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MCN FIRST IN AUSTRALIA TO HAVE BORON-DOPED DIAMOND GROWTH CAPABILITY

MCN will become the first facility in Australia to be able to grow both ultra-high-purity, as well as boron-doped diamond, both of which are useful in the creation of semi conducting materials. This is possible with the installation of two state-of-the-art, chemical vapour deposition (CVD) diamond systems.

A notoriously unstable and unyielding material, diamond has previously been successfully grown through high pressure, high temperature systems which heat carbon to around 2500 degrees Celsius and apply pressure equivalent to the weight of the Eiffel Tower applied through its tip. These presses are large, expensive and difficult to run and cannot easily achieve a pure diamond outcome.

CVD systems, however, use a continuous microwave source to heat hydrogen and carbon (in the form of methane) to between 700 and 1000 degrees Celsius. This breaks down the atoms to become a highly reactive plasma. When the plasma hits an existing diamond sample surface, the hydrogen stabilises the diamond structure, while the methane adds carbon in diamond lattices to the existing material. The systems are able to fabricate either single crystal layers or polycrystalline growths.

Across the world, diamond's biggest use is in cutting and grinding with 70% of mined diamonds sold for industrial applications, while its second biggest use is in the gem stone industry.¹ However, it is also of interest to a number of different sectors within the scientific community as it is the hardest naturally occurring material, is an effective heat conductor, expands very little in high temperatures and is resistant to most acids and alkalis.

Dr Alastair Stacey, a materials scientist at Bionic Vision Australia, says there is a growing diamond community in the Australian research industry. "Diamond is useful for all sorts of applications such as quantum information processing, electronics and medical bionics," Dr Stacey said. "We are using it in the Bionic eye project to make

bionic compatible devices." Diamond is an ideal material for this, as bionic devices need to be both safe for the human body and suitable for being implanted. Some materials which are biocompatible are rejected or attacked by the body, whereas diamond is unique in that it is both bio-safe and accepted. It is also an unyielding material which is unlikely to break, as well as being hermetic, which makes it ideal for encasing electronics and protecting them against fluids. Lastly, when doped with boron it can conduct energy, predisposing it to use in electronics.

Bionic Vision Australia (BVA) through the Melbourne Materials Institute has been using the two diamond deposition systems currently in place at the University of Melbourne, which is one of its five core members. However, with the installation of the two new systems at MCN, which have been partially funded by BVA, a higher quality of diamond can now be achieved, as well as boron-doped semiconducting diamond. "This is an exciting direction for the research community," Dr Stacey said. "We expect to see a lot of growth in this area."

The systems will be available for use by the end of November 2013. For more information or user inquiries, please email lachlan.hyde@nanomelbourne.com



Instrument Manager, Lachlan Hyde showing the new CVD diamond systems to a work experience student.

1. The Diamond Industry Fact Sheet. www.diamondfacts.org

SPIE CONFERENCE BRINGS TOGETHER NANO EXPERTS

MCN is proud to partner with ANFF as sponsors for the SPIE Micro+Nano Materials, Devices, and Applications Conference, to be held from Sunday 8 December to Wednesday 11 December this year at RMIT in Melbourne.

Last held in 2011, the conference is a four-day summit, bringing in experts from around the world to discuss topics such as nanofluidics, plasmonics, solar energies, MEMS, phototonics and much more.

MCN projects feature heavily on the schedule with 27 out of the 210 papers and posters being presented at the conference, co-authored by MCN staff or Tech Fellows. These highlight the valuable work undertaken at MCN. See

below for a list of these publications as well as an overview of the three plenary speakers.

Yet another drawcard for the conference is that fabrication equipment and technology companies, such as Warsash, Realtek, Coltronics and Grey Innovation will be exhibiting new products and presenting on their innovations.

The SPIE Micro+Nano Materials, Devices and Applications Conference is unmissable for those interested or working in fabrication innovations and technologies. **Register at <http://spie.org/x27145.xml> before 21 November 2013 to secure early bird rates.**

PLENARY 1 SEMICONDUCTOR NANOSTRUCTURES IN ENERGY DEVICES

*Prof. Daniel Dapkus
University of Southern
California*



Leading researcher in the field of energy nano-science, Professor Daniel Dapkus has been researching how to create highly efficient solar cells and LEDs utilising semiconductor nanorods to form the cell components. He will discuss prospects for droop-free LEDs and multijunction solar cells.

