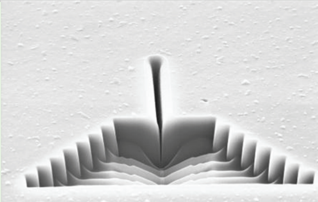
The University of Western Ontario



NANOWESTERN

Western

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INSIDE THIS ISSUE:

...FROM THE NEW NANOFAB DIRECTOR

Dear NanoUsers, Customers, Coworkers and Friends of the Nanofabrication Laboratory at Western;

Since June 1st of this year, I have overtaken the responsibilities as the Director for our fabulous Nanofab from Ian Mitchell, one of the initiators of developing and building the facility and serving as the interim director since then. A warm **THANK YOU !** to Ian Mitchell for all the efforts in bringing the facility to fruition.

It was my pleasure to see the abilities of the Nanofab, the user group and the technical and scientific crew of the Nanofab grow since my arrival as a faculty member in the Department of Physics and Astronomy in September 2003. The presence, capability and accessibility of this facility was, inter alia, one of the reasons which made me accept the offer for a faculty position at Western.

The Western Nanofab is a nanofabrication, nanocharacterization, and photonics facility that offers numerous possibilities for sample preparation and characterization but also to develop new nanotechnology, like nanoprobes and nanolithography technology, just to mention two of many evolving possibilities. It is not restricted to any specific research field, but open to anything within the possibility spectrum of the available technology. From inorganics, like semiconductors, metals and glass, to organic material and biological samples, everything is treated with equal importance.

The Nanofab is designed to serve researchers and scientists, and their students and coworkers in many aspects. Besides the training opportunities students and postdoctoral fellows experience in a general clean room environment, state-of-the-art technology is available both as a service, but also as hands on equipment experience after training. The friendly and knowledgeable staff is always around for help, advice and training, as well as to discuss issues around new developments. In my opinion, this is an excellent centre for training and achieving research goals.

If you have an idea which needs our help, do not hesitate and contact us. We are happy to discuss the idea with you and help you implement the available technology and experience to make your idea a success.

I wish you all a *successful* time in and around the Nanofabrication Facility.

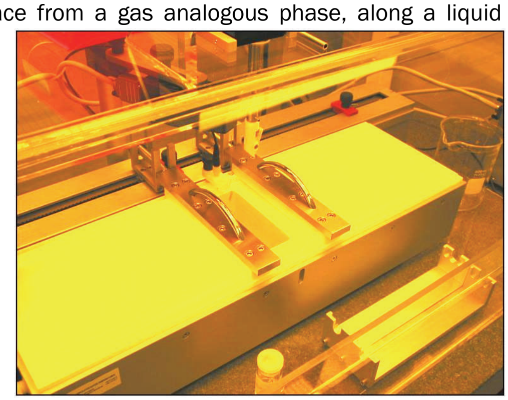
Yours,

Silvia Mittler

NEW EQUIPMENT IN THE NANOFAB: LANGMIUR-BLODGETT TROUGH

A KSV 3000 Langmuir-Blodgett trough (LB-trough) is now available in the Nanofab. It is capable of both the study of area-pressure isotherms at various temperatures, but also for the deposition of LB mono and multilayers with a film lift.

Amphiphilic molecules can be spirited at the air-water interface. Two movable barriers then compress the molecules located at the air-water interface from a gas analogous phase, along a liquid analogous phase, to a solid analogous phase. The lateral pressure π in mN/m is monitored online with a Wilhelmi film balance. Knowing the amount of spirited molecules gives the information of the area per molecule present on the surface.



The transfer of monolayers from the air-water interface onto a substrate is easily accomplished by dipping the substrate slowly with the help of a film lift through the monolayer at the air-water interface. Typically with every stroke 2 monolayers are transferred. In that transfer mode the trough controls with the help of the two barriers the lateral pressure to assure the monolayers stays in the chosen phase.

FOR MORE INFORMATION VISIT OUR WEBSITE
www.uwo.ca/fab

- Examples of work
- Contact Information
- Facilities Information
- How to become a NanoUser.
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- To subscribe or unsubscribe to NanoWestern
- Academic Rates

NEXT ISSUE:

Winter 2006:
Happy "*Nano*" Year!

