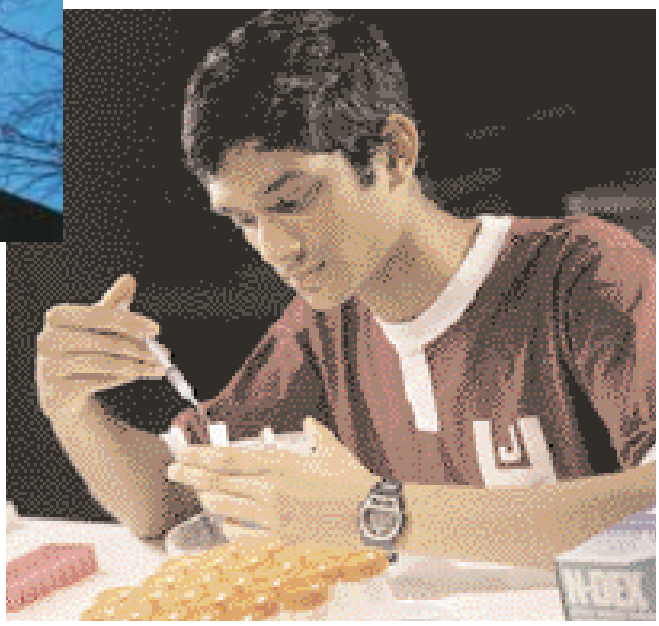
Princeton University

Center for Photonics and Optoelectronic Materials

POEM



POEM

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Graduate student Iris Hsu uses a Plasma Enhanced Chemical Vapor Deposition system for gas phase deposition to grow insulator and semiconductor layers on photonic devices in a specialized growth lab established by Professor Sigurd Wagner. *Photo by Nat Clymer* • Michael Austin, a graduate student in Electrical Engineering, uses nanoimprint equipment for near-atomic scale structures in a specialized laboratory established by Professor Stephen Chou. *Photo by Nat Clymer* • The Nassau Hall bell tower. *Photo by James Elbrecht* • Manish Shah '02, a senior in the Physics Department, prepares cells for fractionation on a chip. *Photo by Nat Clymer*

Introduction

The Center for Photonics and Optoelectronic Materials

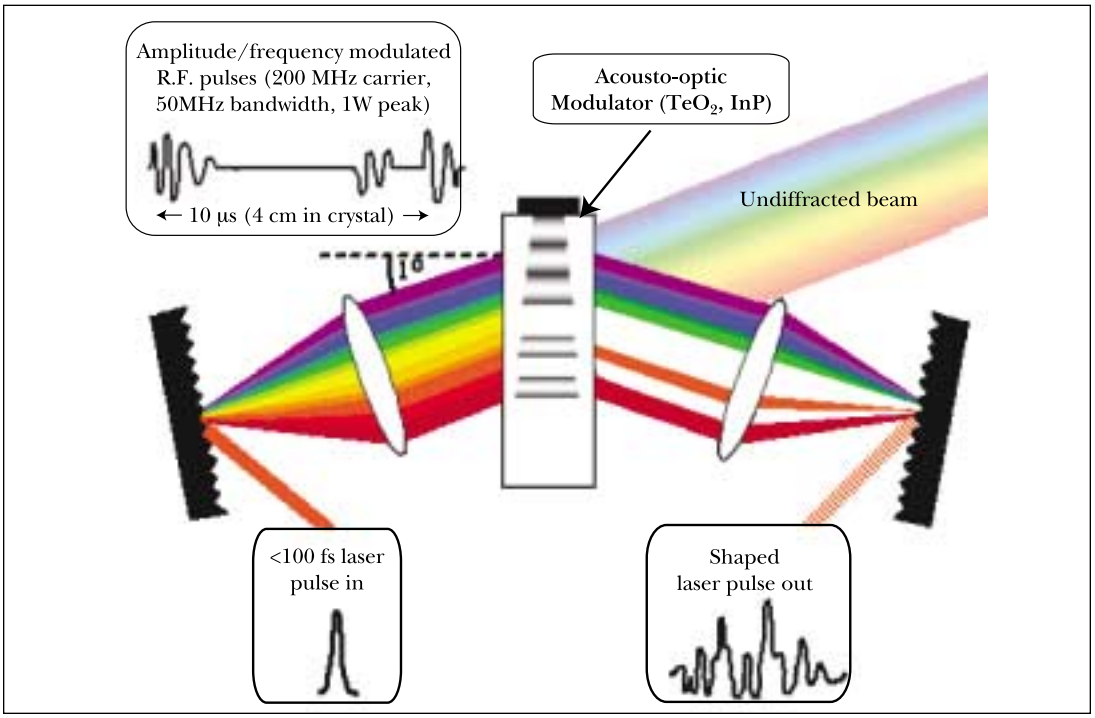
The Center for Photonics and Optoelectronic Materials (POEM) was established in 1988 with the following goals:

1) To promote interdisciplinary research and innovation in the fields of photonics and related areas at Princeton University; and
2) To establish working relationships with technological and scientific communities outside of academia, such as with industry and government.

The fields of photonics and optoelectronic materials hold great promise both for positively impacting our society and for the benefit these will bring to other fields of science and engineering. Princeton and New Jersey have deep strengths in these areas, which are recognized throughout the world. Working with our industrial partners, faculty, students, and staff throughout the University, and the New Jersey Commission on Science and Technology, POEM is designed to be a seamless link between academia and industry. We strive to bring new ideas, problems, and capabilities to those across the technical community as well as create an environment in which the results of our research can go on to benefit society. The education of students is central to our ability to carry out this mission.

POEM consists of more than 30 associated faculty members from seven departments, spanning engineering and the physical sciences, over 20 research scientists and staff members, 100 graduate students, and a leading-edge staff. POEM works closely with the Princeton Materials Institute and the Institute for Integrative Genomics, two other interdisciplinary research organizations at Princeton University with whom several POEM faculty are affiliated.

This brochure describes the center's research and education programs, its impact on photonics and related areas and applications in New Jersey and nationwide, its leadership role in technology transfer, and its industrial affiliates and corporate research collaboration programs. It also summarizes the background, achievements, and research interests of each associated faculty member.



Acousto-optic pulse shaping permits >1000-point resolution for an arbitrarily phase/amplitude modulated pulse.
Illustration by Warren S. Warren

Mission Statement

Conduct interdisciplinary research in the areas of photonics, optoelectronic materials, and related fields; pursue promising research collaborations and applications; and transfer new knowledge and discoveries in a timely fashion to industry and government partners.

The Princeton Context

The University is located in the center of Princeton, a lively and attractive academic and high technology community. It is situated midway between the major metropolitan centers of New York and Philadelphia, and it can be reached from many companies either by train or car within one hour's time.

Residents take advantage of an unusually wide array of intellectual activities and recreational opportunities. The University's neighbors—the Institute for Advanced Study, the Princeton Theological Seminary, the Sarnoff Corporation (formerly the RCA corporate labs), and many high-technology firms—all contribute to the local environment.

The McCarter Theatre has an excellent repertory company in residence, which presents both classic and contemporary films. Westminster Choir College, the Princeton Chamber Orchestra, Theatre Intime, and other organizations also perform regularly.

The ring of open space surrounding Princeton, the nearby ocean and beaches, the hills of northwest New Jersey and the Pocono Mountains of nearby Pennsylvania, the historic Delaware River, the Pine Barrens, and many other natural attractions all offer a wide range of outdoor activities such as cycling, hiking, swimming, and winter sports.

Founded in 1746 as the College of New Jersey, Princeton University was British North America's fourth college. Originally located in Elizabeth, the College moved to

Top: Canoeing the Delaware and Raritan Canal is a popular pastime. *Bottom:* The Cleveland Tower located at the Graduate College. *Photos by James Elbrecht*

the town of Princeton in 1756 and later adopted the name of the town.

Princeton's Graduate School was organized in 1901, and has since attracted international recognition in mathematics, the natural and social sciences, engineering, and the humanities. Princeton is a university noted for combining teaching and research. This is especially evident in the School of Engineering and Applied Science and POEM, where projects are carried out through graduate study, doctoral research, and undergraduate research efforts.

The University has a long and proven history of excellence in physical research, extending back 150 years to Joseph Henry. The many Nobel laureates among its faculty include Eugene Wigner, Philip Anderson, Val Fitch, Toni Morrison, John Nash, and in 1998 for physics, POEM member and Professor of Electrical Engineering Daniel C. Tsui.

In recent years, Princeton faculty in engineering and the sciences have been awarded 50 Presidential Young Investigator awards given by the National Science Foundation. Several members of the faculty have received fellowships from the Guggenheim and MacArthur foundations.

Princeton University has approximately 4,500 undergraduate students, 1,500 graduate students, and 800 faculty members in fields that span the spectrum from science and engineering to the liberal arts. The School of Engineering and Applied Science enrolls approximately 20 percent of Princeton's undergraduates and 30 percent of its graduate students.

In recognition of the fundamental importance of science and technology to today's society and that of the future, Princeton has increasingly made strong commitments to research and education programs in photonics and in related fields in engineering and the natural sciences. In addition to the 1993 expansion of the School of Engineering and Applied Science to provide a home for POEM, other recent additions include Bowen Hall for the Princeton Materials Institute and the Friend Center for Engineering Education (2001).

To strengthen links with the outside world and to foster interdisciplinary work in general, Princeton has recently created several other centers on campus. POEM works closely with two of these interdisciplinary centers, notably the Princeton Materials Institute and the Institute for Integrative Genomics.

Top: Spheric Theme by Naum Gabo is located in the courtyard of the School of Engineering and Applied Science.
Photo by Ann Haver-Allen
Bottom: A student finishes a sketch of Nassau Hall's bell tower.
Photo by James Elbrecht

Photonics in New Jersey

New Jersey has attracted one of the largest concentrations of photonics-related industry in the United States, as evidenced by the number and scale of enterprises that have started and grown in the state. Indeed, the earliest photonics industry was established at Bell Laboratories in Murray Hill, where the transistor was invented and fundamental advances in optical fiber and laser technology were made. Many other key advances, such as methods for integrated circuit production and color television, were developed at the RCA corporate laboratory in Princeton (now Sarnoff Corporation). More recently, photonics and optoelectronic technologies have begun to make inroads into additional applications such as medical imaging, pharmaceutical discovery, and biotechnology, where New Jersey headquarters many of the world's leading companies. POEM's multidisciplinary organization allows it to enter new scientific and technology frontiers by spanning the underlying disciplines from communications to imaging to DNA manipulation.

The past track record of POEM and its future potential to make significant impact in traditional and newly emerging fields are considerable. Indeed, since POEM was created in 1988 many photonics firms have formed and have grown rapidly along the Route 1 corridor, extending the number, size, and diversity of high-tech companies in both directions from Princeton. The partnership that POEM forms with New Jersey industry and the New Jersey Commission on Science and Technology (NJCST) provides it with unique and exciting opportunities that are highly beneficial to both Princeton University and the state's industry in photonics and related fields. POEM provides educational opportunities, expertise, infrastructure, and support conducive to the establishment and growth of small and medium-sized companies in New Jersey. Both state and federal programs for small business—such as the NJCST Springboard Fund and the federal set-aside of research funds for small business known as the Small Business Innovation Research (SBIR) program—represent an important avenue for initiating and supporting cooperative ventures between POEM faculty and local industry.

View of the east wing of the Engineering Quadrangle, the site of POEM.
Photo by Nat Clymer

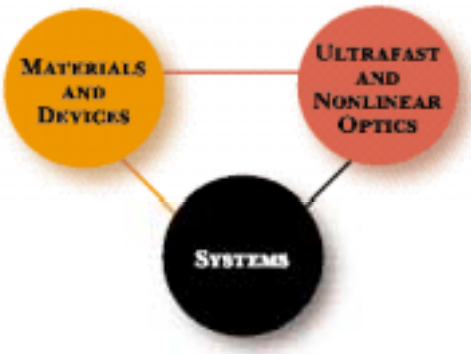
Research

Underlying the research at POEM are the core scientific strengths of its members. These core strengths include the following:

1) A deep understanding of and an ability to make small structures and optoelectronic devices, including materials growth, the physics of small structures, and device design and fabrication;
2) The generation, manipulation, control, and switching of ultrafast optical pulses; and
3) A broad and deep knowledge of systems, especially the interdependence of systems on technology and the design of systems and protocols to benefit from technological advances.

POEM's research mission is to combine this core with the diverse strengths of our outside collaborators in an interactive fashion to foster high-impact advances in both fundamental and applied fields. The research is carried out in large part with graduate students along with undergraduate research projects so that the research and education activities are inseparable. The involvement of our industrial partners not only insures POEM researchers are aware of the key challenges from a wide range of viewpoints, but also facilitates transfer of the research results. Some of the projects involve large mission-oriented teams, and some are more solitary, focused on a fundamental scientific question, but all benefit from the multifaceted environment.

