SRA Awarded Funding for PECVD Modeling

Scientific Research Associates, Inc. (SRA), Glastonbury, CT was awarded Phase I research funding under the Defense Advanced Research Projects Agency's (DARPA) Small Business Innovation Research program to develop a computational model for plasma-enhanced chemical vapor deposition of electronic materials.

SRA intends to develop a comprehensive process model which includes transport of electrons and ions as well as neural atoms and radicals. Fluid flow, heat transfer, and mass transfer with homogeneous and heterogeneous chemical reactions in a PECVD reactor will be simulated. The PECVD chemical kinetics, which is primarily due to electron bombardment of the source gases, will be modeled through self-consistent computation of electron and ion densities and electron temperature. The computational model will be used to predict deposition rates, uniformity and film composition which will be compared against results from growth experiments. SRA developed a similar model for plasma etching and reactive ion etching (RIE) under a U.S. Army Phase II SBIR project. For more information contact M. Meyyappan (203) 659-0333.

Microwave Resonators Are Practical, Available High T_c Product

Superconductor Techuologies, Inc. (STI), Santa Barbara, CA has introduced what it believes is the world's first practical high T_c product, a Microloss Hi-Q Superconducting Resonator.

"We have done the development work, we are testing it as a practical microwave device, it is at realistic power levels, it is in packages that you can use, and it is something you can order and have delivered in a reasonable length of time," says Jim Bybokas, STI vice president for product development, in backing up STI's claim.

Bybokas also claims that the product now has about 10 customers, one of whom is Lockheed, and that the device will have both military and civilian applications. He acknowledges, however, that there is not going to be a market for thousands of resonators. "People will use a resonator to make other devices. For example, you could build oscillators, filters (there are from 50-100 such filters on a communications satellite), couplers, switches, or phase shifters." To facilitate the effort, STI has introduced a custom package that would allow an engineer to design various high T_c circuits.

The device costs about $6,500, in part to cover development, compared to the $1,000 it would cost for conventional resonators. As the technology develops, the prices will go down dramatically, according to Bybokas. Approximately one-half of the development funding was provided by the Defense Advanced Research Projects Agency.

High T_c microwave resonators have a quality factor 20 times that of copper, according to STI. They have also been tested successfully at practical microwave power levels. The standard package size is approximately 1 x 1 x 0.5 inch with standard SMA connectors.

Various high T_c resonators are expected to be tested as part of the U.S. Navy's High Temperature Superconductivity Space Experiment (HTSSE), which is scheduled to launch in early 1993. Some companies expected to provide high T_c resonators include AT&T, Du Pont Company, Ford Aerospace, General Electric, Hughes, Hypres, the David Sarnoff Research Laboratory, Supercon, STI, Lockheed, and Westinghouse.

French Tokamak Uses Oak Ridge Pellet Injector, rf Antenna

Two devices developed at Oak Ridge National Laboratory are currently playing important roles in a French project that uses a uniquely designed tokamak to develop fusion energy as a power source.

A pellet injector and radio frequency antenna have been installed in the Tore Supra tokamak, a new doughnut-shaped superconducting magnetic fusion device. Although it is just one of several large tokamaks built to show that superhot plasmas confined by magnetic fields could give rise to heat-producing fusion reactions, the Tore Supra differs from others in that it is designed to create and sustain hot plasmas for longer times (e.g., 30 second pulses). This requires several technologies, including superconducting magnets to confine the plasma and the Oak Ridge devices.

The centrifuge pellet injector provides fuel to the tokamak by propeling frozen pellets of deuterium (10 pellets per second at velocities of 600 to 900 meters per second) into the plasma's core. The injector is based on a concept developed by C.A. Foster of Oak Ridge, and it acts like a rotary lawn sprinkler, using centrifugal forces to accelerate frozen pellets before they are injected into the plasma.

The radio frequency antenna, an auxiliary heating device, is being tested on the tokamak and transmits energy to the ions of the Tore Supra's fusion plasma at fre-

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quencies close to those used for radio and television but at a much greater power of four megawatts.

