

# Materials Monthly

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Centre for Science and Engineering of Materials

## *Rapid Prototyping* Art & Materials Science



*ABS polymer products of the FDM8000 rapid prototyping machine. The lower artefact has had a thin gold deposition added post-processing. Designed by Gilbert Riedelbauch, Lecturer Applied Design, Computer Art Studio, The Canberra School of Art.*

The Canberra School of Art has recently acquired a FDM8000—a rapid prototyping and tooling device—worth more than \$300,000 and are set to revolutionise computer aided design and many materials science and engineering projects on campus.

Gilbert Reidelbach (Applied Design) and Johannes Kuhnen (Gold and Silver-smithing), the driving forces behind the acquisition of the machine, hope that it will “be used virtually non-stop by students and staff right across campus once it becomes operational early next year.”

The FDM8000 (FDM=Fusion Deposition Modeling) eliminates many of the constraints inherent in the building of large prototypes. The process begins with the machines’ software processing your computer generated file and mathematically slicing and orienting the model for the build process. Support structures, if required, are generated automatically. The build process is then begun by the click of a mouse.

The machine extrudes molten ABS polymer and deposits it accurately and reliably in ultra-thin layers, building parts one layer at a

time. ABS is the engineer’s choice material for detailed, strong prototypes which can be tested, sanded, painted and drilled.

It is hoped that the FDM8000’s capabilities can be enhanced even further by the addition of a water solvable support structure system that will enable the construction of even more intricate 3D structures. This will allow scientists on campus to make physical models of complex materials including geomaterials, biomaterials and composites and to test their properties. The potential is enormous, particularly if the capabilities of the FDM8000 are allied with other equipment on campus, for example, the soon to be commissioned micro CT (Applied Maths), and the extruder in Engineering.

With only three other, less advanced, FDM machines in the country, the ANU FDM8000 is expected to play an important role in the development of many exciting new interdisciplinary materials research projects.

For further information contact:  
Gilbert.Riedelbauch@anu.edu.au

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# Direct from the Director

Phil Evans, Forestry Department

In last month's issue of *Materials Monthly* I tried, with reference to some commonly available scientific dictionaries, to obtain a definition of the term materials science. The results were not entirely satisfactory. Far better definitions exist, however, for the term Materials Science and Engineering of which the following is a good example...

*Materials Science and Engineering (MSE) is the branch of technology dealing with the production and optimisation of the material goods that provide the foundation of our technological age. Metals and alloys, ceramics and glasses, cements and concrete, polymers and plastics, composites, semiconductors, superconductors, and graphite and diamond are all within the purview of the materials scientists or materials engineer.*

*For all these diverse materials, the common theme involves the structure-property-performance paradigm; to understand the **properties** of materials, either alone or in combination so that the **performance** in some specific structural or electrical function is optimised, their **structure** must be understood and controlled. Structure includes the basic arrangement of atoms in crystalline or amorphous materials, the spatial distribution of defects and phases (the microstructure), and the size and shape of the final component.*

*MSE is extraordinarily multidisciplinary and interdisciplinary; metallurgists, ceramists, polymer scientists, condensed matter physicists, chemists, crystallographers, and engineers are all practitioners.*

*The term MSE first began to be used in the 1950s when metallurgists, chemists and solid state physicists were required to collaborate in developing and producing the new semiconductor materials silicon and germanium; ceramics (inorganic non-metallics) and polymers were added shortly after to the classes of materials for which the structure-property-performance paradigm was important. The field is now recognised as one of the enabling technologies for continued progress in the next decade and century.*

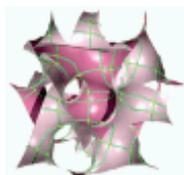
**A.H. Heuer**

Kyocera Professor of Ceramics  
Case Western Reserve University

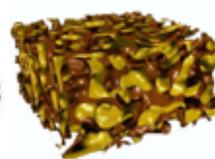
A key point in the above definition is that MSE is seen as an 'enabling technology' which underpins advances in many critical areas of science and technology, including IT, photonics, aerospace engineering, etc. Many countries have recognised this, although depressingly Australia is not one of them, and are currently investing heavily in this area. More on this subject in future issues of *Materials Monthly*.

# Materials on Campus:

Research School of Physical Sciences & Engineering



The Department of  
**Applied Mathematics**



## Introducing Applied Maths

The department comprises over a dozen academic staff, plus visitors, technicians and graduate students who work in a cross-disciplinary area where chemistry, physics, biology, earth science and materials science meet.

**More than half its research is experimental**, including fundamental studies of surface forces, liquid crystals and mesostructured materials. The well-known surface force apparatus was developed in the department, which has provided more than twenty-five research groups around the world with various versions of this instrument. Other areas of particular strength include the statistical mechanics of electrolytes and complex fluids, the self-assembly of amphiphiles, characterisation of and transport in porous media, and biomineralisation.

