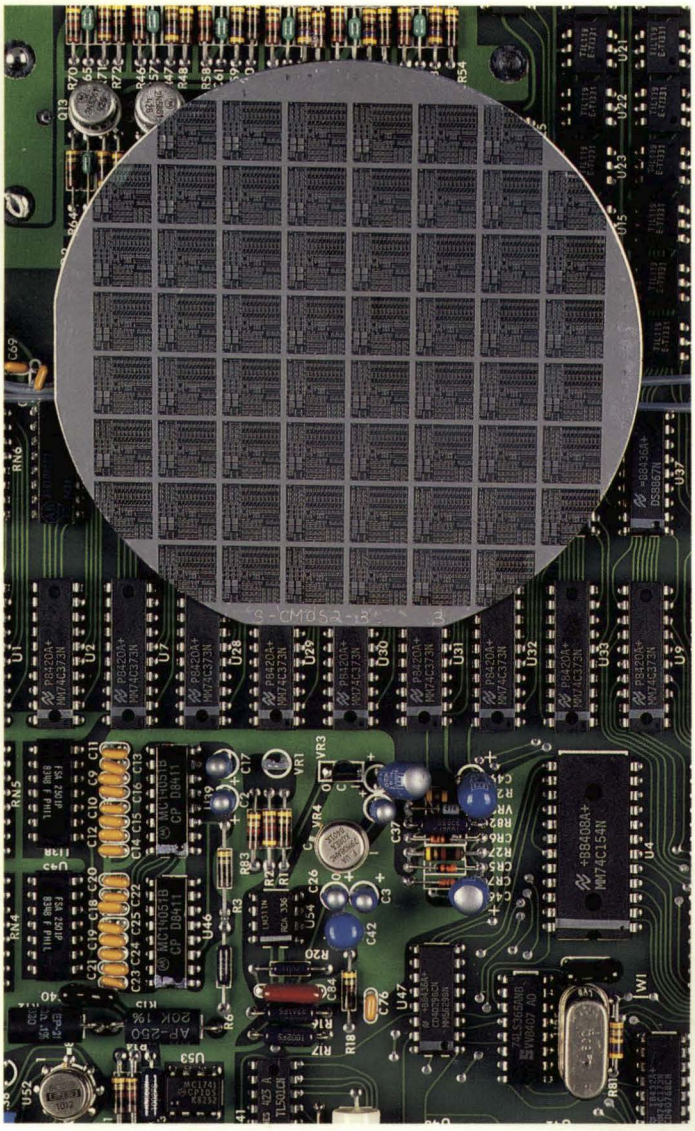
MEIS



MICROELECTRONICS & INFORMATION SCIENCES CENTER

UNIVERSITY OF MINNESOTA

Low-pressure chemical vapor deposition furnace

MEIS—AT THE CUTTING EDGE

Electrical engineering, materials science, quantum physics, surface analysis—the many disciplines that contribute to the development of microelectronics are among the fastest changing and most exciting fields of research. The Microelectronics and Information Sciences Center (MEIS) is an interdisciplinary center within the University of Minnesota Institute of Technology that supports research and education in microelectronics.

The computing power that some years ago required a room full of equipment can now be held in the palm of your hand. The miniaturization of microelectronic devices has reached a scale that challenges our understanding of physics. Ballistic transistors, quantum well devices, microsensors, ultra-fast analog/digital converters—these are examples of state-of-the-art research and education in microelectronics at MEIS.

In the coming years, we expect to maintain our position at the cutting edge as exciting new discoveries pave the way to developing the full potential of microelectronics. We welcome your interest in MEIS and invite you to join us as we explore the ever changing frontiers of science.