- Ontario Photonics Consortium Investigator Project Profile

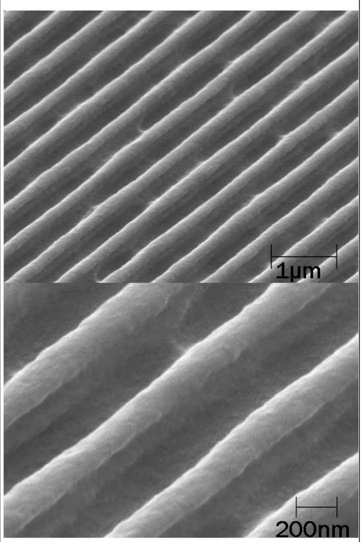
Summer Student working on set-up in the Nanofab

Matthew Turnbull has been working as a summer student in the Nanofabrication Laboratory developing an optical holography set-up for the fabrication of waveguide coupling gratings.

Matthew started is project over the summer of 2004 by ordering all the necessary items, such as the optical table, the HeCd laser, the optical components, photoresist, and developer chemicals.

Experimentally, last year, Matthew became familiarized with photoresist technology and methodology.

This summer, he successfully assembled the holographic set-up and has fabricated the first waveguide coupling gratings in photoresists on glass substrates. Electron microscopy images confirm his success.



The next step will be the milling of the photoresist structures into the glass or a waveguide, using the RIE (reactive ion etching) machine located in the Nanofab. These gratings, with a few hundred nanometer periodicity spacing , become permanent and resistant to chemicals.

The FIB/SEM Crossbeam

The LEO/Zeiss 1540XB FIB/SEM CrossBeam combines a field emission scanning electron microscope (SEM) column and a focused ion beam (FIB) column in a single instrument. The result is an exceedingly powerful research tool, allowing fabrication, imaging, and analysis to be performed at nanoscale dimensions. The gallium ion and electron beams “cross” to converge at a working distance of 6mm. This geometry allows a feature to be simultaneously imaged with both beams without moving the specimen. The 30keV Ga ion beam removes material by sputter milling to perform micromachining with sub-100nm precision. Focused Ion Beam milling is the only route to site-specific sectioning and thinning for in-situ SEM or ex-situ TEM microscopy and analysis. Areas of interest are first located with the SEM and then imaged with the FIB to define the regions to be milled. The FIB can be used for micromachining or sectioning while progress is monitored with the SEM. The feature to be milled or sectioned is referenced to the FIB SE image and can be located with a precision of a few hundred nm. Where this precision is insufficient, milling is monitored by SEM and can be nudged or stopped with 5-10nm accuracy. When combined with the appropriate gas precursor, material deposition and enhanced or selective etching can be performed, enhancing the micromachining capabilities of the sputter milling mode. As an analytical tool, the FIB is used for in-situ sectioning of samples which are imaged by scanning electron microscopy. The x-ray detector provides in-situ elemental mapping and analysis of the milled sections.

FIB/SEM
Academic Rates
$125/hr FIB
$100/hr SEM

Contact:
Todd Simpson
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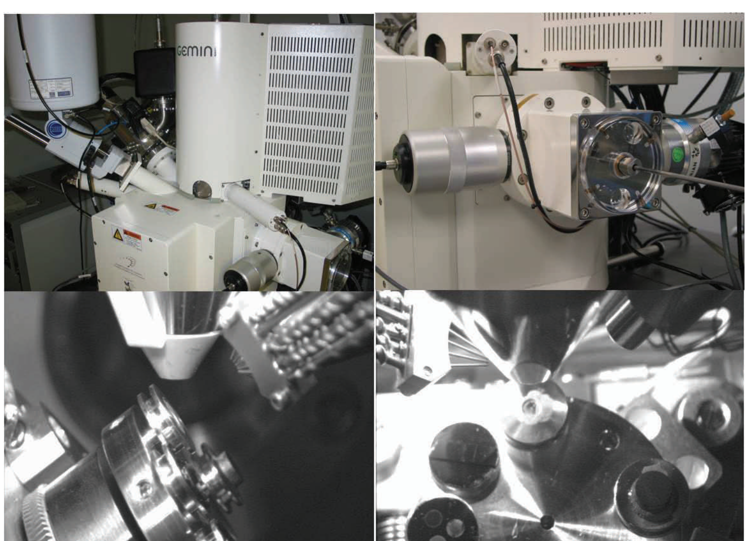
This article illustrates some of the current and potential uses of the instrument with examples drawn from Geology, Biology, Chemistry and Physics. Find out what the CrossBeam can do for your research.