In exchange for the use of the devices, researchers from Oak Ridge's Fusion Energy Division will conduct experiments on the French tokamak in accordance with an agreement between the U.S. Department of Energy and the French Commissariat l'Energie Atomique.

The Tore Supra project is being conducted in Cadarache, France and began on January 25 of this year.

Vuitton-Hennessy Names Recipients of 1990 Science for Art Prize

The recipients of the annual 1990 Louis Vuitton-Moët Hennessy Science for Art Prize, judged by transcontinental jury (New York, Tokyo, and Paris), were elected this past March. The awards, approximately US$16,000 plus expenses to attend the ceremonies in Paris, are given to single investigators whose scientific achievements in materials research stimulate the interaction of art, science, and industry.

The innovation prize was awarded to Werner Ostertag for his development and manufacture of an stable nontoxic interference pigment consisting of aluminum particles covered with a thin layer of iron oxide. The composite particles are prepared with a process that utilizes a hybridization of chemical vapor deposition and fluidized bed technology. The scientific prize was awarded to Hans Kuhn for theoretical work ranging from the properties of monolayers to the energy interactions in complex molecules. His fundamental work is credited with leading to important advances in the technology of organic films as well as a profound understanding of the complex physico-chemical interactions linking color to molecular structure. A special artistic mention wugiven to Peter Struycken for his pattern distribution analysis of color and light in space and time.

Those interested in applying for either of the prizes for the coming year should call or write Olivier Goniak, Louis Vuitton-Moët Hennessy, 135 East 57th Street, New York, NY 10022; telephone (212) 758-7200; fax (212) 758-2801.

Luxtron Acquires Accufiber

Luxtron Corporation, a California-based optical instrumentation and control systems company, has acquired the assets of Accufiber, Inc. of Beaverton, Oregon.

Luxtron's goal is to create a comprehensive optical sensors company supplying test and measurement products, instrumentation to the factory floor, and comple-

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mentary process control systems utilizing modern adaptive and multivariable techniques. Combined, the two companies' product lines will be able to offer contacting and noncontacting measurement systems over a range of -200°C to +3000°C. Luxtron also wants to support an extensive research and development activity designed to continually improve existing products and to regularly introduce new products to the marketplace.

Accufiber products are based on high temperature optical fiber thermometry, a technology originally pioneered by the National Bureau of Standards for precise scientific and research and development application. The products are used in major laboratories, most types of engine development, semiconductor manufacturing processes, ceramics manufacturing including glass and fiberglass, plus numerous other applications.

Luxtron Fluoroptic® products for temperature measurement are based on the variation of the fluorescent decay time of a phosphor with temperature and the use of fiber optics for the stimulation and transmission of this variation. Luxtron's Transmet™ Division products are based on a noncontact principle for temperature measurement of moving products such as wire moving webs or rotating roll surfaces.

K.L. Mittal Receives ASTM's Dudley Award

Dr. Kashmiri L. Mittal, senior chemist at IBM U.S. Technical Education in Thornwood, NY, received the 1990 Charles B. Dudley Award for his work on "STP 640, Adhesion Measurement of Thin Films, and Bulk Coatings."

The Charles B. Dudley Award was established in 1925 in honor of the first chairman of the American Society for Testing and Materials (ASTM). It is presented annually to an author or editor of a book, paper, or standard; or series of books, papers, or standards published by ASTM. The technical publication should make an outstanding contribution of widely recognized impact on a particular field of interest to the society.

Mittal has a BSc from Panjab University in Chandigarh, India, an MSc from the Indian Institute of Technology in New Delhi and a PhD from the University of California. Before joining IBM in 1972, Mittal served as a postdoctoral research scientist in New York.

In addition to authoring 34 books dealing with surface contamination and cleaning, various aspects of adhesion, polyimides, and surfactants, Mittal is the founding editor of an international journal, a worldwide lecturer and organizer of many international symposia. He also is a member of the Adhesion Society, the American Chemical Society, Electrochemical Society, Materials Research Society, Indian Science Congress Association, and the Indian Society of Surface Science and Technology.

