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NASA connects to MCN for carbon nanotube project

Coatings of nanotube forests developed by NASA are the blackest materials ever measured. With assistance from MCN, NASA is developing carbon nanotube technology for use in a variety of scientific applications. Principal Investigator John Hagopian and co-investigator Vivek Dwivedi of the NASA Goddard Space Flight Center are using Atomic Layer Deposition (ALD) to deposit layered thin films suitable for carbon nanotube growth on intricate parts.

NASA researchers worked in collaboration with MCN's Lachlan Hyde to perform a number of iterations for ALD growth of iron thin films. Characterisation using MCN's spectroscopic variable angle ellipsometer allowed the film thickness and uniformity to be optimised on test wafers. "The growth of nanotubes directly onto an ALD catalyst is a new and emerging technique" said Hagopian. "Samples we have grown to date are flat in shape as we have several additional technical challenges to solve in terms of uniformly exposing the surface to the carbon-bearing gas during nanotube growth."

In a joint media release Hagopian stated that he was "extremely impressed with the quality of the work that MCN performed and the professionalism of everyone involved. Both their ALD process development and characterization capabilities are world class", he said. "We intend to continue collaborating to leverage MCN's capabilities to increase our speed of technology development."

Lachlan Hyde working with the Fiji F200 ALD system

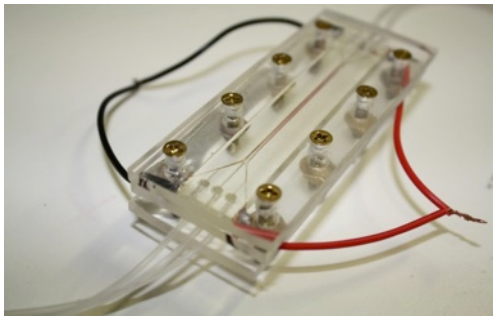
Micro-flow battery company in residence at MCN

Eden Research and Development, an unlisted public company, has taken residency at MCN to develop a number of energy-related inventions. The first device built at MCN is a micro-battery using self-assembling nanocapacitors derived from proprietary metallic oxide glass with potential application as an electric car battery (or other energy storage applications) due to its size, safety and low cost profile.

The Eden micro-battery is believed to be the world's first microfluidics battery using a miniaturised electrolyte (vanadium) flow battery design. The micro-battery uses a third electrolyte stream containing nanocapacitors instead of an ion permeable membrane that is normally used in vanadium flow batteries, which results in a substantial increase in both power and energy density.

A major advantage of this micro-flow battery in an electric car will be that it can be recharged from the recovered energy of the moving car, meaning that future cars will not need to stop to be externally recharged and then have the potential to reach unlimited mileage.

Eden's Technical Director, Dr Ross Mack said "We are very grateful to MCN for their assistance to date. The tools and instruments available at MCN are excellent, the staff are highly qualified and the Victorian Government is to be congratulated for having the vision to create the centre."



A micro-flow battery developed by Eden Research and Development

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Biocapabilities within the ANFF Victorian Node

Nanotechnology and biology are overlapping to a greater extent with the development of miniaturised devices for the advancement of medicine and environmental science with nanotechnology taking design inspiration from biological systems. Nanofabrication, molecular biology and characterisation capabilities are available within the ANFF-VIC Node at MCN and Swinburne Biomedical Engineering.

Biocapabilities at MCN

The MCN combines onsite accessibility to PC2 laboratories, cell culture facilities and a suite of device and biological characterisation tools with state-of-the-art nanofabrication equipment in a cleanroom environment. Biocapabilities include tools for advanced microscopy and rapid analysis of protein, chemical, nanoparticle and membrane structures.

Specific tools include:-

- A Confocal Microscope for nanoparticle and cellular trafficking analysis.
- Bio-Atomic Force Microscope (AFM) combined with confocal imaging for high resolution surface analysis and fluorescent imaging that is unique to Victoria
- Total Internal Reflection Fluorescence (TIRF) microscope for detection of nanoparticles below the resolution limit of the confocal microscope
- Cytoviva Hyperspectral Imaging (HSI) microscope (featured on page 4)
- Princeton Lightfield Microspectrometer equipped with the latest aberration corrected spectrometer allowing %T and Abs measurements from features as small as 100nm
- Protein and chemical analysis can be done in the well-equipped general biochemistry lab space that is augmented by a nano-array spotter for high-throughput analysis of proteins
- 3D printer for rapid prototyping using polymer materials (including biocompatible polymers)
- Characterisation of particles, colloids and membranes can also be achieved by zeta potential analysis using the Malvern Zetasizer and the SurPASS electrokinetic analyzer

