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NanoMeter

The Newsletter of Cornell NanoScale Science & Technology Facility

Volume 14 May 2003 Number 2

Director's Column

At the beginning of this year, we changed our name to the Cornell NanoScale Facility, short for Cornell NanoScale Science & Technology Facility.

The acronym CNF remains the same. What is in a name? Quite a bit. Over the years, the research pursued in our facility has gone through many transformations. From the use of instruments that largely came from semiconductor industry and were employed as research growth took place in III-V electronics, in silicon, in optoelectronics, in physics and materials science, in electro-mechanical systems, in biology, we have now come to a point where a lot of this work is performed at the atomic and nano-scale where the ever-developing top-down, i.e., physical nanotechnology or fabrication, and bottom-up, i.e., from atoms and molecules—chemical nanotechnology, both become very appropriate. The last few years have seen a large increase in such interdisciplinary usage derived from chemistry, and has been applied in all the fields of past rapid growth that I mentioned above. With this broadening of what we do in CNF, particularly in the techniques employed, it is appropriate that the name reflect this transformation.

The starting of April has brought us into the crucial time period where establishing CNF in our new facility in Duffield Hall has begun taking place. The clean room in Duffield is quite a sight, and promises a good leap in what CNF

continued on page 4

University hosts first Japan-U.S. Nanotechnology Symposium

Manipulating materials and devices at the ultrasmall level of one-millionth the size of a pinhead was the focus for three days at Cornell last week when 20 leading Japanese researchers, 20 U.S. researchers and five top officials from the National Science Foundation (NSF) held the first in a series of symposia on nanotechnology. The meetings will, among other things, discuss priority areas of research and attempt to develop technological standards to be adopted for the field.

Called the Japan-U.S. Symposium: Tools and Metrology for Nanotechnology, the meetings will be held twice a year alternately in the United States and Japan. It is not yet decided if Cornell will host future symposia. They parallel similar meetings that Japanese government officials and researchers have held with the United Kingdom and Asian nations.

The U.S.-Japanese symposia are sponsored by the NSF and MEXT (the Japanese Ministry of Education, Culture, Sports, Science and Technology).

The January 22-24 symposium at the Statler Hotel on campus, which attracted an audience of researchers from Cornell and across the United States, was hosted by the National Nanofabrication Users Network (NNUN), whose director is Sandip Tiwari, the L.B. Knight Director of the Cornell Nanoscale Science and Technology Facility (CNF). CNF is one of the five members of NNUN and a national user center funded by the NSF.

continued on page 2

Frank DiMeo/University Photography

Taking part in a session during the Japan-U.S. symposium on nanotechnology in the Statler Hotel, Jan. 22, are, from left, Professor John Silcox, Cornell vice provost for physical sciences and engineering science; Tsuyoshi Maruyama, deputy director-general of the Japanese Office for Materials Research and Development, MEXT; and deputy director, Naoko Okamura.

In This Issue...

www.cnf.cornell.edu

Japan-USA Symposium, continued from page 1

"Hopefully, we can do this for five years and exchange information," said Hiroshi Tokumoto of Hokkaido University, who worked with Tiwari in organizing the symposium. "You can always see publications, but our feeling was that if scientists and engineers who work in labs could meet face to face there would be a good exchange of information."

A very practical reason for engaging in close conversation with U.S. researchers was voiced by Tsuyoshi Maruyama, deputy director-general of MEXT: "We have to encourage curiosity-driven opportunities in the U.S."

He noted that Japan's nanotechnology research is overseen by MEXT and the Ministry of Economy, Trade and Industry. Although the funding support system is complicated, he said, "The advantage of the organization system is that there are two ministers in charge of science and technology, one in the cabinet office."

Among Japan's science and technology policy priorities are the promotion of basic research and research and development in areas that meets social needs, including life sciences, information and communications technology, environmental sciences and nanotechnology and materials. A third priority, he said, is encouraging emerging research areas.