One of POEM's core strengths is optoelectronic materials and related devices. This includes micro/nano design, materials growth, and subsequent device fabrication as well as evaluation and modeling. The ability to grow more complex materials of higher functionality, and to pattern and process them into higher performance devices has been central to the progress and widespread impact of photonics in



Top: Manish Shah '02, a senior in the Physics Department, prepares cells for fractionation on a chip. *Photo by Nat Clymer.*

Bottom: Dr. Jon R. Fox, visiting scientist from a POEM-member company, Research Support Instruments, is collaborating with Professor Richard Miles' group. *Photo by Nat Clymer*

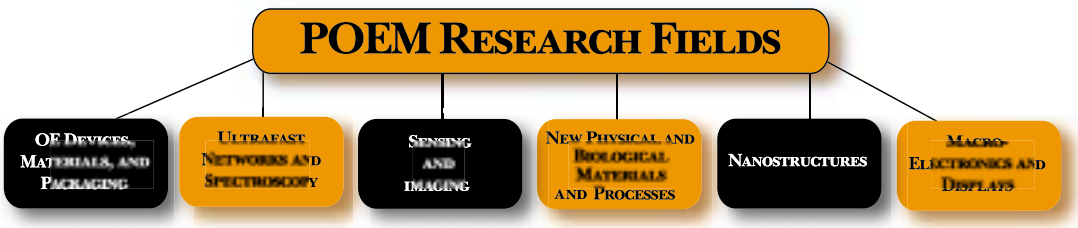
Michael Austin, a graduate student in Electrical Engineering, uses nanoimprint equipment for near-atomic scale structures in a specialized laboratory established by Professor Stephen Chou.
Photo by Nat Clymer

recent history. This trend is expected to continue and to expand to other fields. Device research at POEM includes optical sources, detectors, modulators, and waveguides, as well as nano-silicon based MOSFETs for electronics, SiGeC silicon-based heterostructures, organic devices, thin-film amorphous devices, and MEMS and "bio" devices. This device effort both uses, as well as drives, the POEM central facilities, such as the POEM Micro/Nano Fabrication Lab, the Semiconductor Growth Facility, and the Optoelectronic Packaging Lab.

Another central focus of POEM has always been the field of ultrafast communication networks and ultrafast spectroscopy. This field has enabled the realization of the Internet, and will lead to even higher connectivity as critical issues are solved. One such issue being addressed at POEM is the use of nonlinear optics to realize all-optical switching for avoiding system bottlenecks due to low-speed electronic switching. Another exciting area is novel device and packaging integration approaches for overcoming cost and performance barriers as we seek to develop photonic integrated circuits.

POEM prides itself on being able to direct its core strengths of technological capability and fundamental science with a systems-driven vision onto a wide range of challenging interdisciplinary problems. Therefore, over time POEM's research agenda has grown to encompass other challenging and fruitful fields.

Sensing and imaging projects use photons for noninvasive probing of physical systems such as turbulent flow at high Mach numbers, as well as infrared focal



plane arrays for free-space communication. The ability to generate and manipulate ultrashort pulses of light enables many new kinds of biomedical imaging and analysis. X-ray lasers enable us to pattern structures and image them with unprecedented capability.

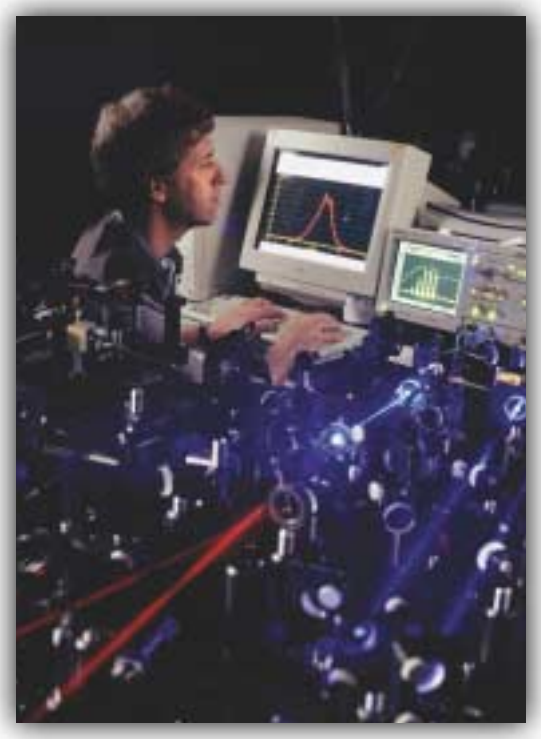
A special strength of POEM is the emerging field of large-area optoelectronics, such as flat-panel displays, wall-sized intelligent surfaces, etc. This work relies on noncrystalline materials, which can be deposited over a large area at low cost, such as organic molecular or polymeric layers for organic light-emitting diodes or amorphous silicon for active intelligence in pixels. Associated with this work is a large effort on novel printing and patterning technologies, from nanoscale imprinting to ink-jet printing for roll-to-roll processes leading to low-cost mass production. This combination of strengths in organic materials, devices, and their interfaces and in printing technologies for electronics is unique to POEM.

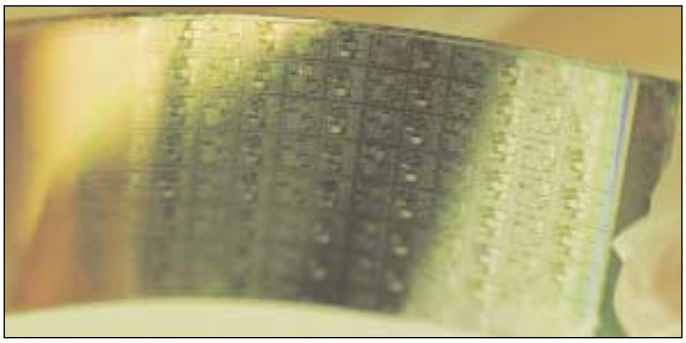
In recent years POEM has developed a leading program in nanoscience and technology based on our expertise in small structures. Areas of impact in optoelectronics range from photonic bandgaps to "quantum-dot" detectors and lasers. On small length scales, previously undiscovered physical phenomena emerge. These lead to a deeper understanding of nature and present opportunities for microelectromechanical systems (MEMS) and for a novel basis for future computational systems (e.g., quantum computing). Most intriguing is the interface of nanostructures, photonics, and biology, a field that is just now emerging. POEM efforts include the manipulation and analysis of single biological molecules to study gene expression, "DNA chips" for medical purposes, and highly parallel microreactors for drug discovery.

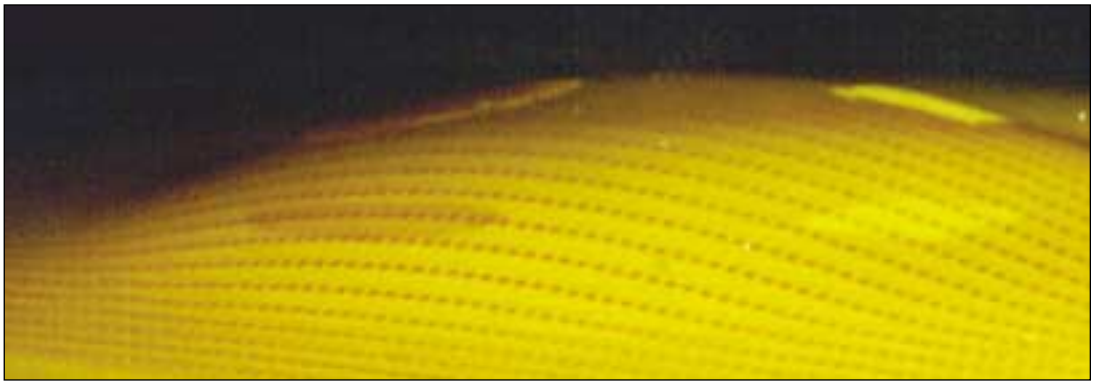
Top: Electric field magnitude with G-10 nozzle. Hypersonic flow diagnostics developed by the Applied Physics and Optics group of the Department of Mechanical and Aerospace Engineering are an important component of POEM's imaging and sensing research thrusts. *Illustration by Richard Miles. Bottom:* Graduate student Iris Hsu uses a Plasma Enhanced Chemical Vapor Deposition system for gas phase deposition to grow insulator and semiconductor layers on photonic devices in a specialized growth lab established by Professor Sigurd Wagner. *Photo by Nat Clymer*

Infrastructure and Facilities

POEM is housed primarily in the J-wing of the Engineering Quadrangle of Princeton University, a wing that was completed in 1993 using a substantial level of funding from the State of New Jersey. The laboratories contain a wide range of facilities for the fabrication and characterization of photonic and related structures. These include semiconductor and MEMS fabrication, device characterization under a wide range of temperatures and magnetic fields, a full range of laboratories equipped for research in fiber optics communications and photonic systems, and extensive capabilities in optoelectronic materials-growth and in ultrafast laser systems and spectroscopy. Its infrastructure includes both specialized labs for individual investigators as well as several central research facilities. These central facilities include equipment for joint collaboration among faculty and with industry, which is beyond the range of individual programs. These three central laboratories are the POEM Micro/Nano Fabrication Laboratory (www.poem.princeton.edu/fabrication.htm), the POEM Ultrafast Laser Laboratory (www.princeton.edu/~cula), and the POEM Optoelectronic Packaging Facility (www.poem.princeton.edu/packaging.htm). These facilities





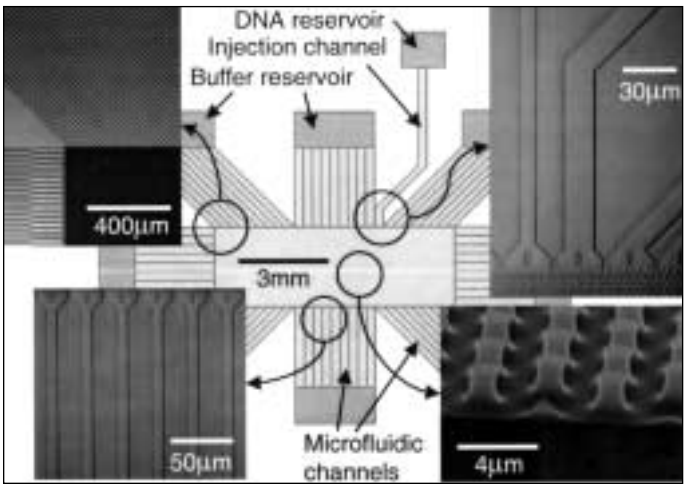


Top: Dr. Elmar Schreiber directs the Ultrafast Laser Laboratory, one of POEM's multi-user laboratory central facilities.
Photo by Nat Clymer
Bottom: Polycrystalline and amorphous silicon TFT's on flexible stainless steel and deformable polyimide foils made in the POEM Micro/Nano Fabrication Laboratory.

are available to POEM industrial affiliates for joint collaborative projects, and together have over 100 users from both on and off campus. In addition to the three central facilities, POEM has exceptional strength in the growth of a wide range of semiconductor materials.

POEM Micro/Nano Fabrication Laboratory

This 3,000-square-foot clean room is used for the microfabrication of semiconductor and MEMS devices. Substrate sizes range up to six-inch diameter, and lithographic capabilities range from micron-scale features by contact lithography down to 100 nanometer (nm) features by electron beam lithography. A special strength of the lab is its ability to handle a wide variety of substrates, from the usual III-V and silicon semiconductor substrates, to the more unusual glass and metal and plastic foils used in novel display projects. The lab has a complete range of thin-film formation techniques available, such as plasma-enhanced chemical vapor deposition, thermal and electron-beam evaporators, and high-temperature diffusion and oxidation. Another strength of the lab is pattern transfer by plasma and reactive ion etching, with over five reactors dedicated to etching a wide range of thin films.

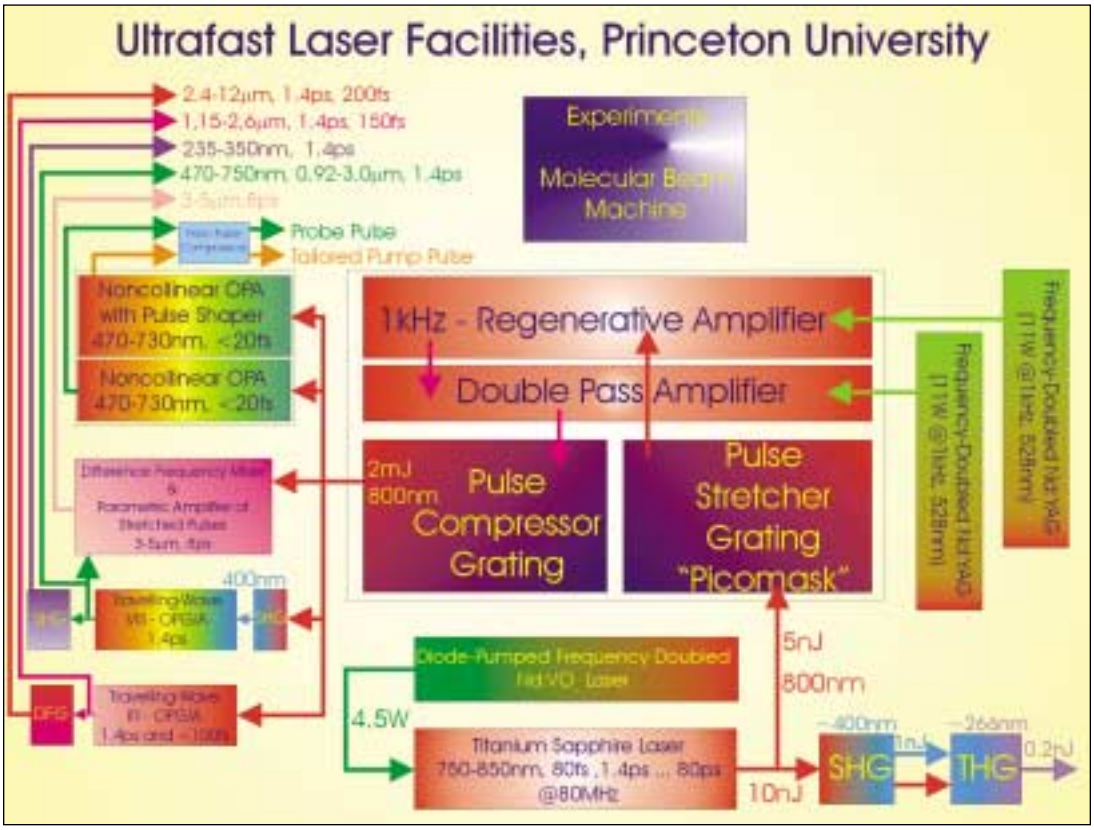


POEM Ultrafast Laser Laboratory

The POEM/CULA Ultrafast Laser Laboratory, directed by Dr. Elmar Schreiber, has state-of-the-art capabilities for generating femtosecond and picosecond pulses. The centerpiece system is a regeneratively amplified Ti: sapphire system with

Top: Brian W. D'Andrade, a graduate student in Electrical Engineering uses a custom built High Vacuum Growth Chamber to make Organic LEDs. The Vacuum Growth Chamber is accessed through a glove box containing a dry, inert gas so that the final OLED devices are free from water or air that are detrimental to device lifetime.
Photo by Nat Clymer

Bottom: Future directions of POEM research utilize a convergence of fabrication, life sciences, and information technologies for new devices such as the Microfluidic Lab-on-a-Chip for DNA fractionation and other biologic separations and detection.
Illustration by Lotien R. Huang



Overview of the setup of laser beam lines of the Ultrafast Laser Facility. It produces ultrashort pulses covering the range from sub-20 femtosecond to 80 picosecond at wavelength from the UV (230nm) to the mid-IR (12μm).
Illustration by Elmar Schreiber

optical parametric amplifiers (both conventional and non-collinear), producing > 2mJ/pulse at 800 nm and significant power at tunable wavelengths in the ultraviolet, visible, and infrared spectral regions; other laser systems are also available. Unique capabilities include low-bandwidth infrared pulses in the important 3-5 micron spectral region and shaped-pulse capabilities in the visible and near infrared. Access to advanced test equipment in three adjacent laser laboratories facilitates collaborative efforts. CULA laser facilities provide an extraordinary value to companies that want to "borrow a cup of photons" to try out a new idea. More extended interactions are usually conducted in conjunction with CULA personnel, and are strongly encouraged.

