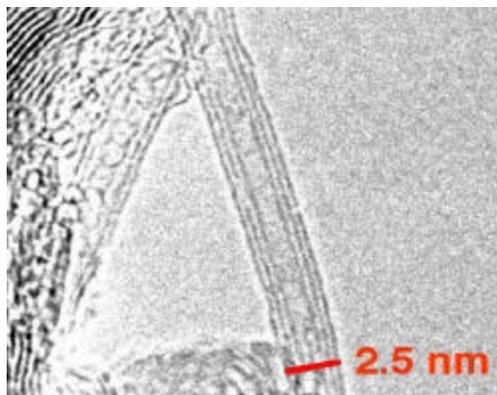


# Materials Monthly

Making materials matter

May 2001

## Talk about tiny tubes



They are 50,000 times thinner than a human hair, and many materials scientists believe they will be the wonder material of the 21st century. It could be they will serve as the key that unlocks new potential from the emerging science of nanotechnology. They are – of course – nanotubes, and our understanding of how to build and use them is growing at an explosive rate.

At the beginning of May, the ANU Research School of Physical Sciences and Engineering hosted a workshop that brought together some of the leading lights of the nanotube world to discuss the science, synthesis and application of nanotubes.

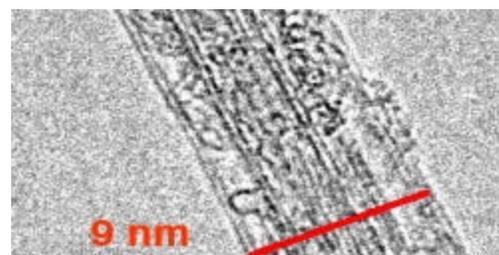
Nanotubes are hollow cylinders of atoms with a range of unique properties: structural, electrical and chemical. They were only discovered a decade ago when a Japanese scientist was experimenting with different ways of synthesising buckyballs using arc-evaporation. By training a high resolution electron microscope onto a previously unexplored part of his experimental chamber he became the first to recognise tubes of carbon atoms – nanotubes. Since then it's been discovered that nanotubes can be created using a variety of methods working with a range of elements, not just carbon.

Nanotubes are still difficult to manufacture, but their potential is enormous. It's believed they might provide us with a new generation of high-strength, light-weight materials; they

could serve as 'fountain pens' that deposit atoms instead of ink; their electrical properties means they'd make great nano circuits; and they may be engineered to build engines with gears only two nanometres across. And working nanotube technology is already coming out of the labs with Samsung producing a prototype version of a flat panel display screen where electrons are fired at a screen from the tips of nanotubes.

Researchers at ANU are leading nanotube science in the areas of boron nitride (BN) nanotubes. While the structure of BN nanotubes is similar to that of carbon nanotubes, they possess significantly different properties, such as thermal and electronic conductivity and resistance to oxidation. Adding to the interest, BN nanotubes are being produced at ANU using quite novel techniques involving the ball milling of boron powder at room temperature followed by heating the resulting nanosized powder in nitrogen gas. This work represents a breakthrough in nanotube preparation and opens a whole new research area for nanotube studies. The latest ANU advances in building, characterising and using BN nanotubes was presented at the May workshop.

Exactly how far nanotube science and technology will take us is anyone's guess but at this early stage it seems the sky is the limit.



Boron nitride (BN) nanotubes grown by Dr Ying Chen (RSPHysSE) and imaged by Dr John Fitzgerald (RSES), one of the speakers at the May nanotube workshop. In the centre of the top image is a hollow nanotube with just 3-layers of BN. The image above shows a rope of similar nanotubes. These images came from a high-resolution transmission electron microscope.

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# Direct from the Director

Phil Evans, Forestry Department

One of the reasons for the establishment of CSEM was to facilitate better public relations and interactions between the material scientists on campus and the broader community. With this end in mind we have steadily built up the circulation of the newsletter and increased the ease of access to our web-site.