The NSF's Esin Gulari, the agency's acting assistant director for engineering, noted how closely Japan's nanotechnology structure and investments match those in the United States. The NSF is the lead agency for the National Nanotechnology Initiative (NNI), which involves a total of 15 to 16 Washington departments and agencies. Fiscal 2002 funding for the NNI was $604 million, with a similar amount being donated by industry and about a further half of this amount from universities and foundations. "We are adding up to perhaps one-and-a-half times the Japanese investment. But if you compare the two countries, the investments are quite comparable," Gulari said.

In addition, she said, the NSF's NNI portfolio is focused on areas very similar to those of the Japanese. Usually the agency invests in three "modes," she said: small exploratory research projects; major investments in interdisciplinary research teams; and investments in research centers, of which six have been launched to date. "It is exciting to see physicists, biologists, materials scientists and engineers working as a team, and in real time advancing knowledge," she said.

Among the NSF's support areas, nanotechnology undergraduate education is a new theme this year, said Gulari. "We are finding that the nanoscale is fascinating for young people learning science and technology. They are learning science in its entirety, not just physics, biology or chemistry, but science," she said.

During the symposium, U.S. and Japanese researchers presented papers on standards, methodology and research in nanotechnology in the two countries. Among Cornell researchers participating were Héctor Abruña, the E.M. Chamot Professor of Chemistry and Chemical Biology, who spoke on single-molecule transistors; John Silcox, vice provost for physical sciences and engineering science, who spoke on scanning transmission electron microscopy approaches to problems on the nanoscale; and Michal Lipson, assistant professor of electrical and computer engineering, who spoke on the challenge of coupling light from fibers into nano-size optical waveguides.

By David Brand
Cornell News Service
January 30, 2003

Shijie Yang/CNF Staff

Symposium participants enjoyed three days of talks and group discussions. The report to the NSF, symposium proceedings and presentations can be found on the web in PDF, at:
http://www.cnf.cornell.edu/JapanUSsymposium.html

The 2002-2003 CNF Research Accomplishments

It is time once again for all CNF Principal Investigators and users to submit reports for the Cornell NanoScale Facility Research Accomplishments. As you may recall, one of the requirements of using the CNF for your research is the submission of an annual technical report.

It is extremely important that we receive complete and interesting reports from all users and projects. The CNF Research Accomplishments (R/A) is distributed each year to industrial affiliates, visitors, potential users and sponsors, and therefore is our primary technical CNF publication. This book is also crucial in maintaining our NSF funding, so it must be a comprehensive summary of our user discoveries, technologies, and publications.

We are acutely aware that successful user research programs like yours are necessary for CNF to survive and thrive. In turn, the CNF R/A is a tool to ensure the survival of all CNF projects. Your cooperation in submitting a report as quickly and completely as possible will help assure that CNF remains a leader and an accessible national resource in nanofabrication science.

The *TECHNICAL REPORT* is a two-part report submitted by each CNF user regarding any and all research accomplishments s/he has achieved in the past year. Part 1 is a written report of the accomplishments, while Part 2 is a pictorial report which summarizes the research through photos, graphs and explanatory bullet items. Each is a stand alone report.

Full instructions can be found at:
http://www.cnf.cornell.edu/

If you have any questions regarding your report, please contact Michael Skvarla immediately. On behalf of CNF, we would like to thank you for your cooperation.

Michael Skvarla
User Program Manager
skvarla@cnf.cornell.edu
Phone: (607) 255-2329, ext. 116

New Staff at the CNF

From Left to Right:

Ms. Leslie Montanye received her B.S. in Accounting in 1992 and has been working in various work environments ever since, including industry, investment banking, and health care. She and her husband, Jerry, enjoy working in and outside the home that they built themselves, finishing up the fine tuning details and growing lots of fresh vegetables and flowers in the summer months in their own garden. Their four sons, the eldest of whom is a Cornell graduate, also keep them busy and on the go, though the boys are mostly all grown up. Leslie and Jerry are the proud grandparents of one grandson and are expecting their first granddaughter in September. Leslie joined the CNF staff this past December doing accounts payable and also editing various journal publications.

