials for lithium-ion batteries. *Materials Chemistry and Physics*, 76 (2002) 1~6.
- [6] J. Gong, H. Wu. Electrochemical intercalation of lithium species into disordered carbon prepared by the heat-treatment of poly (*p*-phenylene) at 650°C for anode in lithium-ion battery. *Electrochimica Acta*, 45 (2000) 1753~1762.
- [7] J. Gong, H. Wu, Q. Yang. Structural and electrochemical properties of disordered carbon prepared by the pyrolysis of poly (*p*-phenylene) below 1000 °C for the anode of a lithium-ion battery. *Carbon*, 37 (1999) 1409~1416.
- [8] Z. Wang, X. Huang, L. Chen. Lithium insertion/extraction in pyrolyzed phenolic resin. *Journal of Power Sources*, 81-82 (1999) 328~334.
- [9] G. T. K. Fey, Y. C. Kao. Synthesis and characterization of pyrolyzed sugar carbons under nitrogen or argon atmospheres as anode materials for lithium-ion batteries. *Materials Chemistry and Physics*, 73 (2002) 37~46.
- [10] S. H. Joo, S. J. Choi, I. Oh, J. Kwak, Z. Liu, O. Terasaki and R. Ryoo. Ordered nanoporous arrays of carbon supporting high dispersions of platinum nanoparticles. *Nature*, 412 (2001) 169~172.
- [11] S. J. Wang. Study on new type of resin carbon electrode materials for lithium ion batteries. *Huaxue Yanjiu Yu Yingyong*, 13 (2001) 383~386.



Nanostructure Characterisation in the Bulk using Small Angle X-ray Scattering (SAXS).

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Small angle X-ray scattering (SAXS) is an excellent technique to characterise the morphology of inhomogeneities in the bulk in the size range from 1 nm - several hundred nm. SAXS is due to the electron density difference between the matrix and the inhomogeneity. It is an indirect imaging technique where information on inhomogeneity size is determined by a transformation from reciprocal space to real space. Materials that are routinely characterised using the SAXS technique include, alloys and ceramics, biological materials, colloidal materials, complex fluids, polymers, and surfaces and interfaces. Where possible imaging techniques such as transmission and scanning electron microscopy (TEM and SEM) should be used in conjunction with SAXS to obtain the best results. TEM is an excellent direct imaging technique to determine the morphology of structure in an extremely small volume, which is not always representative of the bulk structure. SAXS can provide information in a volume of up to 9 orders of magnitude larger than the volume accessed by TEM, and hence can ascertain if the characteristics determined by TEM are occurring throughout the bulk. TEM also has the added disadvantage of difficult sample preparation techniques that can introduce artifacts into the sample under investigation. In these situations SAXS is often the best or the only experimental technique available that is capable of providing structural and kinetic information concerning nano-sized inhomogeneities in the material of interest. When used in tandem SAXS and complementary techniques such as TEM and SEM are a powerful combination for the investigation of nanostructure in materials. In this talk I will introduce the fundamentals of SAXS and describe some of the research being undertaken at the Western Australian SAXS Facility in the Department of Applied Physics at Curtin University.



Catalysis

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A recent conference on new industrial uses of gold¹ attests to the expanding technological possibilities for this metal. In the present paper we address two possibilities, catalysis and capacitance. It is now well-known that discrete gold nano-particles can exhibit these properties, but less appreciated that mesoporous gold sponges can also do so. The catalytic efficiency and capacitance possibilities of sponges and particles are reviewed and compared, and experimental results for the performance of mesoporous sponges produced by de-alloying the intermetallic compound AuAl₂ are presented. The sponges turn out to possess excellent catalytic properties^{2,3} in respect of the low temperature oxidation of CO, as well as (at ~300°C) for the selective catalytic reduction or oxidation of NO. The mechanism of this catalysis presents something of a difficulty⁴ in so far as the reigning paradigm requires the presence of discrete metallic nano-particles^{5,6}. Storage of electrical energy on mesoporous gold sponges has now also been demonstrated⁷. The high density of gold implies that the specific surface area of the gold is about 30% that of carbon when compared on a volumetric basis, which may be a more appropriate parameter in many applications than m²/g. Furthermore, ultra-capacitors are actually used for their power buffering capability, rather than as stores of energy, and the high internal resistance of carbon-based ultra-capacitors limits the power that may be efficiently drawn from them⁸. Devices based on gold have an intrinsically lower internal resistance and hence are potentially capable of a higher power delivery. Some preliminary performance data for proof-of-concept devices is presented.

References

1. Gold 2003, 28th September-1st October 2003, Vancouver.
2. E. van der Lingen, M.B. Cortie, H. Schwarzer, S.J. Roberts, G. Patrick : Gold catalysts prepared via intermetallic precursor, Gold 2003, 28th September-1st October 2003, Vancouver.
3. G. Patrick, E. van der Lingen, H. Schwarzer and S.J. Roberts, Development of gold-sponge catalysts for lean-burn DeNO_x, Gold 2003, 28th September-1st October 2003, Vancouver.
4. M.B. Cortie, and E. van der Lingen, Catalytic gold nano-particles, Materials Forum, vol.26, 2002, pp.1-14.
5. D. Thompson, New advances in gold catalysis. Part I. Gold Bulletin, vol.31(4), 1998, pp.111-118.
6. D. Thompson, New advances in gold catalysis. Part II. Gold Bulletin, vol.32(1), 1999, pp.12-19.
7. M. Cortie and E. van der Lingen, Properties and potential applications of meso-porous gold, Gold 2003, 28th September-1st October 2003, Vancouver.
8. B.E. Conway and W.G. Pell, Power limitations of supercapacitors associated with resistance and capacitance distribution in porous electrode devices, J. of Power Sources, 2002, 105, 169.





Electronic Structure Methods for Nanotechnology

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The modelling of complex systems at an ab initio level is a challenging problem, but one that must be overcome for materials where the electronic properties are of key importance or influence the physical characteristics. One methodology for tackling large-scale quantum mechanical calculations is the technique embodied within the SIESTA code [1], where the construction of the Hamiltonian is always linear scaling and self-consistency can be achieved either through conventional diagonalisation or through order N methods for systems with a band gap. In combination with parallelisation, this makes it feasible to study materials containing many thousands of atoms with tunable precision. As a complement for even more complex problems, we have also demonstrated how it is possible to perform semi-empirical quantum mechanical calculations for condensed phase systems [2].

Two applications of electronic structure methods in the field of nanotechnology will be briefly described to demonstrate the applicability of the methods.

Because of their semi-conducting properties, the sulphides of lead, cadmium and zinc have attracted particular attention as quantum dots. Here we present results of a study of the structure and electronic properties for a range of nanoparticles of PbS in order to examine the influence of morphology. In addition, the influence of embedding the particles within a host silica matrix has been examined.

The SIESTA method has also been applied to the problem of hydrogen storage in carbon nanotubes, where the possibility of chemisorption has been examined. The plausibility of such an event is found to be strongly correlated with the size of the nanotube, as well as the position of attachment, and also is coverage dependent.

[1] J.M. Soler, E. Artacho, J.D. Gale, A. Garcia, J. Junquera, P. Ordejon, D. Sanchez-Portal, "The SIESTA method for ab initio order-N materials simulation", *J. Phys. Cond. Mat.* 14, 2745-2780 (2002)

[2] J.D. Gale, "Semi-empirical methods as a tool in solid state chemistry", *Faraday Disc.*, 106, 219 (1997)



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Nano-Scale Studies of Magnetic Materials by Spin-Polarized Scanning Tunneling Spectroscopy

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In order to probe and tailor magnetic properties at the spatial limit we have combined the scanning tunneling microscope (STM) with spin-sensitivity. This is achieved by the use of ferro- and antiferromagnetically coated probe tips offering a high degree of spin-polarization of the electronic states involved in the tunneling process. Magnetic domain imaging with sub-nanometer-scale spatial resolution has been demonstrated for magnetic transition metal as well as rare earth metal films. Ultra-sharp domain walls were discovered in ultra-thin iron films while for ferromagnetic and antiferromagnetic samples, the different magnitude or orientation of magnetic moments could directly be made visible at the atomic level.

The phenomenon of magnetic hysteresis was observed for the first time at the single-digit nanometer length scale and has directly been correlated with microscopic processes of domain nucleation and domain wall motion.

We also studied magnetic vortex structures in mesoscopic-scale ferromagnetic systems which are of relevance for current developments in MRAM technology.

Magnetic switching phenomena of nano-scale magnetic islands and nanoparticles were studied by time-dependent spin-sensitive STM imaging. It will be shown that granular thin films exhibit a complex magnetic switching behaviour due to the statistical distribution of grain sizes, grain shapes and inter-grain spacings.

Finally, we will discuss the application of spin-sensitive STM measurements to individual atoms and molecules on magnetic substrates. In particular, we will show that both the orbital symmetry as well as the spin character of electronic scattering states around single atomic impurities can be determined from real-space spin-sensitive STM data.



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Nanostructural Engineering of Titania Films and Titania/Alumina Nanolaminates by Atomic Layer Deposition

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Atomic Layer Deposition (ALD) is an important technology for depositing thin-films with controlled nanostructures. Unlike conventional chemical vapour deposition, where growth is dependent on reactant flux, ALD employs sequential surface chemical reactions to saturate a surface with a (sub)monolayer of reactive compounds such as metal alkoxides or covalent halides, followed by reaction with a second compound such as water to "grow" coatings layer-by-layer. A judicious choice of reactants and processing conditions ensures that the exchange reactions are self-limiting, resulting in controlled film growth with alternate exposure. The self-limiting nature of the reactions ensures excellent conformality, even on very convoluted substrates, and sequential processing results in exquisite control over film thickness.