Academy Elects New Members

The National Academy of Sciences recently elected 60 new members and 15 foreign associates from nine countries in recognition of their distinguished and continuing achievements in original research. Being elected a member is considered one of the highest honors that can be accorded a U.S. scientist or engineer.

Among the newly elected members were three MRS members: Esther M. Conwell, research fellow at Xerox Webster Research Center; John W. Hutchinson, Gordon McKay Professor of Applied Mechanics at Harvard University; and Richard S. Stein, Charles A. Goessmann Professor of Chemistry at Polymer Research Institute. C.N.R. Rao, director at the Indian Institute of Science and another MRS member, was one of the 15 foreign associates elected to the Academy.

Davis Named NSF's Waterman Award Recipient

Mark E. Davis, a professor of chemical engineering at Virginia Polytechnic Institute and State University, recently received the National Science Foundation's Alan T. Waterman Award, which is presented to one outstanding young researcher in science, mathematics, or engineering. Davis received the award on May 10 at a formal dinner ceremony at the Department of State.

The Waterman Award, which has been given annually since 1976 in honor of Dr. Alan T. Watterman, NSF's first director, awards honorees with grants of up to $500,000 for three years of scientific research at an institution of his or her choice.

Davis was chosen for his work in synthesizing "molecular sieves" with microscopic pore sizes. These sieves, made of crystalline material that looks and feels like clay, have applications in the synthesis of petrochemicals, and have potential uses in the purification of drugs.

In 1987, Davis's research group reported success in synthesizing molecular sieves with larger pores sizes than had ever been achieved. The sieves have pores about 50% larger than any previously created, and may in the future allow a higher yield of gasoline to be obtained from a barrel of oil.

In addition, last year Davis' group developed a new technique for speeding up reactions using catalysts, which Davis believes will be applied in the manufacture of agricultural chemicals, pharmaceuticals, and other specialty chemicals.

Davis has bachelor's, master's and doctoral degrees in chemical engineering from the University of Kentucky. He is currently an NSF Presidential Young Investigator and has won many awards for his scientific contributions. Last year alone he received the American Institute of Chemical Engineers' Allan P. Colburn Award for Excellence in Publications by a Young Member of the Institute; the International Zeolite Association's Donald Breck Award for the Most Significant Contribution to Molecular Sieve Science, 1986-1988; and the Union Carbide Innovation Award, for academic achievements in catalysis. Davis, an MRS member, will be conducting a symposium entitled "Synthesis/Characterization and Novel Applications of Molecular Sieve Materials" at the 1991 MRS Spring Meeting.

Real-Time Atomic-Level Imaging Uses CCDs and X-Rays

A method for taking ultrafast x-ray diffraction images of materials under stress, which opens the way for a new understanding of their atomic structure, has been developed in a joint collaboration with scientists and researchers from three U.S. organizations.

Scientists at the Argonne National Laboratory along with researchers at the University of Michigan and AT&T's Bell Laboratories used a charge-coupled device (CCD), that was treated to withstand continuous x-ray bombardment, as the image detector. Specially designed circuitry enables it to retrieve data in 25-millionths of a second—the fastest performance ever obtained in this kind of study.

The ultrafast resolution time of the CCD will be used in conjuction with the extremely powerful x-ray beams that can be produced by Argonne's new Advanced Photon Source (APS) to permit studies of material formation and deformation that were not possible before. Fracture and dislocation strains in high-strength materials can be observed on the atomic level as they occur, and stresses often created as new materials are formed can be watched in real time, again on the atomic level.

The performance of the new CCD imaging system was recently tested in an experiment on the Bell Labs x-ray beam line at the National Synchrotron Light Source at Brookhaven National Laboratory on Long Island.

Army Announces GaAs MOCVD Consortium

The U.S. Army Electronics Technology and Devices Laboratory (ETDL) has announced the formation of a government/industry/university consortium to investigate aspects of compound semiconductor metal organic chemical vapor deposition (MOCVD) technology. The two principal objectives of the consortium are: (1) to improve the MOCVD growth of advanced high-speed electronic devices such as high electron mobility transistors (HEMTs) which are important for various military systems and will also have commercial applications; and (2) to develop a less hazardous MOCVD process which utilizes liquid replacements for the toxic compressed gases, arsine and phosphine.