Paul Pelletier is a process piping systems designer who lives in Elmira with his wife, Allison, and sons, Jeffrey and Jonathan. Paul has been involved with installation of high-purity piping systems and processing equipment for approximately 15 years at MIT Lincoln Laboratory, Corning Incorporated, and other semiconductor fabrication facilities. Paul joined the CNF staff in April and will be working as an equipment/facility technician. In Paul's spare time, he is the head coach of his sons' Mite ice hockey team, which included a game at Lynah Rink this past winter. Paul plans on continuing his education towards a degree in engineering.

Ms. Kathy Springer settled in Trumansburg after a somewhat nomadic existence as a military dependent, living in many states and countries. She joined the CNF this past April as Receptionist / User Program Administrative Assistant after working for 12 years in Ithaca's local medical community. When not working, Kathy likes to spend her time in the outdoors, hunting and fishing.

The 2003 NNUN REU Program

During the summer of 2003, the National Nanofabrication Users Network will again host a Research Experience for Undergraduates Program (NNUN REU) from June to August. Engineering and science students with a genuine interest in nanotechnology were encouraged to apply, most especially minority and female candidates.

Forty-eight undergraduates have been chosen from 200 applicants to partake in this ten-week program which offers hands-on nanofabrication research through projects designed and supervised by the NNUN Faculty and Technical staff.

A three-day scientific conference, the NNUN REU Convocation, will be held in August at UCSB to allow each intern the opportunity to present a concise scientific summary of their research. In doing so, interns learn from each other as well as from leaders in the field of nanofabrication, who also participate in this event. Finally, each intern submits a written report of their research findings which in turn will become the 2003 NNUN REU Research Accomplishments; a publication distributed to the NSF, corporations, NNUN, and the interns themselves.

The NNUN REU Program is mainly supported by the National Science Foundation, and co-sponsored by the NNUN and its industrial sponsors.

The CNF is looking forward to an event-filled and successful summer with the following twelve NNUN CNF REU interns:

Ms. Olabunmi Agboola
Molecular & Cellular Biology,
University of Illinois at Urbana-Champaign
CNF REU PI: Antje Baeumner
Project Title: Investigation Of Laser-Induced Nanovesicle Lysis In Microfluidic Devices

Mr. Michael Campolongo
Electrical & Computer Engr/Physics,
Rowan University
CNF REU PI: George Malliaras
Project Title: Organic Thin Film Transistors For Sensor Applications

Mr. Ardavan Farjadpour
Nanoengineering, University of Toronto
CNF REU PI: Sandip Tiwari
Project Title: Back-Plane Based Nano-CMOS Transistors

Mr. Sterling Fillmore
Physics/Chemistry/Math, Brigham Young Univ.
CNF REU PI: Christopher Umbach
Project Title: Two-Dimensional Nanobumps Using Ion Sputtering and Reactive Ion Etching

Ms. Jill Fitzgerald
Chemical Engineering/Chemistry,
Louisiana State University
CNF REU PI: Harold Craighead
Project Title: Microfluidic Test Chambers for Individual Cells

Ms. Rachel Gabor
Chemistry, Harvery Mudd College
CNF REU PI: Michael Spencer
Project Title: Fabrication of Biomolecular Sieves with Novel Geometry

Mr. Alireza Masnadi-Shirazi
Electrical Engr, University of Texas Arlington
CNF REU PI: James Engstrom
Project Title: Chemistry-On-A-Chip: Functionalizing Microfluidic Devices

Ms. Heather McKnight
Physics/Chemistry, Brigham Young University
CNF REU PI: Lipson & Panepucci
Project Title: Polymer Waveguides for Integrated Biosensors

Mr. Michael Miranda
Electrical Engr, University of Notre Dame
CNF REU PI: Edwin Kan
Project Title: Novel Gate Stack Processes for MOS-Based Structures

Mr. Andrew Newton
Bioengineering, Pre-Med, Kansas State Univ.
CNF REU PI: Amit Lal
Project Title: Ultrasonically Driven Microneedle Arrays