Multi-layered optical coatings composed of alternating layers of titania and alumina have been formed via ALD on Si<100> substrates, using titanium tetrachloride/water and trimethylaluminium/water couples as precursors. Sub-unit configurations of high/low refractive index and low/high refractive index were deposited at 200 °C, to build nanolaminates up to five repeat units thick. The optical and structural properties of the nanolaminates were investigated using a variety of techniques, including transmission electron microscopy (TEM), secondary ion mass spectrometry (SIMS), X-ray reflectometry (XRR) and spectroscopic ellipsometry at multiple angles.

TEM revealed that the nanolaminates consisted of chemically homogeneous layers of thickness 20 ± 1 nm, with distinct interfaces between individual layers. Similarly, SIMS depth profiling revealed excellent compositional uniformity within each layer. The chemical and structural uniformity of the nanolaminates over longer length scales was evident from the XRR data obtained with a beam "footprint" of *ca.* 7 cm, which revealed the typical oscillatory reflectance behaviour associated with highly uniform and chemically homogeneous layers, with sharp inter-layer interfaces. Optical parameters were measured and the thickness and refractive indices of the individual layers calculated from spectroscopic ellipsometry models. These data highlight the precise control of film thickness and composition attainable using atomic layer deposition for producing multilayer coatings with controlled nanostructures, opening new opportunities for the design and deposition of antireflection coatings.



Highly efficient immobilization of DNA on the walls of carbon nanotubes

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Carbon nanotubes have enormous potential as components of nanoscale electronic devices and sensors because of their unique conducting properties and high thermal capacity. In many of the envisaged applications, the nanotubes are required to be physically linked or precisely placed in the device. DNA is an ideal molecule for assembling nanotubes into such devices, potentially enabling a multi-component system to be assembled in one step by using different base sequences for each component. To date, the focus has been on placing DNA at the tips of nanotubes. Here we present a simple method for attaching DNA to the sidewalls of vertically-aligned, multi-walled nanotubes on a solid support. The ability to coat this larger area with DNA provides greater scope for attachment of additional components, and, importantly, prevents aggregation of nanotubes when released from the support into solution. The method involves a mild and facile photochemical reaction to functionalise the nanotubes, followed by synthesis of DNA from the photo-adduct. A visual assay, using DNA-modified gold nanoparticles and transmission electron microscopy, confirms the sites of DNA attachment. An extension of the assay provides a method for coating the sidewalls of nanotubes with multiple layers of nanoparticles to modify the surface properties.





Controlled Growth of Carbon Nanotubes for Device Applications

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Carbon nanotubes have fascinating electrical properties such as high current density and ballistic conductance. These features have led to their potential use as nanotube interconnects in microelectronic devices. To build large-scale functional devices integrated with microelectronics circuits, it is essential to fabricate carbon nanotubes on designed substrates in a controllable manner. There is widespread interest in growing controllably aligned carbon nanotubes, one- and two dimensional connections and/or junctions with nanotubes by in situ growth processing. This paper reports the growth of aligned carbon nanotubes with different directions, nanostructures and sizes, on different substrates, selected sites, in designed patterns. The synthesis method used is mechanically activated pyrolysis of iron phthalocyanine. The precursor contains both catalysts and carbon source required for nanotube growth and the pre-ball milling treatment helps the control over the growth process.



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Progress in the development of the Silicon Based Quantum Computer

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Devices that employ single atoms to store and manipulate information will be constructed in the near future. The proposal of Kane [1] provides a starting point for the development of a quantum computer based on a few tens of nanometre period array of individually addressable qubits consisting of ^{31}P donors in a high purity silicon substrate. But numerous daunting technological challenges must be overcome in its construction and operation because the device requires control and readout of the

configuration of single atoms. This paper provides a brief review of a strategy that has been developed to meet the challenge of construction of a working prototype. We focus on a "top-down strategy", which employs a single ion implantation technique, to load single donors into prefabricated cells. We show that this strategy offers a fast route to few-qubit devices that are available now and we outline plans for scale-up of the technology to many qubit system.

[1] B.E. Kane, A silicon-based nuclear spin quantum computer, *Nature* 393, 133 (1998).



Towards Molecular Electronics: Conduction of single molecules

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Molecular electronics, a new emerging science area in the field of nanotechnology, is seen as a possible replacement for silicon device-technology in the next decade. To enable such a technology, an essential initial requirement is a detailed understanding of the electrical conduction properties of single molecules placed between metal electrodes. We recently investigated the electrical conduction of single molecules using first-principle quantum mechanical calculations based on the density functional theory and non-equilibrium Green's function techniques. We demonstrate that each molecule has its own distinct current-voltage characteristic, determined by the positions of the molecular energy levels and the degree of electrode-molecule coupling. We show that the calculated attenuation factors of molecular wires made of polyene-dithiol, polyphenylene-dithiol and alkanedithiol agree with experimental data. Furthermore we reveal that photoisomerization of azobenzene can be utilized as an electrical molecular switch and that bipyridine-dithiol, in the presence of a gate electrode, can function as a single-molecule field-effect transistor. Different experimental techniques that help to elucidate the conduction properties of single molecules will be mentioned.





Hexagonal Close-Packed Ni Nanostructures

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Heteroepitaxial misfit strain and its various relaxation mechanisms are predominant factors in nucleation and growth on single crystal substrates. In some cases, nanostructures and metastable phases are formed which exhibit novel properties. In this paper we report the first observation of the formation and structural evolution of a hexagonal close-packed (hcp) structure in the early stages of the epitaxial growth of nickel on a (001) single crystal MgO substrate. The study was performed in an ultra-high vacuum transmission electron microscope equipped with an electron beam evaporator for in-situ thin film growth. The hcp phase of nickel does not exist in nature and is thought to be stabilized by epitaxy. We observe the nano-sized hcp-nickel islands to subsequently transform into the normal face-centered cubic (fcc) structure with fcc-Ni (110)//MgO(001) when the lateral size of the islands exceeds a critical value of $\sim 5\text{nm}$. The structural transition proceeds via a Martensitic change in the stacking sequence of the close-packed planes, representing a novel way to relieve misfit strain. Equivalent in-plane orientations of the fcc-Ni (110) islands were observed as a result of the four-fold degenerate characteristics of the (001) surface of MgO. The formation of hcp-Ni nanostructures with unusually large crystallographic c/a ratio ($\sim 6\%$ larger than ideal hcp) is very interesting for spintronic applications where controlled uniaxial anisotropies are desirable.



Applications of Plasmonics in Miniaturised Sensors

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Plasmon resonances that occur in nanoscale metal films and particles give rise to several useful optical properties. The plasmon resonance is extremely sensitive to the local dielectric environment and has therefore attracted a great deal of interest for diverse sensing applications. Surface plasmon resonance (SPR) spectroscopy, based on thin gold films on glass, is fast becoming the most popular (and commercially most successful) method for affinity biosensing. On the other hand, the localised surface plasmon resonance (LSPR) that occurs in Au, Ag or Cu nanoparticles has been shown to contribute to the millionfold enhancements found in surface enhanced Raman spectroscopy (SERS). The LSPR also results in wavelength-selective absorption and scattering, which can be observed through UV-visible extinction spectroscopy. Therefore nanoparticles hold out the possibility of highly sensitive sensors with multiple transduction mechanisms. One avenue to exploiting the remarkable optical properties of nanoscale metals is to make use of their intrinsic capacity for miniaturisation. This may be achieved by combining plasmonic structures with the powerful manufacturing capabilities that have been developed in the microelectronics and optical telecommunications industries. In this paper we firstly explore the potential for an SPR dew point sensor based on a gold-on-silicon structure. Secondly, we describe efforts to obtain the LSPR by preparing well-defined and stable nanoscale features on the tip of an optical fibre. An ability to generate reproducible features on the scale of 3 to 100 nm on large numbers of optical fibres could lead to several favourable outcomes. For example, optical fibres are commonly used to couple light into field-portable spectrometry systems. Progress in developing a compact Raman spectrometer will therefore also be described.



Using Carbon Nanotubes and DNA to Transfer Electrons Over Long Distances: Applications to Sensing and Bioelectronics



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The advances in nanomaterials and molecular level fabrication allows unique biosensor interfaces to be fabricated with advantageous properties over conventional fabrication techniques. We use these nanotechnological approaches in the development of electrochemical biosensors for both DNA and enzyme where electrons are transferred over long distance through either carbon nanotubes or DNA. Electron transfer through these 'molecular wires' allows the rest of the electrode to be modified with self-assembled monolayers which resist electrode fouling and/or access of potential interferences.

With regards to enzymes, carbon nanotubes are used as molecular wires to plug into the redox active centres of enzymes such as glucose oxidase. The application of enzymes in sensing and bioelectronics are frequently limited by the need for a cosubstrate to complete the catalytic cycle. Direct communication between enzymes and electrodes is the key to obtaining more efficient enzyme turnover as the need for a co-substrate is obviated. The single-walled carbon nanotubes are aligned vertically off the electrode surface via self-assembly and enzymes attached to the other end. In an extension of this idea we build the actual enzyme around the end of the carbon nanotubes by attaching the redox active centre of the enzyme to the ends of the tubes and then refold the apo-Enzyme around the active centre.

The same principle of transferring electrons over long distances is also used for DNA sensing where the ability of double strands of DNA to act as 'molecular wires' but inability of single strands of DNA to effectively transfer electrons is exploits. In the presence of a redox active marker, no current is observed with ss-DNA but a strong signal is observed upon hybridization. This ability of the DNA to transfer electrons is dependent on perfect base-pair stacking so mismatches are also detected. The DNA biosensor has also been shown to be able to detect the sequence of interest in complex samples with a view towards virus detection.