POEM Optoelectronic Packaging Facility

This facility was constructed in response to the central role that effective and low-cost optoelectronic device packaging plays in making photonic technology practical and economical. Equipment consists of wire bonders, automated precision dicing saws, manipulators, fiber splicing/pulling, flip-chip, and other sophisticated instrumentation. In addition to its photonics applications, it is widely used in general for sample assembly and construction.

Semiconductor Growth Facilities

In addition to the shared central facilities, POEM has exceptional strength and facilities in the area of the growth of photonic and electronic materials. A wide range of reactors such as molecular-beam epitaxy or various chemical-vapor deposition methods exist for the growth and/or deposition of a wide range of semiconducting layers, some with atomic precision. A partial list of the materials that can be grown include GaAs/AlAs and related materials, InP-based heterostructures, nitride-based semiconductors, epitaxial Si/$Si_{1-x}Gex$/$Si_{1-x-y}Ge_xC_y$ heterostructures, amorphous and microcrystalline Si:H and SiGe:H alloys, molecular crystals, organic molecular amorphous semiconductors, and semiconducting polymer thin films. Due to their specialized nature, these labs are not operated as a central facility and are open to industry collaborators through direct interaction with the relevant faculty members.

Education

POEM has developed a long-term plan to create curricula in photonics for undergraduate and graduate students, a role that catalyzes interaction between academic departments at the University. To help professionals update their knowledge and expertise in the photonics area, we offer a wide range of seminars open to local industry.

POEM hosts special meetings that are sponsored by professionals and technical societies as well as meetings and workshops on areas of topical interest in photonics. During the summer it often offers hands-on instruction to students and professionals in laboratory techniques and methods for optoelectronics, such as experimental optics and/or microfabrication.

The Topical Program in Photonics is offered to highly motivated upper-division engineering undergraduates. As part of this program, POEM annually awards prizes to the top-graduating undergraduates in photonics. POEM also offers student internships. A program of undergraduate and graduate student internships at the center and with local industrial laboratories allows students to participate in research sponsored by industry at POEM or at the company itself. This provides an excellent exposure to the practical aspects of photonic science and engineering.

A short list of relevant programs of interest include:

- POEM Graduate Study Fellowships in Photonics. These fellowships pay part of the graduate student tuition for qualified students participating in research at POEM that is sponsored by New Jersey companies. The sponsoring company can also become a POEM affiliate by virtue of supporting significant research activities within the center.
- The Optics and Optoelectronic Engi-

Top: Christine Todd Whitman, then Governor of the State of New Jersey and current administrator, United States Environmental Protection Agency, is assisted in a science education demonstration by Kathryn M. Wagner, Lecturer/Demonstrator, Department of Chemistry, during a statewide forum on technology education organized by POEM. *File photo*

Bottom: The Friend Center for Engineering Education. *Photo by Ann Haver-Allen*

neering (OOE) Program. This program has been established in the Department of Electrical Engineering to instruct students in all aspects of photonics technology. Key courses in photonic materials, devices, and systems are constantly being developed and revised to enhance the educational experience of students primarily interested in studying photonics in their graduate education.

- Research Seminars and Lecture Series. Outstanding scientists and engineers are periodically invited to the center to give seminars or lectures on relevant research. The POEM seminar series hosts approximately 20 lectures each academic year and covers a wide range of topics in this fast-paced technical arena.
- Visiting POEM Researchers Program. Visiting scientists from industry and academia work for extended periods of time at POEM, engaging in one-on-one interactions with POEM scientists. This allows visitors to pursue collaborative work of mutual interest with POEM faculty members. These visitors receive intensive on-the-job training and develop new ideas that can influence future directions taken by the participating company.
- Masters of Science in Engineering. To meet the needs of students looking to enhance their skills without the long-term commitment to a Ph.D. program, Princeton has a very attractive Masters of Science in Engineering program. It can be accomplished in one-year with full-time study, or taken part-time (with tuition appropriately pro-rated) to accommodate schedules. Both a technical track (with a focus on photonics) and a novel management/leadership track are available. For more information on the Masters in Science Engineering program, please see `www.princeton.edu/~seasweb/meng/index.html`.

Top: Christine Coldwell '99 receives the Newport Award for Research Excellence in Photonics for the top performing undergraduate student. Newport Corporation has provided annual awards at POEM to the top performing undergraduate student since 1992, and to the top performing graduate student since 1995.
File photo
Bottom: Allen J. Sinisgalli (center left), Associate Provost for Research and Project Administration at Princeton and Captain Stephen Himes (center right), Naval Air Engineering Station, sign an educational partnership between POEM and Navy Lakehurst; also pictured are Professor James C. Sturm (left), POEM Director, and John Wendolowski (right), Director, Research and Development at Navy Lakehurst.
File photo

Technology Transfer and Outreach/Industrial Partners

A primary mission of POEM is to see that its work impacts society beyond the walls of Princeton. This is accomplished in large part by working with industrial partners who are well suited to bring about such an impact. POEM's collaboration with industrial partners has the objective of promoting the development of advances in photonics and related areas through the rapid and timely technology transfer to industrial sectors. POEM and the New Jersey Commission on Science and Technology are committed to providing the enhanced intellectual and technological resources needed by industry to compete successfully in the world market.

The goal of the POEM Industrial Affiliates Program is not to simply transfer science and technology developed at Princeton to industry, but to have industry involved with POEM in the creation of the advances in the first place. This is done in such a way so as the research serves the public consistent with the University's goal of education, research, and service to the community. To ensure that these goals are met, POEM has created an Industrial Affil-

Greg Olsen, president of Sensors Unlimited Inc., a division of Finisar Corp., and Janice Mahon, vice president of technology commercialization at Universal Display Corp., are two beneficiaries of the technology transfer process.
Photo by Frank Wojciechowski

Among the benefits affiliation provides to industrial members are:

- Receipt of POEM publications such as the POEM Newsletter, *Optical Interconnections;*
- Access to students involved in POEM research programs facilitated through the director's office;
- Assistance with access to POEM faculty and staff in order to make appropriate linkages for solving technical problems or in submitting joint proposals to various funding agencies;
- Rapid access to new technologies developed at POEM through distribution of reprints and preprints from participating POEM research groups; and
- Receipt of announcements of POEM activities such as the Annual Review of Photonics, POEM-sponsored technical programs and seminars, and course listings of photonics-related curricula.

Commensurate with the appropriate level of support, industrial members may be provided with the following additional benefits:

- Access to POEM facilities, such as the POEM Micro/Nano Fabrication Laboratory, through the establishment of collaborations or cooperative agreements with interested POEM faculty;
- The opportunity to designate employees as visiting POEM collaborators and researchers to work on-site with POEM faculty, as a means of obtaining firsthand access to new technologies being developed in our laboratories.

iates Program.

Organizations providing unrestricted support to POEM activities on the level of $15,000—$50,000 per year, depending on the degree of interaction and the nature of the organization, or who enter large-scale partnerships with POEM, are eligible to join as a POEM Industrial Affiliate.

Industrial members, along with members of the New Jersey Commission on Science and Technology, may be invited to serve on the POEM advisory board. This board forms POEM's major contact with the industrial and governmental photonics communities by providing advice and direction to POEM research programs and initiatives. The advisory board meets annually at the POEM Review of Photonics to provide advice on the progress and relevance of current research. This opportunity is also used to inform the advisory board of new initiatives that POEM is considering and to solicit opinions and participation in these programs from board members. The advisory board has a unique opportunity to influence the direction taken by POEM, address issues of greatest concern to the industrial sector, and provide essential input that is used in determining the direction that will benefit both the photonics industry and Princeton University.

For further information contact:

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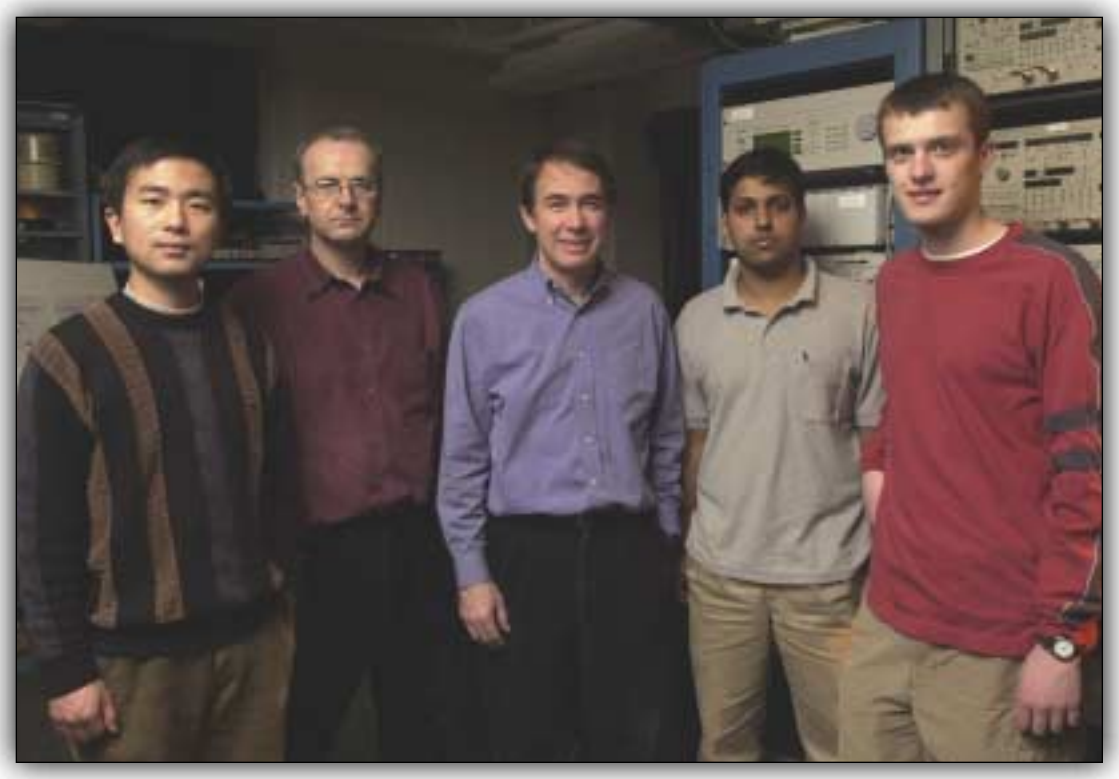


Top: POEM has helped to launch a number of rapidly growing technology companies. Universal Display Corporation (UDC) signed a landmark research and licensing agreement that provides exclusive rights to important Organic LED technology developed at POEM. UDC is now headquartered in a 15,000-square-foot office and prototype development facility in Ewing, N.J. Pictured, from left, are Sherwin Seligsohn, Chairman and founder of UDC; James Wei, SEAS Dean; and Professor Stephen Forrest, Electrical Engineering.
Photo by Robert Matthews
Bottom: Pictured, from left, Lei Xu, Ivan Glesk, Professor Paul Prucnal, Varghese Baby, and Darren Rand are in front of 10 Gbit/s test bed running an *all optical tunable wavelength converter*, which was developed in collaboration with Ultrafast Optical Systems.
Photo by Frank Wojciechowski

Princeton Materials Institute

As part of its research and educational activities, POEM works closely with a sister organization on campus, namely the Princeton Materials Institute (PMI). PMI is a multidisciplinary center for education and research in materials science. Although the principles governing materials design and synthesis emanate primarily from chemistry, physics, and biology, implementation and performance issues are addressed in engineering. Accordingly, it is imperative that there be unimpeded cross-flow of knowledge between the science and engineering disciplines that span materials invention to implementation. Hence, to facilitate interactions across academic departments, PMI now comprises 19 internationally prominent faculty who share joint appointments in Princeton's science and engineering departments. POEM and PMI have worked together to catalyze the growth of materials research at Princeton to a level at which nearly 40 percent of the faculty in seven departments are involved in interdisciplinary materials research.

