EMCORE, PSI-Zurich to Collaborate on III-V Semiconductor Research

EMCORE Corporation and the Paul Scherrer Institute (PSI) have finalized a collaborative technology agreement involving an extensive research program to optimize reactor growth parameters in III-V compound semiconductor materials.

EMCORE (Somerset, NJ) will manufacture and deliver a metalorganic chemical vapor deposition system and direct an extensive training program. Both organizations will share the results obtained in the development of growth processes designed to produce high quality III-V compound semiconductors including InGaAsP-InP and AlGaAs-GaAs quantum well and double heterostructure lasers.

The agreement signifies PSI-Zurich's first step in establishing an optoelectronics technology center for III-V compound semiconductors. In line with its new function as a Swiss goverment research laboratory, the center's facilities will include a cleanroom with a processing line in addition to modern equipment for materials characterization. The facilities will be made available to universities and industry. PSI-Zurich will coordinate its activities with the Swiss Federal Institutes of Technology in Zurich and Lausanne, where III-V semiconductor research is ongoing, and will concentrate its efforts in industrially relevant areas.

PSI-Zurich, with a staff of about 55, is part of the Paul Scherrer Institute, a large government research organization located some 30 miles west of Zurich. Its activities include research in solid-state optoelectronics, optics, and image processing.

Thin-Film Recording Head Helps Demonstrate Gigabit Storage Density

An experimental dual-element, thin-film recording head was recently used by IBM scientists and engineers during a demonstration of gigabit storage density. The demonstrated data density, a billion bits of information on a single square inch of disk surface, was 15 to 30 times greater than that of current "hard disk" magnetic storage devices.

Composed of several layers of very thin films, the new head is made by photolithographic methods common in the semiconductor industry. It features an inductive "write" element and a magnetoresistive (MR) "read" element that can detect recorded magnetic bits too small for a conventional inductive head to recognize. The MR element also has the advantage of similar performance over all disk sizes and speeds. Both elements operate while the head flies over the disk at a height of less than 2 millionths of an inch. Heads in currently available disk drives fly from 6 to 15 millionths of an inch above the disk surface.

The MR head used in the demonstration is similar in principle to one introduced in 1984, but the recorded tracks in the demonstration were more than 100 times narrower than previously.

The disk used in the demonstration was an aluminum disk coated with a thin film of a magnetic cobalt alloy designed for very high bit density and very low magnetic noise. A thin coating of a hard material protects the alloy film from contact with the recording head.

In the demonstration, bits were stored at a linear density of 158,000 bits per inch along concentric tracks packed at 6,350 per radial inch. Each data bit measured only 0.16 microns long by 4 microns wide, comparable in area to current optical storage bit cells. The demonstration also relied on an innovative recording channel which permits significantly greater bit density.

During the demonstration, information was recorded and read at a data rate of 3.5 million bytes per second. The measured error rates were low enough—one in a billion, decreasing to one in 10 trillion if standard error correction codes are used—to meet the data integrity requirements of the computer industry. The demonstration was performed on a precision test apparatus, but all the critical hardware components were made by conventional manufacturing processes. Several additional years of development would be required, however, before gigabit technology could be incorporated into products.

Editor's Note: The March issue of the *MRS Bulletin* will feature a series of five articles on magnetic recording materials compiled by Guest Editor, Ami Berkowitz, professor in the Physics Department and the Center for Magnetic Recording Research at the University of California, San Diego.

University of Tennessee and DOE Announce Math/Science Education Initiatives

Representatives of a University of Tennessee/U.S. Department of Energy cooperative education program recently announced three initiatives to improve math and science education in Tennessee.

The first initiative involves the creation of an "adjunct teaching corps" through alternative certification. The alternative certification plan will permit trained individuals, specifically, scientists and engineers who want to become teachers and retirees from technical professions who want to return to the workforce as teachers, to bring their expertise into the classroom as math or science teaching associates. The University of Tennessee has developed a program, the Lyndhurst Model, that does this. DOE will add laboratory experience to match the University's preparation in teaching methods and materials.

The second initiative, the Young Math or Science Teachers Program, targets college students who want to be math or science teachers. DOE will develop a program with the University of Tennessee to provide a five-year BS/MS degree plus teaching credentials and also offer the students summer research and employment opportunities at a DOE laboratory each year they are in school.

For the third initiative, Energy Secretary James D. Watkins requested Oak Ridge National Laboratory to adopt two schools in the region and asked DOE employees to create a volunteer effort to bring hands-on science and math experience to these children.