Medical Nanotechnology and Developing Nations

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Little documentation exists concerning the applicability, suitability or prospect of nanotechnology in developing nations. Subsequently, there has been minimal discussion of its potential to further marginalise those already deprived, or the mechanisms by which a more equitable distribution of its benefits might be secured.

If 'appropriate', nanotechnology holds great potential for material, electronic, energy and medical applications in developing nations. In particular, bionanotechnology offers cost-efficient devices for rapid response disease diagnosis and targeted drug delivery. With global health currently hindered by limited access to services, cumbersome medical procedures, and increased bacterial resistance, focus on the most promising diagnostic and drug delivery systems are a universal need of the poor. However, an inequitable global distribution of nanotechnology could easily exacerbate the health gap between rich and poor.

Current disparities at the heart of global health problems will not be solved by technology alone. Any assessment of new medical technology that fails to consider contextual issues such as appropriateness, access, governance, infrastructure, socio-cultural differences, ambient contributors to poor health and the rather different priorities and needs of developing nations, will be confounded. It is vital that any strategic framework progress beyond conventional technology transfer, to greater self-determined policy and indigenous-led implementation. Developing nations must be encouraged to explore local systems of innovation and long-term education strategies for emerging areas such as medical nanotechnology. This encouragement should commence with dialogue and partnership stimulated by nations at the forefront of related research. The opportunity exists for Australia to take the lead in bionanotechnology partnerships for the poorer nations of the Asia Pacific.

The aim of the current work is to examine the possible need, applications and implications of medical nanotechnology in developing nations in light of the issues raised above.





Unconventional ferromagnetism in all-carbon nanofoam

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Abstract

We report production of nanostructured carbon foam by a high-repetition-rate, high-power laser ablation of glassy carbon in Ar atmosphere. A combination of characterization techniques revealed that the system contains both sp² and sp³ bonded carbon atoms. The material is a novel form of carbon in which graphite-like sheets fill space at very low density due to strong hyperbolic curvature, as proposed for "schwarzite". The foam exhibits ferromagnetic-like behaviour up to 90 K, with a narrow hysteresis curve and a high saturation magnetization. Such magnetic properties are very unusual for a carbon allotrope. Detailed analysis excludes impurities as the origin of the magnetic signal. We postulate that localized unpaired spins occur because of topological and bonding defects associated with the sheet curvature, and that these spins are stabilized due to the steric protection offered by the convoluted sheets.



Investigation of optoelectronic and spintronic properties of disordered GaN

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Characterising the atomic scale structure and the resulting electronic properties of nano-structured materials is an ongoing challenge in physics research. An especially interesting material with a complex structure is disordered gallium nitride (GaN). It has been predicted that fully amorphous GaN has a well-defined state free band-gap, and may provide a useful alternative to its crystalline counterpart [1]. However, the amorphous state is not in itself unique, and different fabrication techniques give rise to a range of disordered structures. The resulting optical and electronic properties depend sensitively on the details of this nano-structure, including the presence of impurities and defects.

We have prepared disordered GaN films on a range of substrates by a novel ion-assisted deposition process. X-ray diffraction, electron microscopy, and extended x-ray absorption fine structure measurements reveal a range in short-range order from fully amorphous to nano-crystalline. Oxygen impurities appear to play a key role in stabilising the amorphous structure. X-ray absorption near-edge spectroscopy has revealed the presence of molecular nitrogen trapped within the films, interacting only weakly with the surrounding GaN matrix.

We have recently expanded our growth capability to add manganese doping/alloying to the films. Preliminary characterisation indicates that these samples magnetically order below about 30 K. Furthermore, the manganese doped films exhibit a surprising increase in their transparency and the strength of their Raman scattering after exposure to intense UV light.

We gratefully acknowledge financial support from the New Zealand Foundation for Research Science and Technology through its New Economy Research Fund, and through doctoral (AK) and postdoctoral (BJR) fellowships.

[1] P. Stumm and D.A. Drabold, Phys. Rev. Lett. 79, 667 (1997).



Template Directed Synthesis of Nanosized Bone-like Apatite

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In order to maximize the bioactivity of prosthetic materials, synthesis of nanosized hydroxyapatite is required. In addition, it is highly desirable the synthetic hydroxyapatite to have similar chemical substitutions and morphology of biological apatites. A novel method has been developed to produce single phase, nano sized, plate-like, mixed A-B type carbonate containing apatite (CAp) similar to bone apatite for effective bone tissue integration. The methodology emulates biomineralization, where topotactic transition from octacalcium phosphate (OCP) to hydroxyapatite (HAp), which is believed to occur *in vivo*. The process involves formation of thin ($\sim 14\text{\AA}$) layered calcium phosphonate salts by a self-assembly process. The thermal decomposition of these layered salts leads to formation of plate-like carbonated apatite. The overall carbonate content varies from 6.4 to 4 wt%, within the temperature range of 500 - 700°C. This carbonate content corresponds well with the amount found in mammalian hard tissues.

In this report the chemical reactions in solution and the formation of intermediate salts that lead to production of plate-like carbonated apatite are described. The chemical reactions in solution have been studied by one- and two- dimensional multi nuclear magnetic resonance (NMR) while intermediate phosphonate slats by infrared (IR) and Raman spectroscopies.



Mathematical Modeling of Skeletal Muscle

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SUMMARY: Nanotechnology dealing with biological systems use biomathematics or mathematical modeling as a tool to understand the system. The inspiration, regarding mechanism and control features may be taken and applied to the engineering systems which may bring new trends in the miniaturizing engineering world.

KEYWORDS: Myofibril, Actin, Myosin, Cross-Bridge

The term nanotechnology refers to the technology at nano level. This quintessentially deals with SAM or Self Assembling Members. At nano level the links(objects) can't be dealt mechanically, they can't be displaced and assembled mechanically. So based on the chemical properties of certain atoms/molecules, they can be directed to arrange themselves so as to serve the desired purpose.

The purpose of this paper is to study the "regulated motion" at nano level, and thereby citing some pragmatic suggestions to design an analogous system to the system under consideration.

Here, a muscle fiber of skeletal muscle has been considered, and the nano system considered over here is the smallest functional unit of the skeletal muscle tissue.

The nano system comprises of the links(members) Myosin & Actin, both proteins and Adenosine Tri Phosphate(ATP). A mathematical model of the system has been constructed to understand the motion at the nano level.

Study of a system comprising of Myosin, Actin and Adenosine Tri Phosphate(ATP), (the elementary system of a skeletal muscle), where the mechanical work done by the system(at nano level) in sequel to the hydrolysis of the ATP reveals some important facts which can aid us in constructing an application for regulated motion at nano level. Mathematical model of the system is briefed as follows:

The basic monomer of a skeletal muscle is myofibril, which is in fact composed of Actin and Myosin proteins, and a protrusion of myosin, its head is known as cross-bridge.

Behavior/motion of a single cross-bridge will be reciprocated by each one. The cycle of motion exhibited by this cross-bridge is known as cross-bridge cycle.

The cycle of operation for this dynamic system commensurate much with that of a four stroke internal combustion engine. Like the latter, the former has also got the four stages, and does comprise of a "power stroke", again, the most quintessential requirement for a motion generating system. The cycle of operation is known as cross-bridge cycle and is briefed as follows :

This cycle can be analyzed in four easy sequential steps:

1).The actin-myosin bridge very rapidly dissociates due to ATP binding to myosin.



2).The free myosin bridge moves into position to attach to actin, during which ATP is hydrolyzed.

3).The free myosin bridge along with its hydrolysis products rebinds to the actin filament.

4).The cross-bridge generates force, and actin displaces the reaction products (ADP and Pi) from the myosin cross-bridge. This is the rate-limiting step of contraction. The actin-myosin cross-bridge is now ready for the ATP binding of step

The cross-bridge generates force, and actin displaces the reaction products (ADP and Pi) from the myosin cross-bridge. This is the rate-limiting step of contraction. The actin-myosin cross-bridge is now ready for the ATP binding of step 1.

Let i = number of crossbridges in a myofibril.

m = maximum number of crossbridges in a myofibril.

j = number of myofibrils in a muscle fiber.

n = maximum number of myofibrils in a muscle fiber.

L_2 = length of the link 2.

P = force per unit area in a muscle tissue, which is found to be 3-6 kgf/cm².

F_{ij} = force exerted by the system comprising of one cross-bridge only.

τ = torque exerted by the link 2 or cross-bridge on link 3 or the myosin.

θ = angle by which the link 2 displaces.

W = work done by the system.

a = number of ATP molecules consumed for the period of experiment.

E = energy released by 'a' number of ATP molecules on hydrolysis.

η = efficiency of the system.

The significance of this mathematical model lies in the design of a nano system capable of executing desired and regulated motion.

Tremendous work is being carried out at the Dept. of Mechanical Engg. , Jabalpur Engg. College regarding system simulations of these systems.

REFERENCES:

[1]. Textbook of Medical Physiology, Arthur C.Guyton, John E.Hall, 67-77, Harcourt, India Pvt. Limited.

[2]. The Molecular Basis Of Cell Structure Function, Albert L.Lehninger, Kalyani Publications, pp 387-389, 2nd edition.

[3]. Harper's Biochemistry, Robert K.Murray, Daryl K.Granner, Peter A.Mayes, Victor W.Rodwell, Mc-Graw Hill Publications, pp 123-129, 25th edition.