Ms. D. Marie Nguyen
ChemEngr, Cornell University
CNF REU PI: Christopher Ober
Project Title: Nanolithography using Supercritical CO_2 as an Environmentally Benign Processing Solvent

Mr. Justin Scott
Mechanical Engr/Materials Science,
UC Berkeley
CNF REU PI: Amit Lal
Project Title: Silicon Ultrasonic Horns For Thin Film Characterization

The full list of the 2003 NNUN REU interns and the 2002 NNUN REU Research Accomplishments can be found on the web at www.nnun.org

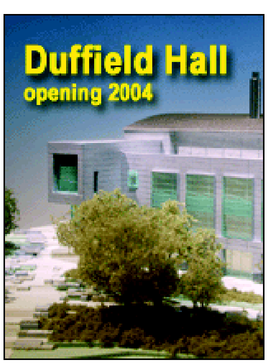
Director's Column, continued from page 1

will be able to accomplish for its users.

Chemistry is one of these areas, and the related equipment at our Langmuir location, and new acquisitions, which will make much of this possible, is being moved in and installed. The first of the enhanced capabilities are the five furnace banks with four tubes each. These will allow a very rational partitioning of the diversified needs of our various users and their needs: from the extremely contamination-sensitive electronics community to the mechanical and optical properties-sensitive electromechanical, optical, and biological community. More similar equipment will be placed during the next few months until the beginning of August when our current instrumentation begins to be moved from our present location.

Included in the new equipment that will appear in Duffield Hall is a new electron-beam lithography system: the JEOL 9300. Together with our VB6, this tool reinforces the unparalleled capability CNF offers in lithography at the nanoscale. The JEOL will be arriving in September, and we plan for the tool to be available for users towards the end of this year after thorough installation and acceptance tests. The VB6 is scheduled to be available in the new location a bit earlier as it will be the first to move on July 15th—dictated by its strategic location in the equipment move corridor between the two sites. We have been requesting that users of electron-beam lithography bear this mind and work hard at doing their work in advance during the current period. We do have arrangements for some work to be done outside Cornell, should rare needs arise.

Sandip Tiwari
Lester B. Knight Director of CNF



New CNF Equipment:

Hitachi S-4700-2 SEM with Oxford EDX

The S-4700 FE Scanning Electron Microscope combines the versatility of PC control with a novel electron optical column to give exceptional performance on large and small specimens. Resolution of 1.5 nm at 15 kV is guaranteed at the EDX and specimen exchange position of 12mm working distance.

The S-4700 also offers excellent low kV perforniance with guaranteed resolution of 2.1 nm at 1 kV—now at a working distance of 1.5 mm. The Type II features a five-axis eucentric motorized stage which will accommodate specimens up to 150 mm in diameter.

Pre-programmed operating modes allow the user to switch from high-resolution conditions to microanalysis conditions at the click of the mouse with no change of objective aperture. The fully integrated new ExB filter opens the door to low voltage, high resolution, backscattered imaging never before possible on a conventional SEM.

The tool manager for the Hitachi SEM is Daron Westly and he can be reached at westly@cnf.cornell.edu

Hitachi
http://www.hitachi-hhta.com/
Oxford
http://www.oxford-instruments.com/OIGMSH2.htm

Oxford PlasmaLab 80+ RIE System

The CNF has aquired two Oxford PlasmaLab 80+ RIE systems; one for immediate use in the Knight Lab and the second to be installed in Duffield Hall.

The Oxford PlasmaLab 80+ is an 8-inch diameter parallel plate, turbo-pumped RIE system dedicated to processes involving Fluorine based gas chemistries such as CHF_3, CF_4, and SF_6. Processes are available to anistropically etch silicon dioxide, silicon nitride, and silicon. Other gasses available are argon and oxygen.

The system has a 500 W 13.56 MHz RF power source coupled to a solid state matching network. The active electrode is equipped with a heater/chiller and is capable of operating at various temperatures. The operating pressure regime for processes in the PlasmaLab 80+ is 10 - 1000 mT.

