The University of Western Ontario

NANOWESTERN

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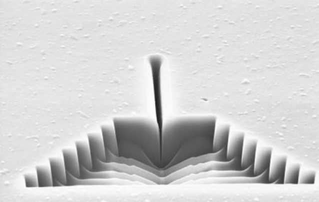

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For More Information Visit Our Website
www.uwo.ca/fab

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Dr. Silvia Mittler, New Director of Nanofabrication Laboratory

Out with the old and in with the new! Effective July 1, the Directorship of the Nanofab will be put on a three year rotation basis and it is a pleasure for me to welcome Dr Silvia Mittler who will be taking up the first such appointment.

Prof. Mittler joined Western's Department of Physics and Astronomy in 2003 as a full Professor and its first Tier 1 Canada Research Chair (Photonics of Surfaces and Interfaces).

Prior to her move to Western, Silvia was, for 10 years, a group leader at the Max Planck Institute for Polymer Research in Mainz, Germany, following postdoctoral appointments at Arizona State University and U. Florida (with George Stegemann).

Silvia's personal research portfolio is broadly based in photonics and in the development of novel applications. She brings into the research mix at Western both new and complementary expertise in photonics and nanotechnology. Research specifics can be found on her website http://quark.physics.uwo.ca/~smittler/.

While Silvia has her own group and her own laboratory, she is also a major user of the Nanofab facility. With this new appointment comes a reaffirmation of the role of the Nanofab as both a support and user facility, and a continuing commitment to accessibility, affordability, high quality of work and adherence to good cleanroom practice.

Since its official launch, the Nanofab has broadened its academic customer base and now reaches well beyond the initial investigator group. It can be anticipated that the pattern of growth and diversification will be further accelerated under Silvia's directorship.

...Next issue, the new Director gets to say her piece!

Ian Mitchell

Dr. Silvia Mittler's Current Research Interests

- integrated optical devices for sensor application
- metal nanoparticles of unusual shapes and clusters thereof, nucleation, ripening, growth and their optical response
- optical tweezers in evanescent fields
- photonic crystals
- heterogeneous photocatalysis in evanescent fields
- defined microporous materials in thin film geometry
- OMCVD for the definition of channel waveguides
- molecular nanoarchitectures of gold nanoparticles and organic functional material
- biocompatibility

How To Become a NanoUser

The Nanofabrication Laboratory is a state of the art "hands-on" facility in The Physics and Astronomy Building. It combines class 10,000 and class 100 cleanroom environments where users are trained in cleanroom protocol, the use of the tools and performing various processes.

If you wish to become a NanoUser, visit the website www.uwo.ca/fab where you'll find forms and instructions.

To discuss your processing, material and project requirements contact Rick Glew, the Laboratory Manager.

Academic User Fee Schedule

1. Daily Access Fee - $25 per day, maximum $ 200/month
2. SEM and FIB - $50/hr SEM equipment charge
   -$25/hr FIB surcharge in addition to SEM charges
3. E-beam Lithography – $50/hr equipment charge
4. Alcatel DRIE – $50 setup fee, $2.50/minute of etch, $100 minimum charge
5. Metal Deposition (Standard metals), Au/Pd -$10 per 100s deposit, E-beam Evaporation: (Au, Cr, Ti)- $50 per run, $200/micron for Au deposit, Sputter Deposition: $50 per run

For a complete list, visit www.uwo.ca/fab

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- Message from the New Director, Dr. Silvia Mittler
- Nanofab Project Profile
- Message from the Lab Manager, Rick Glew

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Deep Reactive Ion Etching with the Alcatel 601E

Deep Reactive Ion Etching (DRIE) of silicon is one of the key processes required for MEMS, microsystems, and sensor development.

Deep Reactive Ion Etching (DRIE) of silicon is one of the key processes required for MEMS, microsystems, and sensor development. Applications typically require high aspect ratios, etch depths of as great as 500 µm, etching through-the-wafer, etching into a buried cavity in the wafer, or etching onto buried oxide.