For more information go to www.nanomelbourne.com

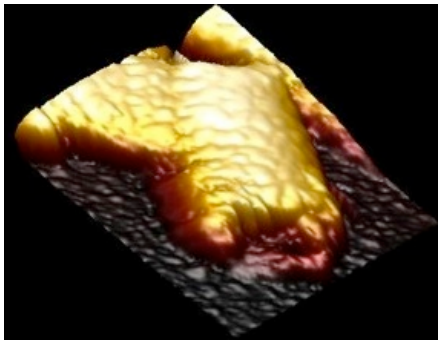
Biointerface Engineering Hub at Swinburne University of Technology

The Biointerface Engineering hub focuses on interfacing technology with biology: controlling the behaviour of proteins, bacteria and cells via the surface modification of materials and devices. The hub is led by Prof Sally McArthur and supported by Dr Thomas Ameringer. Together they apply their expertise in polymer, metal and ceramic sciences to fabricate thin layer coatings (2-200nm) on materials and devices for a wide range of applications. By combining plasma polymerisation, spin coating, self-assembly processes with dip pen nanolithography and photolithography, the group can spatially and chemically tailor materials to control biological interactions.

The fabrication facilities are complemented by analytical characterisation tools including ellipsometry, quartz crystal microbalance (QCM) and PC2 facilities for molecular biology and cell culture. Current work includes the development of interfaces for biosensors, microfluidics and biomaterials as well as antibacterial coatings for wound dressings. For more information go to www.swinburne.edu.au/engineering/iris/biointerface/.

AFM nanoindentation on bacterial cells

In a joint research project between Monash Engineering and Monash Pharmaceutical Sciences, Boyin Liu, a Monash PhD student, is investigating multi-drug resistant bacteria (*Klebsiella pneumonia*) during and after treatment with antibiotics by using JPK Bioscience Atomic Force Microscopy (AFM).



AFM 3D image of a bacteria cell (*Klebsiella pneumonia*) after drug treatment. Scan area: 2x2mm^2

In collaboration with MCN's Dr Hemayet Uddin, Boyin is performing AFM-based nanoindentation at various locations on single bacterial cells in hydrated conditions. The measurement of elastic modulus provides valuable insights into resistance mechanisms of bacterial cells.

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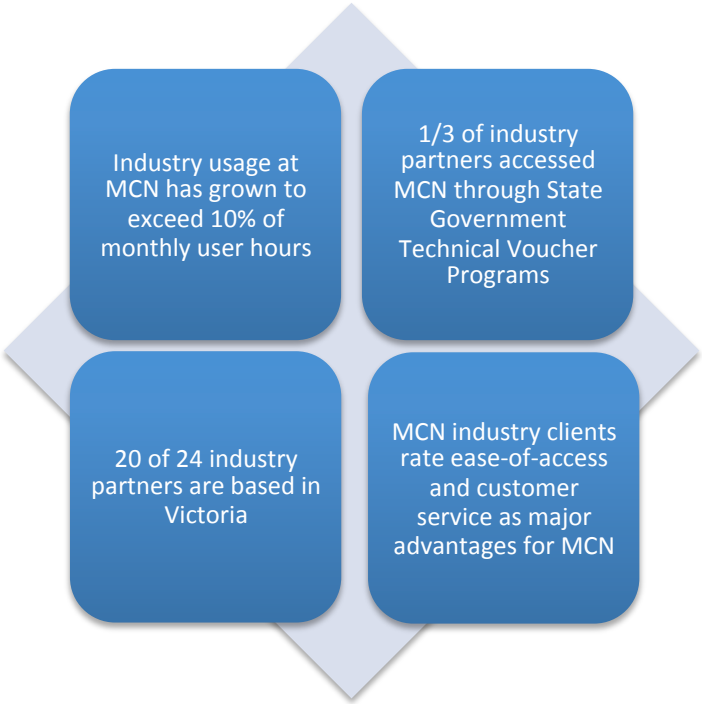
MCN industry snapshot



Uni Melb projects strengthened with new appointment

The University of Melbourne, through the Melbourne Materials Institute, has appointed Dan Smith as a dedicated Platform Support Officer to assist University of Melbourne researchers in accessing and using the facilities at MCN. Dan brings with him over 25 years of experience in micro/nanofabrication, MEMS and semiconductor manufacturing, process development, integration and characterisation. Dan will also be available to provide project support including experimental design, equipment training, process development and characterisation. Representatives from the University of Melbourne and MCN staff met in June for a morning tea to celebrate Dan's appointment.

L to R: Dwayne Kirk (MCN Managing Director,) Ray Dagastine, (MCN Tech Fellow, UoM) Dan Smith (UoM Platform Support Officer) and Gareth Moorhead (MCN Science Director)

New faces at MCN

John Zhu (Client Service Manager)
As a primary point of contact for MCN, John's responsibilities include MCN's weekly new user inductions, management of MCN's equipment booking system and client accounting. He is also responsible for managing the Optical Microscopy Room, including optical microscopes, digital imaging and software issues for confocal microscopes. Prior to joining MCN, John was responsible for sales, marketing, installations and training for Nikon microscopes.