Two initiatives have recently enhanced CSEMs profile locally. First, we held a highly productive meeting with representatives from the Chief Ministers Department of the ACT Government. Academics from the various research schools and departments that comprise CSEM described the commercially orientated materials sciences R & D being undertaken on campus.

Craig Richmond of the Business Assistance Programs, outlined how the ACT Government supports R & D. He clearly articulated the point that the ACT Government is keen to support and capitalise on the R & D in materials science that is being done at the ANU. The Government has committed \$3 million dollars to support R & D that has the potential to attract investment into the ACT. Details of this scheme can be found at <http://www.business.act.gov.au/>.

Further opportunities are also available and during the meeting Angelo Zorbas of the ACT Industry Search and Opportunities (ISO) offered to register those CSEM members interested in acting as consultants to local industry. I have forms to enable you to register with ISO and I hope that many of you will take advantage of this opportunity.

CSEM also took advantage of Science week to promote the Centre's activities. We were part of a very popular stand on Forensics science at the National Convention Centre that

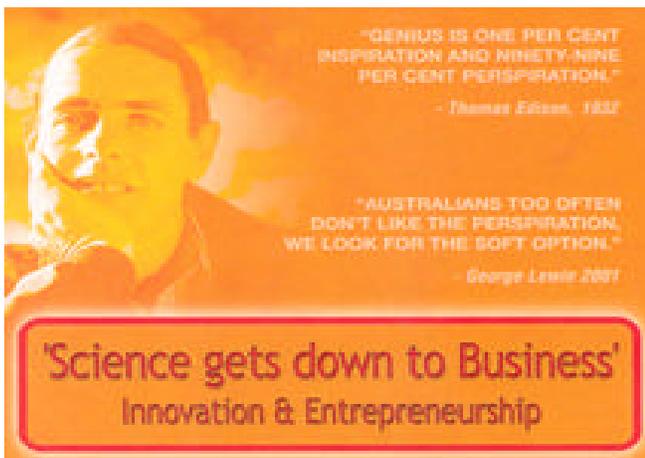
also involved UCAN, CIT and the AFP.

Our display highlighted the important role that materials science plays in the analysis of evidence (paint, glass, plant fibres, fabric etc) left at crime scenes. The stand (see below) featured a mock crime scene with various pieces of incriminating evidence. It proved very popular with the public and my thanks to Nick Welham, David Salt (our new communications officer, see page 5) and Jenny Edwards for helping with our part of the display. We're using the connection between materials science and forensics to attract undergraduate and postgraduate students to the ANU. More on that subject in next month's



**Above:** CSEM took part in the ACT World of Science forensics display, part of this year's Australian Festival of Science. The CSEM display highlighted the role materials science plays in many forensics investigations. A baseball bat lay next to the dead person, and the display showed how investigators might only need a sliver of wood to allow it be identified as having come from the bat vital information when the murder weapon is not at the scene of the crime.

**Left:** Part of the Business ACT website.



# Photovoltaic Materials *on Campus*



## Photovoltaic Research Group

### Department of Engineering

The ANU Photovoltaic Research Group is part of the ANU's Centre for Sustainable Energy Systems. The group was established in 1992 to conduct research in photovoltaics and promote innovation in this field. Here is some of their current research:

#### Epilift Technology

About half the cost of a conventional photovoltaic module is the silicon wafers. Processing the wafers into solar cells, electrical interconnection & encapsulation constitutes the other half of the cost. The Centre has developed a thin crystalline silicon solar cell technique called Epilift. In this process a thin layer of silicon (50 microns) is grown on a conventional silicon wafer. The grown layer is peeled off and converted into a solar cell, while the silicon wafer substrate undergoes many further growth and peel cycles. The cost of silicon ingot sawing is eliminated and the quantity of silicon per solar module is reduced by a factor of about 5.

