Nanometer

Cornell Nanofabrication Facility

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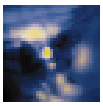
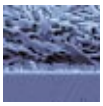
Cornell Nanofabrication Facility

CNF

1978 - 1998

20 years of nanofabrication and things just keep getting smaller . . . . . .









In This Issue . . .

This issue was formatted by Melanie-Claire Mallison

The CNF 20th Anniversary Symposium, Annual Meeting and Career Fair

Hunter Rawlings, President of Cornell University with Sir Alec Broers

Nanofabrication isn't just about making computer chips any more. The ability to manufacture devices smaller than a blood cell has applications in medicine, molecular biology, agriculture, and even the social sciences and humanities, according to participants in the Cornell Nanofabrication Facility's 20th anniversary symposium held in September.

The symposium brought together university researchers, industry representatives and government officials for a look into the future of nanotechnology. Their basic conclusion: They all still need each other. In between show-and-tell sessions about the latest research, much of the talk was about how research would be done, by whom and, especially, how it would be funded.

Sir Alec Broers, vice chancellor of England's Cambridge University, kicked off the three-day event on Wednesday by delivering the Henri Sack Memorial Lecture, "Today's University / Industry Partnership: What Works? What Doesn't Work?" What doesn't work today, he said, is an individual researcher working on a small scale.

"Developments today don't come out of the blue," he said. "They come out of focused effort. Most technical advances have been made by research teams supported by large enterprises." As an example he cited the transistor, not a lucky discovery, he said, but the result of a deliberate research effort by Bell Labs to create a solid-state amplifier.

Today, he said, the ideas of academics and industry researchers must be combined. And after reviewing several approaches to funding, he concluded that the most productive approach is to have industry fund academic research but at the same time have its own scientists participate actively in that research. This way, he said, industry scientists can stay in touch with what's happening in the field, while university scientists can get feedback on what's useful. Nevertheless, he added, small, university-funded research is still important as a way to explore totally new ideas.

And government has to stay in the act, too, said John Hopcroft, the Joseph Silbert Dean of Engineering at Cornell, who kicked off a Thursday afternoon panel discussion. Since it takes 30 to 40

Panelists from left to right: William Brinkman, Bell Labs; Sir Alec Broers, Cambridge; Tom Theis, IBM; Jim Meyer, Kodak; Bernard Eid, Corning; Charles Duke, Xerox; and Harold Craighead, AEP, Cornell University.

years for a scientific breakthrough to grow into a major business, he said, industry can't see an immediate return on investment in basic research. Government still has to support basic research, he said, with the added benefit that this support helps to train the next generation of scientists.

Hopcroft pointed out that the techniques originally developed to build electronic circuits on tiny silicon chips also can be used to make tiny tools and instruments for use in any discipline that deals with the very small. In particular, he said, it will have an important role to play in the university's coming emphasis on molecular biology.

John Silcox, Vice Provost and Sandip Tiwari, new Director of the CNF

The symposium concluded with a luncheon address by David Catalfamo, senior deputy commissioner of New York's Empire State Development Corp., who emphasized the bottom line. Catalfamo also is acting executive director of the New York State Science and Technology Foundation. He displayed impressive statistics about economic growth in New York, which he said results mainly from tax reductions and other incentives offered to businesses.

But he emphasized that part of the state's strategy is also to encourage innovation and new technology that could build future businesses. For example, it funds goal-oriented research through programs like the state-funded Centers for Advanced Technology, which includes the Cornell biotechnology center.

State support is intended to produce economic growth by encouraging business startups and helping existing businesses to become more competitive and more profitable, he explained. "We look at it as an investment, not a grant," Catalfamo said. And in evaluating the results, "We're not going to measure activity, we're going to measure impact."

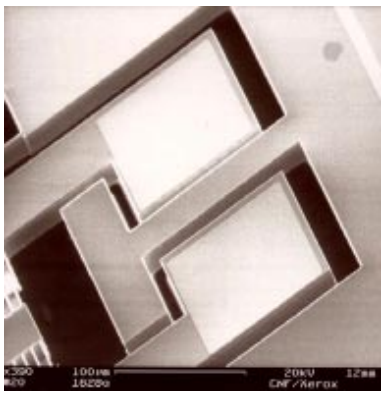
Bill Steele, Cornell News Service
Cornell Engr Magazine, pgs 22-23, Fall 1998

Students discuss their work with Annual Meeting participants at an afternoon poster session.

***During the Career Fair**, CNF Users met with Corporate Representatives to talk about the future. Advanced Micro Devices, Advantest America Inc., AMP, Eastman Kodak, Lucent Technologies - Bell Labs, Motorola SPS, Plasma Therm, and Standard Microsystems Corp took the time to meet with students and hold interviews. See below for one Career Fair Success Story!*

Alex T. Tran, A Career Fair Success Story

Alex T. Tran was born in Da Lat, Vietnam in 1967. He came to Cornell in 1992 and has been working on various topics in the photonics Micro-Electro-Mechanical Systems (MEMS). After receiving his Ph.D. from Prof. Y. H. Lo, he joined Xerox Wilson Research Center as a member of research and technical staff. He is currently a visiting scientist at Cornell and is an outside user of the Cornell Nanofabrication Facility (CNF). Since his graduate student days, CNF has continually played a major role in his professional career. It was through the CNF career fair that he was introduced to Xerox.