PLENARY 2 NANOPHOTONICS FOR BIOLOGY

*Prof. Tanya Monro
University of Adelaide*



An ARC Federation Fellow and Director of the Institute for Photonics and Advanced Sensing, Professor Tanya Monro will be highlighting new advances in the development of optical materials, structures and sensors as well as fluorescent sensing architectures that are more powerful than ever before.

PLENARY 3 HYDRODYNAMIC CHALLENGES IN INKJET PRINTING

*Dr. Detlef Lohse
University of Twente*



Expert in micro and nano fluidics, Dr Detlef Lohse will be discussing the various scientific challenges to optimised high performance printing such as droplet formation and droplet impact on substrates, as well as the coupling between fluid dynamics and acoustics.

MCN CO-AUTHORED PAPERS & POSTERS TO BE PRESENTED AT SPIE 2013

- Micro-optical system-on-a-chip
- Asymmetric cross-shaped slot antennas surrounded with periodic corrugations
- Rapid formation of controlled size and morphology spheroids by surface acoustic wave microfluidic device (SAW) versus liquid overlay method,
- Vanadium dioxide thickness effects on tunable optical antennas
- Micro pore arrays in free standing cyclotriphosphazene membranes: fabrication and surface functionalization strategies for in-vitro barrier tissue models
- Acoustowetting: film spreading, fingering instabilities and soliton-like wave propagation
- Mapping the effect of pulsed surface acoustic waves on a sessile drop
- Characterization of magnetic force driven microflow
- Surface acoustic wave (SAW) atomization of therapeutic antibodies for pulmonary delivery
- Gen silencing using siRNA
- Measuring nanobubble properties using a novel method
- Flow through a microfluidic chip induced by a distal surface acoustic wave atomizing suction pump
- Surface acoustic waves-assisted technique for generation of individual carbon nanotubes and their shear-induced alignment
- Investigation of periodically poled 128° YXcut LiNbO3 achieved with UV direct-written technique for SAW generation
- SAW generation in acoustic superlattice lithium niobate: methods of converting bound acoustic resonances to propagating waves
- Three-dimensional cell patterning in hydrogel by ultrasound standing waves
- Black-Si as a platform for sensing
- Evaluation of optical fibres for surface enhanced Raman scattering probes
- Laser nanostructured surface for biomedical sensing using surface-enhanced Raman spectroscopic mapping
- Hybridization in 3D: optical and plasmonic elements
- THz photomixer with a sub-50 nm nanoelectrode gap on low temperature grown GaAs
- Ion-beam and plasma etching of a conicalpores photonic crystal for thin-film solar cell
- Fabrication and replication of micro-optical structures for growth of GaN-based light emitting diode
- Optical and thermal characterization on micro-optical elements made by femtosecond laser writing
- Characterization of optical polarization converters made by femtosecond laser writing
- How to fabricate robust microfluidic systems for a dollar
- Integrated microdroplet-based system for enzyme synthesis and sampling

BE REWARDED FOR YOUR WORK

SHOW YOUR POSTER AT SPIE FOR A CHANCE TO WIN!

ANFF is offering its staff and users the opportunity to win a share of \$500 with a \$250 award for both Best Poster and Best Image.

The posters should highlight a valuable or novel fabrication process and should reference how ANFF has facilitated this work.

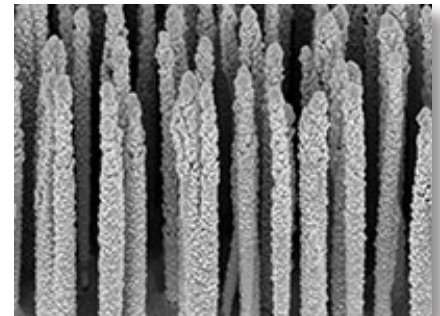
The posters will be displayed during a specific ANFF poster workshop at the SPIE conference on Tuesday 10 December 2013 from 3:30-5:30PM and the winners announced at the SPIE Gala Dinner on Tuesday evening from 6:30PM.

Please submit your posters to paul.spizzirri@nanomelbourne.com by November 1 2013, with a 150 word abstract, the poster's title, author and a list of affiliations and make sure you are registered for the day at the SPIE conference to be eligible for the competition.