**The research interests are pure as well as applied**, with externally funded projects in various aspects of materials science. There are numerous collaborative links, both within Australia and with groups in Sweden, Germany, Italy, Japan, France and the U.S.

**Facilities include** several different types of surface force apparatus, atomic force microscopy, small-angle X-ray diffraction, as well as ready access to other campus-wide facilities such as supercomputers, electron microscopy and nuclear magnetic resonance spectroscopy. Excellent mechanical and electronic workshop services are available. All these factors combine to provide an unparalleled environment for high-quality research, both experimental and theoretical.

The department encourages postgraduate research and offers a range of projects across the disciplines of physics, chemistry, maths, and engineering. These can range from theoretical to industrially relevant.



## Disordered Materials Research Group

*How do we describe and compare structures of complex - often disordered - materials? How does oil, water, gas, or nuclear waste flow through porous rocks? Why does ink-jet printing give clear and sharp lines on some papers, while it smudges on others?* These questions are of enormous interest to both the pure scientific and the industrial communities. In the petroleum industry in excess of a billion dollars a year is spent on laboratory measurements of core materials (rocks). To date, there is little basic science to support the interpretation of data. A major shortcoming in the understanding of processes involving complex porous and composite materials has been the inability to accurately characterise the microstructure.

Successful predictive modelling of the properties of “real world” materials is reliant on this accurate characterisation. Our group is addressing these issues with a combination of theoretical, computational and experimental skills.

The objective behind the ‘Disordered mesoscale physics’ programme is to bring the tools of physics and mathematics to bear on these problems which are the concern of engineers, geologists and forestry researchers. The recent significant award of an internal ANU PPF grant will ensure that we can build on our theoretical understanding and remain in the forefront of this development.

We have also received an award from the federal Research Infrastructure scheme to build a **High-resolution X-ray CT (Computer Tomography) facility** to experimentally characterise the morphology of complex materials and visualise multiple fluid phases in porous materials. This experimental facility will provide us with a rich source of data for the goals of our research. We have also been very successful in leveraging funding from government and industrial sources for specific applied projects.

## Other Applied Maths Research Groups:

Self Assembly

Interfacial Forces

See [www.rspysse.anu.edu.au/appmaths](http://www.rspysse.anu.edu.au/appmaths) for more info.

# Recent ANU Materials Publications

**An electron diffraction and XRD study of the a1' and a1'' fluorite-related phases in the (1-x)/2Bi<sub>2</sub>O<sub>3</sub>·xCaO, 0.20 < x < 0.29, system.** R.L. Withers, A-K. Larsson and S. Schmid. *J. Solid State Chem.* **149**, 218-225, (2000).

**Structured diffuse scattering, displacive flexibility and polymorphism in Ba-Hexacelsian.** Y. Tabira, R.L. Withers, Y. Takeuchi and F. Marumo. *Phys. Chem. Minerals* **27**, 194-202, (2000).

**Incommensurate Cu/Co ordering in the TiCo<sub>2-x</sub>Cu<sub>x</sub>Se<sub>2</sub> system.** L. Noren, R.L. Withers and R. Berger. *J. Solid State Chem.* **151**, 260-266, (2000).

**The inherent displacive structural flexibility of M<sub>x</sub>V<sub>2</sub>O<sub>5</sub> framework structures.** R.L. Withers, P. Millet and Y. Tabira. *Z. für Krist.* **215**, 357-363, (2000).

**Organometallic Complexes for Nonlinear Optics 18. Molecular quadratic and cubic hyperpolarizabilities of aryldiazovinylidene complexes.** M.P. Cifuentes, J. Driver, M.G. Humphrey, I. Asselberghs, A. Persoons, M. Samoc, and B. Luther-Davies. *J. Organomet. Chem.* **607**, 72-77, (2000).

**Syntheses, Structure and Molecular Cubic Hyperpolarizabilities of Systematically Varied Ethynylgold(I) Complexes.** J. Vicente, M.T. Chicote, M.D. Abrisqueta, M.C. Ramirez de Arellano, P.G. Jones, M.G. Humphrey, M.P. Cifuentes, M. Samoc and B. Luther-Davies. *Organometallics* **19**, 2968-2974, (2000).

**Organometallic Complexes for Nonlinear Optics. 19. Syntheses and molecular quadratic hyperpolarizabilities of indoanilinoalkynylruthenium complexes.** A.M. McDonagh, N.T. Lucas, M.P. Cifuentes, M.G. Humphrey, S. Houbrechts, and A. Persoons. *J. Organomet. Chem.* **605**, 184-192, (2000).