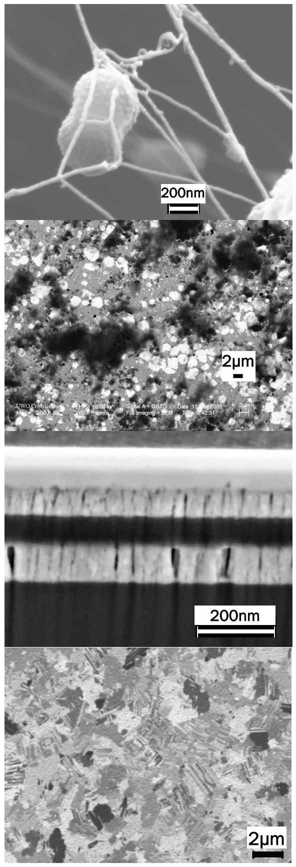


The turbo-pumped airlock chamber allows for rapid sample exchanges – less than 5 minutes

A variety of specimen mounts are available, including the standard 8-stub holder.

The 6-axis motorized stage allows rapid sample survey and site location.

Secondary Electron Imaging



Scanning electron images can be generated from both the electron and ion beams. The minimum probe diameter, determined by imaging ideal samples, is ~1nm for the electron beam and ~7nm for the ion beam. However, the actual image resolution is typically limited by the interaction volume of the probe with the specimen and by the image contrast. In practice, conditions must be found to optimize resolution and contrast to achieve the most useful images.

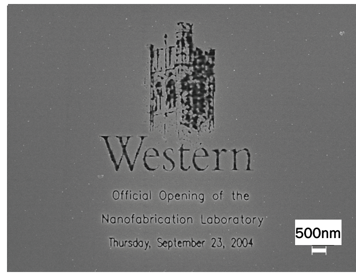
Examples, from top to bottom: a) conventional high resolution imaging of a bacterial cell with the Everhart-Thornley detector†, b) Z-contrast imaging of aluminum on steel using the backscatter detector††, c) Low kV, short working distancing imaging with the inlens detector. Low kV is typically used for imaging nanoscale objects to minimize the interaction volume, d) Ion-induced secondary electron images are sensitive to crystal orientation: grain orientation contrast in pure nickel.

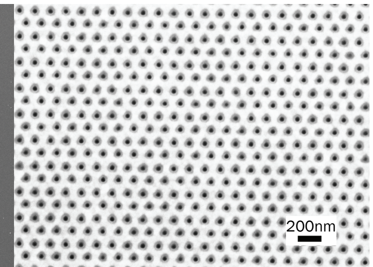
Full-service SEM imaging is available for all customers and training is available to nanousers.

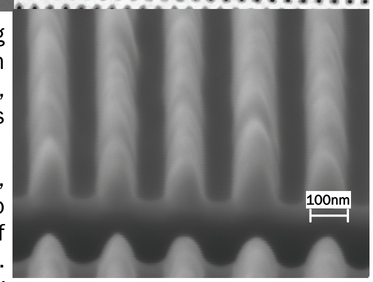
†Kebbi Hughes (Southam group).

†† Andreas Lachenwitzer / Norton Group

Focused Ion Beam Lithography & Milling







For complex micromachining applications, the FIB is fitted with an NPGS lithography system, identical to the one that controls our e-beam lithography system.