The PC interfaced system is equipped with a laser interferometry endpoint detection scheme that can be configured to allow the PC to control and stop the etch. This also allows the etch depth to be used to control when an etch process is stopped.

The Oxford tool manager is Meredith Metzler and he can be reached at metzler@cnf.cornell.edu.

The website for this tool at Oxford Instruments is http://www.oxford-instruments.com/PLMPDP415.htm.

User Profile:

Helena Silva

Helena Silva is currently a graduate student in the School of Applied and Engineering Physics at Cornell University. She came to Cornell in August 1998 after obtaining her bachelor's degree in Engineering Physics from the Lisbon Technical University, Portugal. At LTU, her undergraduate project involved amorphous and micro-crystalline silicon thin film transistors (TFTs) for large area electronics, and since then Helena has become interested in solid state and device physics.

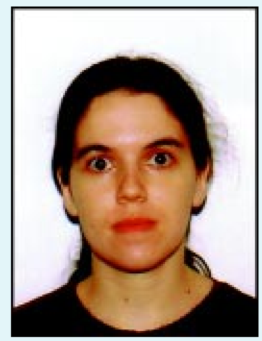
Although still working mainly in the fields of silicon and devices, she moved from large area electronics, where large areas are needed at the expense of speed (displays, photocopy machines, scanners, etc) into the ultra-small area electronics, where small and fast is the priority. Helena is also interested in nano-electronics and the physics of small devices.

After one year at Cornell, Helena joined Professor Tiwari's research group where she has been working on silicon nano-crystals memories, and the role of defects and interface states in small devices. She started working at the CNF in September 1999.

Currently she is working on a new device structure, a scalable non-volatile memory cell and transistor based on back-side trapping. This is a charge-trapping based memory where the trapping occurs at the interface or bulk defects in oxide-nitride-oxide stacked films placed on the back of a thinned Si channel.

Helena uses a method that has been developed by Lei Xue, Arvind Kumar and Chris Liu, also in Professor Tiwari's group. This process consists of a low temperature bonding followed by a hydrogen-induced exfoliation which allows the transfer of a thin single-crystal silicon layer onto another wafer that may already have other devices (for 3D integration, e.g.) or stacks of films, as for this memory-transistor device fabrication. This process makes use of chemical mechanical polishing (CMP) and bonding techniques available at CNF. Helena uses the Leica VB6 electron beam lithography tool and has fabricated memory-transistors of 40 nm gate length.

The unique feature of this new device–the fact that the same structure can operate both as a scalable SOI (silicon-on-insulator) transistor and as a scalable reliable non-volatile memory–may lead to useful and creative developments in the integration of logic and memory on a chip.



Helena Silva,
Cornell University
hgs4@cornell.edu

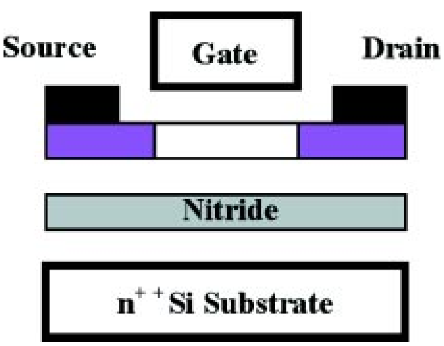


Figure 1: Schematic cross-section of the device.

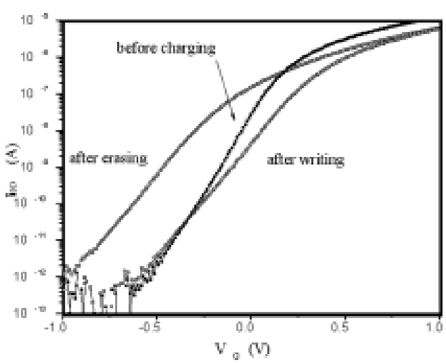


Figure 3: Transistor and memory operation of a 0.5 µm device with back ONO stack of 7/20/100 nm. (a) Transfer characteristics in erased and written states, VD = 1 V. Suthreshold slope degrades from 119 mV/dec to 160 mV/dec after charging.