PMI receives a substantial level of federal support from the National Science Foundation's Materials Research Science and Engineering Center (MRSEC) program for its Princeton Center for Complex Materials. These resources have enabled PMI to establish and expand an undergraduate Certificate Program in Materials Science and Engineering and develop a materials specialization option in many graduate programs. PMI is located in Bowen Hall, adjacent to POEM and the Engineering Quadrangle. Central facilities at PMI include the W. M. Keck Computational Materials Laboratory and the Imaging and Analysis Center (IAC). The facility provides a wide range of advanced electron beam and scanning probe tools, including transmission (Philips CM200 FEG—TEM and a LEO/Zeiss 910 TEM) and scanning (a Philips XL30 FEG—SEM and a LEO 982 FEG—SEM) electron microscopes. The IAC also has microchemical and microstructural analysis capabilities (EDS, PEELS, WDS, CL, OIM); probe microscopies (a Cameca SX 50 electron microprobe, DI AFMs, and a UHV-STM); computer simulation (molecular dynamics and image processing); and materials preparation (ion-beam sputtering, cryo-ultramicrotome, mechanical dimpler, and ion-beam mill). More recently, a Dual-beam Focused Ion Beam System has been added. Many of these resources are widely used by POEM faculty.

For additional information about PMI, visit the Web at `www.princeton.edu/~pmi`.

The Princeton Materials Institute.
Photo by James Elbrecht

Faculty research interests

The Princeton University shield tops the Fitz-Randolph gate in front of Nassau Hall.
Photo by James Elbrecht.

Robert H. Austin
Professor of Physics
Protein and DNA dynamics from the molecular to the polymeric levels, development of free electron lasers.

Jay B. Benziger
Professor of Chemical Engineering
Thin-film processing, surface reactions, catalysis.

Steven L. Bernasek
Professor of Chemistry
Surface chemistry, dynamics of heterogeneous reactions, electronic materials chemistry.

Ravindra N. Bhatt
Professor of Electrical Engineering
Theory of disordered and correlated electronic materials, metal-insulator transitions, doped semiconductors, low-dimensional semiconductor structures, quantum Hall effect, random magnets.

Jeffrey D. Carbeck
Assistant Professor of Chemical Engineering
Molecular recognition, protein folding, biosynthetic hybrid materials, micro- and nano-scale biochemistry.

Stephen Y. Chou
Professor of Electrical Engineering
Innovative nanoscale processes for electronic, optoelectronic, and magnetic devices.

Edward C. Cox
Professor of Molecular Biology
Behavior of single molecules of DNA in micro- and nano-fabricated environments.

Stephen R. Forrest
Professor of Electrical Engineering
Photonics materials, devices and systems, molecular-beam epitaxy, photonic integrated circuits, organic electronics.

William Happer
Professor of Physics
Atomic physics in vapors of alkali-metal atoms, spin-polarized atoms and nuclei, optical pumping, magnetic resonance imaging.

Antoine Kahn
Professor of Electrical Engineering
Physics and chemistry of semiconductor surfaces and interfaces.

Hisashi Kobayashi
Professor of Electrical Engineering
Optical network architectures, control algorithms, performance modeling.

Kevin K. Lehmann
Professor of Chemistry
Laser spectroscopy of highly excited molecules, novel spectroscopic detection methods, spectroscopy of ultracold molecules.

Kai Li
Professor of Computer Science
Scaleable display wall, routers for next-generation Internet, SHRIMP (Scaleable High-performance Really Inexpensive Multiprocessor).

Michael G. Littman
Professor of Mechanical and Aerospace Engineering
Lasers, optical design, parallel computing, intelligent control, robotics.

Stephen A. Lyon
Professor of Electrical Engineering
Quantum dots, ballistic electron transport, time-resolved spectroscopy.

Richard B. Miles
Professor of Mechanical and Aerospace Engineering
Optical diagnostics for aerospace applications, laser development, nonlinear optics, optical imaging, atomic and molecular spectroscopy.

Nai-Phuan Ong
Professor of Physics
Physics of electron transport in novel systems, high-T_c superconductivity, and high-field transport.

Paul R. Prucnal
Professor of Electrical Engineering
Optical broadband integrated services networks, photonic switching, optical interconnects for multiprocessors.

Herschel A. Rabitz
Professor of Chemistry
Physical chemistry, chemical kinetics, optical interactions with matter.

Richard A. Register
Professor of Chemical Engineering
Micro- and nano-structured polymeric materials.

Barrie S. H. Royce
Professor of Mechanical and Aerospace Engineering
Relationship between the atomic-level structure of materials and their macroscopic performance.

Jeffrey Schwartz
Professor of Chemistry
Applications of organometallic chemistry to organic synthesis, organozirconium chemistry, organometallic reaction mechanisms, oxide-supported organometallic complexes.

Stuart C. Schwartz
Professor of Electrical Engineering
Optical communications, modeling and performance analysis.

Giacinto Scoles
Professor of Chemistry
Molecular beams/laser spectroscopy for study of molecular and chemical dynamics in gases, clusters, and at the gas-solid interface.

Mordechai Segev
Visiting Lecturer with rank of Professor in Electrical Engineering
Nonlinear optics, solitons, quantum electronics.

Mansour Shayegan
Professor of Electrical Engineering
Physics and technology of gallium arsenide-based heterostructures.

The Princeton University campus has many pathways to explore.
Photo by James Elbrecht.

Lydia L. Sohn
Assistant Professor of Physics
The merging of nanotechnology with molecular biology.

Thomas G. Spiro
Professor of Chemistry
Resonance Raman spectroscopy and applications to biological structure, role of metals in biology, bonding in inorganic molecules, metalloporphyrins photoelectrochemistry.

James C. Sturm
Professor of Electrical Engineering
POEM Director
Novel electronic and semiconductor devices for VLSI, silicon-based heterostructures, silicon-germanium processing, polymer organic LEDs.

Szymon (Simon) Suckewer
Professor of Mechanical and Aerospace Engineering
X-ray lasers, plasma physics, spectroscopy, theoretical modeling, and lasers in biomaterials and medical devices research.

Zhigang Suo
Professor of Mechanical and Aerospace Engineering
Material structures of small feature size, fracture, deformation, mass transport.

Sandra M. Troian
Associate Professor of Chemical Engineering
Heat transfer, mass transport and slip in confined microchannels, hydrodynamic instabilities in liquid films and microstructures, wetting behavior of rough or chemically patterned surfaces.

Daniel Chee Tsui
Professor of Electrical Engineering
Electrical properties of thin films and microstructure of semiconductors and solid-state physics.

Sergio Verdú
Professor of Electrical Engineering
Information theory, communication via multi-user channels.

Sigurd Wagner
Professor of Electrical Engineering
Devices, processes, and materials for large-area electronics and solar cells.

Warren S. Warren
Professor of Chemistry
POEM Associate Director
Laser-selective chemistry, optical pulse shaping coherent optical spectroscopy, laser-enhanced magnetic resonance.

Ron Weiss
Assistant Professor of Electrical Engineering
Experimental and theoretical study of cellular and biochemical computing systems.

The Princeton Materials Institute (Bowen Hall).
Photo by James Elbrecht.

Faculty and staff biographies

James C. Sturm
Professor of Electrical Engineering
Director, POEM
Ph.D. 1985, Stanford University

James C. Sturm joined the faculty of Princeton University in 1986, where he is currently a professor of electrical engineering, and director of POEM since 1997. He received his B.S.E. in electrical engineering and engineering physics from Princeton University, and his M.S.E.E and Ph.D. from Stanford University. Professor Sturm's previous experience includes his work at Intel Corp. as microprocessor design engineer as well as Siemens in Munich, Germany. In 1994-95, he was a von Humboldt Fellow at the Institut für Halbleitertechnik at the University of Stuttgart in Germany. He has worked in the fields of silicon-based heterojunctions, three-dimensional integration, silicon-on-insulator, optical interconnects, TFT's, and organic light-emitting diodes. His current research interests include silicon-germanium-carbon and related heterojunctions on silicon, silicon-on-insulator(SOI) and 3-D integration, large-area electronics, flat panel displays, organic semiconductors, and the nanotechnology-biology interface. Professor Sturm is a fellow of the IEEE and a member of the American Physical Society, and the Materials Research Society. Formerly he was a National Science Foundation Presidential Young Investigator. He has won ten awards for teaching excellence from both Princeton University and the Keck Foundation. In 1996 and 1997 he was the technical program chair and general chair of the IEEE Device Research Conference, for which he is now a charter trustee. He served on the organizing committee of International Electron Devices Meeting (IEDM) in 1988-92 and 1998-99, having chaired both the solid-state device and detectors/sensors/displays committees. He also has been a symposium organizer for the Materials Research Society and has served on the SOS/SOI, EMC, and several other conference committees.

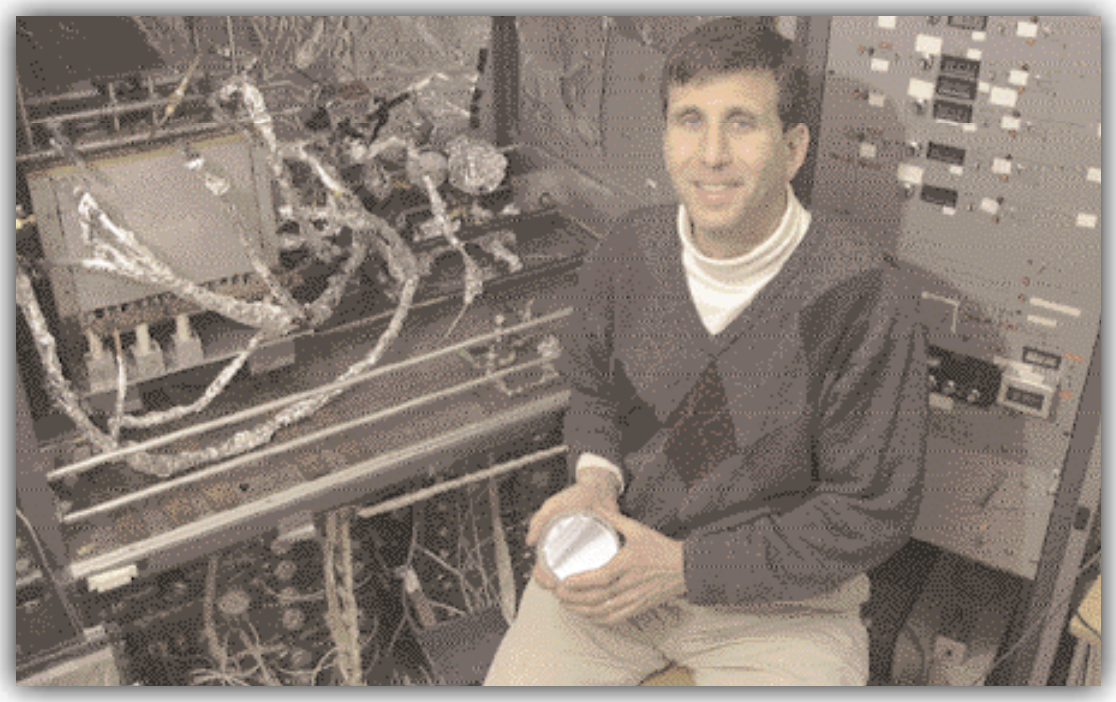
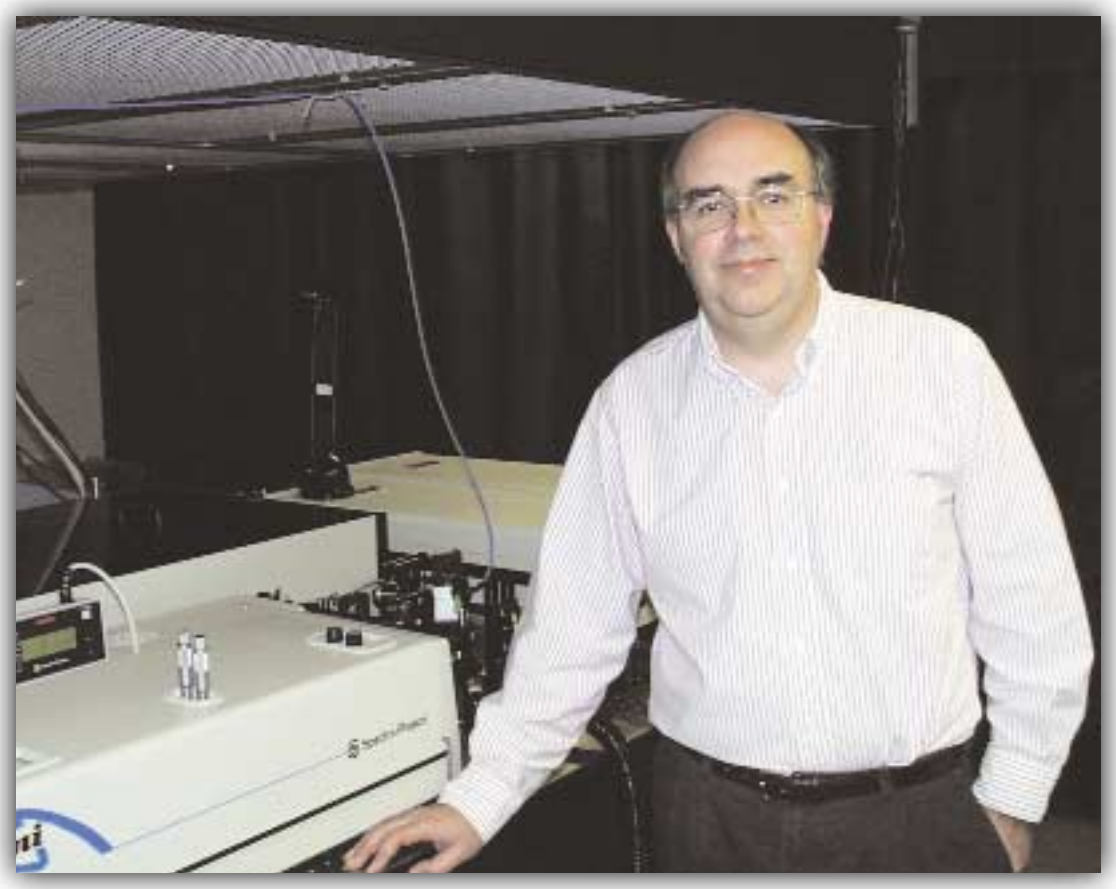


Photo by Frank Wojciechowski

Warren S. Warren

Professor of Chemistry
Associate Director, POEM
Associated Faculty, Electrical Engineering, Molecular Biology, Physics, Program in Neuroscience
Ph.D. 1980, University of California, Berkeley

Warren S. Warren received his A.B., summa cum laude, in chemistry and physics from Harvard University in 1977. He received his M.S. and his Ph.D. from the University of California, Berkeley, in 1979 and 1980, respectively. He has been at Princeton University since 1982. Professor Warren specializes in laser spectroscopy and magnetic resonance, developing techniques to control the shapes of femtosecond laser pulses and using these new techniques to alter molecular dynamics and reactivity. He is the editor of the journal *Advances in Magnetic Resonance* (Academic Press). He won the Nobel Laureate Signature Award of the American Chemical Society in 1982, and was an Alfred P. Sloan Fellow from 1986 to 1988. He currently serves as associate director of POEM and director of the affiliated Center for Ultrafast Laser Applications (CULA), and was just named director of the new Center for Molecular and Biomolecular Imaging.