The Alcatel 601E can achieve deep anisotropic plasma etching of silicon by either of two types of processes. In the cryogenic process regime, an ultra-thin layer of silicon-dioxide is formed for sidewall protection to control the mask undercut. In the room temperature process regime, thin fluoro-carbon polymer film is deposited for sidewall protection (Bosch process).

The system is currently configured for 100mm wafers. A robotic wafer transfer arm transports substrates from the loadlock into the low pressure process chamber. Etch rates of 5µm/min are typically achieved with good uniformity across the wafer (< ± 5%). Very high etch selectivity to SiO_2 (>200:1) and resist (>100:1) allows very deep etching to be performed with relatively thin masking layers.

The four examples shown here were patterned by e-beam lithography in the Nanofabrication lab. The very high etch selectivity and room temperature etching allows the patterned resist to be used directly as the mask for etching, avoiding the extra step of transferring the pattern to a harder mask material.

The typical result of highly vertical sidewalls and flat floors achieved by this process are shown in figure 1, where 5um circles have been etched to a depth of 3um.

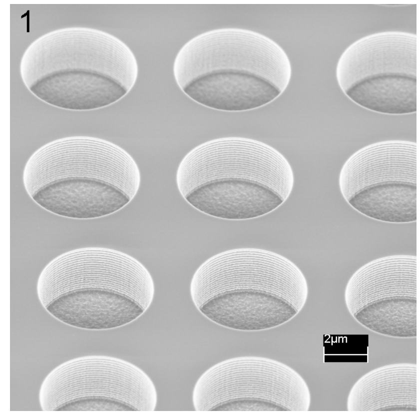
In figure 2, a photonic band gap structure etched by DRIE is shown in cross-section after being cut open by focused ion beam (FIB) milling in the nanofabrication lab.

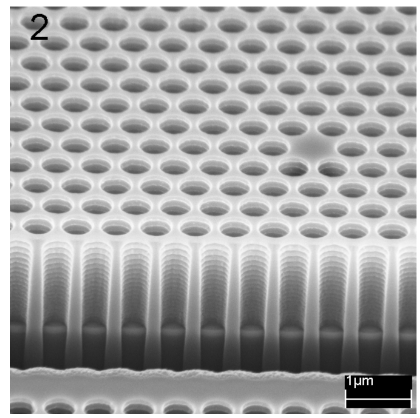
Figure 3 shows 50nm trenches on a 200nm pitch etched to a depth of 1um, also imaged in cross-section after FIB milling.

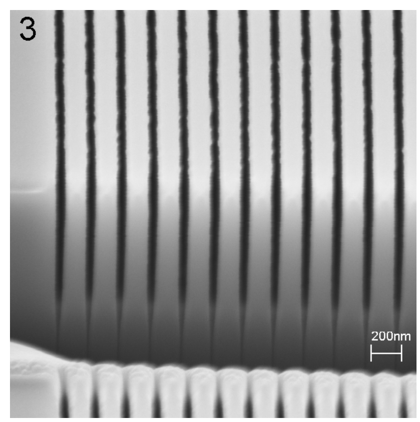
The structures shown in the first three figures were patterned with the standard positive e-beam resist, PMMA. This results in the areas written with the electron beam being exposed and etched while the remaining areas of the wafer are protected.

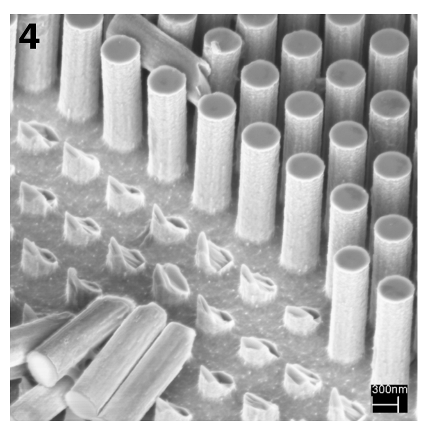
Figure 4 shows an array of 400nm diameter of silicon pillars, patterned with the negative e-beam resist, ma-N 2403, prior to etching. With a negative resist, only the areas written with the electron beam are protected from etching; the remaining areas of the wafer are etched.