In-Situ Real-Time Monitoring Demonstrated for Compound Semiconductor Growth

A technique for monitoring and precisely controlling the composition of advanced semiconductor materials as they are being made has been demonstrated at Sandia National Laboratories. The technique involves making in-situ real-time measurements while compound semiconductor materials are grown by molecular beam epitaxy (MBE).

During MBE, not all the molecules impinging on a surface condense to form the growing crystal. Depending on the temperature, composition, and reactivity of the surface, some of the molecules reflect from the surface. Sandia researchers are measuring the reflected fluxes using line-of-sight reflection mass spectrometry (REMS) to instantaneously deduce the surface chemical reactivity.

For example, during growth of indium gallium arsenide, three molecular species impinge on the surface. A significant fraction of the arsenic, which is volatile, tends to reflect. That fraction depends on the relative amounts of indium and gallium at the surface, and so can be used to deduce the composition of the growing crystal. "REMS is the most direct way of measuring and understanding surface chemistry during gallium-arsenide-based molecular beam epitaxy," said physicist Jeffrey Y. Tsao.

Reflection high-energy electron diffraction (RHEED), the only existing in-situ method of monitoring surface conditions during epitaxy, is limited to physical, or structural, aspects of MBE. The REMS technique offers additional advantages over electron diffraction in that it can be used while the semiconductor wafer is being rotated in the MBE chamber, and measurements can be made at any temperature. It can also provide complementary scientific insight into the chemical aspects of MBE.

Although the control offered is considerable, to within 5% according to Tsao, he does not expect rapid adoption of the technology as a fabrication tool. He expects that its acceptance will happen first with materials—such as compound semiconductor materials made of aluminum gallium arsenide, indium gallium arsenide, or indium antimonide arsenide—where composition control is difficult and critical. "It would be fantastic if we could apply it to gas-source MBE," he said.

Gorham to License Ceramic and Ceramic Matrix Composite Technology

Gorham Advanced Materials Institute (GAMI) will begin licensing its proprietary technology for fabricating fully dense advanced ceramic and ceramic matrix composites. During a three-year $2 million research program, processes were developed for five material groups: aluminum oxide, silicon nitride, aluminum nitride, partially stabilized zirconia, and silicon carbide.

GAMI is offering a technology licensing/product development program to individual companies that manufacture or are considering the manufacture of advanced parts, or to suppliers of ceramic raw materials. During a 12-month laboratory research program, GAMI will develop an optimum process technology for any one of the five above mentioned materials selected by the company. The program's goal is to develop specific commercial products for manufacture. A non-exclusive, royalty-free license will be given for the process technology used.

Westinghouse-Argonne to Develop Electrical Current Leads Using High T_c Superconductors

Westinghouse Electric Corp. and the Superconductivity Pilot Center at Argonne National Laboratory have agreed to a joint research project to develop electrical current leads that incorporate high temperature superconductors. The project will aim at developing current leads that use high temperature superconductors to connect low temperature superconductors to sources of current. The project could benefit superconducting magnetic energy storate technologies and make it easier to use superconducting technologies in space. Each party will contribute $60,000 to the six-month project.

Existing superconducting technologies are based on low temperature superconductors, which are connected to current sources by leads made from normal conductors. But resistive heating in normal conductors converts liquid helium to gas, which either escapes form the system or needs reconversion to liquid, a process that requires much energy.

Leads of high temperature superconductors could eliminate resistive heating and conserve liquid helium, an important consideration in certain circumstances, such as in space, where helium replacement could be prohibitively expensive.

For large-scale earth-bound applications, such as magnetic energy storage, current leads of ceramic superconductors could reduce helium losses by providing better thermal insulation than metal leads between the outside environment and the helium-cooled environment of the superconductor.

The Engineering Technology division at the Westinghouse Science and Technology Center in Pittsburgh, Pennsylvania will participate in design and will test new current leads. Argonne will fabricate high temperature superconducting leads and match them to other lead components.

Oak Ridge, Sematech to Develop Advanced Semiconductor Etch Program

Oak Ridge National Laboratory will conduct research to develop an advanced technology for producing semiconductors for Sematech, a consortium of 14 semiconductor manufacturers seeking to regain world competitiveness. Sematech seeks to develop the technology to produce chips with circuit paths more than 40% narrower than existing ones. This reduction would allow production of smaller, more powerful computers and electronics with American-made products.

The Work-for-Others project, to be conducted by Oak Ridge's Solid State and Fusion Energy divisions, would develop and evaluate experimental etching concepts for fabricating high-density semiconductor chips. Precision etching is a critical step in producing a circuit with a million transistors on one side of a quarter-inch chip. The technology would then be transferred to a U.S. tool manufacturer, which would design and produce the commercial etching tools.

