Nanometer

Cornell Nanofabrication Facility

Volume 9 October 1998 Number 2

Dr. Joseph Ballantyne, New Director of CNF

Dr. Joseph M. Ballantyne, Cornell professor of Electrical Engineering, has been named the Lester B. Knight Director of the Cornell Nanofabrication Facility (CNF).

A member of the Cornell faculty since 1964 and founding director of the university's first micro-electronics fabrication facility, Ballantyne takes over from Noel C. MacDonald, who is on leave of absence from the faculty to direct the federal DARPA (Defense Advance Research Projects Agency) Electronic Technology Office.

"Joe Ballantyne is ideally suited to head the facility as Cornell, through the national network, takes a national and international leadership role in the enhance-ment of nanotechnologies," said Norman R. Scott, Cornell vice president for research and advanced studies, in announcing the appointment. "He has a clear vision of the major impacts nanotechnologies will have on society and believes CNF will continue to build a legacy of scientific achievement."

One of two principal sites in the five-site, university-based, National Nanofabrication Users Network (NNUN) supported by the National Science Foundation, CNF formerly was the National Nanofabrication Facility and before that, the National Research and Resource Facility for Submicron Structures.

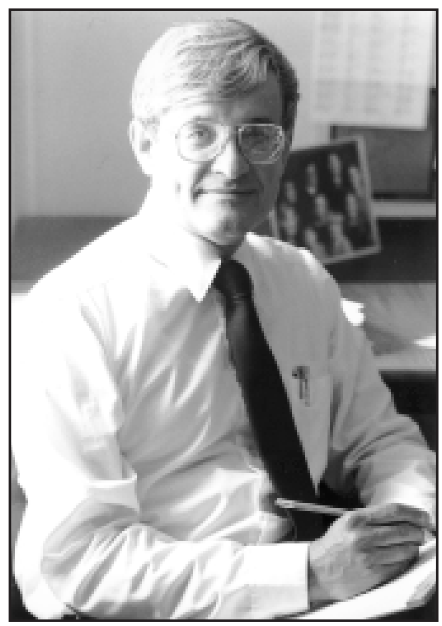
Prior to becoming director of the School of Electrical Engineering (1980-84), Ballantyne in 1976 organized the winning bid for the National Research and Resource Facility for Submicron Structures, the first national laboratory of its kind in the world, and he served as its acting director the first year. Key to Cornell's success in this competition was an inter-disciplinary vision, stemming from the Cornell Materials Science Center, a vision which has become the hallmark of the current national network, NNUN.

Ballantyne also served as university vice president for research and advanced studies from 1984 through 1989, before returning to teaching and research in the School of Electrical Engineering. His research focuses on the synthesis and character-ization of III-V compound materials for optical devices and on the design, construction and testing of optoelectronic devices and circuits.

He earned bachelor's degrees in mathematics and electrical engineering (1959) from the University of Utah, as well as a master's degree (1960) and a Ph.D. (1964) in electrical engineering from MIT.

An elected fellow of the Institute of Electrical and Electronics Engineers, Ballantyne has been a consultant to more than 20 companies and several universities. He will continue as director of the SRC (Semiconductor Research Corp.) Center of Excellence in Microscience and Technology.

Article by Roger Segelken of Cornell Chronicle



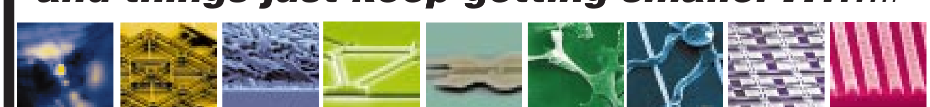
In This Issue . . .

This issue was formatted by Melanie-Claire Mallison

1978 - 1998

CNF Cornell Nanofabrication Facility

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



NNUN National Nanofabrication Users Network

The NNUN REU Program

1997 marked the first year in which the National Nanofabrication Users Network (NNUN) combined their efforts and research sites to hold a joint Research Experience for Undergraduates Program. Now, even though the 1998 program has

The Cornell Nanofabrication Facility REUers

just ended (look for the 1998 report in the December Nanometer), it isn't too late to look back at last year's success.