An Analytical Single-Electron-Transistor Model Based on Free Energy Difference across The Tunneling Barrier

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While most of the single electron transistor analytical models found in the literature focused on unilateral electron tunneling across the tunneling junctions, we proposed an analytical model that uses free energy difference between energy levels on each side of the tunneling barriers and that considers electron tunneling from either side of the barriers. Accordingly, we modified the Helmholtz's free energy differences for electrons tunnel from either side of the source-island junction as well as the drain-island junction of the SET. By using the orthodox theory and taking the two tunneling junctions of SET into consideration simultaneously, the I-V characteristics of SET can be correctly described. The proposed model gives a tunneling rate that are non-continuous and has quadratic relation with VGS, which is more accurate than those obtained from other model (Superlattices and Microstructures, 28, (5/6), pp.345-349, 2000). When compared with the widely accepted Monte-Carlo SET simulator SIMON 2.0, the simulation results of the proposed model including IDS-VDS and IDS-VGS characteristics at different operating temperatures are quite close to those of SIMON 2.0. We also compares the IDS of the proposed model and the most-cited analytical model developed by Uchida et. al. [Jpn. J. Appl. Phys. 39, pp.2321-2324, 2000] at different temperatures by taking SIMON 2.0 as a reference. We found that the difference in IDS with that of SIMON for both the Uchida's model and the proposed model increases as temperature increases. However, our proposed model gives much closer results to those of SIMON 2.0 than does the Uchida's model





Building a strong nanocomputing industry in Australia

Dr Steve Duvall
Director, Intel Capital

Enormous economic opportunities will be created by the development and commercialization of nano-scale technologies for computing and communications. Whether being applied to continue the historical pattern of scaling of integrated electronics or providing an alternative, the development and commercial exploitation of new materials, manufacturing and computing technologies will generate enormous economic growth over the next 10-20 years. In this talk, I will discuss emerging nanotechnologies and their prospects for application in computing and communications. I will offer perspectives on Australia's potential for contributing to the scientific and technological bases of nanocomputing and for building strong companies upon these foundations.



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pSivida's Commercialisation of Nanotechnology.

Gavin Rezos
Managing Director, pSivida Ltd



pSivida Limited is an Australian listed public company (ASX: PSD) that is committed to the biomedical nanotechnology sector. Its focus is the development and commercialisation of nano-structured porous silicon (BioSilicon") for multiple potential applications in human and animal healthcare through a UK operating subsidiary, pSiMedica Limited. pSivida's joint venture partner is the United Kingdom Government Research and Development Agency, QinetiQ Group plc (formerly DERA).

The company is focused on drug delivery with an initial emphasis in brachytherapy products, which is the short range treatment of cancer in situ, through the direct delivery of active agents into cancerous cells. Products are being developed in this area through its 90% owned subsidiary pSiOncology Pte Ltd in Singapore, a joint venture with Singapore General Hospital (SGH).

The company is also developing BioSilicon" in non-core areas such as tissue engineering, orthopaedic devices and diagnostics through collaborative ventures with specialist partners. The unique semiconductor properties of silicon and BioSilicon" further provide the company with the opportunity to develop smart devices capitalising on the use of microchips.

BioSilicon™

BioSilicon" is a biodegradable, bioactive and biocompatible form of silicon, which dissolves in the body to become silicic acid, the most common form of which is found in everyday food-stuffs.

BioSilicon" retains the key properties of silicon, but is also machineable at a micro level, and is created through a physical change in the silicon at the nano level, as opposed to a chemical change. BioSilicon" is an element, not a compound, and the resultant porous honeycomb structure from physical nano structuring mimics porous membrane structures found in nature. The rate at which BioSilicon" biodegrades is controlled through nano-structuring, thus providing a system that safely degrades in the body in days, months or years.

Competitive Advantages of BioSilicon"

- Biodegradable, biocompatible, semi conductor
- Abundant and Low Cost silicon makes up approximately 28% of the earth's crust and is freely available.
- Scale up and manufacture of silicon proven with more than 30 years experience in the electronics industry.





Nanotechnology Victoria Ltd: A new vehicle for commercializing nanotechnologies in Victoria

Dr Peter Binks, CEO
Nanotechnology Victoria

Nanotechnology Victoria Ltd was formed in September 2002, and was awarded m of Victorian Government (STI) funding to foster the development of nanotechnology in Victoria. Current members of Nanotechnology Victoria are Monash University, Swinburne University of Technology, and RMIT University.

Nanotechnology Victoria represents a new mechanism for the commercialisation of multi-discipline-based technologies. Its genesis and structure recognises both the fragmented Australian research base and the need for achieving critical mass in nanoscience infrastructure. Nanotechnology Victorias business model leverages its funding capability and commercial skills to complement the intellectual resources of its research institution members.

The commercialisation of nanotechnologies presents major challenges for Australia, particularly while its intellectual base is fragmented and development activities left largely to industry. This demands clear choices about priority areas, and requires focus on commercialisation options and strategies.

Dr Peter Binks was appointed start-up CEO of Nanotechnology Victoria on May 1, 2003. Over the last six months he has put the organisational infrastructure for Nanotechnology Victoria in place, and assisted his Board form an impressive coalition of resources for the development of commercial nanotechnologies.

Dr Binks will outline the aims and mechanisms of Nanotechnology Victoria at Oz Nano 03, and present perspectives on the commercialisation of new nanotechnologies.



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Nanocarbon Production, and Application Developemnt

Dr. Raouf O. Loutfy
MER/FIC Corporations
Tucson, Arizona USA

It has been over ten years since the development of a way to produce macroscopic quantities of fullerene, and the related discovery of fullerene nanotubes. As a result over 2000 worldwide patent have been filed for the production and applications of these new materials. These applications are so wide ranging that they extend across different industries with products from polymers (as additive), electronics (photoconductors, photo-resists, and nanoelectronics), machining (ultra-nanocrystalline diamond, and MEMs), and pharmaceutical (bioactive agents) to cosmetics. As part of the Nanotechnology exciting emerging science and technological field, fullerenes are expected to contribute to the paradigm change in our future. A brief review of the strategy to scale the production of these materials will be presented. The different applications investigated by MER/FIC will also be reviewed. The key technical results and their impact on potential applications commercialization will be presented and discussed. This will include our work on: Batteries, gas storage, (hydrogen, oxygen, CO₂), electrochemical systems (sensors, electrode materials, supercapacitors), diamond (coating and bulk), thermal protection coatings, flame retardant additives, gas separation, polymer and ceramic composites, cold cathodes for electron field emission, and filter materials for liquids and gases. An overall assessment of near term promising applications in terms of technical and economical performance, and barrier to market entry will be discussed.



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Does Nanotechnology equal macro returns? An investor's view of nanotechnology.

Dr Andrew Baker, Associate Director, GBS Venture Partners



Nanotechnology has captured the imagination of the media, politicians and scientists, yet the question remains: is there fire near all the smoke? Applications for 'nano' are potentially quite broad, encompassing materials sciences, micro fluidics, self-assembling drug delivery systems, even environmental sustainability. Terms such as revolutionary and transformational are frequently applied to this area. The challenge for early stage venture investors is to look beyond the hype and to focus on viable nano-solutions for real world problems.

GBS Venture Partners (GBS) is a leading life science investor which has been investing in Australia since 1996 in the seed, start-up or early expansion stage of company development. The GBS investment focus includes: human therapeutics and diagnostics, animal therapeutics and diagnostics, medical devices, health information technology, agribusiness, food and environmental technology.





Development of Small to Medium Business in Nanotechnology, in South West Sydney.

Michael A. Wilson, Kim Leever, Robert Creelman, Jan Temple and Adriyan Milev University of Western Sydney, Locked Bag 1797, PENRITH SOUTH DC NSW 1797.

The University of Western Sydney has a significant grant for the development of sustainable businesses based on nanotechnology in South West Sydney. These involve products used for printing, surface coating fertilisers, and absorbents. The nature of these collaborations will be discussed, together with the structure of a network developed to inform and encourage local small businesses to develop commercial nanotechnology.



Lessons Learned from three Technology Start-ups.

Ian Maxwell

Venture Partner, Allen & Buckeridge Emerging Technology Fund



My key lessons from founding three technology start-ups.

- (1) First, solve a problem that is a large and difficult problem for a big customer(s).
- (2) Two, be the only known solution for the problem.
- (3) Three, know and be known to the market you are operating in, and be able to demonstrate a deep knowledge of 'hidden information' about the market.
- (4) Four, your CEO must be experienced, articulate and out-going; first impressions with customers and investors are critical.
- (5) Five, understand the economics and costs in minute detail, and be able to predict revenues and profits.
- (6) Six, have an intellectual property position that protects your revenue forecasts - do not be an 'execution play'.
- (7) Seven, have large corporate partners and/or or customers, since these make investment in the start-up that much easier.
- (8) Eight, people matter; start-ups fail most often because the investors, the board and executive have the wrong skills or cannot work together. You have to like and respect the people you are working with, including your investors and board. When times get tough mutual respect may carry the day. And the people have to be tough and optimistic, and not get overly despondent when things look bad.

There are many other 'rules' also; this list is just a subset. I have broken many of these rules, sometimes for good and sometimes for bad reasons. Breaking these rules simply makes success harder because the start-up becomes a higher risk proposition, and in order to justify the risk, higher returns must be promised.

However, good technology that solves real problems generally gets out to market. A founder's job is to make sure that the investors and founders are amongst the people that benefit from that success. A founder/CEO should also avoid ultra-high risk opportunities simply because, unlike a venture capitalist, a founder can only work with one opportunity at a time. If the risk is too high, the opportunity becomes a 'gamble'.

Finally, the biggest hurdle is that faced by founders who actually have a good idea that addresses all the hurdles (rules) defined above. The hurdle is the time and money that is required in order to generate the information required to attract investment. A source of resources is early stage venture funds or angel investors. Often the price of early money may make the opportunity not worth the effort for founders. However, experience costs, and an experienced founder can often get a better deal than a novice. Patience is the key; it may take one or three start-ups to get that success.





Nanotechnology Investment Interest from a Pre-Seed Fund

Dr. Greg Smith, Cofounder
SciVentures Investments Pty. Ltd.