Regarding his research, Alex says, "The goal of our group is to develop prototypes of photonics MEMS devices for integration into Xerox's integrated imaging system. To date, the elimination of motion induced image artifacts remains one of the biggest challenges facing an imaging system designer. These artifacts, which are readily visible to the naked eye, result from the motion induced errors of the photoreceptor belt and/or the polygon ROS (Raster Output Scanner). Typically, these motional errors can have amplitude up to few hundred microns and bandwidth up to few hundred Hertz. Rather than having to build a better optical imaging system, it is more cost effective to perform real time, closed loop control of the interactions between the polygon ROS and photoreceptor belt subsystems. Our focus is to track these relative errors in real time and to dynamically correct for the image mis-registration using a high bandwidth micromirror."

Sandip Tiwari of IBM named Director of Cornell Nanofabrication Facility

Sandip Tiwari, a leader in advanced device work at IBM Corp. and a manager at IBM's Thomas J. Watson Research Center, has been named the Lester B. Knight Director of Cornell Nanofabrication Facility (CNF), which is among the nation's leading nano-technology centers.

Tiwari, who earned his doctorate in electrical engineering at Cornell in 1980, also will become a Cornell professor of electrical engineering. He will assume his new post March 1.

He succeeds Joseph M. Ballantyne, Cornell professor of electrical engineering, who took over as director in January 1998. Ballantyne, who was founding director of the university's first microfabrication facility in 1976, the first national laboratory of its kind in the world, will resume full-time teaching and research.

Ballantyne said that Tiwari was chosen because of his direct experience in building small electronic devices in the areas of microwave, optical and silicon structures, as well as for his interest in new frontiers of nanofabrication, such as biological devices. "He is also one of the world leaders in very small scale innovative silicon devices, which are at or beyond the current industry goals 15 years out," Ballantyne said. "We can see fundamental limits restricting progress of the chip industry unless we do something differently from the past. Physical limits are there, and if the industry is going to continue and not become mature, new kinds of physics must be brought into chip development. Sandip is at the edge of that."

Tiwari's appointment also was praised by James S. Thorp, director of the Cornell School of Electrical Engineering as well as the C.N. Mellowes Professor of Engineering. "During his time at the Watson Lab, he has maintained visibility in the academic community," Thorp said. "Because of his work in nanofabrication architecture at IBM, he was an excellent choice for director."

CNF serves as a research and instructional center for the application of man-made nanostructures in a broad range of disciplines, including emerging uses in biological and medical sciences, materials research, physics and chemistry, as well as engineering applications in microelectronics, optics and the new area of MEMS, or microelectromechanical structures.

Tiwari noted that the influence of small structures has led "to some of the most inspiring work in the physics and chemistry of condensed matter in the present decade." He said, "Nanostructures are now at one of those rare moments of creation. The next few decades will bring many more discoveries, new areas of research and new applications, and I look forward to helping bring many of them to fruition at CNF."

The new director was born in India and received his undergraduate degree at the Indian Institute of Technology, Kanpur. He earned his master's degree in electrical and systems engineering at Rensselaer Polytechnic Institute, Troy, N.Y., before coming to Cornell for his Ph.D. He joined IBM's Watson Center as a research staff member in 1982 and became a manager for exploratory memory and device modeling in 1989. He has been a visiting associate professor at the University of Michigan and an adjunct professor at Columbia University.

Tiwari has reported extensively on his research and development of electronic and optical semiconductor devices and structures using silicon, as well as on compound semiconductors, in various publications and at scientific conferences.

CNF is located in Knight Laboratory at the College of Engineering and serves annually approximately 160 research groups and 450 users, who come from universities and corporations throughout the United States, including about 210 student researchers and faculty members from Cornell's colleges of Engineering, Arts and Sciences, Agriculture and Life Sciences and Veterinary Medicine.

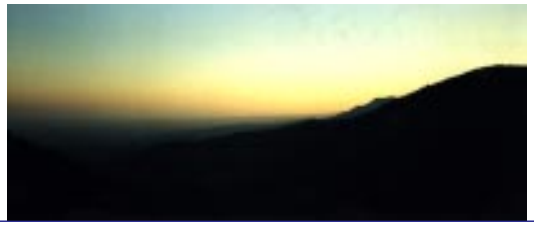
Sandip Tiwari

by David Bland
Cornell Chronicle
January 21, 1999

Participants take a break to enjoy the California sunshine.