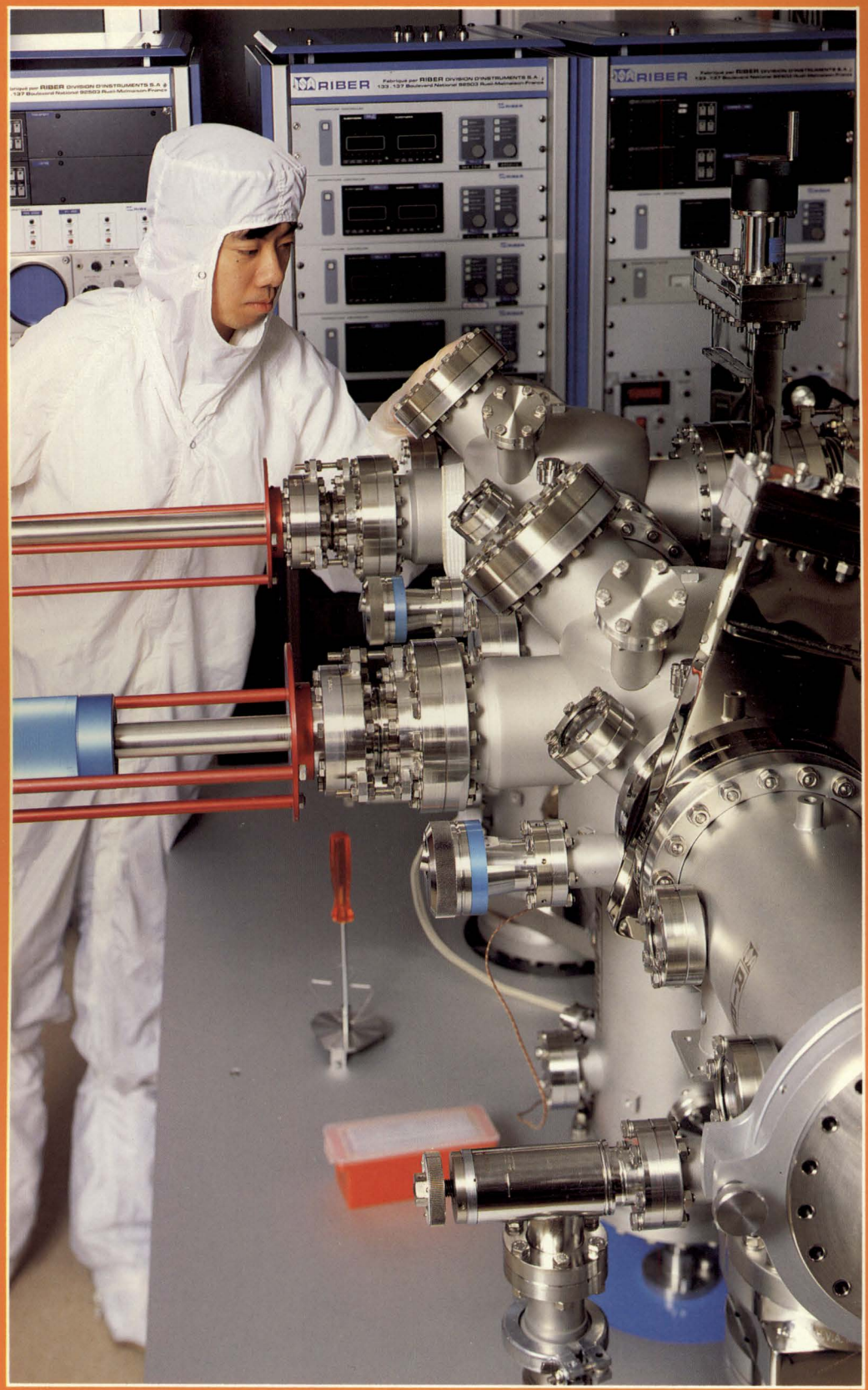
HISTORY

MEIS is a natural outgrowth of a long tradition of excellence in microelectronics and computer research and development, both at the University and within the state of Minnesota. As early as the 1940s, research at the University began paving the way for the microelectronics revolution. The Electrical Engineering department's research on oxide cathodes in vacuum tubes broke new ground in surface analysis—which in turn opened the door to the development of semiconductors, solid state electronics, and magnetic film. Hand in hand with the University's accomplishments, private Minnesota companies started to climb to prominence and emerged among the world leaders in computing and supercomputing research and development.