The Commonwealth Government established four pre-seed venture capital funds in 2002 under its Backing Australias Ability program. The SciVentures Pre-Seed Fund, with a .3 million fund, is one of these four PSFs.

The SciVentures PSF is a general fund with an interest in investment across a broad range of technological fields. We believe that this is essential for a 10-year, closed-end trust fund in order to reduce risk as investment interest in a specific technology may change over time for various reasons (viz, note the issues with photonics today, gobally).

To date, SciVentures has invested in opportunities in mechatronics, horticulture and chiral chemistry. Among other offers in negotiation, it also has an offer out to a nanotechnology opportunity at the time of writing this abstract.

SciVentures sees its role as one of transforming Australian publicly funded research outcomes into start-up companies that have attractive characteristics for next round private investment. It sets out to achieve this by first focussing on the development/potential of the IP strategic position and then the characterisation of the potential for a differentiated global market for the opportunity. Successful completion of these steps leads to business plan development and key executive recruiting. Early prototyping/trials with lead customers/partners is also key part of its pre-seed development process. In short, the role of pre-seed in SciVentures view is to undertake and complete all steps required for the opportunity to be an attractive next round investment

One of the principals of SciVentures has a strong background in advanced materials and nanotechnology. He has personally been associated with the commercialisation of a number of nanotechnology opportunities in major USA-based corporations. One of two of these will be described in brief case studies during the presentation.



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Patent Protection For Nanotechnology Inventions

Mark Roberts
Patent Attorney/Partner
Davies Collison Cave, Melbourne

Securing strong and commercially focused patent protection is imperative for the successful commercialisation of any new nanotechnology development. It is therefore imperative that nanotechnology researchers have a general understanding of the patent system and can identify technology developments that may warrant patent protection.

This paper provides an outline of the patent system including the rights obtained and the requirements that must be met in order for valid patent protection to be secured. In particular, the requirements of novelty, inventive step and lodgement of a detailed written application will be discussed with reference to nanotechnology inventions. A number of specific examples of successful patenting strategies relating to nanotechnology inventions will be presented, which will bring to light not only the important legal issues but will also consider commercial factors to be addressed in developing a comprehensive strategy for the patent protection of nanotechnology innovations.



Near-field Optical Nanolithography using Surface-Plasmons

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One of the oldest problems in optics is diffraction, which limits the resolution that can be achieved. Conventional lens-based optics cannot resolve objects much of the illumination used; this enables resolution smaller than the wavelength down to a few hundred nanometres for visible light, just outside the realm of nanotechnology. However, in the optical near field region – where the separation between an 'object' and its 'image' is less than the wavelength – diffraction limits can be overcome and optical techniques can be used for nanotechnology applications.

In this paper some important issues affecting optics in the near field region will be discussed. In particular, the role of surface plasmons – charge fluctuations on the surface of the 'object' – in producing sub-wavelength resolution will be highlighted. Techniques for controlling these surface plasmons for near field photolithography (patterning with light) have been investigated, with resolution down to 70 nm being demonstrated using ultraviolet light. Computer simulations show that resolution down to 20 nm (20) should be possible. In addition, a new prediction has been made that a perfect lens can be made with resolution beyond the diffraction limit for near field proximity printing. Applications for this work lie in the areas of optical microscopy, optical data storage and nanolithography for the semiconductor industry.



Intracellular Targeting of ^{10}B compounds to Solid Tumors by Transferrin-PEG Liposomes, for Boron Neutron-Capture Therapy (BNCT)

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The successful treatment of cancer by boron neutron-capture therapy (BNCT) requires the selective delivery of relatively high concentration of ^{10}B compounds to malignant tumor tissue. This study focuses on a new tumor-targeting drug delivery system for BNCT that uses small (less than 200 nm in diameter), unilamellar mercaptoundecahydrododecaborate (BSH)-encapsulating, transferrin (TF)-conjugated polyethyleneglycol liposomes (TF-PEG liposomes). These liposomes were prepared from DSPC, CH, DSPE-PEG and DSPE-PEG-COOH (2:1:0.11:0.021, molar ratio), and each liposome bears approximately 20 TF molecules conjugated via the carboxyl residue of DSPE-PEG-COOH. TF-PEG liposomes and PEG liposomes encapsulating BSH were prepared and their tissue distributions in mouse colon 26 carcinoma (Colon 26)-bearing mice after i.v. injection were compared with those of bare liposomes and free BSH. On the basis of the findings in the biodistribution studies, we selected a suitable dosage of BSH and a time point for thermal neutron irradiation for successful BNCT. We then examined the antitumor activities of liposomal BSH in combination with thermal neutron irradiation in Colon 26 tumor-bearing mice. When TF-PEG liposomes were injected at a dose of 35 mg ^{10}B /kg, we observed a prolonged residence time in the circulation and low uptake by the reticuloendothelial system (RES) in Colon 26 tumor-bearing mice, resulting in enhanced accumulation of ^{10}B into the solid tumor tissue (e.g., 35.5 $\mu\text{g}/\text{g}$). TF-PEG liposomes maintained a high ^{10}B level in the tumor, with concentrations over 30 $\mu\text{g}/\text{g}$ for at least 72 hours after injection. This high retention of ^{10}B in tumor tissue indicates that binding and concomitant cellular uptake of the extravasated TF-PEG liposomes occurs by TF receptor and receptor-mediated endocytosis, respectively. On the other hand, the plasma level of ^{10}B decreased, resulting in a tumor/plasma ratio of 6.0 at 72 hours after injection. Therefore, 72 hours after injection of TF-PEG liposomes was selected as the time point of BNCT treatment. Administration of BSH encapsulated in TF-PEG liposomes at a dose of 5 or 20 mg ^{10}B /kg and irradiation with 2×10^{12} neutrons/cm² for 37 min produced tumor growth suppression and improved long-term survival compared with PEG liposomes, bare liposomes and free BSH. Thus, intravenous injection of TF-PEG liposomes can increase the tumor retention of ^{10}B atoms, which were introduced by receptor-mediated endocytosis of liposomes after binding, causing tumor growth suppression in vivo upon thermal neutron irradiation. These results suggest that BSH-encapsulating TF-PEG liposomes may be useful as a new intracellular targeting carrier in BNCT therapy for cancer.



Nuclear magnetic resonance detection of nano-precipitate phases in dilute aluminium and magnesium alloys



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Abstract

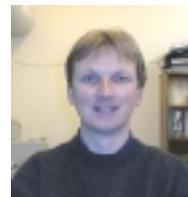
A nuclear magnetic resonance (NMR) method is described for monitoring the evolution of nano-scale precipitate structures in dilute aluminium and magnesium-based alloys. The NMR signal from the (dilute) solute species in the alloy is used to detect and characterize the different precipitate structures which form, either by the interaction of the solute species with the host, or by interaction between different solute species. Both equilibrium and non-equilibrium phases can be detected. The nano-scale ($\sim 2 - 10$ nm) and low dimensionality of the non-equilibrium species (eg. Guinier-Preston zones) make them difficult to detect and quantify by diffraction methods. The NMR technique yields a quantitative estimate of how the NMR probe element is partitioned between the various precipitate structures, leading to an estimate of the relative concentration of the phases present. In the cases presented here each of these phases is detected as a clearly resolved spectral line; a separate line is also detected for the solute species in substitutional sites in the Al or Mg host lattice. Relative concentrations can thus be estimated by determining the area under the component lines of the spectrum by graphical integration. Five examples are given of recent work in this field: (i) ^{63}Cu detection of Guinier-Preston (GP) zones and θ'' , θ' and θ -phase in Al(Cu), (ii) ^{63}Cu detection of Guinier-Preston-Bagaryatsky (GPB) zones and S, S' -phase in Al(Cu, Mg), (iii) ^7Li detection of δ' (Al₃Li) and T₁ (Al₂CuLi) phases in Al(Cu, Mg, Li) alloys, (iv) ^{27}Al detection of γ -phase (Mg₁₇Al₁₂) formation in Mg(Al) alloys, and (v) ^{45}Sc detection of Al₃Sc formation in Al(Sc) alloys.



The Use of Focused Ion Beams in the Development of Nanostructured Materials

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The focused ion beam (FIB) miller has in recent years found growing and widespread application in the characterisation of advanced materials. It is an exceptionally powerful tool in the preparation and examination of material structure and the preparation of TEM specimens from, often, very challenging materials. The emergence of the 'dual beam' FIB further expands the application of this instrument in materials development. The use, in tandem, of energetic ion and electron beams, allow three-dimensional structural, crystallographic and chemical data to be obtained routinely with minimal prior specimen preparation. Furthermore, this instrument can be used in the prototyping and fabrication of devices. Applications are found in micro machining, for example in the manufacture of diffraction gratings for optical microscopy and X-ray diffraction, in the controlled implantation of species and in the lithographic preparation of devices. In this presentation the principles of focused ion milling will be briefly outlined and a range of applications of this instrument to materials development will be described.