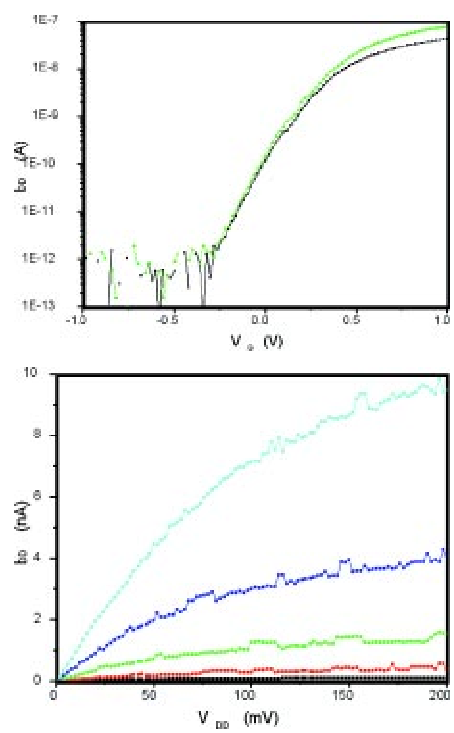


Figure 4: Transfer and output characteristics of a 50 nm x 50 nm device.
S = 157 mV/dec
(a) VD = 0.1, 0.2 V.
(b) VG = 0, 0.1, 0.2, 0.3, 0.4, 0.5 V.

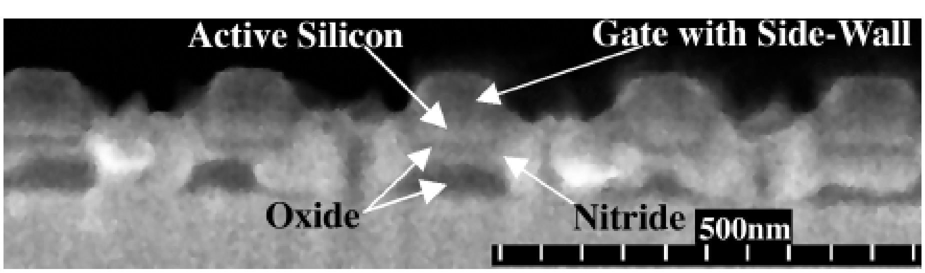


Figure 2: SEM image of a cross-section of a memory array.

A Selection of CNF Patents

[1] Project Number: 381-90
[2] Nanostructure Fabrication Using Gas-Microstructure Reactions
[3] Principal Investigator: David Hsu
[4] Institution: Naval Research Laboratory
Technology Transfer: "Self-Aligned Integrally Gated Nanofilament Field Emitter Cell and Array" David S.Y. Hsu US Patent No. 6,448,701, Sept 10, 2002. "Methods for Manufacture of Self-Aligned Integrally Gated Nanofilament Field Emitter Cell and Array" David S.Y. Hsu US Patent No. 6,440, 762, Aug 27, 2002.

[1] Project Number: 408-91
[2] Monolithic Optoelectronics
[3] Principal Investigator: Joseph Ballantyne
[4] Institution: Cornell University
Technology Transfer: Patent application in process for growing microcrystals of GaN (believed to be defect - free) on Silicon Tips processed in CNF.

[1] Project Number: 599-96
[2] NEMS
[3] Principal Investigator: Harold Craighead
[4] Institution: Cornell University
Technology Transfer: Mechanically Resonant Nanostructures, U.S. Patent #6,515,751 issued February 4, 2003. Patent Disclosures: Operation of Nano-Mechanical Resonant Structures in Air Laser Annealing for MEMS Devices.