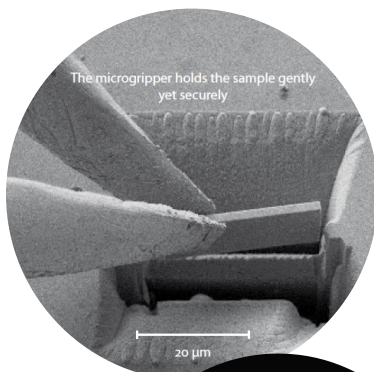


IMAGE OF THE YEAR COMP!

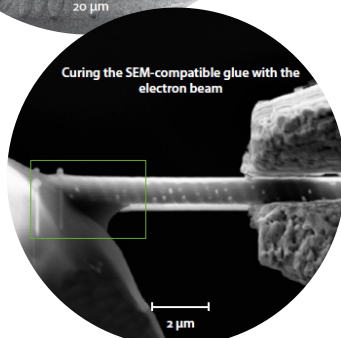
MCN'S image of the year competition is back on and open to all MCN users. Users are invited to submit any images, photographic or scientific, of work undertaken at MCN for the chance to win a \$200 voucher to a restaurant of their choosing. For all the details and information on how to enter, visit <http://nanomelbourne.com/image-competition>. Entries close at 5pm on November 8 and the winner will be notified within two weeks.



FIB-SEM ENHANCED WITH MICRO GRIPPER



The microgripper holds the sample gently yet securely



Curing the SEM-compatible glue with the electron beam

MCN's Dual Beam FIB-SEM has been enhanced with the Kleindiek Nanotechnik Lift-Out Shuttle which features a three axis sub stage and high resolution micro gripper for transport and assembly of micro sized objects. It allows efficient sample preparation for TEM as well as atom probe microscopy. The gripper ensures that the FIB cut sample is held securely and non destructively, eliminating the need for time consuming ion beam induced deposition and ion beam cutting steps associated with using a single probe tip micro manipulator. This ultimately allows for reduced cost, higher throughput sample preparation with higher yield in a shorter time frame than previously possible.

To add further value to the FEI Helios Nanolab 600 FIB-SEM, additional upgrades and accessories will be deployed over the next few months. These include a Quick Loader chamber which allows sample exchanges 30 times faster than currently possible; Nanobuilder software which is used to automatically fabricate complex multilayer nanostructures, offering high precision ion beam control including automated beam alignment and drift control; as well as a Metal-enhanced Etch Gas Injection System which will enhance the FIB etch rate and shorten the milling time of large areas on silicon and metallic substrates. For more information on the micro-gripper or any of the planned upgrades, please contact fatima.eftekhari@nanomelbourne.com

THINNER, MORE DURABLE ELECTRONICS ON THE HORIZON

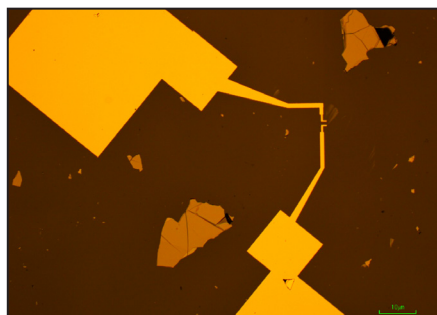
Imagine a TV screen you could roll up and take on holiday with you or a paper-thin digital watch that wraps around your wrist in a transparent shimmer. ARC Laureate Fellow Michael Fuhrer and his team from the school of physics at Monash University, are helping to make these futuristic technologies a realistic possibility.

"The work we're doing is leading towards smaller, thinner, more robust electronics technologies," said Jacob Tosado, a member of the Fuhrer research team. The group is investigating atomically-thin two-dimensional materials such as graphene (a single atom-thick plane of graphite), and layered transition-metal dichalcogenides such as molybdenum disulphide. These single layer materials can be practically transparent and can have extraordinary properties. For example, graphene is stronger than steel and can be more conducting than copper, while molybdenum disulphide is a semiconductor that can be used to make working transistors which are just a few atoms thick. These new materials could lead to new types of flexible, transparent electronic devices.

Single layer crystals are isolated at Monash University's School of Physics, after which they are brought to the MCN for further analysis. The group

uses MCN's Atomic Force Microscope capabilities to assess the quality of their samples. The Nikon Eclipse Ti Confocal Microscope and the CytoViva Hyperspectral Microscope allow them to further characterise the crystals' photo luminescent properties. The group is currently investigating the optical and electron-beam lithography capabilities at MCN for fabricating electronic devices from these 2-D materials.

"MCN demonstrates the capability to characterise low dimensional, semi-conducting materials," Tosado explained. Within six months of coming from the University of Maryland, the Fuhrer group has been able to recommence their research in fundamental physics by using the resources of the MCN.