Sensitive Electrochemical Biosensing Platforms using Platinum Nanoparticles and Carbon Nanotubes

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Platinum (Pt) nanoparticles (diameter, 2-3 nm) were prepared and used together with single-wall carbon nanotubes (SWCNT) for fabricating electrochemical sensors with remarkably improved sensitivity towards H₂O₂. Nafion, a perfluorosulfonated polymer, was used to solubilize SWCNTs and also displayed strong interactions with Pt nanoparticles to form a network that connected Pt nanoparticles to the electrode surface. TEM and AFM micrographs illustrated the deposition of Pt nanoparticles on carbon nanotubes whereas cyclic voltammetry confirmed an electrical contact through SWCNTs between Pt nanoparticles and the glassy carbon (GC) or carbon fiber backing. With glucose oxidase (GOx) as an enzyme model, we constructed a GC or carbon fiber microelectrode-based biosensor that responds sensitively to M and a response time of 3 s.mglucose with a detection limit of 0.5

Our -aminopropyltriethoxysilane (APTES)gsecond sensing platform involved the use of to solubilize multi-wall CNTs and served an immobilization matrix for GOx to construct a mediatorless biosensor for efficiently monitoring direct electroactivity of the enzyme. Although CNTs modified by APTES acted as semiconductors to reduce the exposed sensing surface, we reasoned nanoscale "dendrites" of CNTs modified by APTES formed a network and projected outwards from the electrode surface and acted like bundled ultra-microelectrodes that allowed access to the active FAD site of GOx and facilitated direct electron transfer to the immobilized enzyme. The glucose biosensor prepared using a carbon fiber (11 m) exhibited picoamperometric current response within 5 s with detection limits of 5-10 μM.



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Gold and Silver Nanorods: Optical Properties and Vibrational Response to Laser Heating

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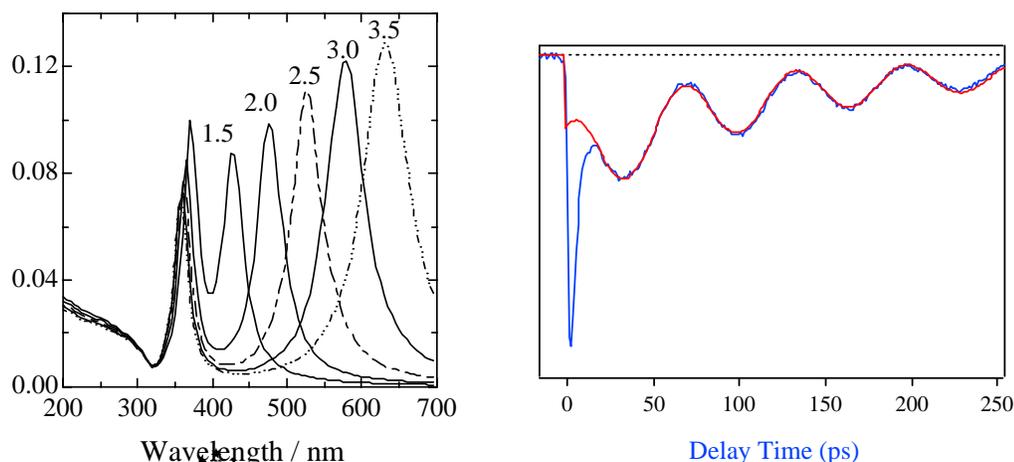
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Abstract: In this talk, we examine the optical properties of gold nanorods, some of their unusual physical properties and their behaviour when excited by short laser pulses. In the first part of the talk, we show that high laser doses can melt nanorods, causing them to convert back into spheres. Electron donation to the rods causes strong shifts in the plasmon modes as does embedding within dielectric substrates. Coating silica spheres with rods or spheres allows one to make "large" objects with optical properties close to those of the individual rods.

In the second part of the talk, we also demonstrate that laser irradiation excites vibrational modes within the rods. The breathing mode dominates the mechanical deformation of the rod and this is confirmed by finite element analysis. However, because the frequency of the fundamental extensional mode is much lower than that of the breathing mode, the extensional mode will dominate the transient optical response for a real experiment, that is, for a finite-time heating/expansion process. The results of this model are compared to data from transient absorption experiments performed on gold nanorods with average aspect ratios (length / width) between 2 and 6, and lengths between 30 and 110 nm. The transient absorption traces show pronounced modulations with periods between 40 and 120 ps, which are only observed when the probe laser is tuned to the longitudinal plasmon band of the sample. The best fit suggests the Young's modulus is significantly less than that of the bulk material.





A Modified Scanning Electron Microscope as a Nanolithography Tool

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Electron beam lithography is an important technique for fabricating devices with dimensions on the nanometre scale. The high cost of commercial electron beam lithography equipment has motivated the development of an electron beam lithography instrument based around the electron optics, sample stage, and vacuum system of a scanning electron microscope (SEM). The instrument is designed for direct-write electron beam lithography and has been used to fabricate nanoscale devices. A dedicated computer controlled pattern generator and pattern alignment system has been developed and interfaced to the deflection coils, electron detector and beam blanking of the SEM. This provides digital control of the electron beam deflection coils for exposing patterns and also enables images to be acquired for use in pattern alignment prior to exposure. A novel image correlation technique is used to align the exposed patterns with structures already on the sample. This is useful for exposing multiple layered structures that require precise alignment between successive layers. A focus compensation algorithm has also been developed to ensure that the beam is at the optimum focus during exposure. The electron beam energy may be set up to a maximum of 40 kV with beam currents from 10 pA to 1 nA. The field size may be continuously varied and is typically in the range 100 μm to 600 μm . Devices have been written on blank samples as well as accurately aligned with features already patterned on the sample. The instrument has been used to write devices which are contained within a single writing field such as nanowires, optical detectors and high electron mobility transistors. Patterns which cover several adjacent fields have also been written to fabricate diffraction gratings and optically variable devices.



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Nanoscale Electronics

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Minaturisation of electronic components has led to attempts at constructing nanometer scale electronics. The ability therefore to arrange and synthesise particles suitable to attempt the bottom up construction of such devices has therefore come to the forefront. A fundamental understanding into how electronics will behave at these dimensions is also critical. Scanning probe microscopy allows the investigation and addressability of these devices be realised. Construction of a single monolayer of monodispersed semiconductor nanoparticles at a conducting surface produces a memory storage device on the nanometer scale that can be addressed through the selective accumulation of charge on individual particles. A synthetic route producing of monodispersed semiconducting particles of varying size has shown altered electronic structure in the particles. The narrow size distribution has lent itself to the formation of monolayer arrays of these particles which can be resolved using STM. The ability to orientate and address individual nanocrystals has led to attempts at altering the electronic state of individual semiconductor particles.



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Exploring Nanomaterials Using Advanced Transmission Electron Microscopy

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With the size of a material approaching to the nanometer scale, significant changes in its properties, such as electronic and optical properties are expected. From materials science/engineering point of view, the properties of a material are closely related to its structure. For nanosized materials, the properties are intimately associated their nanostructures (size, shape and nature of defects and their distributions), surface and interface behaviours, composition distributions within the nanomaterials. Therefore, to understand the nature of nanostructure and chemistry is essential in order to fully understand their macroscopic properties. On the hand, understanding of their nanostructure and chemistry shall enable us to learn the evolution of the nanomaterials' fabrication. Consequently, it can be a fundamental guide for building/designing nanomaterials.

Advanced transmission electron microscopy (TEM) provides a uniquely powerful tool for studying the nature of defects, nanostructure and composition distribution of nanomaterials. In this presentation, several examples will be outlined, in which a wide rage of advanced TEM techniques were employed.



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Conducting Polymers in the Nanodomain

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Inherently conducting polymers (ICPs) have been an area of intense interest over the past 30 years, culminating with the award of the 2000 Nobel Prize in Chemistry to MacDairmid, Heeger and Shirakawa. More recently the unique properties of these materials (eg higher conductivity, more rapid discrete electrochemical switching processes) apparent at the nano-dimension have become accessible. Significant breakthroughs in synthesis and fabrication of inherently conducting polymers with nanodimensional control have made this possible. Examples of the preparation of nanostructured conducting polymers, nanodispersions and composites will be presented illustrating potential applications of these systems.



Design of functional liposomes and their application to drug and gene delivery

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Because liposomes can act as biocompatible and biodegradable nanocapsules, they are considered to be an ideal carrier for drugs and genes. In order to elevate their usefulness, functionalization of liposomes has been actively attempted. In this study, we designed functional liposomes by surface modification with synthetic polymers. We prepared two types of liposomes, namely temperature-sensitive liposomes and pH-sensitive, fusogenic liposomes. To obtain liposomes with temperature-sensitivity, egg yolk phosphatidylcholine liposomes were modified with various thermosensitive polymers, which change hydrophilicity/hydrophobicity in response to ambient temperature. We found that the polymer-modified liposomes were very stable below the lower critical solution temperature (LCST) of the polymer, but were destabilized intensively above the LCST, resulting in drastic release of their contents. In addition, we found that the surface property, such as hydrophobicity and charge density, of the polymer-modified liposomes could be controlled by the temperature-dependent conformational change of the polymer. We also prepared liposomes modified with pH-sensitive and fusogenic polymers. We found that the liposomes were stable at neutral pH, but were destabilized under mildly acidic conditions, resulting in intensive fusion of the liposomes. We examined cytoplasmic delivery of water-soluble compounds by using the pH-sensitive fusogenic liposomes and found that the liposomes delivered the contents into cytoplasm of the cells by fusion with endosome. Then, we attempted their use for gene delivery. Complexes of lipoplexes and the pH-sensitive fusogenic liposomes were prepared to obtain efficient gene delivery system. We found that the complexes bearing transferrin introduced gene effectively into target cells via receptor-mediated endocytosis and subsequent fusion with endosome. The functional liposomes and complexes developed in this study are expected to be useful as site-specific drug carriers and efficient non-viral vectors for gene therapy.



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G-Protein Receptor Biosensors

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Future diagnostic and biosensor platforms will require development of cell-free, high-throughput, microarray formats with "smart", bioengineered sensors mimicking the specific interactions between ligand and receptors normally occurring in cell signalling. For bio-diagnostic technologies, G-protein coupled receptors (GPCRs) are likely to have application as biosensors reporting on the many different ligands influencing physiological and pathophysiological functions. GPCRs are a large and ubiquitous class of cell membrane-associated receptors activated by a wide range of extracellular ligands, (biogenic amines, amino acids, ions, small and large peptides, and bioactive lipids) which act as hormones, neurotransmitters, chemokines etc. Signalling through these receptors regulates responses such as neurotransmission, chemotaxis, inflammation, cell proliferation, cardiac and smooth muscle contractility, and visual and chemosensory perception. GPCRs signal to numerous down stream cellular effectors via a set of heterotrimeric G-proteins (G α , G β , G γ) through GTP dependant processes. GPCRs are the target for >50% of current therapeutic drugs with drug discovery programs relying on high (and ultrahigh) throughput screening technologies.