Given their success, local companies recognized the need for continued breakthroughs in this field and a strong supply of highly trained scientists and engineers on which to draw to remain on the cutting edge in their respective industries. The creation of MEIS was the next logical step to support their efforts and uphold the fine tradition of excellence in research at the University. In 1981, MEIS was established through donations from Control Data Corporation, Honeywell, 3M, and Sperry Univac (now Unisys), along with state and University funds.

Initially, MEIS funded individual research projects in much the same way as is done by federal funding agencies. These research projects were conducted in the microelectronics laboratory and in other laboratories around the University. Although that laboratory supported significant research, it soon became apparent that its facilities could not keep pace with the rapid advances in microelectronics. In the mid-1980s, planning was begun for a state-of-the-art microelectronics laboratory to be housed in the new Electrical Engineering and Computer Science building. A decision was made for MEIS to develop and operate a laboratory that would give faculty members and students the tools they need to excel in microelectronics research and education. The Microelectronic Research Laboratory was completed in 1989. Since that time, the caliber of research conducted at the Center has attracted considerable attention.

Although MEIS's mode of operation has changed substantially during its brief history, its objectives have remained the same: to provide students with a strong and diverse education in microelectronics and information sciences, to support a comprehensive agenda of microelectronics research, and to facilitate mutually beneficial collaborations with industry.



Gas-source molecular beam epitaxy system

FACILITIES

The Microelectronics Research Laboratory and supporting facilities are the heart of MEIS. With the construction of a new laboratory in 1989 and the installation of a full complement of research equipment, MEIS now offers our faculty members and students access to facilities that only a handful of universities can match.

The laboratory is uniquely suited to serve the broad spectrum of Institute of Technology faculty members who depend on MEIS support for their research and teaching. The clean room contains 4000 square feet of class 10 space and 5000 square feet of class 100-1000 space. The laboratory, which is laid out in a chase/bay arrangement, is divided by wall systems made of metal-clad, enamel-coated panels that can be reconfigured to meet changing needs.

The entire clean room area lies on vibration isolation pads anchored directly in bedrock, providing a vibration-free environment for fine-line work. Temperature and humidity controls are among the most exacting anywhere. The laboratory is divided into 29 zones in which varying temperatures can be controlled to within one-tenth of one degree Fahrenheit. Ultra-high purity process gases are distributed throughout the lab using electro-polished, stainless steel delivery systems.

Centralized smoke, fire, and toxic air monitoring systems—along with a rigorous safety training program and detailed operating procedures—safeguard personnel against potential dangers. In addition, the laboratory is outfitted with automated gas cabinets with remote shut down, automated laboratory shut down and notification, and multiply contained process units. The facility and process equipment are maintained by a staff of four engineers and scientists and nine student interns.

The laboratory has a full complement of process equipment needed to support world-class research in microelectronic materials growth, processing, and characterization. This includes a gas source molecular beam epitaxy system and a low pressure organometallic vapor phase epitaxy system for growing III-V semiconductor heterostructures, and a rapid thermal epitaxy system for growing IV-IV heterostructures.

In lithography, the optical tools include two contact/proximity printers with 0.5 micron resolution and a 0.7 micron projection stepper wafer system. A variety of plasma equipment is available, including sputter deposition systems, plasma-enhanced chemical vapor deposition systems, plasma etchers, reactive ion etchers, and an ion mill. A hot process area that includes eight automated furnace tubes, three automated low pressure chemical vapor deposition tubes, and two rapid thermal reactors is used for oxidation, annealing, and thin film deposition.