In June of 1997, forty-one interns representing over 24 colleges, began participating in the program, taking full advantage of the unique opportunities at each of their assigned sites, and working with faculty and graduate student mentors. Each REU intern experienced hands-on lab work, and had the satisfaction of producing results from their own efforts. The summer was not all research, though,

The Howard University REUers

The First Annual NNUN REU Convocation, Cornell University, August 1997

what with ocean surfing at UCSB, shopping in New York City, and various other side trips. Interns agreed that one of the best parts of the REU experience was meeting with so many diverse fellow REUers, and seeing a new part of the United States.

The Pennsylvania State University REUers

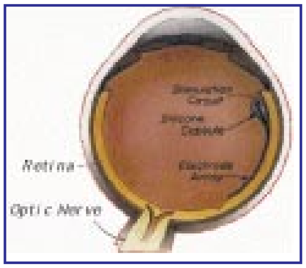
The summer-long program culminated with an NNUN REU Convocation, held at Cornell University, where the REUers presented their findings to the entire group. Undergraduates, faculty and staff were equally impressed by the scope of the investigations, and experts in the field of nanofabrication spoke, encouraging the REUers in this pursuit. And the Ithaca weather cooperated providing a memorable picnic with hiking, volleyball, and potato rockets.

While the NSF provided the primary funding, this research program could not have taken place without the generous financial support of each of the five sites, and these companies:

The Stanford Nanofabrication Facility REUers

Advanced Micro Devices
Analog Devices
Applied Materials
Corning, Inc.
DuPont, Inc.
Ericsson
Hewlett Packard
Hitachi
IBM
Intel
LAM Research
Lucas Novasensor
Motorola
National Semiconductor
Philips Research
Rockwell Int'l Corp.
Siemens AG, Corporate R&D
Texas Instruments
VLSI Technology, Inc.
Xerox, Inc.

University of California at Santa Barbara REUers



The Retinal Implant Project, Harvard-MIT Collaboration

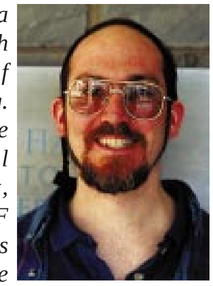
The goal of the Retinal Implant Project is to develop a microelectronic prosthesis to restore some vision to patients with retinal disease, specifically macular degeneration and retinitis pigmentosa. The project began in 1988 as a collaboration between the Massachusetts Eye and Ear Infirmary and the Massachusetts Institute of Technology.

The target diseases for this project, age-related macular degeneration and retinitis pigmentosa, are not rare. The former affects 700,000 Americans each year and is the leading cause of blindness in the Western world. Retinitis pigmentosa, while less common, affects 1.6 million people worldwide. It is the leading cause of inherited blindness worldwide.

In our design the retinal implant has two silicon microchips. The first is a tiny “solar battery,” which receives light from a miniature laser mounted on a pair of glasses. One purpose of the solar battery is to provide electric power to the implant. A second purpose is to provide an electronically encoded version of the visual scene in front of the patient. This will be obtained by a small electronic camera also residing on the glasses. A signal-processing microchip on the glasses will convert the visual information to an electronic code that will be carried on the laser beam, similar to the way a television picture is carried on a cable. The second chip, the stimulator chip, will decode the picture information carried by the beam and transmit electric pulses to the nearby ganglion cells in the retina. These will be carried to the brain and hopefully provide a useful image for the patient.

We have developed a basic prototype of the prosthesis and have performed “proof-of-concept” experi-ments with animals, showing that implantable electronics can deliver a visual signal to the brain. Our next major project is to carry out additional short-term implant experiments with blind human volunteers. These will help to determine the quality of perception that can be attained over a period of two or three hours with electrical stimulation of the retina through a surgically implanted microelectrode array. [Our] long-term goal is ambitious, and we can't provide an accurate timetable for its completion, but we don't anticipate having a suitable device to treat these diseases within the next five years.