The consortium is comprised of four member organizations: ETDL, EMCORE (Somerset, NJ), American Cyanamid Company (Wayne, NJ), and Polytechnic University (Brooklyn, NY). Besides overall program coordination, ETDL will be responsible for materials characterization, device fabrication, and evaluation. EMCORE will carry out the MOCVD thin-film growth, and American Cyanamid will provide the MOCVD precursor chemicals, particularly the TBA (tertiarybutylarsine) and TBP (tertiarybutylphosphine), the less hazardous liquid replacements for the toxic gases. Polytechnic University will carry out basic investigations into the MOCVD process, including mechanisms and modeling, utilizing these chemical sources.

ETDL is currently monitoring the Army's gallium arsenide microwave/millimeterwave integrated circuit (MIMIC) programs. The roles of MOCVD and molecular beam epitaxy (MBE) for the production of devices, particularly HEMTs, are being actively debated. Key issues include enhancing the quality and uniformity of MOCVD devices while significantly reducing the processing hazards represented by the toxic gases.

"We are hopeful that the outcome of the

Robert N. Noyce, a pioneer in the electronics industry and president and chief executive of Sematech, died June 3, 1990 in Austin, Texas after suffering a heart attack at his home. He was 62 years old.

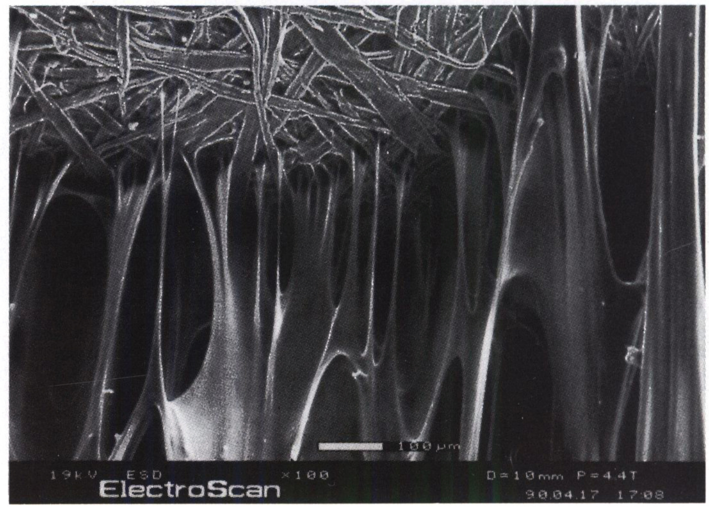
Recognized as the "instrumental figure in creating the semiconductor industry," Noyce was one of the inventors of the integrated circuit. Working separately, Jack Kilby of Texas Instruments is also credited with inventing the integrated circuit. Noyce was co-founder of the Silicon Valley's first successful semiconductor company, Fairchild Semiconductor Corp. He also founded Intel Corporation and was a noted spokesman and lobbyist for the electronics industry.

At Grinnell College, Iowa, where he earned a bachelor's degree, Noyce studied solid state physics under Grant O. Gale, who in 1948 was given one of the first transistors by one of its inventors, John Bardeen. After receiving a doctorate in physics from the Massachusetts Institute of Technology in 1953, Noyce joined the Philco Corporation and then the Shockley Semiconductor Laboratory, leaving in 1956 to help found Fairchild Semiconductor Corp. In 1968, Noyce and Gordon E. Moore, started Intel Corporation. At the time of his death, Noyce was the president and chief executive of Sematech Inc., a research consortium funded by the Department of Defense and 14 corporations to help the U.S. computer industry regain its worldwide market position. Noyce believed strongly that such a cooperative effort would greatly benefit the United States and explained his outspoken views during a plenary address at the 1989 MRS Fall Meeting in Boston (see the text of his address on p. 4-7 in the May 1990 issue of the *MRS BULLETIN*).