The future development of microarray technologies for GPCRs is relevant for the development of highly specific ligands in drug discovery and for utilising GPCRs as potential biosensors. Present assays for ligand screening against GPCRs can be classified into two major categories-whole cell assays with cell-associated, down-stream signalling systems for detecting activated receptors, and homogeneous, cell-free assays consisting of membrane fragments containing (usually cloned) GPCRs. For the latter, some form of signalling/reporting system must be added if functional assays, as opposed to ligand binding, are to be used. Our strategic objective is the construction of a cell-free system to enable reconstitution and nanoconstruction onto an appropriate surface for future adaptation to microarray formats suitable for high throughput, multiplex screening.





Drug & Gene Balls: Nanostructured Colloidal Devices for Drug & Gene Discovery

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High Throughput Screening of compounds on miniaturized, inexpensive platforms is key to the revolution taking place in the biotechnology industry. This is particularly so in relation to novel drug target/lead identification and drug development. Chip based technologies offer a possible solution, however are currently limited by high cost and the restricted number of compounds (<105) that may be displayed on the two-dimensional surface of the chip. We shall present an alternative method, developed within our group¹⁻⁵, of screening extremely large (>1010) compound libraries on extremely cheap platforms: encoded colloidal suspensions. The colloidal suspensions are produced via combinatorial chemistry procedures, however are optically encoded for rapid and unique recognition of each individual compound. Once encoded, these particles may be screened at rates of 30 000 – 100 000 compounds per second on a conventional flow cytometer. Potential applications include High Throughput Screening in the areas of Genomics, Proteomics, Drug Discovery and Diagnostics.

1. Battersby, Trau, et al., Chem. Commun. 14, 1435-1441 (2002)
2. Trau, Battersby, Adv. Materials, 13, 975 (2001)
3. Battersby, Lawrie, Trau, Drug Discovery Today, 6, 123 (2001)
4. Trau et al., J. Am. Chem. Soc. 122, 2138 (2000)
5. Trau et al., Science 272, 706 (1996)



The Bio-mimetic Approach in Nanotechnology

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Nature provides us with the ultimate example of nanotechnology in action, i.e. in the way complicated processes take place within and between living cells. Examples - exonucleoase[1] but this circular include "molecular machines" such as the (toroidal) enzyme threads onto DNA and then performs multiple rounds of catalysis before it dissociates, and hence it is said to be processive, resembling many industrial machines but operating on the nanometer scale. Another inspiring example for Nature comes from the electron transport chain in the mitochondria. Here, electrons (energy) move from one nanoscale complex to another in a highly efficient and directional manner, an elegant example of a bioelectronic circuit.

This paper describes attempts to mimic the above Natural processes in order to make functional nanodevices based on these systems but free of the restraints that a cellular environment puts on these systems. In the case of processive molecular machines an analogous system was made by threading a synthetic catalyst (porphyrin) onto a polymer (polybutadiene).[2] The catalyst, which is only about 1-2 nm in diameter, was shown to modify the polymer in a processive manner as it ran along the polymer. This system is one of the best examples of a "nanomachine" to date, pointing to a novel way of modifying both synthetic and natural polymers (e.g. DNA). A second project aimed at making a bio-electronic device based on the electron transport chain will also be presented. In this system the main goal is to be able to switch the system on and off on demand with chemical- or light-stimuli. The design, initial results and some potential applications of this approach will be discussed.

[1] R. Kovall, B. W. Matthews, *Science*, 1997, 277, 1824.

[2] P. Thordarson, E. J. A. Bijsterveld, A. E. Rowan, R. J. M. Nolte, *Nature*, 2003, 424, 915.



Ion Channels as Membrane-Bound Nanoscale Control Elements

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Ion channels are membrane-bound proteins that transport charged particles across the lipid membranes of cells. Much of the initial literature described the properties of ion channel proteins in terms of electrical circuit analogues derived from the analysis of electrophysiological recordings, especially from the technique of single microelectrode voltage-clamp of micron sized patches of cell plasma membrane ("patch-clamping").

Many ion channel proteins have been sequenced, and more recent work in nanoscale cell physiology is uncovering complex control pathways that rely on the function of ion channels. That type of understanding at the cellular level is allowing the manipulation of ion channels as important components in nanobiotechnology applications, including extremely sensitive nanosensors.

We report our research into 2 different ion channels. The first is the induction of an ATP-sensitive potassium channel in genetically-engineered liver cells (HEP G2ins/g). The HEP G2ins/g cells were engineered [1] to secrete insulin in response to a glucose stimulus at physiologically-relevant concentrations. Our recent work demonstrates that the ATP-sensitive potassium channel is an integral part of the control loop for the glucose-stimulated secretion of insulin. The genetically-engineered liver cells are aimed at providing a replacement for non-functional pancreatic β cells, thereby reversing type I diabetes.

The second is a chloride channel, CLIC1, which is a member of the highly conserved class of intracellular chloride channels that exist in both soluble and integral membrane forms. CLIC1 was the first nuclear chloride channel cloned and we produced the first electrophysiological evidence for this channel by patch-clamping the lipid membrane of the cell nucleus [2]. Subsequent work has confirmed its activity as an ion channel-forming protein [3]. The crystal structure of the soluble form of CLIC1 has been recently solved at 1.4-Å resolution [4]. We will discuss our recent success in imaging CLIC1 protein in a lipid membrane using atomic force microscopy. The use of atomic force microscopy is allowing us to investigate the fundamental interactions of CLIC1 with a lipid membrane. Such information of the nanoscale interactions of CLIC1 will assist in its nanotechnological application.

References:

1) Simpson AM, Marshall GM, Tuch BE, Maxwell L, Szymanska B, Tu J, Benjon S, Swan MA, Camacho M (1997). Gene therapy of diabetes: glucose stimulated insulin secretion in a human hepatoma cell line (HEP G2ins/g). *Gene Therapy*. 4:1202-1215





2) Valenzuela SM, Martin DK, Por SB, Robbins JM, Warton K, Bootcov MR, Schofield PR, Campbell TJ, Breit SN (1997). Molecular cloning and expression of a chloride ion channel of cell nuclei. *Journal of Biological Chemistry*. 272:12575-12582

3) Warton K, Tonini R, Fairlie WD, Matthews JM, Valenzuela SM, Qiu MR, Wu WM, Pankhurst S, Bauskin AR, Harrop SJ, Campbell TJ, Curmi, PG, Breit CN, Mazzanti M (2002). Recombinant CLIC1 (NCC27) assembles in lipid bilayers via a pH-dependent two-state process to form chloride ion channels with identical characteristics to those observed in chinese hamster ovary cells expressing CLIC1. *Journal of Biological Chemistry*. 277:26003-26011

4) Harrop SJ, DeMaere MZ, Fairlie WD, Rextsova T, Valenzuela SM, Mazzanti M, Tonini R, Qiu MR, Jankova L, Warton K, Bauskin AR, Wu WM, Pankhurst S, Campbell TJ, Breit SN, Curmi PG (2001). Crystal structure of a soluble form of the intracellular chloride ion channel CLIC1 (NCC27) at 1.4- Å resolution. *Journal of Biological Chemistry*. 276:44993-45000





Influence of nano-domain on conducting properties in doped CeO₂ solid electrolyte

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Doped ceria (CeO₂) compounds are fluorite related oxides which show oxide ionic conductivity higher than yttria stabilized zirconia, in oxidizing atmosphere. As a consequence of this, considerable interest has been shown in application of these materials for solid oxide fuel cells. In this study, the microstructures in rare earth (i.e. Sm, Gd, Y) doped CeO₂ were observed using high resolution transmission electron microscope (HR-TEM). The diffuse scattering without extra spots was clearly observed in electron diffraction pattern of fluorite symmetry. This diffuse indicates that doped CeO₂ has coherent micro-domains with ordered structure. The results in this study tell us that the conducting property in doped CeO₂ sintered body is strongly influenced by domain size. We will show you some results and propose how we can minimize domain size and maximize conducting property in the sintered body.



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Cinema to help Educate People about Nanotechnology

Justin Gooding
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Cinema is a very powerful medium for opening people's minds to the new ideas and events. For example, much would many of us know about Steve Biko without the film Cry Freedom or Oscar Schindler without Schindler's List. Science also has a strong tradition in cinema, not just through science fiction but also through a variety of other films which use science with which to establish the plot. Usually this means once the science is used as a convenient vehicle for which to establish the plot the film then slips into a more established genre such as the adventure film (think of Jurassic Park) or the romance film (Gattaca is a good example). There are however some films where the science appears and reappears throughout the film (e.g. Outbreak) which makes them valuable for education. The fact that the science is often distorted and the films not what we would call classics does not however compromise their value for education. At the University of New South Wales we have established a general education course called Cinema and Science to open up scientific ideas to a students with a non science background. In this talk I will discuss the course and how it works followed by sharing some ideas about the emergence of nanotechnology in cinema and how that could be useful in nanotechnology education. Nanotechnology in cinema possible started with The Fantastic Voyage, with more recent films which address nano ideas including Gattaca and Spider Man with the new Michael Crichton film soon to follow.



What is TAFE NSW doing playing with emerging technologies?