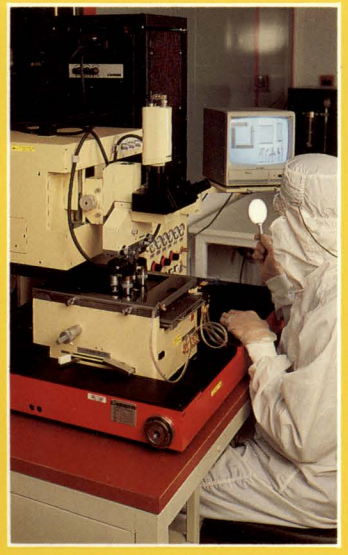
Finally, process support equipment includes wet chemical hoods, photo-resist tracks and spinners, line width and film thickness measurement tools, and optical microscopes. MEIS also has a separate, well-equipped characterization laboratory that includes an ellipsometer, automated I-V and C-V tools, as well as DLTS and Hall stations.

EDUCATION

As an interdisciplinary center within the Institute of Technology, the role of MEIS is to support and assist the education of IT students in the various disciplines relating to microelectronics. Although MEIS is not a degree-granting unit, each year, some 60 graduate students and senior-level undergraduates take advantage of its laboratories and course offerings to gain the background and experience on state-of-the-art equipment that has earned our graduates a reputation for excellence.

In addition, the laboratory serves as a teaching facility for an interdepartmental undergraduate certificate program in Semiconductor Manufacturing that allows students from the departments of electrical engineering, mechanical engineering, and chemical engineering/materials science to specialize in semiconductor manufacturing technology. The University of Minnesota is one of only five schools nationwide that have been funded by the Semiconductor Research Corporation to offer this program. After completing the core curriculum in their home departments (typically during their first three years) students are instructed in semiconductor processing and gain hands-on experience through a group project that includes designing, fabricating, and testing a built integrated circuit. Several courses have been developed specifically for this program, including "Clean Room Design and Particle Control," Electronic Materials I and II," "Properties of Interfaces," and "Experimental Design and Statistical Process Control."

MEIS offers numerous opportunities for students to gain exposure to industry standards and procedures through summer internships.



Top:
Optical and infrared
contact aligner

Bottom:
Control panel
for the LPCVD furnace

FACULTY

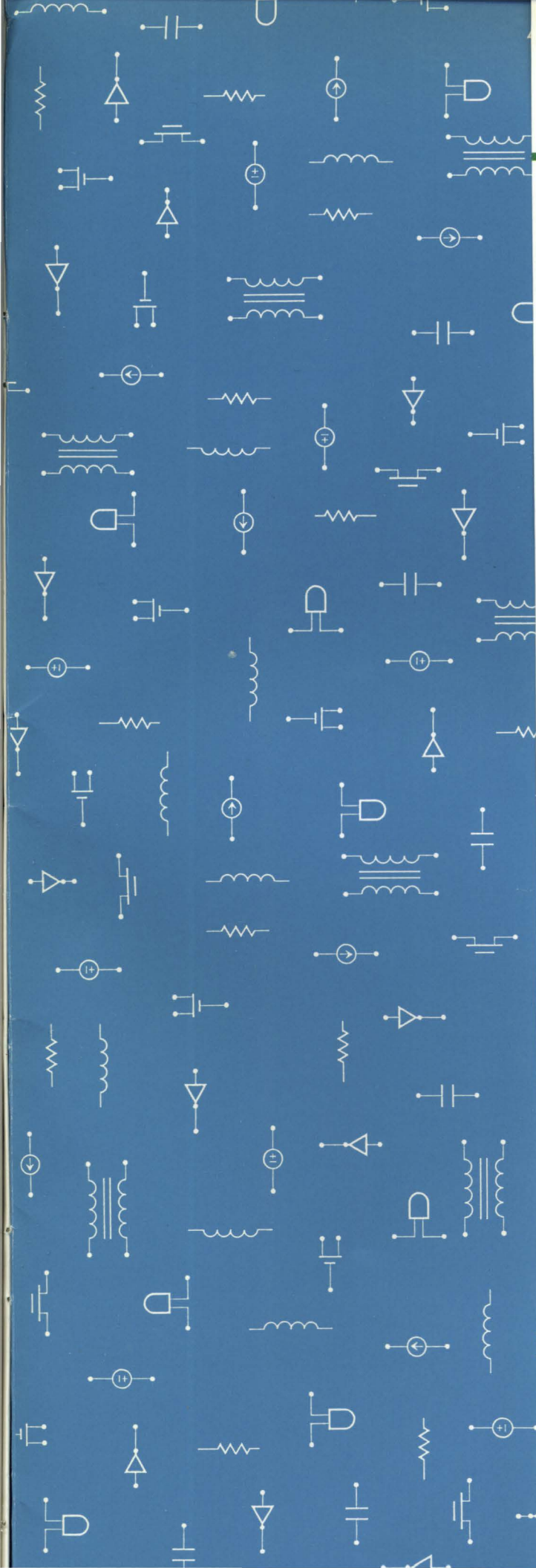
Faculty members affiliated with MEIS for research and instruction come from several disciplines, including electrical engineering, mechanical engineering, physics, chemical engineering, and materials science. The extraordinary facilities and fertile environment attract some of the best scientists and educators from within the Institute of Technology, many of whom have achieved world renown for their research efforts. The interdisciplinary nature of MEIS encourages collaboration among the disciplines and opens the door to new areas of research as participants draw upon each other's expertise to further their understanding of the challenges that come with pushing toward new horizons in microelectronics.