#### High Performance Solar Cells and Concentrators

High-performance silicon solar cells for concentrator systems in the range 10-60 suns are being manufactured. An elegant process sequence allows high efficiencies (20-24%) to be obtained at moderate cost. Several thousand cells were fabricated for a 20 kW demonstration photovoltaic/trough concentrator system at Rockingham in Perth.

Concentrator receivers for use with parabolic trough concentrator systems have been developed. One version has a light weight, high-performance, patented, aluminium-fin heatsink. Another version has water cooling. The receivers feature thermal cycling stress relief, bypass diodes, high-quality encapsulation and high-performance silicon concen-

trator solar cells.

#### Multicrystalline Silicon Solar Cells

Cells on multi-crystalline silicon substrates with efficiencies above 18.6% have been fabricated using substrates provided by commercial solar cell manufacturers. Record minority carrier lifetimes and open circuit voltages have been obtained. Skills in the area of process control, gettering, texturing of multi-crystalline silicon, preservation of cell blue response, silicon/metal contact behaviour and cell fabrication have been developed. Current research activities aim at increasing the performance of commercial grade multi-crystalline silicon.

#### Characterisation of Semiconductors and Photovoltaics

The Department of Engineering has excellent facilities for the characterisation of semiconductors and photovoltaic devices. There is particular expertise in the measurement and monitoring of minority carrier lifetime and surface recombination processes. Innovative work has been done in the area of photoconductance testing of the minority carrier lifetime and other relevant physical parameters. Testing equipment for spectral response and cell efficiency has been developed for commercial applications. A new simple method for measurement of solar cells under concentrated light using a flash lamp has been developed.

#### Silicon Processing Technologies

A wide expertise exists in the basic technologies used for semiconductor processing: dopant diffusion, oxidation, photolithography and epitaxial growth. Research work has optimised these technologies with a particular emphasis on the fabrication of solar cells.

#### Modelling

Theoretical modeling of semiconductor devices, in particular solar cells, is an ongoing activity that supports the experimental work. One dimensional and three dimensional computer simulation packages are available. Members of the group have contributed to the development of analytical models for a physically intuitive, approximate modelling of semiconductor devices.

#### Further information

Centre for Sustainable Energy Systems  
Department of Engineering  
The Australian National University  
CANBERRA ACT 0200 AUSTRALIA

[solar@anu.edu.au](mailto:solar@anu.edu.au) / <http://solar.anu.edu.au/>





# Jobs & Scholarships



## Australian National University

**Research Fellow in Bio-Robotics (closes 30/5/01)**  
Research School of Physical Sciences and Engineering  
<http://www.anu.edu.au/hr/jobs/academic.html#ise274>

## Overseas

**EEC Research Fellowship in Lithium-in-Silicon Nano-structured Anodes for On-chip Battery Applications (closes 13/7/01)**

Imperial College, London  
<http://jobs.ac.uk/jobfiles/HJ010.html>

**Post-doctoral Research Fellowship in Nanocomposite Modelling and Simulation (closes 22/6/01)**

**Post-doctoral Research Fellowship in Nanocomposite Synthesis and Processing (closes 22/6/01)**  
Department of Materials, Queen Mary, University of London  
<http://jobs.ac.uk/jobfiles/BC950.html>