Gold electrodes contacting single layer graphene. The patterns are written using the IMP direct write lithography system. Image taken by Changxi Zheng, a member of the Fuhrer research group.

PRESTIGIOUS JOURNAL COUPS FOR MCN USERS AND TECH FELLOWS

Two recent publications penned by MCN staff, users and Tech Fellows have been highlighted in prestigious journal, *Nature Materials*. "The Dark Side of Plasmonics," co-authored by MCN Tech Fellows Dr Daniel Gomez and Dr Tim Davis of CSIRO and MCN Senior Process Engineer Matteo Altissimo has been highlighted, as has "Combining UV Lithography and an Imprinting Technique for Patterning Metal-Organic Frameworks," by Doherty et al. A big congratulations goes to all involved in the publications. Details of the articles can be found here:

<http://www.nature.com/nmat/journal/v12/n10/full/nmat3770.html>

<http://www.nature.com/nmat/journal/v12/n9/full/nmat3752.html>

INDUSTRY MEETS RESEARCH AT COMS 2013

Victorian research organisations had a strong presence at this year's COMS (Commercialization of Micro and Nano Systems) conference, held in the Netherlands in August.

COMS is the only conference world-wide to be dedicated to the commercialisation process for micro and nanofabrication technologies. Bringing together leaders in nanofabrication from across the globe, COMS creates productive partnerships and focuses on entrepreneurship and marketable nano solutions.

Plenary sessions included how to connect market needs with emerging technologies, and how to cross academic, industry and government boundaries to create a fruitful innovation environment that fulfils research goals and achieves marketable products.

"The conference was particularly valuable for its unique convergence of large scale nanofabrication research labs with an active and focused investment community, all within the specialised precinct of Kennispark," said MCN's Managing Director, Dwayne Kirk.



MCN's Managing Director, Dwayne Kirk, with Ron Lawes and Clive Davenport from Small Technologies Cluster, Bruce Whan from Swinburne University and Lily Chisholm from Monash University.

CROWD SOURCING THE NEW FRONTIER

Have a great idea for a research project but not quite sure how to fund it? Government funding is available through ARC and NHMRC grants, though these are often highly competitive forums for funding.

Crowd sourcing, which has been popular since 2009 in the creative industries in particular, has begun to make a name for itself in research communities too.

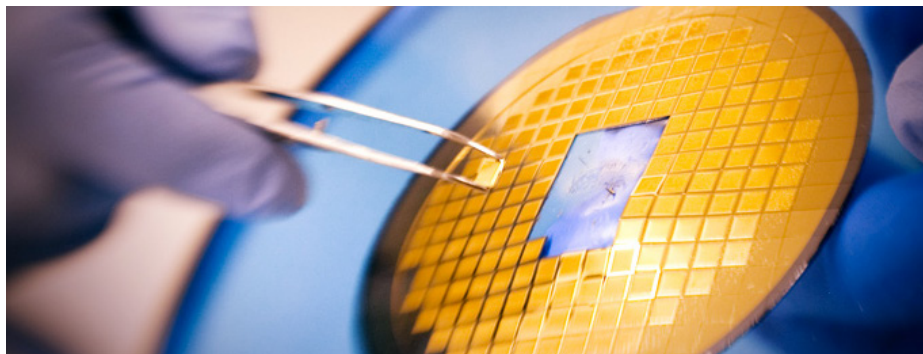
Sites such as **Kickstarter**, and **Pozible** connect entrepreneurs with people interested in seeing a new idea succeed. Supporters can donate anywhere between \$2 and several thousand dollars to help entrepreneurs get their project off the ground. In some cases, investors are rewarded with a share in the project should the item succeed and in other cases, people get involved just to support an idea that they think worthwhile.

Now sites such as **Microryza** and **Petridish**, are looking to give science research projects a voice in the crowd funding sphere.

Successful crowd funding projects build a narrative around the concept and keep supporters informed of developments through social media, keeping the community discussion alive. Not only is crowd-funding an alternative way to fund your research project, it is an amazing way of connecting to the community and voicing the importance of your scientific endeavours.

For more info head to:
www.microryza.com or
www.petridish.org

NANOPATCH TAKING THE HURT OUT OF VACCINES



Vaccinations, though vital in preventing the spread of disease in the modern world, have several major drawbacks which limit their effectiveness and uptake in developing countries.