A member of the National Academy of Sciences, National Academy of Engineering, and American Academy of Arts and Sciences, Noyce held 16 patents for semiconductor devices, methods and structures, and received extensive honors for his work.

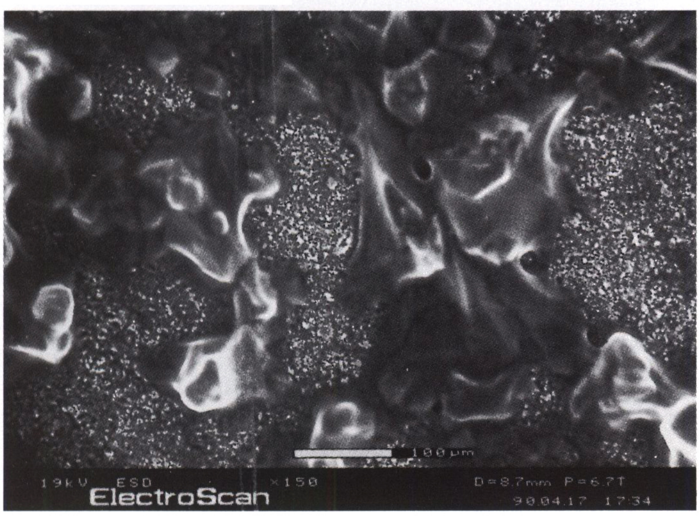
Problem: ADHESIVES

How do you evaluate the microscopic dynamics of adhesion, absorption, contamination and other characteristics of surfaces coated with soft, wet, outgassing materials? Are you unable to use the SEM due to its rigid vacuum requirements? If you can, does the observation of non-conductive, irregular specimens present a problem due to charge-up under the beam? Are you unable to perform good elemental analysis under low kilovoltage beam conditions? Are you forced to rely on before-and-after inspection because there is no way to observe dynamic processes as they occur?



Adhesive label being removed from paper.

Spray adhesive on fax paper.



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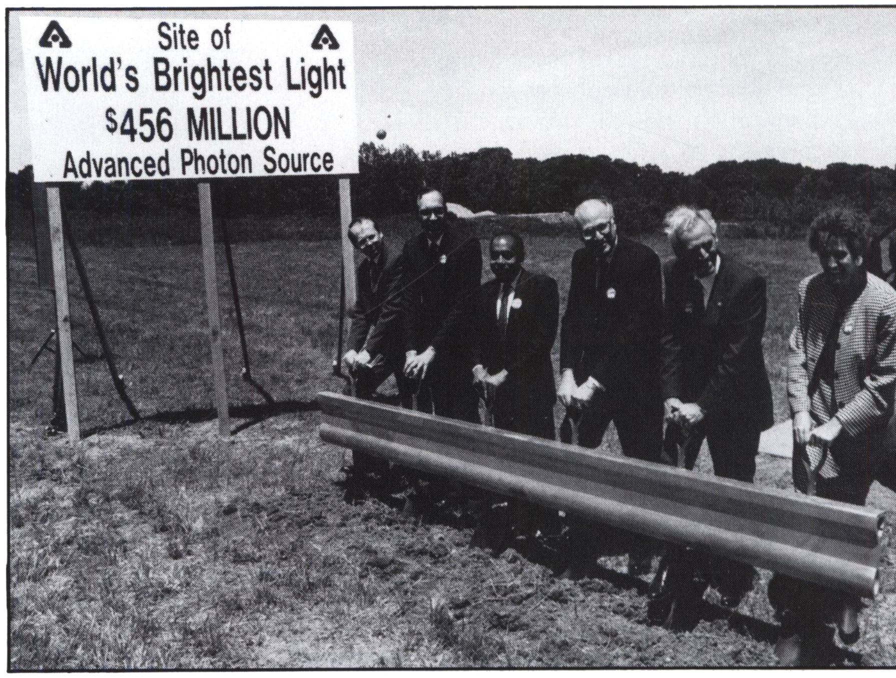
consortium's activities will feed directly into supporting the MIMIC program," said Dr. Kenneth Jones, consortium coordinator at ETDL. "The Japanese have recently demonstrated large-scale MOCVD growth of HEMT structures as well as the potential performance and safety benefits of using TBA in this process. We feel that we can become competitive with our consortium's collaborative approach."