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Robert H. Austin

Professor of Physics
Ph.D. 1975, University of Illinois, Urbana

Robert H. Austin received his B.A. in physics in 1968. He attended the University of Illinois, Urbana, for graduate school, studying in the department of physics, and was fortunate to receive his Ph.D. in physics under the guidance of Professor Hans Frauenfelder in 1975. He spent three years at the Max Planck Institute for Biophysical Chemistry in Germany and then came to Princeton University in 1979 as an assistant professor in the physics department. He has remained at Princeton since then and is now a full professor. His interests have broadened over the years from protein dynamics, in which he still is involved, using picosecond infrared light sources to include DNA dynamics and DNA sequence-dependent structures and lately the use of microfabrication and nanofabrication technologies in biotechnology. This work has broadened to include fractionation of cells in microfabricated structures and ultrarapid mixing techniques for protein folding. He is a fellow of the American Physical Society and the American Association for Advancement of Science, president elect of the Division of Biological Physics (APS) and the Biological Physics division of the International Union of Pure and Applied Physics, and a member of the National Academy of Sciences. His activities include electronic publishing, trying to open the world of biological physics to the community at large and membership on the Publications Committee of the American Physical Society. As well, he is presently the editor of the *Virtual Journal of Biological Physics Research* (www.vjbio.org).

Jay B. Benziger

Professor of Chemical Engineering
Ph.D. 1979, Stanford University

Jay B. Benziger has been a faculty member at Princeton since 1979. His research interests focus on reactions at the fluid-solid interfaces. He has developed several methods to characterize surfaces with infrared spectroscopy, including polarization, modulated reflection spectroscopy, and infrared photoacoustic spectroscopy. His group has employed multitechnique characterization of solid-state transformations in catalyst materials, such as silica, silica alumina, and vanadium phosphates. These studies facilitated new synthesis approaches to vanadium phosphates for improved catalytic performance. His recent research has involved fabrication of microstructured composite polymer membrane catalyst systems. This work has developed ink-jet patterning methods for preparing patterned Pt electocatalysts for fuel cells and chlor-alkali reactors. His group has recently collaborated with Professor Steve Forrest to improve the reactor design for Organic Vapor Phase Deposition in vapor transport reactors. He also has led a large-scale effort in designing and building a scintillator preparation and delivery system and a purification system for achieving ultrahigh purity in multiton quantities of aromatic solvents required for the Borexino solar neutrino detector. He has received the Exxon Award in Solid State Chemistry from the Inorganic Chemistry Division of the American Chemical Society, and the Purdy Award from the American Ceramic Society.

Top: File photo
Bottom: Photo by Frank Wojciechowski

Steven L. Bernasek

Professor of Chemistry
Associate Chair, Chemistry
Ph.D. 1975, University of California, Berkeley

Steven L. Bernasek joined the faculty of the chemistry department at Princeton University in July 1975. He was promoted to associate professor in 1981, and to professor of chemistry in 1986. Professor Bernasek's research concerns the chemistry of solid surfaces. His work focuses on the use of gas-phase molecular dynamics methods for the study of chemical reactions at surfaces. His work addresses questions of the chemistry of heterogeneous catalysis, particularly on iron, molybdenum, and platinum surfaces as well as chemistry relevant to the processing of electronic and optoelectronic devices. In his work, studies using laser ablation deposition of electronically active thin films, scanning probe characterization of semiconductor and insulator surfaces, and novel approaches to the growth of electronic materials using organometallic precursors have been carried out. Professor Bernasek is also a member of the Princeton Materials Institute. He is a member of the American Chemical Society and the Materials Research Society and is a Fellow of the American Vacuum Society (AVS). He has served as program vice chairman for the 40th National Symposium of the AVS.

Ravindra N. Bhatt

Professor of Electrical Engineering
Director, Princeton Center for Complex Materials
Ph.D. 1976, University of Illinois, Urbana

Ravin N. Bhatt joined the theoretical physics research department at Bell Laboratories as a Member of the Technical Staff in 1976, subsequently becoming the department head. He has had visiting appointments at Ecole Normale Superieure (Paris), Imperial College (London), and the Institute for Theoretical Physics (Santa Barbara). In 1990 he joined Princeton University as a professor of electrical engineering. He has taught courses in both electrical engineering and physics, where he holds associated faculty status. Professor Bhatt's field of research is theoretical condensed-matter physics. His current research includes disordered and correlated electron systems, metal-insulator transitions, the quantum Hall effect, and random magnets. He has published over 100 technical papers in these fields. He is on the Scientific Advisory Board of the Aspen Center for Physics and is a member of the National Allocations Committee for the Cornell Theory Center. He is a fellow of the American Physical Society.

Top: file photo
Bottom: Photo by Frank Wojciechowski

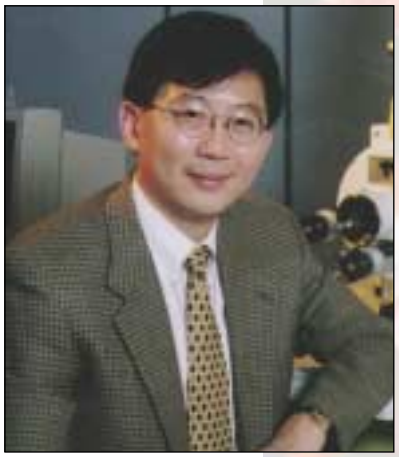
Jeffrey D. Carbeck

Assistant Professor of Chemical Engineering
Ph.D. 1996, Massachusetts Institute of Technology

Jeffrey D. Carbeck is a chemical engineer and materials scientist with expertise in biomaterials, biophysical and bio-analytical chemistry, nanomaterials, molecular simulations and theory. Professor Carbeck joined the faculty of Princeton University in the Department of Chemical Engineering in February of 1998. He received his B.S. from the University of Michigan in 1990 and his Ph.D. from MIT in 1996. Both degrees were in materials science and engineering. From 1995 to 1998 he was a postdoctoral fellow of chemistry and chemical biology with George Whitesides at Harvard University. His research program is focused on using both experiments and modeling to develop quantitative understanding of the role of molecular recognition in protein folding, receptor-ligand binding, and cell adhesion. This knowledge is being used to engineer the stability of proteins, the affinity and specificity of drugs, the transport of proteins in nanoporous materials, and the interfaces between cells and synthetic materials.

Stephen Y. Chou

Joseph C. Elgin Professor of Electrical Engineering
Professor of Electrical Engineering
Ph.D. 1986, Massachusetts Institute of Technology



Stephen Y. Chou holds the Joseph C. Elgin Professor of Engineering chair at Princeton University. His current research focuses on exploring new nanotechnologies and innovative applications of nanostructures in electronics, optoelectronics, data storage, and biotechnology. Professor Chou and his co-workers have originated and demonstrated a variety of innovative nanofabrication technologies and nanodevices, including nanoimprint lithography (NIL), lithographically induced self-assembly (LISA), room-temperature Si single electron memory and switches, quantized magnetic disks (QMDs), ultrahigh-speed photodetectors, subwavelength optical elements, terahertz polarization-switching tunable lasers, and nanoscale MOSFETs and lateral resonant tunneling transistors. Among the awards Professor Chou has received are the IEEE Fellow, the Packard Fellow, the McKnight-Land Grant Professorship and George Taylor Distinguished Research Award at the University of Minnesota, the IBM Faculty Development Award, and the DARPA ULTRA program Significant Technical Achievement Award. He has published over 150 journal and conference papers, and he has several U.S.-issued patents as well as a number of patents pending applications.

Photos by Frank Wojciechowski

Edward C. Cox

Edwin Grant Conklin Professor of Biology, Professor of Molecular Biology
Director, Program in Biophysics
Ph.D.1964, University of Pennsylvania

Edward (Ted) S. Cox received his Ph.D. from the University of Pennsylvania in 1964. His research interests include morphogenesis and developmental genetics in the slime molds Dictyostelium and Polysphondylium. In these species, growth and cell division are cleanly separated from differentiation and morphogenesis. In the presence of bacteria, autonomous amoebae grow and divide. When the bacterial food supply is exhausted, individual amoebae begin to differentiate into aggregation competent cells. A few randomly dispersed cells send out chemotactic signals toward which other amoebae swarm, forming a primitive tissue that further differentiates into stalk and spore cells. As these two kinds of cells differentiate, cell movement generates the mature organism. His current research focuses on new methods to visualize Polysphondylium mutants defective in various morphogenetic steps, and the study and modeling of spiral waves in aggregating territories of Dictyostelium. In both cases Professor Cox tries through his research efforts to understand how cell populations self-organize in order to produce a mature organism. In collaboration with POEM faculty Robert Austin in physics, the behavior of single DNA molecules in nano- and micro-fabricated environments are studied with very high precision and very rapidly.

Stephen R. Forrest

James S. McDonnell Distinguished University Professor of Electrical Engineering
Professor of Electrical Engineering and Princeton Materials Institute
Ph.D. 1979, University of Michigan, Ann Arbor

Stephen Forrest worked at Bell Laboratories from 1979 to 1985, where he was involved in research and development of photodetectors and integrated optoelectronic devices for long wavelength optical communications systems. Professor Forrest joined the University of Southern California in 1985 as professor of electrical engineering and materials science, where he continued his research on optoelectronic integrated circuits and organic semiconductors. He joined Princeton University in 1992 as a professor of electrical engineering and the Princeton Materials Institute, and as director of POEM. Professor Forrest has served as associate editor of the *Journal of Quantum Electronics and Photonics Technology Letters* and as founding editor of *Organic Electronics*. He has served on the OSA Technical Council and the LEOS Board of Governors. In 1999, he received the MRS Medal "for pioneering contributions to the growth and optoelectronic applications of organic semiconductor thin films," and in 2001 shared the IEEE/LEOS Scientific Achievement Award with Joe Campbell for contributions to the development of detectors for optical communication. He is a fellow of the IEEE and OSA, and a member of the APS and MRS.

Top: file photo
Bottom: photo by Frank Wojciechowski

William Happer

Eugene Higgins Professor of Physics; Chair, University Research Board
Ph.D. 1964, Princeton University

William Happer received his Ph.D. in physics from Princeton University in 1964. His research focuses on the physics of spin-polarized atoms and nuclei, and in the application of these spin-polarized systems in other areas. Together with Professor Cates, research associates and graduate students at Princeton, and collaborators from various medical schools, he has been working on ways to use polarized ^{3}He and ^{129}Xe for magnetic resonance imaging of lungs and perhaps other organs. In most of the work, circularly polarized laser photons are used to pump angular momentum into electron spins, and hyperfine interactions are used to transfer angular momentum from the polarized electrons to the nuclei. In appropriate containers, the polarized nuclei can be stored for hours or even days with little loss of spin. Much of his present work is aimed at understanding the slow loss of spin that occurs in these containers. The physics of this process is not well understood, especially in the case of surface interactions.

Antoine Kahn

Professor of Electrical Engineering
Director, Program in Engineering Physics
Ph.D. 1978, Princeton University

Antoine Kahn was a visiting postdoctoral fellow at Princeton University, the California Institute of Technology, and Stanford University after receiving his Ph.D. from Princeton. In 1979 he joined the faculty of the Department of Electrical Engineering at the University as an assistant professor. He was promoted to the rank of associate professor in 1985, and full professor in 1991. Professor Kahn's research interests are in the areas of the physics and applications of semiconductor surfaces and interfaces, organic molecular thin films, and scanning probe microscopy. Professor Kahn was the recipient of a Presidential Young Investigator Award in 1981, and was elected a fellow of the American Vacuum Society in 1999. He has authored and co-authored more than 200 papers and invited review papers. He is a member of the American Physical Society and the American Vacuum Society. He was the general chair of the International Conference on the Formation of Semiconductor Interfaces in 1995, and of the International Conference on Solid Films and Surfaces in 2000.