The Oak Ridge project is part of Sematech's University and National Laboratory Program, where scientists and educators cooperate under research grants.

U.S. Navy Awards R&D Contract for Nickel Aluminides

The U.S. Naval Sea Systems Command has awarded Gorham Advanced Materials Institute a Phase I, Small Business Innovation Research (SBIR) contract to develop nickel alumnides for use as structural components in tactical missiles.

Headed by Dr. Andrew C. Nyce and Michael Concannon, the research will focus on a novel processing technology which can potentially accelerate the development of nickel alumnides into mature materials for advanced applications. This technology comprises a continuous, two-phase process in which closed-porosity nickel aluminide bodies are first fabricated by exothermally driven self-propagating combustion synthesis from elemental powder blends and then fully densified *in-situ* by rapid hot isostatic pressing. This process will be investigated and its feasibility determined for producing both monolithic and composite (silicon carbide whisker-reinforced) Ni_3Al materials.

UNM's Center for High Technology Materials to Host Semiconductor Optoelectronics Workshop

The University of New Mexico's Center for High Technology Materials has received a grant from the National Science Foundation under its Undergraduate Faculty Enhancement Program enabling it to sponsor a one-week intensive workshop on "Semiconductor Optoelectronics" from June 10-15, 1990. The NSF grant is part of a program intended to revitalize the teaching of undergraduate science and engineering and to encourage development of semiconductor optoelectronics as an undergraduate discipline.

Covering such topics as III-V semiconductor growth and processing, optoelectronic device physics, and systems engineering and applications, the workshop is open to undergraduate teaching faculty interested in establishing optoelectronics programs at U.S. colleges and universities. The program will feature interaction among participants and faculty from UNM and Sandia National Laboratories both during and after the workshop. Deadline for application is **March 15, 1990.** Stipends and living expenses will be provided to successful applicants under the

NSF grant. For additional details contact Prof. John G. McInerney, CHTM, University of New Mexico, Albuquerque, NM 87131; telephone (505) 277-0768; fax (505) 277-6433.

Alfred University, Centorr Furnaces to Collaborate in R&D Efforts

Alfred University and Centorr Furnaces are joining forces to confront issues facing manufacturers of advanced ceramic components. Through joint research on continuous sintering of non-oxide ceramics, particularly aluminum oxynitride and aluminum nitride ceramics, they aim to develop compositions, processing, and equipment to enable repeatable and economic processing of advanced ceramic components.

Preliminary studies conducted in the furnace have yielded AlON with densities greater than 99% theoretical. According to Mike Heslin, a graduate student conducting continuous sintering research, "Some of the single-phase AlON samples already have transparent sections and we are in the process of examining powder preparation and fine tuning our sintering procedures."

P. Goodhew Assumes Professorship at University of Liverpool

Peter Goodhew, formerly professor of microstructural science at the University of Surrey, has become Henry Bell Wortley Professor of Materials Engineering and head of the Department of Materials Science and Engineering at the University of Liverpool.

Educated at the University of Birmingham, Goodhew was largely responsible for the development of the microstructural studies unit at Surrey. He has published five books on microscopy in addition to over 120 research papers, many of them related to the study of interfaces and inert gas bubbles in metals.

Goodhew is looking forward to interacting wth several of the department's research groups. He is particularly interested in the prospects for the growth of compound semiconductors by metalorganic molecular beam epitaxy (MOMBE), which Liverpool is undertaking as part of a consortium supported by DTI and SERC.

An MRS member, Goodhew is also a member of the Councils of the Institute of Metals and of the Federation of Materials Institutes.

Huntington Labs Expands Capacity

Huntington Laboratories, a supplier of vacuum components and custom ultrahigh vacuum equipment, has just completed the second phase of capacity expansion plans. Facilities were increased by 40% and over $3 million of capital equipment was installed.

Huntington has also added several representatives throughout the United States: Environment Associates in Chatsworth, California; Semitorr Northwest in Beverton, Oregon; and Dela Technology in Rockville, Maryland. In overseas markets, Oriel was appointed as a distributor in France and SPECS Gmbh as a distributor in West Germany.

Phule Joins University of Pittsburgh

Phradeep P. Phule recently joined the University of Pittsburgh as assistant professor of materials science and engineering. Phule received bachelor's and master's degrees in metallurgical engineering from the Indian Institute of Technology, Bombay, India, in 1983 and 1985, respectively. He graduated from the University of Arizona, Tucson with a PhD in materials science and engineering. His research interests involve the chemical synthesis, processing, and characterization of electronic and optical ceramics. He is currently helping to organize the new Greater Pittsburgh Section of the Materials Research Society. (See the article on p. 68.)

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