The 1998 NNUN REU Convocation, was held at the University of California, Santa Barbara. All forty-three REU interns and several site staff members spent three days taking in the sights, sounds and tastes of the West Coast. We heard from each intern about the results of their project, and listened to lectures from a few experts in the field of nanofabrication. The weather was perfect, the mountains were very distracting, and the company was interesting and friendly. A good way to end the year!

The 1998 NNUN REU Research Accomplishments are avaiable from Melanie-Claire Mallison. Use the address on the back of this newsletter to request your copy.



Sunset over the San Rafael Mountains

Publications:

"A Prototype Computational Environment for Concurrent Design of Micro-Electromechanical Systems (MEMS)," Hrishikesh Upendra Dixit, Master Thesis, Cornell University, 1997.

"A Semiconductor YBaCuO Micro-bolometer for Room Temperature IR Imaging," A. Jahanzeb, C. Travers, Z. Çelik-Butler, D. P. Butler and S. G. Tan, IEEE, 1997.

"Atomic Steps in the Decay of 1- and 2-Dimensional Gratings," J. Blakely, C. Umbach, and S. Tanaka, Dynamics of Crystal Surfaces and Interfaces, 1997.

"Chaos, Interactions and Nonequilibrium Effects in the Tunneling Resonance Spectra of Ultrasmall Metallic Particles," O. Agam, N. Wingreen, B. Alshuler, D. Ralph and M. Tinkham, Phy Rev Lets, V78, p.1956, 1997.

"Characterization and Applications of Cryogenic Processed Schottky Contacts to Indium Phosphide," J. Palmer, Ph.D. Thesis, SUNY Buffalo, 1997.

"Chips and Packages as Drivers of Computing Technology," J.P. Krusius, Invited presentation at Symposium in Honor of Senior Vice President and Group Executive of IBM, Patrick A. Toole, Cornell Univ., April 30, 1997.

"Development of Channel Electrophoresis with Electrochemical Array Detection," P.F. Gavin, Ph.D. Thesis, Cornell Univ., 1997.

"Fabrication Semiconducting YBaCuO Surface-Micromachined Bolometer Arrays," C.M. Travers, A. Jahanzeb, D.P. Butler, and Z. Çelik-Butler, accepted for J Micromechanical Syst, 1997.

"Frequency Dependence of Shot Noise in a Diffusive Mesoscopic Conductor," R.J. Schoelkopf, P.J. Burke, A.A. Kozhevnikov, D.E. Prober, and M.J. Rooks, Phys Rev Lett 78, #17, p.3370, 1997.

"Investigations of Titanium Tungsten Opticas Microelectromechanical Systems," A.T. Tran, Ph.D. Thesis, Cornell Univ., 1997.

"Lasing Behavior of Circular Grating Surface-Emitting Semiconductor Lasers," R.H. Jordan, D.G. Hall, O. King, and S.Rishton, Opt Soc Am 14, p. 449, 1997.

"Mechanical Integrity of Area Array Solder Joints," C. Lopez, M.Eng. Thesis, Cornell Univ., 1997.

"Monolithic Integration of III-V Compound Light-Emitting Devices in Silicon-Based Electronics," J.-W. Lee, Ph.D. Thesis, Cornell Univ., 1997.

"Recessed Gate GaN MODFETs," J. Burm, W Schaff, G Martin, L Eastman, H. Amano, and I. Akasaki, SSE, 41#2, p. 247, 1997.

"Room-Temperature Operation of a YBaCuO Microbolometer," Z. Çelik-Butler, D.P. Butler, C.M. Travers, and A. Jahanzeb, SPIE's Optoelectronics '97 Symposium: Photodetectors: Materials and Devices II, Feb. 10-14, San Jose, CA, 1997.

"Scaling of the Specific Heat of Confined [4]He," S. Mehta and F.M. Gasparini, Bull Am Phys Soc 42, p. 436, 1997.

"Self-Alligned Single-Lateral Mode Waveguide Diode Ring Lasers," S.T. Lau, M.H. Leary, and J.M. Ballantyne, IEEE J Lightwave Technol, 1997.

"Shrunk and Post-Shrunk Integrated Circuits and their Computing Applications," J.P. Krusius,Invited presentation at the IEEE Rochester Section Joint Chapters Meeting, March 12, 1997.

"Specific Heat and Scaling of [4]He Confined in a Planar Geometry," S. Mehta and F Gasparini, PRLett 78, p.2596, 1997.

"Superconducting Single Photon Imaging X-Ray Spectrometers," S. Friedrich, Ph.D. Thesis, Yale, 1997.

"Technology and Theory of High-Frequency Directly Modulated Semiconductor Lasers," R.M. Spencer, Ph.D. Thesis, Cornell Univ., 1997.

A Small Selection of CNF Related Publications

Nanometer is published periodically by the Cornell Nanofabrication Facility at Cornell University.
Comments and future article ideas can be sent to: Nanometer, c/o Knight Laboratory, CNF - CU,
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Your comments are welcome!

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