Top: photo by Frank Wojciechowski
Bottom: file photo

Hisashi Kobayashi

Sherman Fairchild University Professor of Electrical Engineering and Computer Science
Ph.D. 1967, Princeton University

Hisashi Kobayashi joined the IBM Research Center in Yorktown Heights, New York, in 1967. In 1986 he came to Princeton University as the Sherman Fairchild University Professor of Electrical Engineering and Computer Science and the dean of the School of Engineering and Applied Science. From 1982 to 1986 he served as the founding director of the IBM Tokyo Research Laboratory. His research interests included radar systems, high-speed data transmission, seismic signal processing, coding for high-density magnetic recording, image compression algorithms, performance modeling and analysis of computers and communication systems, and VLSI design algorithms. His current research activities are on performance modeling and analysis of high-speed networks, wireless communications and geo-location algorithms. He holds eleven U. S. patents, has authored more than 150 research articles, and has published a book titled *Modeling and Analysis* (Addison-Wesley, 1978). He has been a fellow of IEEE since 1977 and has been the recipient of the Humboldt Prize from Germany (1979), the International Federation of Information Processing Silver Core Award (1981), and the IBM Outstanding Contribution Award (1975, 1984). Professor Kobayashi was elected a member of the Engineering Academy of Japan and a member of the Board of Governors of the International Council for Computer Communications (ICCC), both in 1992.

Kevin K. Lehmann

Professor of Chemistry
Ph.D. 1983, Harvard University

Kevin K. Lehmann was elected to the Harvard Society of Fellows in 1983. During this time he worked both at Harvard and in the NSF-funded regional laser center at MIT. In the fall of 1985 Professor Lehmann was appointed an assistant professor in the Princeton University chemistry department. He was promoted to the rank of associate professor in 1991, and professor in 1995. His primary area of research has been in the field of high-resolution gas-phase spectroscopy, with particular emphasis on the spectroscopy of highly excited molecules. He uses both laser spectroscopy and theoretical methods to follow the interchange of energy between electronic, vibrational, and rotational degrees of freedom, both in isolated molecules and in bimolecular collisions. Professor Lehmann also has been active in the development of spectroscopic methods of extreme sensitivity and has two patents for inventions in the field of cavity ring down spectroscopy for trace gas detection. A major focus of his current work is spectroscopy of atoms and molecules dissolved in nanodroplets of superfluid liquid helium. He is a fellow of the American Physical Society and a member of the American Chemical Society.

Top: photo by Frank Wojciechowski
Bottom: file photo

Kai Li

Professor of Computer Science
Ph.D. 1986, Yale University

Kai Li received his Ph.D. in computer science from Yale University in 1986. His research interests are in computer architecture, operating systems, parallel systems, and networking. His current research projects focus on architecture and system issue in using PC clusters to build High-performance Really Inexpensive MultiProcessor (SHRIMP), Scalable Display Wall systems, scalable storage servers, and Extensible Network Router. SHRIMP investigates how to construct high-performance servers with a network of commodity PCs, and commodity operating systems. The cost of such a multicomputer server is substantially less than a commercial, custom-designed multicomputer. The goal is to study how to build such a system to deliver performance competitive with or better than commercial multicomputer servers. Scalable Display Wall project explores research issues on how to build and use immersive systems to collaborate across space and time. Current research topics that are being pursued include seamless imaging, parallel rendering, data visualization, intelligent networking, spatialized sound, and camera and design methodologies for creating applications. Extensible Router project investigates how to build a router for the next generation Internet. Driven by pressures to push functionality from end devices back into the network, this project recognizes the need for routers to move from being closed, special-purpose network devices to being open, general-purpose computing/communications systems.

Michael G. Littman

Professor of Mechanical and Aerospace Engineering
Ph.D. 1977, Massachusetts Institute of Technology

Michael G. Littman joined the faculty of the Department of Mechanical and Aerospace Engineering at Princeton University in 1979. He is the co-inventor of the grazing-incidence design for tunable lasers, a configuration that is widely used in research and industry. Professor Littman currently is working with several colleagues (Professors Kasdin and Miles [MAE], Spergel and Turner [AST]) on a new satellite-based telescope design for the direct detection of earthlike planets around nearby stars. He taught POEM's summer technical training course in optics and lasers for many years. He is an honorary life member of the Franklin Institute in Philadelphia. He has served as topical editor for the *Journal of the Optical Society of America: Part B, Atomic Spectroscopy,* and as chairman of the 1990 Annual Meeting of the Optical Society of America. Professor Littman is a member of the OSA, Sigma Xi, and Phi Beta Kappa.

Top: file photo
Bottom: Photo by Frank Wojciechowski

Stephen A. Lyon

Professor of Electrical Engineering
Ph.D. 1979, California Institute of Technology

Stephen A. Lyon has been a member of the Department of Electrical Engineering at Princeton University since 1978. His interests are in the areas of ultrafast processes in semiconductors and highly nonequilibrium transport phenomena and their applications to electronic and optoelectronic devices. His research group has developed a new technique, Ballistic Electron Luminescence Spectroscopy, for observing and studying ballistic transport in semiconductor heterostructures. They also have been among the first developers of quantum well-infrared photodetectors and have extensively studied hot-carrier effects in Si devices. Professor Lyon has received the California Institute of Technology Graduate Fellowship Award, the ARCS Foundation Fellowship Award, and the National Science Foundation Presidential Young Investigator Award. He also has served as the technical chairman of the IEEE Semiconductor Interface Specialists Conference. As well, Professor Lyon is a member of the American Physical Society, the Optical Society of America, and the Electrochemical Society.

Richard B. Miles

Professor of Mechanical and Aerospace Engineering
Ph.D. 1972, Stanford University

Richard B. Miles joined the Department of Mechanical and Aerospace Engineering at Princeton University in 1972 after completing his Ph.D. at Stanford. He was promoted through the ranks to professor in 1982. In 1975 he developed Resonant Doppler Velocimetry, which extracted pressure, temperature, and density measurements from fluorescence images of sodium seeded into hypersonic gas flows. This was a forerunner of laser-induced fluorescence techniques for flow field and combustion diagnostics. More recently, Professor Miles's research has focused on optical diagnostics of gas flows and the study of flow modification by energy addition. He has developed RELIEF (Raman Excitation + Laser-Induced Electronic Fluorescence) molecular tagging, which is capable of writing and tracking lines or grid patterns in the air; and Filtered Rayleigh Scattering, which images density, velocity, and temperature fields in air and in plasmas, dispersive atomic filtering for Raman imaging, and the pulse burst laser for real-time flowfield imaging. His group is developing new approaches to the creation of atmospheric plasmas for aerodynamic applications, and using advanced diagnostics to study high-speed gases and plasmas. He is principal investigator on the Princeton Radiatively Driven Hypersonic Wind Tunnel Project. He is the recipient of the 2000/2001 AIAA Aerodynamic Measurement Technology Award, a member of the American Physical Society, a senior member of the IEEE, a fellow of the Optical Society of America, and a fellow of the American Institute of Aeronautics and Astronautics.

Photos by Frank Wojciechowski

Evgenii Narimanov

Assistant Professor of Electrical Engineering
Ph.D. 1995, PhysTech, Moscow Institute of Physics and Technology

Evgenii Narimanov has focused on the mesoscopic physics of photonic and electronic devices, such as semiconductor microlasers and quantum dots, which represents a scale intermediate between "micro" and "macro," or substantially larger than the (de Broglie) wavelength, but still coherent. As a result, the interference effects become important and strongly affect the properties of the corresponding devices. He is particularly interested in the manifestations of the classical transition from integrability to chaos, which can have a dramatic effect on the device performance. Recent efforts have demonstrated that introducing non-integrable deformation to the shape of a semiconductor microdisk laser leads to an increase of the power output of the device by three orders of magnitude. Most of the work in the field of "quantum" (or "wave") chaos has addressed the behavior of systems governed by linear equations such as Shroedinger's or Maxwell's equations. However, the evolution of a device interacting with the environment is often characterized by an essentially nonlinear law. This becomes important for semiconductor lasers due to the spatial "hole-burning" and Kerr nonlinearity of the refraction index. The interplay of this "quantum" nonlinearity and the "classical" chaos is an interesting problem relevant for the development of future semiconductor devices. Another direction of his research is the development of information theory for fiber optics communication systems.

Nai-Phuan Ong

Professor of Physics
Ph.D. 1976, University of Southern California, Berkeley

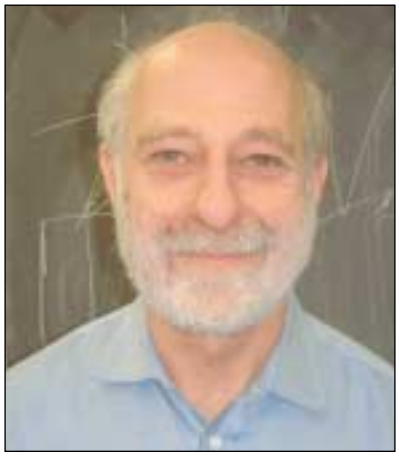
Nai-Phuan Ong joined the faculty at the University of Southern California in 1976, and was promoted to professor of physics in 1984. In 1985 he joined the Department of Physics at Princeton University. His research interests are in the physics of novel metals and semiconductors. Currently he is working on the transport properties of high-temperature superconductors, with the goal of understanding both the mechanism responsible for superconductivity at such high temperatures and the properties of the vortex state in intense magnetic fields. He is also working on the electronic transport properties of novel molecular wires and organic molecular conductors. Professor Ong is a fellow in the American Physical Society.

Top: Photo by Frank Wojciechowski
Bottom: file photo

Paul R. Prucnal

Professor of Electrical Engineering
Ph.D. 1979, Columbia University

Paul R. Prucnal came to Princeton University in 1988 as a professor of electrical engineering. His research interests include experimental and theoretical work on optical multiple access techniques for broadband networks, photonic fast-packet switching with optically processed control, and optical multiprocessor interconnects. He has published over 100 papers and holds several patents in these fields. From 1990 to 1992, Professor Prucnal served as acting director of POEM. He is currently the associate editor of the *IEEE Transactions on Communication* in the area of optical networks, applied optics in the area of networks and switching, and *IEEE Lightwave Communications Magazine*. He is an IEEE fellow (1992) and a recipient of the 1990 Rudolf Kingslake Medal from the International Society of Optical Engineering. He was chairman of the Technical Subcommittee on Optical Switching, Logic, and storage for the 1993 IEEE conference on lasers and electrooptics, and a member of the program committee for the Optical Society of America 1993 Topical Meetings on Photonics in Switching and Optical Computing.



Herschel A. Rabitz

Professor of Chemistry
Ph.D. 1970, Harvard University

Herschel A. Rabitz joined the faculty of the Department of Chemistry at Princeton University in 1971. He became an associate professor in 1976, and a full professor in 1980. From 1974 to 1979 he was a Camille and Henry Dreyfus Teacher Scholar, and from 1975 to 1979 he was an Alfred P. Sloan Fellow. In 1984 Professor Rabitz became an affiliated member of the applied mathematics program at Princeton. From 1993 to 1996, he was chairman of the Department of Chemistry. Throughout his career, Professor Rabitz's research interests have been at the interface of chemistry, physics, and engineering, with his principal areas of focus including molecular dynamics, chemical kinetics, and optical interactions with matter. His research has particularly emphasized molecular scale systems analysis. A special emphasis of this research is laser control of quantum dynamic phenomena. Professor Rabitz has to his credit over 325 publications in the general area of chemical physics. In addition to his academic and research accomplishments, he is also currently serving as the associate editor for two journals: *Progress in Physics, Chemistry, and Mechanics* and the *Journal of Mathematical Chemistry*. He is a member of the American Physical Society, the American Chemical Society, and the American Institute for the Advancement of Science.

Top: photo by Denise Applewhite

Bottom: file photo

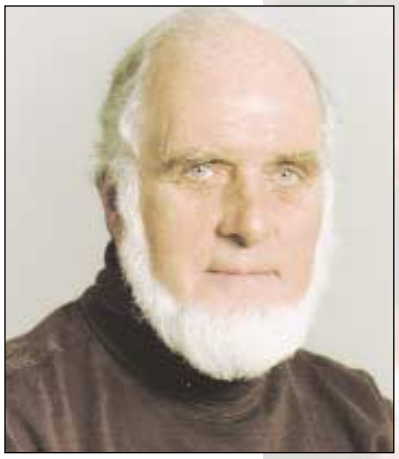
Richard A. Register

Professor of Chemical Engineering
Ph.D. 1989, University of Wisconsin-Madison

Richard A. Register has been a member of the chemical engineering faculty at Princeton University since 1990, where he currently holds a part-time appointment in the Princeton Materials Institute. His research interests focus on the morphology and properties of multiphase polymeric materials such as block and semicrystalline polymers, polymer phase transitions, rheology of associating polymers, electroluminescent polymers for display application, and the development of nanopatterning technologies. He has been named a NSF Young Investigator Award and a DuPont Young Professor, and received the Unilever Award sponsored by two divisions of the American Chemical Society.

Barrie S. H. Royce

Professor of Mechanical and Aerospace Engineering
Ph.D. 1954, University of London, King's College



Barrie S. H. Royce came to Princeton University in 1960 as a research associate and lecturer and has been a member of the faculty of the Department of Mechanical and Aerospace Engineering since 1961. Professor Royce's research interests have focused on the relationship between atomic defects in materials and their macroscopic performance. Most of his studies have been concerned with optical or electronic probes for charge storage in insulators subjected to ionizing radiation, radiation damage in ionic and covalently bonded insulators, metal oxide semiconductor devices, properties of biological ceramics, electrochemical interfaces, and the spectroscopy of powdered catalytic systems. His recent research has focused on understanding signal generation in Fourier transform photoacoustic spectroscopy and photothermal deflection spectroscopy. These techniques have been applied to the study of photoelectrochemical reactions, surface adsorbates on high specific-surface area materials, photocorrosion, and photopolymerization. Professor Royce serves on the editorial board of *Progress in Photothermal and Photoacoustic Science and Technology,* is a member of the American Physical Society, and has served as past president and is now a current member of the Princeton chapter of Sigma Xi.