Please contact Todd Simpson tsimpson@uwo.ca for further information, training, or scheduling

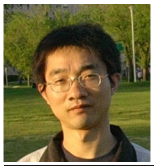








Cheng Lu, NanoUser Awarded at Canadian Chemistry Conference



Congratulations to NanoUser Cheng Lu, working with Prof. Rob Lipson. Cheng received an honorable mention in the Physical, Theoretical and Computational Division graduate student oral presentation competition for his presentation at the Canadian Chemistry Conference in Saskatoon, Saskatchewan.

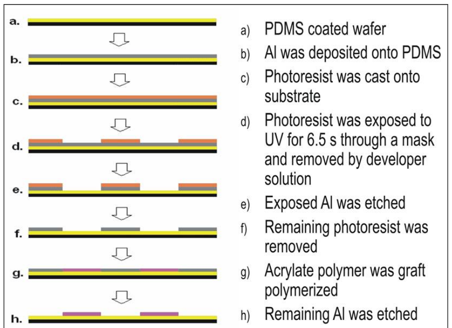
NanoUser Project Profile: UV-Graft Polymerization of Acrylates

Polydimethylsiloxane (PDMS) is a transparent, elastic polymer that is becoming an increasingly popular material in the development of microfluidic devices, especially in bioanalytical research. The application of the PDMS-based microfluidic devices has been hindered by the material's extreme hydrophobicity. A large amount of research is being put into the surface modification of siloxane polymers, trying to improve the wettability and biocompatibility of PDMS.

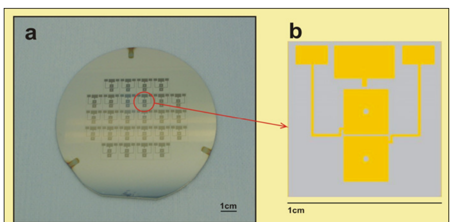
One method of permanently modifying PDMS is by covalently linking hydrophilic polymers on a surface via UV-initiated graft polymerization (UV-GP).

NanoUsers Natasha Patrito, PhD candidate, and fourth year student Swanda Chiang's work in the Nanofab has lead to the successful graft polymerization of poly(acrylic acid) and poly(methacrylic acid) onto spin-coated PDMS thin films.

Their work demonstrated that in all UV-initiated graft experiments, a significant decrease in the measured water contact angle was observed post-grafting when compared to that of native PDMS, demonstrating an improvement in the hydrophilic character of the treated surface. This technique was used to improve the adhesion of epithelial and fibroblast-like cells on PDMS by the grafting of acrylate polymers.



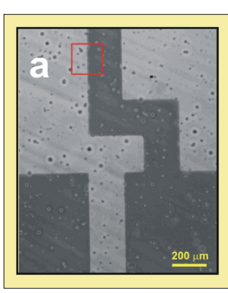
Photolithographic sequence for patterned acrylate grafting.



A. Patterned wafer at Step F of photolithographic sequence.
B. Schematic of a repeat pattern unit.

The grafted polymer layers were patterned and depositioned with sub-micron fidelity using a combination of photolithography and UV-GP (above). A thin layer of aluminum is deposited in Step B of the photolithographic sequence, acting as an adhesive layer for the photoresist.