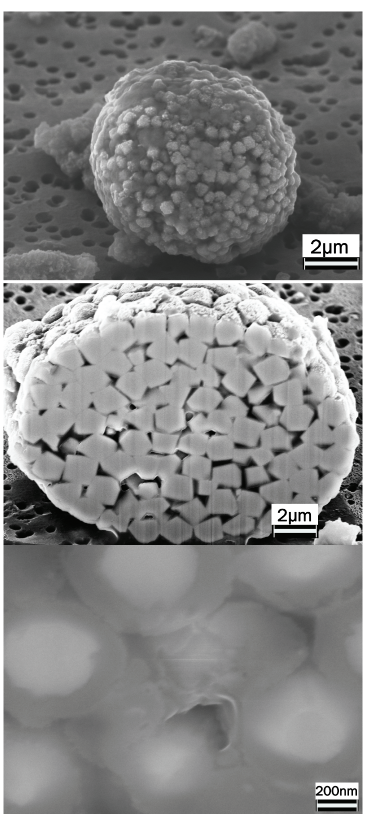
Unlike e-beam lithography, patterns are directly milled into the sample without the use of resist or further processing. Additionally, the depth of milling is controlled, allowing 3-d patterns to be produced. Since progress is monitored in real time by the SEM, prototyping is rapid and efficient when compared with other lithographic techniques.

Top left: FIB milling of a bitmapped image. Line width is 30nm.

Top right: A hexagonal array of FIB drilled holes in silicon through a thin gold surface layer: 40nm diameter and 130nm nearest neighbor separation.

Bottom right: 100nm wide gold lines milled from a continuous film on silicon.

Site-Specific FIB cross-sectioning



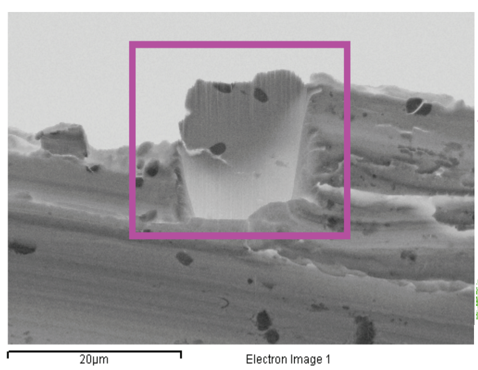
FIB machining is a standard technique for preparing thin foils for TEM analysis. With the 1540XB, we have the ability to perform high resolution SEM and EDX on sectioned features in situ. This allows us to rapidly and efficiently obtain much of the information that has traditionally required TEM and the associated, time consuming sample preparation. Repeated imaging or a full avi movie can be recorded in real-time with the SEM while FIB sectioning is performed, allowing 3-d reconstruction of the sample.

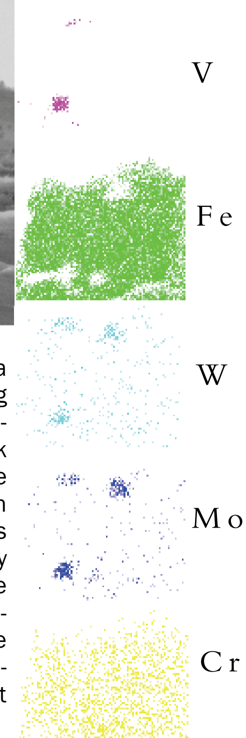
Top: SEM image of an Iron sulphide framboid captured on filter paper (Lachlan MacLean / Southam group).

Centre: A framboid cut open by FIB milling to expose the interior structure.

Bottom: High resolution SEM image of the newly exposed surface.

In-Situ FIB thinning for Elemental X-ray Analysis





The electron micrograph (above) shows a FIB thinned section milled at the cutting edge of a steel machining tool. The site-specific thinning procedure exposes a crack formed during mechanical sharpening. The thinned area was analyzed in-situ: a high resolution, quantitative, elemental map was acquired from the x-ray spectra generated by the scanning electron beam. Thinning the area of interest reduces the interaction volume, increasing the lateral resolution of the analysis. Working at the edge of the specimen eliminates the background signal that would otherwise be present.

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Western

Nanotechnology to the Rescue

Dr. Richard Glew, Nanofabrication Laboratory Manager

There is something about me which makes people confer their little problems. Fortunately, being a Nanofabrication Laboratory Manager, I can surprise them with a solution based on a little science.

"What really bugs me is that when I'm down the pub and I spill beer down my pants, it always soaks in and leaves a stain".