Top: Photo by Frank Wojciechowski
Bottom: file photo

Jeffrey Schwartz

Professor of Chemistry
Ph.D. 1970, Stanford University

Research in Professor Schwartz's group is in the general area of organometallic chemistry. Currently, they are studying how to create interfaces between organics and inorganic materials by chemical deposition of organometallic complexes onto solid surfaces. It seems reasonable, if you wanted to join together an organic and an inorganic, that you might choose an "organometallic" as an interface, since it should be possible to get the "metallic" part to bind to the inorganic partner and the "organo" part to interact strongly with the organic one of a composite. Indeed, composite systems are important components of "high tech" devices, and we are interested in two such "high tech" areas. The first involves surface modification of indium tin oxide, which is the anode material of modern organics-based light-emitting diodes (OLEDs), as a means to enhance device performance. The other aims to develop interfaces to enable strong interactions between metallic implants and small peptides, in the context of stabilizing the bone-to-implant interaction in a biomedical application. At first glance, areas such as optoelectronic devices and surgical implants might seem rather unrelated. But, in fact, at the level of interface organometallic chemistry, they are conceptually quite similar! Whether the inorganic substrate is a metal (in the context of biomedical implants) or an oxide (in the context of diode electrode modification), the surface chemistry and characterization techniques are more or less the same.

Stuart C. Schwartz

Professor of Electrical Engineering
Director, Master of Engineering Program
Ph.D. 1966, University of Michigan

Stuart C. Schwartz joined the Department of Electrical Engineering at Princeton University in 1966, where he currently serves as professor. He served as chairman of the department from 1985 to 1994. During academic year 1972-73, he was a John S. Guggenheim Fellow and visiting associate professor at the Technion in Haifa, Israel. In 1980-81 he was visiting member of the technical staff at the Radio Research Laboratory, Bell Laboratories, working in the area of mobile telephony. He was visiting professor at Dartmouth and the University of California, Berkeley, during academic year 1989-90. His principal research interests are in the application of probability theory and stochastic processes to problems in statistical communication theory and signal processing. He has done work in the modeling and performance analysis of optical communication systems and multi-user communications. Professor Schwartz is a member of Sigma Gamma Tau, Eta Kappa Nu, and Sigma Xi. He has served as an editor for the *SIAM Journal on Applied Mathematics* and as program chairman for the 1986 International Symposium on Information Theory. He is a fellow of the IEEE, and in 1993 he served as president of the IEEE Information Theory Society.

Photos by Frank Wojciechowski

Giacinto Scoles

Donner Professor of Science, Department of Chemistry and Princeton Materials Institute
D.Sc. 1968, University of Genova, Italy

Giacinto Scoles obtained his first degree in chemistry in 1959 at the University of Genova, Italy, and spent three years at the Kamerlingh Onnes Laboratorium of the University of Leiden in the Netherlands. He obtained a D.Sc. in physics from the University of Genova in 1968. From 1968 to 1971, he was an associate professor of physics at Genova while performing several pioneering experiments on the nature of intermolecular forces using supersonic molecular beam techniques. In 1971 he moved to the University of Waterloo in Canada as a professor of physics and chemistry and was instrumental in establishing the Guelph-Waterloo Center for Graduate Work in Chemistry. In 1987 he was appointed Donner Professor of Science at Princeton University, where he has since conducted experiments on the mechanisms of energy relaxation in polyatomic molecules, the structure and bonding of molecular clusters, superfluity in liquid helium droplets, and the structure and dynamics of organic monolayers self-assembled on gold-crystal surfaces. Professor Scoles's present research interests are in the properties and applications of self-organizing organic materials and in the high-resolution spectroscopy of isolated molecules and clusters. He has edited a handbook, *Atomic and Molecular Beams Methods*, coauthored more than 200 refereed publications, is a fellow of the Royal Society of London (UK), and has been recently selected to receive the 2002 Peter Debye Award for Physical Chemistry of the ACS.

Mordechai Segev

Visiting Lecturer, with rank of Professor in Electrical Engineering
D.Sc. 1990, Technion, Israel

Mordechai (Moti) Segev is a professor of physics, at the Technion—Israel Institute of Technology, Haifa, Israel, and a visiting professor of electrical engineering at Princeton University. He received his B.Sc. and D.Sc. from the Technion, Israel, in 1985 and 1990, respectively. Moti Segev spent one year at Caltech University as a post-doctoral fellow and two more years there as a senior research fellow. He joined Princeton in September of 1994 as an assistant professor, becoming an associate professor in 1997, and a professor in 1999. In 2000, he returned to his home country, Israel, and joined the Technion. Moti Segev's research interests are mainly in nonlinear optics, solitons, and quantum electronics, although he finds some entertainment in thermodynamics, and nonlinear dynamics. He has roughly 150 publications in refereed journals, seven book chapters, and he has given numerous invited conference presentations. Among his most significant contributions are the discoveries of photorefractive spatial solitons and self-trapping of spatially incoherent and white incoherent light beams. Moti Segev is a fellow of the Optical Society of America (1997) and the American Physical Society (2000), and he has won several awards, among them the Sloan Research Award in Physics (1995). But above all, he takes pride in the success of the graduate students and post-doctoral fellows he has worked with over the years.

File photos

Mansour Shayegan

Professor of Electrical Engineering
Ph.D. 1983, Massachusetts Institute of Technology

Mansour Shayegan joined the Department of Electrical Engineering at Princeton University in 1985. Professor Shayegan's research is in solid-state physics, with an emphasis on semiconductors. Specific areas he is presently working in are electron states in high magnetic fields and low temperatures, and material science of IIIV semiconductor compounds and their growth by molecular beam epitaxy (MBE). Professor Shayegan and his colleagues are currently searching for the elusive "Wigner crystal" (an ordered array of electrons) in these high-quality structures. He is also studying various aspects of the physics and materials science of the MBE growth process. Professor Shayegan received both the National Science Foundation Presidential Young Investigator Award and the IBM Faculty Development Award in 1986, the Alfred P. Sloan Fellowship in 1989, the Princeton University Rheinstein Faculty Award in 1990, and a Fulbright fellowship for research and lecturing in Germany in 1992-93.

Lydia L. Sohn

Assistant Professor of Physics
Ph.D. 1992, Harvard University

Lydia L. Sohn received her Ph.D. from Harvard University in 1992. She is an assistant professor at Princeton University. Her current research is in the area of "nanobio" or the merging of nanotechnology with molecular biology. In particular, her research group has developed a variety of on-chip nanoscale electronic sensors to detect single biological molecules such as DNA and proteins. These sensors are being used to elucidate stochastic behavior in biological systems. In addition, her research includes experimental mesoscopic physics, scanning probe microscopy and lithography, electron transport in nanoscale devices, tunneling, 2-D electron systems, Josephson-junction array and molecular electronics.

Top: Photo by Frank Wojciechowski
Bottom: file photo

Thomas G. Spiro

Eugene Higgins Professor of Chemistry
Ph.D. 1960, Massachusetts Institute of Technology

Thomas G. Spiro has been a faculty member in the Department of Chemistry at Princeton University since 1963. After receiving his Ph.D. in chemistry, he spent his postdoctoral years in Copenhagen and Stockholm on Fulbright and National Institutes of Health fellowships. He served as chair of the Department of Chemistry from 1980 until 1989. His research interests are primarily in the areas of metalloporphyrin structure and function, photochemical properties of metalloporphyrins, and environmental chemistry. His laboratory has spearheaded the development of resonance Raman spectroscopy as a probe of biomolecular structure and dynamics. Professor Spiro received the first Bomem-Michelson Award in 1986 for fundamental contributions to molecular spectroscopy. He serves on the editorial boards of *Protein Science* and *Issues in Environmental Science*.

Szymon (Simon) Suckewer

Professor of Mechanical and Aerospace Engineering
Director, Program in Plasma Science and Technology
Ph.D. 1966 and D.Sc. 1971, Warsaw University

Szymon (Simon) Suckewer joined the research staff at the Princeton University Plasma Physics Laboratory in 1975 and became a faculty member of the Department of Mechanical and Aerospace Engineering at the University in 1987. Professor Suckewer's research interests are primarily in the development and applications of X-ray lasers, powerful picosecond and femtosecond laser sources, laser interactions with matter, the application of lasers to gas and plasma diagnostics, spectroscopy, and atomic processes in plasma and gases. Professor Suckewer is a fellow of the American Physical Society and the Optical Society of America. He was a member of the Committee of the National Academy of Science on Line Spectra and several boards and scientific committees of international conferences on laser and plasma spectroscopy, as well as the chairman of the International Society of Optical Engineering Conference on Ultrashort Wavelength Lasers in 1991 and 1993.

Photos by Frank Wojciechowski

Zhigang Suo

Professor of Mechanical and Aerospace Engineering
Ph.D. 1989, Harvard University

Zhigang Suo joined the Princeton University faculty in 1997. Between 1989 and 1997 he was a faculty member at the University of California, Santa Barbara. He works on fracture, deformation, and structural evolution in materials. His current research topics include thermomechanical instability in interconnect structures and configurational forces in nanostructures. He is a member of the Materials Research Society and the American Society of Mechanical Engineers. Suo has received the Pi Tau Sigma Gold Medal and Young Investigator Award from American Society of Mechanical Engineering (ASME), the Alexander von Humboldt Research Fellow from Germany, the Eric Reissner Medal at the International Conference on Computational Engineering and Science, and the Young Investigator Award and the Research Initiation Award from the National Science Foundation.

Sandra M. Troian

Associate Professor of Chemical Engineering
Ph.D. 1987, Cornell University

Sandra M. Troian received her B.A. in physics from Harvard University (1980) and her M.S. (1984) and Ph.D. (1987) in condensed matter physics from Cornell University. She was a postdoctoral associate in the Complex Fluids Group at Exxon Corporate Research Laboratories in Annandale, New Jersey from 1987 to 1989 and a French Ministry of Science fellow at the College de France in Paris from 1989 to 1990. She returned to Exxon as a staff physicist in the Polymers and Fluids Laboratory in 1990 and joined the faculty in chemical engineering and the associate faculty in the Department of Physics and the Program in Applied Computational Mathematics. She was a recipient of a 1996 NSF Career Award and the 1999 Frenkiel Award from the Division of Fluid Dynamics of the American Physical Society. Her current interests center on the stability of thin films and liquid microstructures, with applications of biological flows and microelectronic printing. Her group is now developing a novel open architecture microfluidic device based on configurable patterned thermal fields and is pursuing contact-printing techniques for electronic device fabrication on flat and curved substrates.

Photos by Frank Wojciechowski

Daniel Chee Tsui

Arthur LeGrand Doty Professor of Electrical Engineering
Ph.D. 1967, University of Chicago

Daniel Chee Tsui has been a faculty member at Princeton University since 1982. From 1968 to 1981, he worked in the solid-state Electronics Research Laboratory at Bell Laboratories in Murray Hill, New Jersey. His current research concerns the fundamental properties of electronic materials, especially the fractional quantum Hall effect, conduction in ultrasmall structures, and transport through heterojunctions. Of particular significance is his work on transitions in high magnetic fields from a fractional quantum Hall liquid to Wigner solid around Landau level filling. He is a member of IEEE, an elected member of the National Academy of Science, a fellow of the American Association for the Advancement of Science, and a recipient of the 1984 Olive Buckley Condensed Matter Physics Prize of the American Physical Society. In 1998, Professor Tsui was a corecipient of the Nobel Prize in physics for his work on the fractional quantum Hall effect along with Horst Störmer of Columbia University and an adjunct physics director at Lucent Bell Labs as well as Robert B. Laughlin of Stanford University.

Sergio Verdú

Professor of Electrical Engineering
Ph.D. 1984, University of Illinois, Urbana-Champaign

Sergio Verdú received his Telecommunications Engineering degree from the Polytechnic University of Barcelona in 1980 and his Ph.D. in electrical engineering from the University of Illinois at Urbana-Champaign in 1984. He joined the faculty of Princeton University in 1984, where he is a professor of electrical engineering. His research interests are in information theory and multiuser communication. He has held visiting appointments at the Australian National University, the Technion-Israel Institute of Technology, the University of Tokyo, and the University of California, Berkeley. He is author of *Multiuser Detection* (Cambridge University Press, 1998). Professor Verdú served as associate editor for *Shannon Theory on the IEEE Transactions on Information Theory*. He served on the Board of Governors of the IEEE Information Theory Society from 1989 to 1999, and was president of the society in 1997. He was cochairman of the Program Committee of the 1998 IEEE Symposium on Information Theory, and cochairman of the 2000 IEEE International Symposium on Information Theory. He was guest editor of the special commemorative issue of the *IEEE Transactions on Information Theory*, commemorating the fiftieth anniversary of the field. He is a recipient of the NSF Presidential Young Investigator Award, the IEEE Millennium Medal, and the Frederick Terman Award from the American Society of Engineering Education.

Top: photo by Elizabeth Amon
Bottom: file photo

Sigurd Wagner

Professor of Electrical Engineering
Ph.D. 1968, University of Vienna, Austria

Sigurd Wagner is helping to lay the foundation for the new industry of macroelectronics by developing concepts, materials, devices, and processes for integrated circuits on large glass, metal and plastic surfaces. Large-area electronics came into being with thin-film solar cells, grew to an industry with flat-panel displays, and now is branching out to sensitive skin, mechatronic materials, and e-textiles. His research interests stem from his career that began in 1970 at the Bell Telephone Laboratories, where he worked first on the 1Kb RAM project and then on new device applications for ternary chalcopyrite-type compound semiconductors and other novel electronic materials. During this research he co-invented several new solar cells, of which the $CuInSe_2$/CdS cell is in industrial production. While branch chief from 1978 to 1980, he established the photovoltaic laboratory of the newly founded Solar Energy Research Institute at Golden, Colorado. He then joined Princeton University as a professor of electrical engineering. His membership with POEM reflects his interest in displays and solar cells. He is also interested in environmental applications of electrical engineering. He is a member of the Program in Plasma Science and Technology for his work in plasma-enhanced deposition of silicon films. He has been active in the IEEE, the Materials Research Society, and the Electrochemical Society and is a fellow of the American Physical Society and of the IEEE, as well as a corresponding member of the Austrian Academy of Sciences.