**Post-doctoral researcher: Airborne Particle Exposure Pathways in the Indoor Environment (closes 8/7/01)**

National University of Ireland  
<http://jobs.ac.uk/jobfiles/IE665.html>

**Post-Doctoral Research Associates and Studentships: Biosynthetic human dermis (2 positions) (closes 1/6/01)**

University of Sheffield  
<http://jobs.ac.uk/jobfiles/IE658.html>

**Post-doctoral Research Associate, Surface/Interfacial Science (closes 1/6/01)**

University of Cambridge  
<http://jobs.ac.uk/jobfiles/HI973.html>

**Postdoctoral Research Fellow, Polymer Research (closes 4/6/01)**

University of Surrey  
<http://jobs.ac.uk/jobfiles/HI945.html>

**Oppenheimer Research Fellowship, colloid science and surface chemistry (closes 31/5/01)**

University of Cambridge,  
<http://jobs.ac.uk/jobfiles/HI881.html>

**Research Fellowship / PhD Studentship, Raman Spectroscopy (closes 15/6/01)**

Imperial College, London  
<http://jobs.ac.uk/jobfiles/HI819.html>

**Engineering Doctorate, Engineered Metals for Aerospace (closes 19/6/01)**

University of Birmingham  
<http://jobs.ac.uk/jobfiles/BC866.html>

**Directorship, Advanced Wood Products Laboratory, (closes when filled)**

Georgia Institute of Technology, Atlanta  
more info, contact Prof Check Eastman  
[chuck.eastman@arch.gatech.edu](mailto:chuck.eastman@arch.gatech.edu)

## For Your Diary

- |   |   |
|---|---|
| <ul style="list-style-type: none"> <li> <p> <b>Materials for Advanced Technologies (ICMAT)</b><br/>           International Conference, Singapore<br/>           see <a href="http://www.mrs.org/sg/icmat2001">www.mrs.org/sg/icmat2001</a> </p> </li> <li> <p> <b>Advanced Engineered Wood Composites (AEWC)</b><br/>           2nd International Conference, Bethel, Maine, USA<br/>           see <a href="http://www.aewc.umaine.edu/conferences/default.htm">www.aewc.umaine.edu/conferences/default.htm</a> </p> </li> <li> <p> <b>Advances in Materials and Processing Technologies (AMPT)</b><br/>           International Conference, Madrid, Spain<br/>           email: <a href="mailto:congrega@fund.uczm.es">congrega@fund.uczm.es</a> </p> </li> <li> <p> <b>European Panel Products Symposium</b><br/>           5th International Conference, Llandudno, Wales<br/>           see <a href="http://www.bc.bangor.ac.uk">www.bc.bangor.ac.uk</a> </p> </li> <li> <p> <b>Composites Technologies for the Future</b><br/>           3rd Asian-Australasian Conference, Auckland, New Zealand<br/>           see <a href="http://www.cce.auckland.ac.nz/accm">www.cce.auckland.ac.nz/accm</a> </p> </li> </ul> | <p>1-6 July</p> <p>14-16 August</p> <p>18-21 Sept</p> <p>10-12 October</p> <p>31 Jan - 2 Feb 2002</p> |
|---|---|

# Archived in Art

It's exceedingly unlikely you'll ever see a cabinet made from pink gum, brown stringybark and mugga ironbark (relatively obscure native timbers from South Australia). It's even more unusual to see wood veneer baskets using the now rare Victorian waratah, kanuka box and lillipilli satinash. And yet that's exactly what you'll find together with other exquisite objects of art crafted from timbers from around Australia when you visit the unique 'Rings of History' exhibit now on show at Craft ACT (1st floor, North Building, 180 London Circuit, Canberra).

'Rings of history' is fusion of art, history and materials science. It combines the inspiration of some of Aus-



A visitor at the opening of 'Rings of history' has a closer look at 'Rain dance' by Western Australian artist Peter Lowe. The work was crafted from a variety of woods including broome bloodwood and western woody pear.

tralia's leading wood artists with off-cuts from Australia's largest and most significant wood reference set – the Dadswell timber collection. Originally assembled between 1929 and 1932 by scientists from CSIR (CSIRO's predecessor), the collection serves as a wood library for the identification of all timbers grown in Australia. It contains samples from 260 hardwoods (including 143 species of eucalypt), and 26 species of indigenous and introduced softwoods.

But CSIRO only needed small samples for their reference work and the bulk of the wood eventually ended up in

storage at ANU's Department of Forestry, curated by Phil Evans and Peter Beutel. Time has taken its toll on the samples and Evans was keen to explore ways of using the timber that might preserve their character while allowing more people to access them – keeping in mind that many of these timbers are now very rare.