More than 20 faculty members currently use the facilities and are developing funding to support research in MEIS. As new projects are funded, the influx of new faculty members and new ideas fosters an atmosphere of vitality and creativity that will maintain MEIS's position at the cutting-edge of microelectronics research and development.

INDUSTRIAL AFFILIATES PROGRAM

An active program of exchange between industry and the world of academics is essential to the success of any research and education center. To enhance that exchange, MEIS has founded an Industrial Affiliates Program that allows researchers to gain valuable input from their industrial counterparts regarding the direction of their research and permits affiliates to stay abreast of breakthrough research that may affect their industry. Representatives from companies that join this program are invited to an annual review of all research activity at MEIS and are among the first to share in the latest research developments at the center. Affiliates are also given opportunities to meet individually with researchers, to probe more deeply into areas of particular interest, and, where feasible, to make arrangements with faculty members to sponsor further research into specific areas.

In addition, the Industrial Affiliates Program gives graduate students valuable exposure to the industrial side of microelectronics through internships and interaction with company representatives. At the same time, affiliates have an opportunity to become familiar with prospective employees.



RESEARCH

The future is never certain, but in microelectronics we can be sure of this much: the race will be won by the swift. The next generation of computers, communications equipment, lasers, sensors, and other microelectronics-based systems will be born out of research on smaller, faster transistors, lasers, and switches, purer compounds, new technologies, and a better understanding of the basic physical properties of microelectronics materials and devices.

The basic objective of research at MEIS is to help pave the way to that future, through research that spans the entire spectrum of microelectronics. MEIS research falls into six main areas:

Silicon-based integrated circuits and devices. Among these, the most exciting currently under investigation are the silicon-germanium alloy structures. They hold the promise of producing extremely high-speed devices.

Very high-speed and high-frequency devices and circuits based on gallium arsenide and other compound semiconductors.

Materials growth, including gas source molecular beam epitaxy, low-pressure organometallic vapor phase epitaxy, and rapid thermal epitaxy.

Optoelectronics, including lasers, photodetectors, and other integrated optical circuits.

Particle technology, including contamination studies, three-dimensional airflow modeling, clean room design and analysis, and work station design.

Superconductive materials and devices, especially those built with the new high-temperature materials.

Initially, MEIS served as a funding agency for microelectronics research at the University. Today, MEIS funds are used to operate and maintain a laboratory that is truly world-class. These facilities support a caliber of research that is proving to be attractive to federal agencies and other external funding sources and will lead to numerous advances in microelectronics.

Some of these advances have already made their way into the private sector. Others are providing the initial work upon which private companies will build new technologies. MEIS wholeheartedly endorses collaborative efforts and encourages inquiries from those interested in a more detailed accounting of our many vital research projects.

For more information, please contact the MEIS office at (612) 624-8005.

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