From: http://rleweb.mit.edu/retina



Douglas Shire is a Visiting Scientist with Cornell's School of Electrical Engineering. He is part of the Harvard-MIT Retinal Implant Project, working under CNF Project 657-97. His primary goal for the past year has been to perform the proof-of-concept experiment. He writes, "This system will be proven first using rabbits. The function of the electrode arrays designed and fabricated at the CNF has been to provide a ‘micro-cable.’ The remaining problem of long-term biocompatibility will require major additional effort."

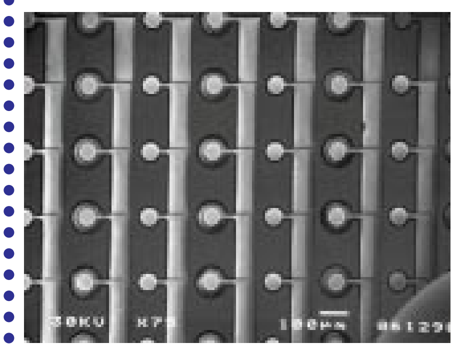
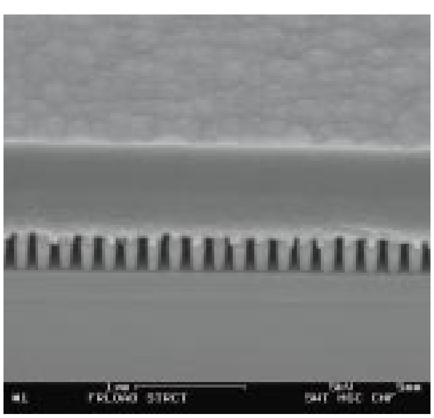


Photo: Detail of Electrode Array’s Tip Region

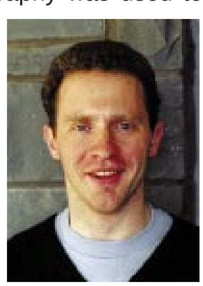
DNA Sieve Structures

Cornell Applied Physics Professor Harold Craighead and Ph.D. candidate Steve Turner are collaborating with Prof. Bob Austin of Princeton on nano-fabrication of structures designed to manipulate and separate DNA. Dr. Austin has been working with DNA structures for several years, but the newer models are considerably smaller than the earlier prototypes.



The DNA channels have a height between 50 and 500 nm, and are essentially capillary tubes containing nanometer-scale seives whose purpose is to separate DNA strands according to size. The tubes are fabricated using a sacrificial layer of polysilicon on a silicon nitride base. The polysilicon is covered with another coat of silicon nitride and then removed by wet etch with TMAH, the active ingredient in most photoresist developers.

The technology gives very accurate height control--variances of less than 5 nm for an entire wafer. The dimensions of the retarding grids are unprecedented: electron beam lithography was used to produce pore sizes of 100 nm. The SEM micrograph shows a cross section of the DNA seive structures made with the new sacrificial layer removal technique.



Steve Turner

Lithography Engineer Needed!

The Cornell Nanofabrication Facility has an immediate opening for a senior microfabrication engineer. Graduate degree in Applied Physics, Electrical Engineering, Materials Science or a related field preferred; B.S. considered with appropriate experience. Minimum of two years experience in any aspect of semiconductor microfabrication. Extensive experience with scanning electron microscopy, photo-lithography, and/or e-beam lithography is desirable, in addition to computer skills. Engineer will support processes, equipment, and facility users in the execution of complex custom nanofabrication projects. The CNF hosts an extensive array of state of the art lithographic and thin film tools, including two e-beam lithography machines, as well as g-line, i-line, and DUV steppers. The CNF provides a stimulating environment in which the staff support the research of over 400 users from across the country. Cornell offers an attractive work setting with excellent benefits plus the opportunity for professional advancement. Send letter and resume to: Alton H. Clark, Assoc. Director, CNF, Knight Lab, Cornell University, Ithaca, NY 14850.