**Organometallic Complexes for Nonlinear Optics. 20. Syntheses and molecular quadratic hyperpolarizabilities of alkynyl complexes derived from (E)-4,4'-HC≡CC<sub>6</sub>H<sub>4</sub>N=NC<sub>6</sub>H<sub>4</sub>NO<sub>2</sub>.** A.M. McDonagh, N.T. Lucas, M.P. Cifuentes, M.G. Humphrey, S. Houbrechts, and A. Persoons. *J. Organomet. Chem.* **605**, 193-201, (2000).

**Callitroid (Callitrisoid) thickening in Callitris.** R.D. Heady and P.D. Evans. *IAWA Journal* **21**, 293-319, (2000).

**Weathering of chemically modified wood surfaces.** P.D. Evans, A.F.A. Wallis and N.L. Owen. *Wood Science and Technology* **34**, 151-165, (2000).

## Jobs & Scholarships

### ANU

#### University House Accommodation Scholarship

Uni House will again offer a scholarship, of one year's free accommodation, to be held by a doctoral student currently enrolled at the University. Applications are invited with a closing date of Friday 24 November, and the scholarship will be available from January.

Contact Gail Reekie of the Graduate School on x5922 or email: Graduate.School@anu.edu.au for further information.

#### Complex Materials Studies - Research Fellow/Fellow

Applied Maths, RSPHysSE

The Department is seeking two physicists/chemical physicists with interests in the following areas: soft condensed materials (synthetic and/or biological), statistical physics and disordered systems, physics and physical chemistry of surfaces including surface interactions (eg biological recognition).

Further info: rsphysse.anu.edu.au/appmaths or Stephen.Hyde@anu.edu.au

#### Theoretical Plasma Physics - Postdoc/Research Fellow

Physics and Plasma Research Lab, RSPHysSE

Applications are invited for a research position in the Department of Theoretical Physics in the area of plasma physics. The appointee will have a broad interest in the theory of plasmas, with strengths in both analysis and computation, an outstanding research record, and be able to interact with the experimental program of the School's Plasma Research Lab.

Further info: rsphysse.anu.edu.au/~rld105 or robert.dewar@anu.edu.au

#### Experimental Chemical Physics - Postdoc/Research Fellow

Atomic and Molecular Physics Lab, RSPHysSE

The position is for an experimentalist who will make significant contributions to the Unit's newly-funded Solar-Terrestrial Environmental Program. The successful applicant will plan and undertake experiments relevant to the atmospheric photochemistry and radiative transmission.

Further info: rsphysse.anu.edu.au/ampl or brenton.lewis@anu.edu.au

#### Atom Optics, Nanotechnology, Atomic Collisions - Research Fellow/Fellow

Atomic and Molecular Physics Lab, RSPHysSE

The position is for an experimentalist who can make major contributions to the Department's experimental activities based on the laser control of metastable helium atoms for experiments in atom optics, nanotechnology and atomic collision physics.

Further info: rsphysse.anu.edu.au/ampl or stephen.buckman@anu.edu.au

### Overseas

#### University of California Forest Products Laboratory

Two positions: Head and Research Associate of the Service to Industry Program.

Both involve: organising and leading investigations working with design professional and other construction or building consultants; evaluating and analysing design, product quality and installation, and their effect on performance of materials used in wood structures generally in the context of field investigations.

Further info: www.ucfpl.ucop.edu/employop.htm

#### University of Canterbury

Lecturer or Senior Lecturer in Engineering Materials

Department of Mechanical Engineering.

The successful candidate will be expected to conduct personal research, to supervise postgraduate students and to teach undergraduate courses in the area of polymeric and composite materials.

Further info: jobs.ac.uk/jobfiles/YA606.html

#### University of Massachusetts

Assistant professor, Wood Science and Engineered Products

The Department of Natural Resources Conservation is seeking applications for a tenure-track faculty position in building materials and wood technology beginning August 1, 2001.

Further info: Paul Fisette, pfisette@forwild.umass.edu

**Don't forget to check out the web site 'jobs.ac.uk'** - unfortunately the site was 'down' at the time of printing.

### Looking for a Position

#### Polymer Physics, Ceramics & Composites

Currently I am looking for a post doctoral/ visiting scientist position for a year or two and am in the process of identifying labs/ groups.

At present I am working as a Principal Scientific Officer in the Department of Physics at IIT Delhi. My current interests lie with the preparation, characterization and application of bulk ceramics, ceramic films (by sol-gel) and transparent ceramic:polymer nano-composites for piezo, pyro, MEMS and non-linear optical devices. Earlier I had done extensive work in the area of polymer physics, specially on the electrical properties of polymers, their blends and photosensitized polymers.

Dr.A.K.Tripathi

Department of Physics

IIT Delhi-110016, India

Contact Arvind by email to receive a copy of his CV and further info:

arvind\_31@hotmail.com



# Timber Industry *wants* MSE Graduates

CSEM was recently contacted by Lance Vinnell, Sales Manager for Wilson Engineering Systems—a major supplier of sawmill equipment in NZ and Australia.