Fatima Eftekhari (Instrument Manager)
Fatima is responsible for the Dualbeam Focused Ion Beam Scanning Electron Microscope (FIB/SEM) at MCN and also assists with electron beam lithography. Prior to joining MCN, Fatima worked with MCN Technology Fellow, Dr Tim Davis of CSIRO developing subwavelength plasmonic devices using electron beam lithography. Fatima obtained her PhD in Electrical and Computer Engineering from the University of Victoria, Canada in 2009.

Eugeniu Balaur (Instrument Manager)
Eugeniu is responsible for electron beam lithography and focused ion beam lithography at MCN. Eugeniu has vast expertise in various nano- and micro-fabrication techniques as well as numerous characterisation techniques. Eugeniu received his Masters degree in Materials Science and Engineering from the University of Kiel and obtained his PhD from the Erlangen-Nuremberg University, Germany in 2007.

Fiona Glenn (Instrument Manager)
Fiona is responsible for the nickel and gold electroplating capabilities at MCN as well as the daily running of the PC2 and Biochemistry laboratories. Fiona comes to MCN with 20 years of electroplating and thin film deposition experience. Prior to joining MCN, Fiona worked on various projects at CSIRO including developing electroplated overlays for high performance engine bearing and manufacturing switchable relays using multi-step MEMS technology.

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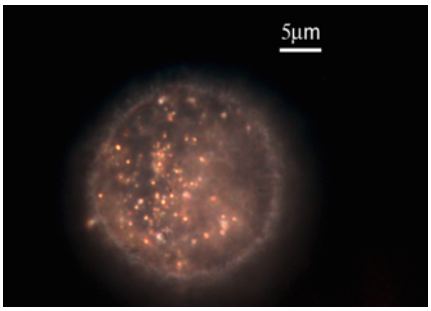
The Direct-write Lithography System is now open for user training for design of micro-patterns and photomask fabrication with a feature size to 5microns. Photomasks with features to 2microns are available by quotation. For more information contact yang.lim@nanomelbourne.com

Hyperspectral Microscopy



Optical image (100×) showing gold nanoparticles in an oral cancer cell. (Courtesy: CytoViva Inc., Auburn, AL., USA)

The MCN has installed a Hyperspectral Imaging (HSI) microscope for characterisation and quantification of nanomaterials.

This HSI microscope, the first in Australia, combines a a high signal-to-noise (S/N) optical microscope for imaging below the resolution limit using patented optics with hyperspectral imaging technology for identification of particles and fluids by their spectral signature. The HSI system operates at visible to near infrared wavelengths of light (400–1000nm) to capture complete spectra within each individual pixel with a spectral resolution of approximately 1.5nm.

The HSI microscope is best suited for characterising nanoparticles, carbon nanotubes, quantum dots, fluoroprobes, pathogens and subcellular materials that have their own spectral signatures. For more information contact john.zhu@nanomelbourne.com.

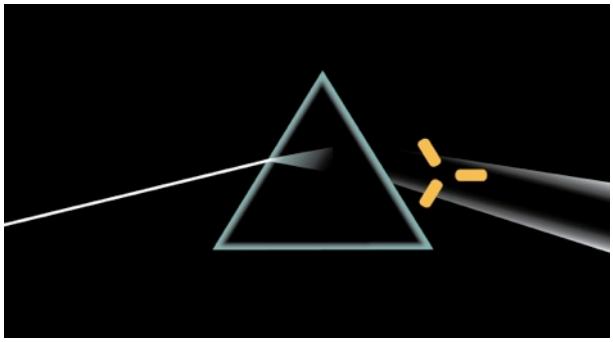
When were you inducted?

MCN holds annual induction refreshers for all onsite users. Attendance on an annual basis is a prerequisite for continued access to MCN facilities. The refresher will take approximately 1.5 hours and will be offered every day at 10am for the week of 2 September 2013. Bookings are not necessary, however all attendees will need to bring their access fobs.

Stay informed by checking the MCN training page at www.nanomelbourne.com/training. For more information contact john.zhu@nanomelbourne.com.

Latest publication…

Congratulations to MCN Tech Fellows Dr Daniel Gomez and Dr Tim Davis of CSIRO and MCN Senior Process Engineer Dr Matteo Altissimo on their publication in **Nanoletters** (2012 Impact Factor: 13.025). The paper demonstrates for the first time the excitation of a collective dark plasmon mode using radially polarized light. Details of the publication can be found at: www.nanomelbourne.com/publications/



The dark side of plasmonics
D Gomez, Z-Q Teo, M Altissimo, T.J. Davis, S Earl and A Roberts, Nanoletters 2013, DOI: 10.1021/nl401656e

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