Publications:

"0.12 µm Gate III-V Nitride HFET's with High Contact Resistances," J. Burm, K. Chu, W. J. Schaff, L. F. Eastman, M. A. Khan, Q. Chen, J. W. Yang, and M. Shur, IEEE Elec Dev Lett, V18, #4, p. 141, 1997.

"A Model for Optically Quenched Lasers," M. A. Parker and D. B. Shire, Appl Phys Lett, V70, p. 146, 1997.

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"Biological Near-Field Scanning Optical Microscopy: Instrumentation and Sample Issues for Shear-Force Feedback," G.A. Valaskovic, M. Holton, and G.H. Morrison, Ultramicroscopy, 1997.

"Cathodeluminescence Study of GaAs Quantum Wells and of Submicron Dots Fabricated by Magnetron Reactive Ion Etching," L.-L. Chao, G. S. Cargill III, M. Levy, R. M. Osgood, Jr., and G. F. McLane, Appl Phys Lett, V70, p. 408, 1997.

"Heat Capacity of Sn Nanostructures via a Thin-Film Scanning Calorimeter," S. L. Lai, G. Ramanath, L. H. Allen, P. Infante, and Z. Ma, Appl Phys Lett, V70, p. 43, 1997.

"Long Wavelength Vertical Cavity Light-Emitting Devices," Gina Lee Christenson, Ph.D. Thesis, Cornell, 1997.

"Method for Control of an Integrated Ring Laser," S. T. Lau and J. M. Ballantyne, J IEEE Lightwave Technol, 1997.

"Nanofabricated Carbon Detectors NACAD for Atomic Force Microscopy," V. Parpura and J. Fernandez, Biophys J 72, p. 156, 1997.

"New Methacrylate Block and Random Copolymer for Submicron Lithographic Imaging," C Ober, M Hupcey, and A Gabor, Proc ACS Polym Chem 38#1, p. 477, 1997.

"Noise in Semiconducting YBaCuO Microbolometers and its Applications," Z. Celik-Butler, A. Jahanzeb, D. P. Butler, and C. Travers, presented at 14th Intl. conf. on Noise in Physical Systems and 1/f Fluctuations ICNF '97, July14-18, 1998, Leuven, Belgium.

"Optical Antenna: Towards a Unity Efficiency Near-Field Optical Probe," R. D. Grober, R. J. Shoelkopt, and D. E. Prober, Appl Phys Lett 70, p.1354, 1997.

"Performance of an Internally Water-Cooled Monochromator for a High Power Beam Line at CHESS," K. W. Smolenski, P. Doing, and Q. Shen, J Synch Rad, 1997.

"Physical Model of ORIC-Compatible Lateral Current Injection Lasers," E. Sargent and J Xu, The Special Issue of IEEE J Selec Topics on Quantum Electronics, 1997.

"Scanning Probe Microscopy Studies of Molecular Redox Films," J. E. Hudson and H. D. Abruna, IUPAC Monograph of Chemistry for the 21st Century, 1997.

"Selective Scanning Tunneling Microscope-Induced Light Emission from Self-Assembled Monolayer-Covered Au Surfaces," S.Evoy, F.Pardo, P.St. John, and H.Craighead, J Vac Sci Technol A 15#3, 1997.

"Supersonic Molecular Beam Studies of the Dissociative Chemisorption of Group IV Hydrides on Single Crystal Silicon and Germanium," Martha E. Jones, Ph.D. Thesis, Cornell Univ., 1997.

"Time-Resolved Reflectivity Study of Interface Stability during Solid Phase Epitaxy of Strained Germanium-Silicon and Other Group IV Alloys," Xiaobiao Zeng, Ph.D. Thesis, Cornell Univ., 1997.

"Twist Wafer-Bonding: A New Tech. that enables the Monolithic Integration of all III-V Compounds for OptoElectronic Devices," E.F. Ejeckam, Ph.D. Thesis, CU, 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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