Traditionally, Australia's capacity to develop and apply emerging technologies has been largely derived from its strong R&D community – universities, CSIRO, DSTO, industry sectors and, more recently, Cooperative Research Centres. This community has developed significant expertise in pockets of technology. However, just focusing on developing expertise is no longer sufficient. This narrow R&D community cannot alone provide the productivity solutions to future industries. Within that R&D community, the vocational education and training (VET) sector, particularly TAFE NSW through its TAFE Industry Partnership Centre, is increasingly being acknowledged as having a significant role to play in knowledge and skills transfer, as leading edge R&D becomes translated into commercialised products and services.



This technology transfer role is an emergent role for the VET sector and is premised on the notion of a National Innovation System where industry, government and the education sector work synergistically together to build a nation's capacity to innovate and compete in a global economy.

In New South Wales, the Australian Technology Park (ATP) in inner-city Sydney provides an environment that encourages the growth of research and innovative technological development and the incubation of new business models. The TAFE Industry Partnership Centre, located at ATP, has enabled TAFE NSW to gain significant leverage from the advantages of this location by facilitating the early adoption of emerging technologies and skill transfer into the TAFE sector, in ways that have not been matched by any other Australian State or Territory. The roles and functions of the TAFE Industry Partnership Centre are unique within TAFE NSW and within the VET sector, generally. This session provides an insight into one of the roles and functions of the Centre and the challenges presented to the VET sector by emerging technologies, including nanotechnology.

Session presenter:

Bronte Price
Director, TAFE Industry Partnership Centre





Science Outreach and Nanotechnology

Rebecca Hurrell
Science Outreach Programme
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The University of Canterbury has a well established Science Outreach Programme which aims to enhance science education and to encourage secondary school students to study more science subjects to higher levels. The programme targets 15 and 16 years olds with informative and fun presentations on topical issues in science and technology. Presentations have been developed in collaboration with researchers in the science and engineering departments at the University, with topics ranging from 'Issues in the Atmosphere' to 'Nanotechnology: the future of electronic devices'. Over 400 presentations on 20 topics have been given so far this year. The programme has also run a number of very successful workshops for teachers in an effort to strengthen ties between the University and the secondary school teaching community. New workshops are under development focusing on physics in the high school curriculum, with a number of activities on nanotechnology and materials science to introduce teachers to these areas of research.

The aims and activities of the programme will be discussed as well as the perceived impact the programme is having on schools in New Zealand.



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Current Research and High Education on Nanostructured Semiconducting Materials in the Institute of Materials Science

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An overview of current research and high education (MsC and PhD) on nanostructured semiconducting materials in Vietnam is presented. The following materials have been fabricated and studied: Photoluminescence nanocrystalline porous silicon prepared by electrochemical method; Silicon nanocrystals implanted and embedded in SiO_x ($x \leq 2$); Nanostructured silicon thin films prepared by DC and RF sputtering; Ge/Si quantum dots prepared by MBE deposition; CdS nanocrystals dispersed in porous silica prepared by Sol-gel technique; Nanocrystalline diamond-like thin films prepared by HF-CVD and carbon nanotubes by CVD.



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Establishment of Undergraduate Degrees in Nanotechnology

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School of Chemistry, Physics and Earth Science
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Justin Gooding
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Mark Ogden
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The teaching of nanotechnology was pioneered in Australia. Now several universities in Australia and overseas have various offerings examining Nanotechnology or Nanoscience. This presentation will concentrate on some of the degrees offered in Australia, the constraints that apply to their establishment and the reasoning behind the decisions made during that establishment. Finally, a path to a national strategy for Nanotechnology education in Australia will be discussed.

Joe Shapter

Ph. D. from the University of Toronto in 1990 working with Dr. J. C. Polanyi on the detection of small molecules and the determination of their energies.

From 1990 to 1996, worked at the University of Western Ontario (London, Ontario) building a scanning tunneling microscope and lecturing first year chemistry.



In 1996 moved to Flinders and is now a Senior Lecturer

Course Coordinator for the Bachelor of Science Degree in Nanotechnology.

Our group examines individual molecules via STM to determine their properties with an eye to using molecules for either detection mechanisms or as the basis for electronics.



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Justin Gooding

- D. Phil. From Oxford University in 1994 with Professor Richard Compton on heterogeneous reaction kinetics at a nonconducting solid/solution interface
- From 1994-1996, began research into electrochemical biosensors at the Institute of Biotechnology, Cambridge University
- Moved back to Australia to become a Vice-Chancellor's Post-Doctoral research fellow at UNSW as his first independent research position investigating molecular level fabrication of biorecognition interfaces
- Commenced a lectureship at Flinders University in 1998 before returning to UNSW as a lecturer and then Senior Lecturer at UNSW in 1999 where he leads a research group investigating nanoscale modification of electrodes and other surfaces.



He was heavily involved in the development of the UNSW nanotechnology degree

Undergraduate Nanotechnology at UTS

Mike Ford

UTS Institute of Nanoscale Technology, University of Technology, Sydney
PO Box 123, Broadway, NSW 2007, Australia



There is a clear demand for training students in the tools of Nanotechnology at the tertiary level in order to provide expert man power for nanoscience research and the potential nanotechnology industry. The question arises as to whether this can be done successfully at the undergraduate level or whether it lies within the realm of post-graduate education ? A number of Australian universities, UTS included, have now established undergraduate nanotechnology programs. This paper will outline the structure and rationale of the UTS degree.





Nanotechnology Education at Curtin University of Technology

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The Nanotechnology degree at Curtin University of Technology commenced in 2002, with a modest intake of students to the course. In 2003, 23 students were accepted into the degree, and interest in the course appears to be increasing judging by attendance at Open Day activities and related public events. The Departments of Applied Physics and Applied Chemistry teach the majority of the course. The degree structure was developed such that graduates will be eligible for membership of the professional societies of chemistry and physics. This presentation will describe the existing course structure, some plans for the future, and the challenges that have been encountered along the way.

Bachelor of Science (Nanotechnology) Program at University of Western Sydney

Michael A. Wilson, Saravanamuthu Maheswaran and G.S. Kamali Kannangara

College of Science, Technology and Environment, University of Western Sydney, Locked Bag 1797, Penrith South DC, NSW 1797, Australia

A significant recent trend in scientific and technological developments towards nanotechnology has led to an ever-increasing demand for the graduates with skills in this rapidly expanding field. In order to be at the forefront of these global technological advancements and demands, the University of Western Sydney will offer new specialist degree courses in areas of cutting edge sciences including an undergraduate degree in nanotechnology. The Bachelor of Science (Nanotechnology), which will be offered from 2004, will give students highly specialised skills in the exciting area of nanotechnology, a modern science that has the power to dramatically transform the world around us. The field involves studies across many disciplines, including physics, chemistry, biology, materials and engineering. This extremely interdisciplinary degree course offers the opportunity to study all of these disciplines, with an emphasis on the advancements taking place in the boundaries between the different sciences. During the undergraduate program, the students will have an opportunity to be involved in 'real-life' nanotechnology projects. For example, UWS is now joining forces with the Federal Government to bring nanotechnology to businesses and industries in the Campbelltown-Camden region - helping them to identify ways to incorporate nanotechnology into their manufacturing. This program aims to increase the enrolment of high-achievers, allowing the graduation of high-calibre graduates who would secure employment in the industries of Greater Western Sydney and beyond in accordance with the UWS Strategic Plan 2003 - 2005. For more information, visit our website:

<http://handbook.uws.edu.au/hbook/course.asp?course=3591>



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Department of Education,
Science and Training

Undergraduate Laboratories designed for Nanoscience students

ERIC WACLAWIK

Inorganic Materials Program, School of Physical and Chemical Sciences,
Queensland University of Technology, GPO Box 2434, Brisbane ,Australia,
4001



Establishing a complete course in nanotechnology and nanoscience that will appeal to undergraduates should give them the hands-on experience with the techniques and scientific principles they need in order to construct nanoscale materials and devices. By way of example, a short overview of the nanotechnology practical program conceived at Flinders University will be given to show how nanoscience concepts can be taught and demonstrated within the undergraduate laboratory.

Nanotechnology Laboratory Demonstration

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As part of the Nanotechnology Education section of the conference there will be two laboratory demonstrations.

In the undergraduate course students are exposed to a large amount of new and innovative research in Nanotechnology. Unfortunately, it is difficult to include such new areas into an undergraduate lab setting due to facilities, time and cost constraints. However, by concentrating on the underlying basic science behind the current advances in Nanotechnology it is possible to use existing physical science experiments and develop new experiments with an emphasis on Nanotechnology.

The experiment that I will demonstrate will be Quantized Conductance, which demonstrates the quantization of conductance in a micro-fine wire. The theory behind this experiment relies on some quantum mechanical principles and demonstrates how a simple experiment can be related to a complex topic which has applications in Nanotechnology.

It is hoped that these demonstrations will encourage other universities and educational institutions to incorporate nanotechnology into their curriculum.





Bridging the scientific landscape

Telescience and the NANO-MNRF

Dr Peter Hines,
Telepresence Project Manager, NANO-MNRF.



The Nanostructural Analysis Network Organisation (NANO) Major national Research Facility (MNRF), is the peak Australian facility for nanometric analysis of the structure and chemistry of materials in physical and biological systems. NANO as an organisation spans thousands of kilometres, with core nodes in Brisbane, Sydney, Melbourne and Perth. Through the development of telescience capabilities, NANO aims to improve access to its instrumentation and facilitate collaboration between researchers across the nation.

This seminar examines the technical, organisational and human challenges of telemicroscopy. Two levels of remote access are being developed at NANO: passive, where a local operator interacts with a remote investigator who has access to live microscope images; and active telemicroscopy where the remote investigator also has direct control of the microscope. Initiatives under development at the NANO-MNRF will be showcased, including remote operation of an FEI XL30 SEM.



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