Well, you should visit your local mall and buy a pair of Dockers or Eddie Bauer Chivas made with Nano-tex. This is a fabric which incorporates Teflon coated nanofibres which make it water and stain resistant. Don't spill the beer too often though- the water resistant properties only last through thirty washes.

"I practice like crazy but my Tennis game doesn't seem to improve".

What you need is a Wilson nCode tennis racquet. It incorporates nanofibres to help you win those critical match points.

"Why is it that when I hit a perfect shot down the fairway the ball never seems to go straight?"

Switch to NanoDynamic golf balls. They incorporate nanomaterials which enable the balls to fly straighter without the skill of Tiger Woods. But at five bucks each, you'd best keep them out of the rough.

"I'm off to a family wedding, but my dry skin makes me look ready for Halloween".

For dry skin, you should use skin care products, such as L'Oreal Revitalift products, that contain nanosomes to transport active ingredients, such as Vitamin E and retinol, deeper into skin layers without degradation, delivering the active ingredients where they are needed most.

"These cold mornings, when I jump into my car and turn on the engine, the windows fog over".

Talk to the group at MIT, they have devised a nanoparticle coating for glass which makes the surface fog-proof. Foggy car windscreens and misty bathroom mirrors will soon be a thing of the past.

"I can't eat ice cream because it hurts my teeth".

A research team at the University of Leeds found that nanospheres can be used to fill channels in the dentine thus reducing the pain experienced by people afflicted with sensitive teeth.

"How do we sell more of our mp3 players than any of our competitors?"

Call it an Apple iPod Nano. It doesn't have to incorporate any nanotechnology but nano makes it sound really small, cool and NEW.

Actually there's nothing new about nanoparticles. Two thousand years ago the Romans used gold nanoparticles to pigment the glaze of vases. In the 10th century gold nanoparticles were incorporated into glass giving it the cranberry colour that you see on stained glass windows today. Of course, they didn't understand the science behind it. We had to wait until the 1850's when Faraday performed the first proper research on nanoparticles. Since then we have acquired the tools, technology and understanding to move forward rapidly.

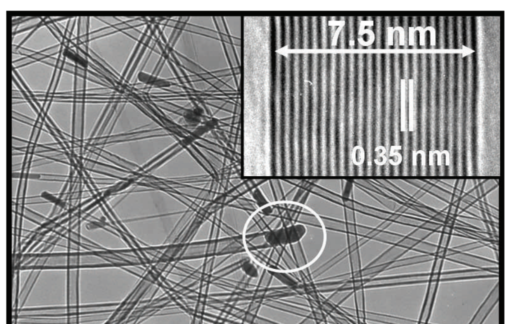
Today, consumers are not going to notice whether or not a product actually contains Nanotechnology. Consumers are already benefiting from existing products and procedures which have improved performance because they include Nanotechnology. There are already signs that Nanotechnology is giving rise to entirely new products.

This year, two exciting breakthroughs caught my eye: The first item involves the quest for the optical holy grail; an artificial material that exhibits negative refractive index. A team at Purdue University utilized an array of gold nanorods to demonstrate negative refraction at optical wavelengths for the first time. Another group, this time at Berkley, used a silver superlens (a lens with negative refractive index) to image an object with sub wavelength resolution. The complete solution has not been achieved, but nanotechnology will be an essential component of the technology .

The second item involves Intel. They announced the world's first silicon laser to operate continuously at room temperature. The laser is not very practical because it has to be externally pumped. What the Intel device lacks is nanotechnology. I predict that with the incorporation of silicon nanoparticle technology, pioneered by Lorenzo Pavesi, it will be possible to construct an electrically pumped silicon laser.

We can't predict what the next nanotech breakthroughs will be but we can reasonably expect that some will emerge from the talent assembled here at Western.

You too can be a part of the nanotechnology community here at Western. Just contact one of the Nanofab team and you will be well on your way to becoming a Nanoscientist.



Multi-Walled Carbon Nanotubes synthesized at Dr. Sun's lab, Department of Mechanical and Materials Engineering, University of Western Ontario (i). TEM image of carbon nanotubes (marked circle is Ni catalyst for nanotube growth) (ii). Inset showing HRTEM image of one wall of nanotube