Ground is broken for APS by (left to right): David Nelson, David Moncton, Prof. Walter Massey, Alan Schriesheim, Rep. Harris Fawell, and Rep. Lynn Martin.

Ground Broken for Construction of $456 Million Advanced Photon Source

Argonne National Laboratory Facility to be Completed in 1995

Construction of the $456 million Advanced Photon Source at Argonne National Laboratory officially got under way on June 4 when ground was broken at the future site of the new facility. The APS, the nation's largest federal science project to formally begin construction in 1990 and the largest federal construction project in 25 years for Illinois, is expected to be completed by 1995.

The facility is expected to employ 375 full-time staff and host an estimated 1,000-1,200 visiting scientists each year who will take advantage of the x-ray source's ability to study crystals as small as one micron.

As a gesture to recognize the cooperative spirit of industry, government and academia in establishing the facility, ground was broken jointly by David Nelson, executive director of Energy Research, U.S. Department of Energy; David Moncton, associate laboratory director for APS; Prof. Walter Massey, University of Chicago vice president for research and for Argonne National Laboratory; Alan Schriesheim, director of Argonne; and Reps. Harris Fawell (R-IL) and Lynn Martin (R-IL). Speakers at the ceremony attended by over 500 people included Prof. Steve Durbin (Purdue University), vice chairman of the APS Users' Organization Steering Committee, and Senator Alan Dixon (D-IL).

U.S. Industrial Competitiveness to Benefit

Because of its potential to contribute to U.S. competitiveness, the APS attracted more industrial participation in its planning stages (begun in 1984) than any basic research facility ever built in the United States.

"It is clear that understanding of complex materials is central to maintaining our high-technology society," said David Moncton. "So much of our technology de-

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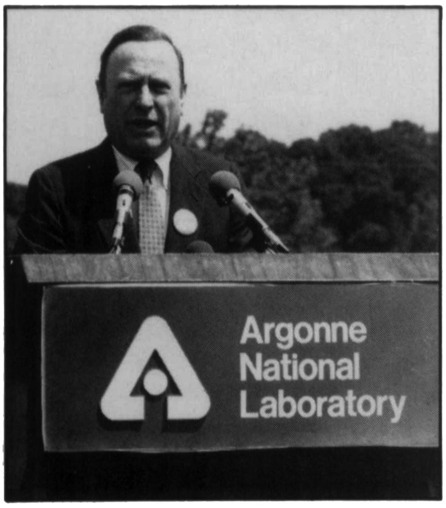
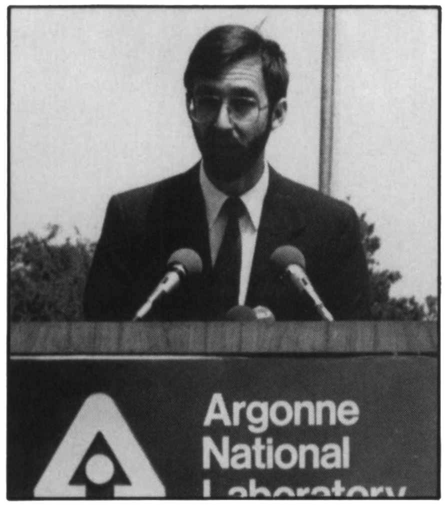


Senator Alan Dixon speaks at APS groundbreaking ceremonies.



Prof. Steve Durbin addresses attendees at APS groundbreaking ceremonies.

pends on our ability to manipulate materials and develop new uses for them—coatings for magnetic tapes, thin layers of solid-state circuitry, metals and plastics that display strengths and properties well outside their long understood and accepted ranges, drugs that beneficially alter the body's functions.... Synchrotron radiation research has played a central role in these exciting discoveries, and the APS will provide science with the tools that will make possible the next steps."

