Europhysics Letters to Begin Publication in 1986

A new journal incorporating *Lettere al Nuovo Cimento* and *Journal de Physique Lettres* is slated to publish its first issue in January 1986. Organized and managed by the European physics community, the bimonthly *Europhysics Letters* will be published by a partnership composed of the European Physical Society, French Physical Society, Italian Physical Society, and the Institute of Physics. *Lettere* (3,000-word articles with illustrations and references) will be published in their original languages — English, French, German, or Russian.

For information about submitting manuscripts, contact Staff Editor, Europhysics Letters, European Physical Society, P.O. Box 69, CH-1213 Petit-Lancy 2, Switzerland.

For subscription information, contact Les Editions de Physique, Z.I. de Courtaboeuf, B.P. 112 — Avenue du Hoggar, F-91944 Les Ulis Cedex, France.

Charles W. Allen Joins Argonne

Dr. Charles W. Allen, formerly of the Department of Materials Science and Engineering at Notre Dame University, has joined the Materials Science and Technology (MST) Division of Argonne National Laboratory. Allen will be in charge of the high-voltage electron microscope (HVEM) in the Electron Microscopy Center for Materials Research. He will also participate in a research program involving *in situ* studies of iron irradiation of alloys in the HVEM.

The HVEM-tandem accelerator national users facility has capabilities for *in situ* electron and ion irradiation, sample temperatures from 10 K to 1600°C, as well as straining stages and environmental stages for observations under gaseous atmosphere. Allen's major task, said MST Director Frank Y. Fradin, will be to keep the facility at the state of the art and to assist numerous users from the universities, industrial research laboratories, and national laboratories.

Dr. Allen holds a PhD in metallurgy from Notre Dame University. He had been on the Notre Dame faculty since 1959. He is a member of the Materials Research Society.

Brimrose Studies Energetic Crystalline Materials

The Office of Naval Research has awarded Brimrose Corporation of America, a Baltimore-based R&D lab, $482,500 in Phase II Research funds for examination of energetic crystalline materials used both in propulsion and explosion applications. These materials typically include organic, inorganic and polymeric crystals (e.g., RDX/HMX ammonium perchlorate, aluminum, etc.) The study is based on nondestructive, noncontact, nonintrusive, and quantitative x-ray techniques for characterizing microstructural features of bulk crystalline powders. The computer-aided x-ray materials characterization methods developed and used here are greatly amenable to production-oriented environments involving remote crystal growth and characterization operations.

Some of the anticipated benefits of the Phase II contract include (1) microstructural characterization of energetic crystalline materials for improved predictability of performance; (2) improved material energetics using newly developed automated remote annealing and real time x-ray analytical tehniques; and (3) potential use of RDX/HMX in controlled propulsion.

MRC Introduces "Giant" Substrates

The Hybrid Products Division of Materials Research Corporation is now producing 6-inch-square aluminum oxide substrates of 99.6% purity. They are the largest size available in the industry, offering about twice the area of the next largest size (4¼ inches). In addition, flatnesses of the new product are available to 0.002 inch per inch camber, making them suitable for more efficient and cost-effective production of thin film circuits.

The new substrates are manufactured by a continuous tape-casting process and fired in an automatic kiln. Surface smoothnesses of less than 4 microinches can be obtained in standard, hybrid, and circuit grades. The 6-inch boards are available in thicknesses from 10 to 50 mils, and they can be further fabricated by laser machining to specified hole, slot, and size requirements.

Use of the large-area boards is foreseen in military hybrids as carriers of surface-mounted passive devices and as hermetic chip carriers. They may also have widespread use in hybrid/subhybrid combinations; i.e., electronic subassemblies made of leadless or minilead hybrids (subhybrids) surface-mounted on large substrates previously coated with thick or thin film patterns. In computer applications, these film-coated ceramics may be used to fabricate multilayer motherboards for IC chip interconnects as well as thermal printheads.

Materials Handbook Revised

Offering concise, authoritative information on thousands of specific substances, the thoroughly revised and updated 12th edition of the *Materials Handbook* by George S. Brady and Henry R. Clauser contains capsule descriptions of all the different materials likely to be encountered today in industry and engineering technologies.

The handbook examines the composition, methods of production, major properties and characteristics, uses, and commercial designations of more than 13,000 substances. Each article discusses up to 100 related materials.

The handbook uses both U.S. customary and metric (SI) units to list all quantities, weights, and measures.