'Rings of History' was the innovative solution. The idea was to turn the samples into works of art where their inherent beauty is on show for all to see, and their ongoing care is assured. Billets of the rare wood were offered, via Craft ACT, to artists from all over the country and the resulting exhibit is now open to the public.

Launched during National Science Week, 'Rings of history' forms part of the multi-venued METIS – Exhibitions of Science and Art. The exhibition is on show in Canberra at Craft ACT up until 3 June, after which it will tour the country. For more details contact Craft ACT on (02) 6262 9333.

## New faces at CSEM

It is with excitement and hope - and a little fear and trepidation - that I take on the role of Communication and Student Recruitment Officer for CSEM. The excitement lies in the potential CSEM holds for catalysing great science and attracting top-notch science students. The fear and trepidation comes with getting a grip on the complexity of the many groups that make up CSEM and understanding its varied interactions

While not a complete stranger to Canberra, I am new to ANU and I have a lot of learning ahead of me to understand its labyrinthine ways. For the past two years I have been based in Sydney where I was the inaugural editor of a new popular science magazine called *Newton*. Before that I was the Communication Manager at CSIRO Wildlife and Ecology (Gungahlin, ACT) for two years and before that I was the editor of a student science magazine titled *The Helix* (for CSIRO). In one way or another I've worked with most of Canberra's science institutions but never as an ANU insider.

I'm taking over from Jenny Edwards who has recently given birth to Seamus and wants some quality 'mum' time at home. Jenny has done a sterling job in establishing *Materials Monthly*, revamping the CSEM website and setting in train many initiatives that are now starting to give real edge to CSEM's public face. She has given definition to many of the ideas that were circulating when CSEM was first created. I hope I can continue what she has started and maybe start a few programs of my own.

And while on the topic of new faces, CSEM also has a new Admin Officer with Sylvana Ransley taking over from Amanda Cook.

So, if you have any ideas or thoughts on how we might make CSEM more effective, please drop us a line.

## More on Nanotubes

### Nanotubes at ANU

Background and links on BN nanotubes  
[www.rphysse.anu.edu.au/nanotube/index.htm](http://www.rphysse.anu.edu.au/nanotube/index.htm)

### All aboard the nanotube

Worldlink, a good general article  
[www.worldlink.co.uk/discuss/msgReader\\$227](http://www.worldlink.co.uk/discuss/msgReader$227)

### Carbon nanotubes

A good central nanotube reference site  
[www.rdg.ac.uk/~scscharip/tubes.htm](http://www.rdg.ac.uk/~scscharip/tubes.htm)

### The Nanotube Site

Another good central reference site  
[www.pa.msu.edu/cmp/csc/nanotube.html](http://www.pa.msu.edu/cmp/csc/nanotube.html)

## Use and abuse of fibre evidence - a cautionary tale -

**Wednesday, 30 May 2001 - 7.30pm**

Drawing on his personal involvement in three murder cases from three continents, Dr James Robertson, Director of AFP's Forensic Services, will discuss the use of fibre examination in major crime investigation.

A fascinating lecture put on by the Australian and New Zealand Forensic Science Society. Seating is limited so bookings are essential.

**Where: Auditorium, Canberra Hospital, Woden**

**Cost: members \$2 / students \$5 / non-members \$10**

**Bookings: 6287 0636 or [clifton.frost@afp.gov.au](mailto:clifton.frost@afp.gov.au)**

# CSEM

Centre for Science and Engineering of Materials

#### Faculties

Department of Chemistry  
Department of Engineering  
Department of Forestry  
Department of Geology

#### Institute of Advanced Studies

Research School of Biological Sciences  
Research School of Chemistry  
Research School of Earth Sciences  
John Curtin School of Medical Research

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**We welcome any feedback, enquiries or contributions.**

**Please let us know if you wish to be added to our electronic or postal mailing lists.**

Electronic copies of *Materials Monthly* can be accessed at:

[www.anu.edu.au/CSEM](http://www.anu.edu.au/CSEM)