Some research activities anticipated to be conducted at the facility are studies of catalysts that could lead to more efficient and productive chemical and industrial processes, studies to improve ways of growing semiconductor crystals, development of light-weight, high-strength materials for aerospace applications through more detailed studies of the structure of polymers,

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development of stronger steels through studies of structural changes that take place during heat treatments, studies of physical and chemical properties of materials under geological temperatures and pressures, and studies of high-temperature superconductors.

69 Beam Lines, Annual Operating Budget to $85 Million

The facility will house 69 experimental beam lines. The large storage ring, with an anticipated average energy of 7 billion volts (maximum capability is 8.5 billion volts) will be divided into 40 straight and 20 curved sectors along its 1,214-yard circumference.

Six of the straight sectors will be taken up by control and testing equipment. Each of the remaining 34 sectors will contain one undulator which will produce the x-ray beams. Bending magnets in these sectors will provide an additional 35 beam lines for experimentation, for a total of 69.

Other equipment will include a 34-yard long accumulator (to bunch positrons), a 7-billion volt booster synchrotron 405 yards in circumference, a 450-million volt linear accelerator 64 yards long, and 1,503 magnets to control the beams (1,108 of which will be located in the large storage ring).

Users are expected to spend several hundred million dollars in building their beam line stations. The estimated annual operating budget is $70-$85 million.

Engineering Innovations

The design of the APS required several innovations to solve a number of technical problems. One problem was how to keep the crystal used to diffract the x-ray beams from flexing. When the x-ray beam comes out of the storage ring, its temperature is about that of the surface of the sun. Only a small fraction of the energy is diffracted off the single large silicon crystal and the rest of the heat is absorbed by the crystal. This amount of heat is enough to cause the crystal to bend and throw off the aim of the diffracted beam.

To keep the crystal flat, two rows of parallel holes are drilled through the crystalline block, and liquid gallium is pumped through the holes at two different temperatures. The liquid gallium pumped through the upper row of holes is used to cool the surface of the crystal, and the higher temperature gallium pumped through the bottom row of holes causes the crystal to bend in the opposite direction from the bowing caused by the heat from the x-ray beam. When the temperature difference and flow rates are controlled exactly right, the two forces offset each other and the crystal remains flat. □

Artist's rendition of APS facility targeted for completion in 1995.

APS: The World's Brightest Light

Excerpts of Remarks by David Moncton at the Groundbreaking Ceremony for the Advanced Photon Source

The APS construction will be completed in 1995, the centennial year of the discovery of x-rays by Wilhelm Roentgen. The APS represents a trillion-fold increase in x-ray beam brilliance over Roentgen's tube, which was itself such a monumental achievement of technology that it remained unsurpassed for 75 years. In the 20 or so years that scientists have pursued accelerator-based x-ray production, the rate of increase in x-ray beam brilliance has been about a factor of three per year.

This pace, which has accumulated to account for the trillion-fold improvement, makes the growth in computer technology (a mere ten-thousand-fold increase in power over the same 20-year period) look like a snail's pace by comparison.

But the technology for x-ray production is only half the story: the tremendous breadth of applications of APS beams crosses over all fields of scientific and technological inquiry where the goal is to understand the way atoms organize themselves to form materials, from semiconductors to catalysts and from the double helix of DNA to the AIDS virus. A single machine has never been built with as broad a mission as the APS.

But that mission is broad in another dimension which is less often recognized, but equally important. That other mission is the time scale for the return on taxpayers' investment in the APS. From the minute the APS turns on, scientists from a cross section of U.S. companies will begin to undertake measurements, many of immediate value to their respective industries and to the technologies that underlie their products. But equally strong representation will come from scientists pursuing very profound questions as important to mankind's understanding of the physics of matter as any other research project currently under way in the world.

The results of this research are not known today—they cannot even be forecast today—but with the history of condensed matter physics behind us, and the role of x-ray research in that history, I believe this machine will leave a research legacy which will impact life well into the next century.

So part of this return on investment will be virtually immediate, five years or so, and a very important part of the return will be spread over time scales much greater than five years. Perhaps, like Roentgen's original invention, the impact of this machine will still be felt 75 years from now.

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