Lance is frequently asked if he knows of people suitable for particular jobs. Such enquiries have revealed a high level of demand for MSE graduates who are keen to do wood science/process control research and who want to move quickly into operational management. Lance says that prospective employees “don’t really have to know wood and that, in fact, starting with a clean slate and being able to look at the problems very objectively could be an advantage”.

Below are just 3 recent examples of sawmill positions:

1. Two different sites have asked for: A MSE/Forestry/ Engineering graduate that would be willing to learn about the hardwood sawmilling industry. The first challenge would be focused on the kiln dried timber quality issues. Therefore putting in place quality control systems, and tuning of existing systems; log storage, sawing accuracy, stacking, air/ pre-drying, steaming, final kiln drying and machining. Once proving oneself there is the possibility of moving to sawmill management, and hardwood timber marketing (including exporting challenges).
2. One major softwood company is looking for a MSE/Forestry/ Engineering graduate preferably with experience but not essential, that would be willing to join the team of one of the biggest sawmills in Australia. The first challenge would be focused on benchmarking the existing sawmill operations and uplifting

production/quality to world class standard. Thereafter putting in place quality control systems, and tuning of existing systems etc. Once proving oneself there is the possibility of moving to sawmill management, and building a new green field, state of art, sawmill.

3. One medium-sized softwood company is looking for a MSE/Forestry/ Engineering graduate that would be willing to learn about the softwood sawmilling industry. The first challenge would be focused on the kiln dried timber quality issues and putting in place quality control systems, and tuning of existing systems; log storage, sawing accuracy, stacking, kiln drying and machining. Once proving oneself there is the possibility of moving to sawmill management.

As always pay is negotiable and will depend on performance, we would expect **min. AUD \$50,000 p.a.** with a review within six months to a year for a major increase.

These enquiries are regular so if you are interested in working in the Timber Industry please post, email or fax your CV to the following address:

Lance Vinnell  
Wilson Engineering Systems Pty Ltd  
Private Bag 35  
Campbellfield  
Melbourne VIC 3061

Lance is looking forward to your responses.

## For Your Diary

- **Photonics Education Forum & Photonics Industry Forum** Nov 8 & 9  
National Convention Centre  
The Australian Photonics Cooperative Research Centre (CRC)  
For more info contact: Helen McMartin, x0693, helen.mcmartin@anu.edu.au
- **The “New” ARC Grant Schemes - Information Seminar** Dec 6  
1.30pm in the Haydon Allen Tank  
Bookings essential, phone x0099 or email Reserach.Services.Office@anu.edu.au
- **5th Pacific Rim Bio-Based Composites Symposium** Dec 10-13  
hosted by ANU at Rydges Canberra Hotel, Canberra
- **Raman Microscopy Workshop** Feb 2000  
Presented for CSEM by Vincent Otieno-Alego of the University of Canberra’s Microscopy Unit for Materials Analysis. Contact Phil.Evans@anu.edu.au for more info.
- **PICMET '01 (Portland Int. Conf. on Management of Eng. and Tech.)** Jul 29 - Aug 2, 2001  
Theme: *“Technology Management in the Knowledge Era: Life in the e-World”*  
see www.picmet.org

# Communication News

**New CSEM Promotional Materials** - folder and information sheet designs are being finalised in the next few weeks.

**CSEM Seminar: "Atomic Scale Materials Characterisation with Synchrotron Radiation"** - Mark Ridgway of the Electronic Engineering Materials Department, RSPHysSE will be presenting the above seminar on Wednesday 29 November at 4pm, in a yet to be determined venue in RSPHysSE. As it is our final seminar for 2000, **extra drinks and refreshments will be provided.**

**Collaboration with the Canberra School of Art** - after an extremely positive meeting with David Williams (Director CSA) and Jill Peck (Undergraduate Convenor CSA) we hope to have our first Materials Science/Art student enrolled in 2001. Elizabeth, a prospective student we met at Open Day, is very keen to combine her passion and skill for art, science and engineering.

**Collaboration with the CIT Centre for Forensic Science and the AFP Forensic Services Unit** - discussions regarding research and teaching collaboration in the area of materials forensics are progressing well. A successful outcome to discussions will mean that ANU materials students will be able to access particular forensic courses offered by CIT. Phil Evans will be giving a lecture on forensic wood anatomy as part of the CIT BAppSci on Tuesday 31 October.

## CSEM

Centre for Science and Engineering of Materials

### Faculties

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

### Institute of Advanced Studies

Research School of Biological Sciences  
Research School of Chemistry  
Research School of Earth Sciences  
John Curtin School of Medical Research  
Research School of Physical Sciences and Engineering

### Institute of the Arts

Materials Workshops

## Materials Monthly

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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.

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