[1] Project Number: 639-97
[2] MEMS Device Development
[3] Principal Investigator: Joel Kubby
[4] Institution: Xerox Wilson Ctr for R&T
Technology Transfer: Development of SOI-MEMS process described in the following US patents: US 6,362,512 MEMS defined from silicon on insulator wafers. US 6,379,989 Process for manufacture of microoptomechanical structures. US 6,479,311 Process for manufacturing micromechanical and microopto-mechanical structures with pre-applied patterning. US 6,479,315 Process for manufacturing micromechanical and microoptomechanical structures with single crystal silicon exposure step. US 6,506,620 Process for manufacturing micro-mechanical and microoptomechanical structures with backside metalization.

[1] Project Number: 657-97
[2] Retinal Implant Project
[3] Principal Investigator: John Wyatt
[4] Institution: MIT
TT: A patent, "Ab Externo Retinal Prosthesis," has been applied for.

[1] Project Number: 715-98
[2] Technology For Self-Assembled Entities In Logic And Memory Units Below The Optical Lithography Limit
[3] Principal Investigator: Edwin C. Kan
[4] Institution: Cornell University
Technology Transfer: 1. Silicon olfactory bulb: Chemoreceptive Neuron MOS Transistors (C(MOS) for chemical and molecular sensing, status: provisional patent by Cornell Research Foundation, 2002. 2. Embedded Metal Nanocrystals for Improving Injection Efficiency over Heterojunctions, patent by Cornell Research Foundation, 2002.

[1] Project Number: 731-98
[2] Mouse on a Chip: A microfluidic cell culture analog device to mimic animal responses to chemical exposure
[3] Principal Investigator: Michael Shuler
[4] Institution: Cornell University
Technology Transfer: Aegen Biosciences was formed by Greg Baxter (formerly CNF Sr. Scientist) to commercialize our inventions. Aegen Biosciences has licensed some of the patents and patent applications. Shuler is a member of the Scientific Advisory Board for Aegen Biosciences.
Patents: 1. M.L. Shuler and A. Sin. Self priming micropump. (Docket Number: 1153,053PV). 2. M.L. Shuler, G.T. Baxter, S. Meyers, A. Harrison, and A. Sin. Devices and methods for pharmacokinetic-based cell culture system. (Docket Number: 1153,008US1)

1] Project Number: 836-00
[2] Synthesis and Applications of Carbon Nanostructures
[3] Principal Investigator: Michael Simpson
[4] Institution: Univ. of Tennessee, Knoxville
Technology Transfer: Patent Application Filed: M. A. Guillorn, T. E. McKnight, A. V. Melechko, V. I. Merkulov, M. L. Simpson. "Individually Electrically Addressable Carbon Nanofibers on Insulating Substrates".

[1] Project Number: 903-00
[2] MEMS Flextensional Actuator using PZT and Cymbal Structure
[3] Principal Investigator: Susan Trolier-McKinstry
[4] Institution: Pennsylvania State University
Technology Transfer: MOS Clean Process, LPCVD Nitride, Polysilicon Process, PECVD Oxide Process.

[1] Project Number: 917-00
[2] Fabrication of Fluidic Structures
[3] Principal Investigator: Stephen Turner
[4] Institution: Nanofluidics, Inc.
Technology Transfer: Effective this year, Nanofluidics, Inc. and the Cornell Research Foundation executed a license agreement providing NFI with exclusive worldwide rights to a suite of technologies originating from Cornell and work conducted in the CNF. These include: entropic trap array DNA separation, integration of planar waveguides with capillary microfluidics, entropic recoil separation of long strand DNA, the Zero-Mode waveguide, and monolithic fabrication of nanofluidics structures for DNA manipulation.

[1] Project Number: 926-01
[2] Electrochemically Based Microfluidic Components
[3] Principal Investigator: Susan Hua
[4] Institution: SUNY Buffalo
Technology Transfer: US Patent (filed on 11-28-02): "Method to make microfluidic systems and components without moving mechanical parts" Z. Hua, H. D. Chopra and F. Sachs.

[1] Project Number: 972-01
[2] A Microreactor for In-Situ Hydrogen Production by Catalytic Methanol Reforming
[3] Principal Investigator: Mayuresh Kothare
[4] Institution: Lehigh University
Technology Transfer: 'Microreactor and method of use to produce hydrogen by methanol reforming', A. Pattekar and M. Kothare. U.S. Patent docket # LUNX-101USP, provisional disclosure filed Dec 2002.