Digital photographs (below) and AFM images of both the PAA and PMAA grafts demonstrate that the UV-GP of acrylate polymers can be achieved



a. Digital high magnification photograph of patterned PMAA graft sample (dark grey) and PDMS (light grey)

on the surface of PDMS in a high fidelity pattern. The edges of the patterned regions are well-defined and section analysis of the grafted samples indicate that uniformly thick acrylate films have been deposited. Identical experiments performed proved that PMAA appears to graft more readily than PAA, generating 62 ± 8nm and 33 ± 1nm thick films, respectively.

Future work will focus on the surface modification of PDMS with polymers whose properties can be modulated for active control of cellular attachment. Thermo– or photo-responsive polymers may be grafted onto PDMS using the UV-initiated method. By tuning temperature or light exposure, the adhesion of cells to the surface of a microfluidic device may be regulated.

Reproduced from poster entitled "Micropatterned Surface Modification of Polydimethylsiloxane via UV-Initiated Graft Polymerization of Acrylates" by N.Patrito, S.Chiang, P.R.Norton, N.O.Petersen. Permission from Natasha Patrito.

Natasha Patrito (supervised by Profs. Norton and Petersen) won first prize Graduate Presentation, Analytical Chemistry Division, at the 2005 Canadian Chemistry Conference, (20 students participated in the competition). She also won a poster prize at the first WINS One-Day Workshop on May 19, 2005.

UV-Initiated graft polymerization is a highly attractive surface modification technique which can be used to improve the wettability and biocompatibility of PDMS.

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We're on the Web
www.uwo.ca/fab

WINS Holds First Nanomaterials Workshop at Western

On Thursday May 19 the Western Institute for Nanomaterials Science (WINS) held a one-day workshop to highlight Western's diverse strengths in the area of materials and biomaterials, particularly at the nanometer scale.

When WINS was first established in 2004, it had a number of mandates. One of those was to serve as an organization where Western's scientific community working in materials research could meet, interact and hopefully forge new and potent collaborations. This workshop was the first major step in fulfilling that goal. It was organized jointly by Rob Lipson and myself, Mike Cottam as Associate Director and WINS Director, respectively. The response of the research community to our call to attend this workshop was gratifying, especially on relatively short notice.

In total, about 130 researchers from across several of Western's Faculties, including Science, Engineering, and Medicine & Dentistry, registered for the workshop. This reflected the strong interdisciplinary nature of research work in nanomaterials, cutting across the traditional boundaries between subject disciplines.

The one-day meeting was organized into 17 short oral presentations on key research topics in the morning and afternoon sessions. There were also two poster sessions with 41 posters, taking place over an extended networking lunch period and at the end of the afternoon sessions over refreshments.

We were especially pleased to see that many graduate students and postdoctoral fellows presented posters. There were prizes for the best graduate-student posters, and the poster judges had a very difficult time selecting the winners. The workshop was brought to a close at a dinner for all participants, at which it was announced that the poster awards would go to (in no particular order) Eric Meloche from Physics & Astronomy, Kim Dalby from Earth Sciences, and Charmaine Lee, Derek Wilson, Natasha Patrito, and Jayna Chan, all from Chemistry.

The Faculty of Science provided the budget that made it possible for WINS to put on this workshop at nominal cost to the participants, and Roland Haines (the Acting Dean) was present to open the event. Ted Hewitt, Western's Vice-President for Research and International Relations, addressed the participants at the beginning of the afternoon sessions.

By taking stock of the work taking place at Western, WINS will be better placed to fulfill its second goal, which is to provide a cohesive presence and collective vision for Western's Faculties, departments, laboratories and facilities whose researchers work on materials and biomaterials, particularly nanomaterials.

The timing of this workshop was not coincidental. It followed the official opening last fall of the Nanofabrication Laboratory located in the Physics and Astronomy Building, and has taken place just before the call for the next round of Canadian Foundations for Innovation (CFI) proposals.

The dream is to make Western and WINS significant players in nanomaterials science. If even one new idea or collaboration has emerged from the workshop, then we will be one step closer to making that goal a reality.

Dr. Mike Cottam
WINS Director