Professor Mark Kendall from the Australian Institute of Bioengineering and Nanotechnology, has spent the last ten years developing the Nanopatch - a needle free solution to many of the problems facing vaccine use. A tiny square of microneedles coated in vaccine, the Nanopatch is simply placed on the skin and the vaccine dispersed into the immune system just below the skin.

Vaxxas Pty Ltd, which was established to develop the Nanopatch, engaged with MCN at the beginning of the year to increase the outputs of their trial patches. By providing Vaxxas with access to state-of-the-art development equipment and expertise, MCN has accelerated and improved the production of the Nanopatch.

Eliminating the pain of traditional injections is just one small advantage of the Nanopatch. As the vaccine is dry coated onto the patch, the need for refrigeration is eliminated. This vastly increases its stability and reduces cost barriers for transporting vaccines to where they are needed most in third world countries. Similarly, the need for highly-trained professionals

to administer the medications is diminished. In this way, the Nanopatch has the capacity to transform the world's disease landscape, and to stamp out illnesses in third world countries that have long been preventable in the developed world. Furthermore, because the vaccine is delivered straight into the immunological cells, preclinical trials have shown a strong immune response with much lower doses than conventional intramuscular injections.

The Nanopatch is manufactured using mono-crystalline silicon wafers which are subjected to deep-reactive ion etching (DRIE), the same process that is commonly used to fabricate components of smart phones and other microtechnology devices.

Over the last ten months, MCN has helped to fine tune the Nanopatch production process so that the layers deposited on these wafers achieves better uniformity, increasing the output from each wafer. Furthermore, MCN has allowed Vaxxas to move from 4 inch wafers to 6 inch wafers, once again increasing the yield. MCN also hosts two DRIE systems which enables them to double their final outputs by processing wafers in parallel.

More information on the Nanopatch can be found at www.vaxxas.com

NEW PVD SPUTTER SYSTEM ONLINE

Adding to MCN's already expansive thin film deposition capabilities, we are now pleased to house an ANATECH Hummer RF/DC Sputter System.

The new sputter deposition system is a physical vapour deposition sputter system and can not only deposit metals, but also oxides and nitrides with high precision. This unique capability will allow users to directly deposit insulating layers onto their thin films, saving time and achieving more precise layers.

The Hummer sputter system is now fully operational and we expect it to be in high demand among MCN users. For more information, please contact ricky.tjeung@nanomelbourne.com



Above: The Hummer RF/DC Sputter System.



Left: The Hummer BC-20's round planar chamber with three 3-inch round sources.

INDUCTIONS NOW BIMONTHLY

MCN inductions will now be held on the first and third Monday of the month only. Inductions are compulsory for all users of the centre and refresher courses are required every year. The times for inductions are as follows:

10AM-12:30PM	MCN general induction
1PM-2:15PM	Dangerous Goods Waste Management
3PM	Local Area Induction

For more information contact john.zhu@nanomelbourne.com.

NEW FACES AT MCN

Sarah Abramson (Communications Coordinator)



Sarah is responsible for MCN's written communications, website content and visual branding. Graduating from the University of Melbourne with a bachelor in Media and Communications in 2009, Sarah has been working in marketing and communications in both academic and commercial settings. She brings with her experience in video creation, copywriting and graphic design. Please contact sarah.abramson@nanomelbourne.com with any communications or media inquiries.

MCN presents at NanoS-E3

MCN's Dr Matteo Altissimo recently participated in the fourth NanoS-E3 Conference in Queensland. The workshop brought together Nanotechnology experts with a focus on sensors, electronics, energy and the environment.

Recognising these four fields as critical in the growth of nanotechnologies and their applications in the world economy, the NanoS-E3 workshops aim to foster collaboration between Nanoscience researchers who are currently undertaking work that has the possibility to transform a range of scientific endeavours.

Speaking about Electron Beam Lithography research undertaken at MCN, Matteo discussed high level work in the fields of plasmonics and nano-sensing, performed by Dr Xingzhan Wei and Thanh Nguyen from the University of Melbourne and Dr Daniel Gomez from CSIRO. The works were selected because they highlight the outstanding capabilities of the MCN's Electron Beam Lithography tool.

About the conference, Dr Altissimo said, "It was a fantastic opportunity to network with colleagues and friends from Australia and overseas, as well as a perfect chance to present MCN's capabilities to a new audience, some of who had not previously heard about the centre."

Melbourne Centre for Nanofabrication

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