[1] Project Number: 984-01
[2] SiNx Membranes for Low Energy Electron Beam Windows
[3] Principal Investigator: Daniel Murnick
[4] Institution: Rutgers University
Technology Transfer: Technique for deposition of SiNx on silicon and etching of required patterns have been transferred for use at the microelectronics laboratory of the New Jersey Institute of Technology

[1] Project Number: 101602
[2] Nanophotonics - Novel Structures for Optical Integrated Circuits
[3] Principal Investigator: Wayne White
[4] Institution: Luxtera, Inc.
Technology Transfer: Luxtera has demonstrated proof of concept for several novel nanophotonic structures on silicon. Those structures are now being reproduced in a wafer foundry using the foundry's standard processes. Products utilizing integration of those structures with electronics are expected out in late 2004

A Selection of CNF Publications and Presentations

"4He Confined to 1 μm Boxes, 0D Crossover, Surface and Edge Effects"; M.O. Kimball and F.M. Gasparini paper, proceedings, 23rd International Conference in Low Temperature Physics, Hiroshima, Japan 2002.

"A Comparison of Tunneling through Thin Oxide Layers on Step-Free and Normal Si Surfaces"; A. Oliver and J. Blakely, Proceeding, MRS conference, Dec 2002, to be published, 2003.

"A DNA Prism: High Speed Continuous Fractionation of Large DNA Molecules"; L.R. Huang, J.O. Tegenfeldt, J.J. Kraeft, J.C. Sturm, R.H. Austin and E.C. Cox, Nature Biotechnology 20, 1048-1051, 2002.

"A Simple Model for the Formation of Step-Free Surfaces"; K.-C. Chang and J. Blakely, Proceedings of MRS conference, Dec 2002, to be published in 2003.

"Atomic Force and Scanning Tunneling Microscopy of Network-Disrupted Amorphous Oxide Interfaces: Fracture and Sputter Morphologies"; C.C. Umbach and J.M. Blakely, Proceedings of MRS conf., Dec 2002.

"Atomically Flat Areas on Si(001) and (111): Fabrication by Evaporation or Growth and Defect Characterization"; D. Lee, Cornell University, 2002.

"Bacterial Chromosome Extraction and Isolation"; C. Prinz, J.O. Tegenfeldt, R.H. Austin, E.C. Cox and J.C. Sturm, Lab on a Chip 2:207-212, 2002.

"Bigger Is Better: the Influence of Particle Size in Diffusion Arrays"; L.R. Huang, P. Silberzan, J.O. Tegenfeldt, E.C. Cox, J.C. Sturm, R.H. Austin and H. Craighead, Phys. Rev. Lett. 89: 178301-4, 2002.

"Continuous Separation of Biomolecules by the Laterally Asymmetric Diffusion Array with Out-Of-Plane Sample Injection"; M. Cabodi, Y. Chen, S. Turner, H. Craighead and R. Austin, Electrophoresis 23:3496-3503, 2002.

"Coulomb Blockade and the Kondo Effect in Single Atom Transistors"; J. Park, A. Pasupathy, J. Goldsmith, C. Chang, Y. Yaish, J. Petta, M. Rinkoski, J. Sethna, H. Abruña, P. McEuen and D. Ralph, Nature 417, 722, 2002.

"Critical Behavior of Finite Systems: The Superfluid Transition of 4He in a Confined Geometry"; F.M. Gasparini and M.O. Kimball, Paper, proceeding of the 8th International Conference on Similarity in Diversity, 2002.

"Dissolution Rate Measurements for Resist Processing in Supercritical Carbon Dioxide"; V.Q. Pham, G.L. Weibel, N.G. Rao, C.K. Ober, Proceedings of SPIE-The International Society for Optical Engineering, 2002, 4690, Pt. 1, Advances in Resist Technology and Processing XIX, 425-431.

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