Ron Weiss

Assistant Professor of Electrical Engineering
Ph.D. 2001, Massachusetts Institute of Technology

Ron Weiss joined the faculty of the Department of Electrical Engineering at Princeton University in 2001. He recently received his Ph.D. from the Department of Electrical Engineering and Computer Science at the Massachusetts Institute of Technology, where he pursued research that combines Computer Engineering principles with Molecular Biology substrates. His research interests include experimental and theoretical work on understanding and synthesizing cellular and biochemical computing systems. A major thrust of his work is the synthesis of gene networks that are engineered to perform in vivo analog and digital logic computation and signal processing. He is also interested in programmed cell-cell communications using biochemical diffusion mechanisms such as quorum sensing. He has also published papers in a variety of other topics, including distributed systems, information retrieval, multimedia, and networking.

Photos by Frank Wojciechowski

Research Staff

Ivan Glesk

Senior Research Scientist, Electrical Engineering
Ph.D. 1989, Comenius University, D.Sc. 1998, Slovak Academy of Sciences

Ivan Glesk received his Ph.D. in quantum electronics and optics from Comenius University in Slovak Republic. In 1986, he joined Comenius University. Shortly after he became associate professor at the Department of Optics. Dr. Glesk conducted his research in the areas of nonlinear optics, laser physics, and LIDAR sensing of the atmosphere. He is a recipient of the IREX Fellowship and was a visiting fellow at the Department of Mechanical and Aerospace Engineering at Princeton University from 1990 to 1991. In 1991 he joined the Department of Electrical Engineering at Princeton University, where he is currently a senior research scientist. Dr. Glesk is also the manager of the Lightwave Communication Research Laboratory. His area of current research interests encompasses optical communications, ultrashort pulsed laser systems, ultrafast all-optical devices, all-optical switching, optical networks and interconnects. He has written three book chapters and over 120 scientific publications and presented 15 invited talks at various conferences. Currently he is also the chairman of the Slovak Committee for Optics.

Helena Gleskova

Manager, POEM Micro/Nano Fabrication Lab, Research Scientist, Electrical Engineering
Ph.D. 1993, Comenius University, Slovakia

Helena Gleskova is a research scientist in the Department of Electrical Engineering at Princeton University and manager, POEM Micro/Nano Fabrication Lab. She is an expert in the integration of thin-film silicon devices with flexible substrates, the use of printing techniques for device fabrication, and the defect physics of hydrogenated amorphous silicon. Dr. Gleskova was the first to carry out and analyze the controlled bending to very small radii of thin-film transistors on plastic, and the first to process thin-film transistors on free-standing foils of glass and plastic. She demonstrated that state-of-the-art amorphous silicon transistors can be fabricated using all-laser-printed masks. She has made seminal contribution to the understanding of the light-induced annealing of dangling bond defects in hydrogenated amorphous silicon. Dr. Gleskova holds her Ph.D. (1993), M.S., and B.S. in solid-state physics, and a B.S. in pedagogy and didactics of physics from the Comenius University in Bratislava, Slovakia.

Photos by Frank Wojciechowski

Joseph E. Palmer

Cleanroom Manager, POEM
B.A. 1990, Rutgers University

Joseph E. Palmer graduated from Rutgers University with a B.A. in physics. While attending Rutgers, he was the assistant engineer of the Rutgers Nuclear Physics Laboratory. After graduation, he spent two years doing combustion research with AeroChem Research Laboratories, Inc. From there he went to Electron Transfer, where he helped develop a prototype electrochemical stibine generator used to grow $InP_{0.88}$ $Sb_{0.12}$ for Sensors Unlimited and the David Sarnoff Research Center. At Hoechst-Celanese he joined the Light Emitting Polymers Group led by Dr. Hermann Schenk, developing the technology for producing flexible light-emitting polymer displays. During that time he helped develop a novel barrier method for use in non-planar displays. Later, as a representative of Hoechst, he consulted for Uniax in Santa Barbara, California. Currently he manages the POEM cleanroom facility operations.

Elmar Schreiber

Senior Technical Staff Member I, Department of Chemistry
Ph.D. 1989, University of Paderborn, Germany

Elmar Schreiber received his B.S. in solid-state physics in 1984 and his Ph.D. in 1989 in the field of "Time-resolved Raman spectroscopy of exciton dynamics in ionic crystals," both from the University of Paderborn, Germany. During his postdoctoral study, he used quantum beat spectroscopy to study ultrafast dynamics in semiconductors. He received his habilitation with the topic "Femtosecond real-time spectroscopy in small molecules and clusters" in 1996 from the Free University Berlin in Germany. At the Max-Born-Institut in Berlin he investigated the ultrafast dynamics of complex molecules, and in 1998 he came to Princeton University, where he directs the Ultrafast Laser Facility. He currently works on the development of new ultrafast laser sources and the ability to tailor ultrashort pulses. The generated shaped pulses are used for time-resolved spectroscopy on molecules, solutions, and thin films, in particular, using optimal control techniques. Professor Schreiber is the author of a Springer monograph on femtosecond spectroscopy.

Top: photo by Frank Wojciechowski
Bottom: file photo

Conrad Silvestre

Process Engineer, POEM
Ph.D. 1991, Princeton University

Conrad Silvestre received his Ph.D. in electrical engineering from Princeton University in 1991. He became a postdoctoral research associate/laboratory manager for the Engineering Research Center for Advanced Electronic Materials Processing (AEMP) at North Carolina State University in Raleigh, N.C., specializing in the fabrication and characterization of remote plasma enhanced chemical vapor deposition MOSFETs from 1991 to 1994. He was a postdoctoral research associate at the Naval Research Laboratory in Washington, D.C., specializing in the molecular beam epitaxy of SiGe layers 1995-1997, and clean room manager and process engineer at the Laboratory for Surface Science and Technology at the University of Maine in Orono, Maine from 1998 to 2000. His present duties at Princeton University include managing the Undergraduate Integrated Circuit Fabrication Laboratory and performing research into the fabrication of microchannel and MEMS structures for microfluidic applications.

Jonas Tegenfeldt

Research Staff Member, Department of Molecular Biology
and Lecturer, Department of Physics
Ph.D. 1997, Lund University, Sweden

Jonas Tegenfeldt was born in Sweden and received his M.Sc. in engineering physics at Uppsala University, with his masters thesis: "Atomic Force Microscopy." This he carried out at the Division of Solid State Physics in Lund, Sweden in 1991. He pursued graduate studies at Lund University and received his Ph.D. in 1997 with the thesis: "Nanofabrication and Characterization for Applications in Biochemistry and Molecular Electronics." In 1998 he joined the Cox (Department of Molecular Biology) and Austin (Department of Physics) labs at Princeton University as a research associate, and in 2001 he became a research staff member in the Department of Molecular Biology and a lecturer at the Department of Physics. From 1998 to 1999 he received an award from the Wenner-Gren Foundation, which partly financed his stay at Princeton. Working in the labs of Bob Austin and Ted Cox, his research uses physical methods and nano/microfabrication to try to solve biological problems. One of the goals is to understand gene regulation on a single cell basis—to find one single cell with a particular set of properties or a particular history, extract its DNA and analyze it with respect to the transcription factors and other molecules that are bound to it. The pattern of molecules bound to the DNA is then related to the state of each cell. In this way some new understanding can be gained about how the cell regulates its genes as a function of external and internal stimuli.

Photos by Frank Wojciechowski

Staff

Kim Hegelbach
Manager, POEM

Kim Hegelbach manages POEM. It is her job to see that the organization serves its "customers" — the POEM family of faculty, researchers, students, and outside collaborators. It is her responsibility to ensure that contracts are in order, annual reviews and any number of other things run smoothly. She was born in Malaysia, and came to the United States after spending some years in Europe. She has been working at the University in a variety of roles for a quarter of a century, and she has been handling the administration of POEM since it was founded in 1988.

Joseph X. Montemarano
Director for Industrial Liaison, POEM
B.A. 1975, M.S. 1983, The Johns Hopkins University

Joe Montemarano joined POEM in 1994 as Director for Industrial Liaison. He helped POEM establish a leadership position at Princeton for effective management of Intellectual Property and interactions with high tech companies, which has fueled a major increase in sponsored research and technology licensing. Mr. Montemarano was Associate Director for Science, Technology, and Business Ventures with the New Jersey Commission on Science and Technology, and managed diverse science, engineering and business programs. In 1995, a Resolution of the New Jersey Senate was passed in recognition of his dedicated service to the state's biotech community. His research experience includes PA Consulting Services, Inc., Allied-Signal/Bendix, the University of Maryland Medical School, and The Johns Hopkins University.

Top: photo by Frank Wojciechowski
Bottom: file photo

Carolyn Arnesen

Departmental Office Support, POEM

Carolyn Arnesen was hired as a temp in July of 2001. Her main responsibility is purchasing, but now as permanent employee, she also assists in the many aspects of the day to day operation of POEM.

Robert Kuper

Data Management Support, POEM

Robert Kuper designs and maintains the POEM Website and supports the POEM faculty and staff with various computer related projects. Robert is a welcome new member of the POEM staff.

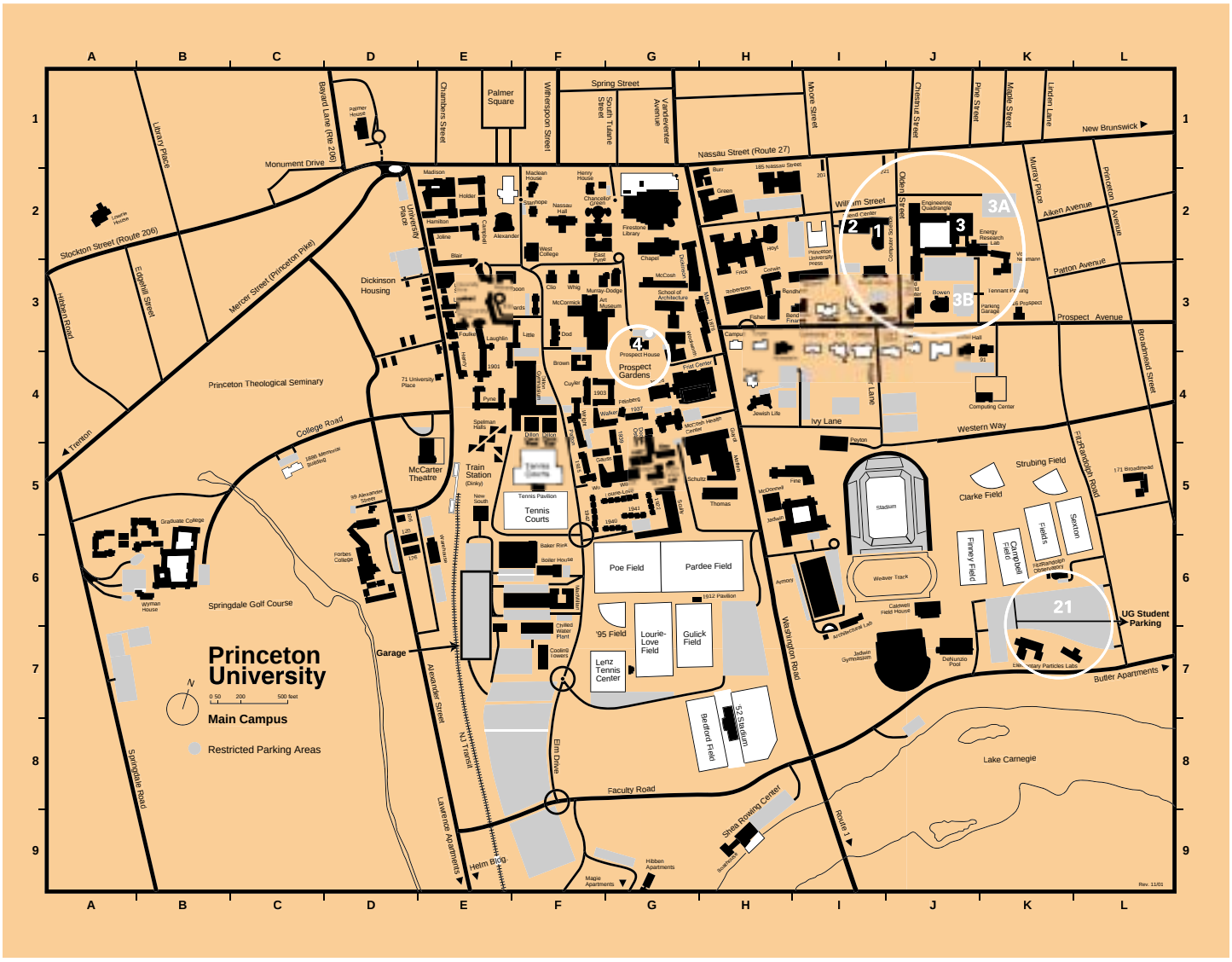
Barbara Varga

Business Manager, POEM

Barbara Varga has been at Princeton University since 1988 during that time she has worked in Sponsored Research Accounting and the Princeton Materials Institute. Barbara was hired as the Business Manager in POEM and her job is to assist in the many aspects of the daily financial operation of POEM.

Photos by Frank Wojciechowski

Notes



Key

1	Computer Science Building
2	Friend Center
3	POEM Center/Atrium
3A	Parking lot #2 (permit required)
3B	Prospect Street garage (visitor parking on top level)
4	Prospect House
21	Event Parking

Credits:

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