Subtitled *An Encyclopedia for Managers, Technical Professionals, Purchasing and Production Managers, Technicians, Supervisors, and Foremen*, the handbook is an ideal resource for selecting, buying, or processing materials for on-the-job applications. It includes vital data on chemicals, metals, minerals, fuels, ceramics, plastics and rubbers, textiles, finishes, woods, pharmaceuticals, industrial substances, foodstuffs, and natural plant materials.

The *Materials Handbook* (ISBN 0-07--007071-7) is priced at $59.50 and is available from McGraw-Hill Book Company, 1221 Avenue of the Americas, New York, NY 10020; telephone (212) 512-3493.

Three Livermore Lab Developments Among Top 100 New Products

Three instruments developed by researchers at Lawrence Livermore National Laboratory have been named among the top 100 technical developments of the year by *Research & Development* magazine.

• The **Optical Tunneling Remote Sensor** uses a combination of fluorescent and colorimetric chemicals to improve 1,000-fold the chemical selectivity, sensitivity, and dynamic range of optical fiber sensors to the sub-parts-per-billion range. The sensor is an extension and improvement of chemist Tomas Hirschfeld's Remote Fiber Fluorimeter, which won an IR-100 award in 1981. Hirschfeld found that optical quantum tunneling was the process responsible for the sensitivity of the new optrode design. "We were doing direct transfer of energy from the fluorescer to the absorber without the light going through the normal process of being emitted and reabsorbed," said Hirschfeld. "The energy goes from one molecule to another without passing in between."

• The **High Brightness Test Stand**, invented and developed by a team led by physicist Daniel L. Birx, is a tough, compact and inexpensive million-watt electron accelerator for commercial applications ranging from food processing to sewage treatment. The six-foot-long accelerator can produce 1,000 pulses per second of electrons, each with an energy of 2 million electron-volts. The high power results from the large changes in magnetic permeability exhibited by saturating ferromagnetic materials to produce large changes in impedance. Birx's group found essentially no limitations in peak power levels and an efficiency approaching 90%. They also found that repetition rates are set by primary switch recovery and that reliability approaches that of a power line transformer.

• The **Transmission Grating Streaked Spectrograph with an Ellipsoidal Mirror** (TGSS-EM) is a very sophisticated, highly specialized diagnostic instrument to detect and characterize the output of an experimental x-ray laser. Co-inventors are physicists Nat Ceglio, Hector Medecki, and Bob Kauffman. The three key elements to the TGSS-EM are an *ellipsoidal* x-ray mirror, an x-ray transmission grating, and an x-ray streak camera. The ellipsoidal mirror collects and images the x-rays emitted by the x-ray laser. The mirror's large size, four inches in diameter, makes the instrument very sensitive. The transmission grating spreads out the x-rays according to their different wavelengths. The grating is composed of a series of gold bars, each 1,000 Å wide and separated from one another by 1,000 Å. The streak camera records the pattern of x-ray wavelengths as they occur over a very short period of time. It records the time history of the x-rays with a resolution of 20 trillionths of a second.

New Polymer Conducts Protons at Room Temperatures

In a development that could have a major impact on battery, fuel cell, sensor and other technologies, researchers for Allied-Signal Inc. have created a polymer that conducts protons at room temperatures. The new polymer — a blend of polyvinyl alcohol and phosphoric acid — supports proton conduction from about -40°C to +40°C, making it ideal for many applications previously ruled out because of the need for higher temperatures (70-200°C and even higher). These applications include smaller, much more efficient batteries and fuel cells, and microsensors that could efficiently analyze a range of hydrogen-containing materials, from oil, gases, and chemicals to soil samples and blood.

"Not only may this be the best room temperature proton-conducting polymer, it's probably the best ionic-conducting polymer known," according to Anthony Polak, research scientist who led the work. Its conductivity is not as high as the best solid inorganic ionic conductors, such as rubidium silver iodide, but its ability to operate at room temperature, its flexibility, and its accuracy as a hydrogen sensor are key advantages. Said Polak, "We can tailor the conductivity from a thousandth to a millionth of an ohm centimeter at room temperature. As a hydrogen sensor, it is accurate to within one percent. And it is accurate from very small concentrations of hydrogen measured in parts per million to concentrations greater than atmospheric pressure."

To better understand how protons move through the polymer, and thus improve its physical properties, researchers are using several techniques, including computerized molecular modeling and solid-state nuclear magnetic resonance in cooperation with the University of Illinois. They also plan to start a small-angle neutron scattering program with the National Bureau of Standards.

ACS Offers New Publications on Polymers

The American Chemical Society (ACS) is offering several recently published books on various aspects of polymers and applied polymer science. These books are all part of different ACS Symposium Series. For more information, contact ACS Distribution Office, Dept. 390, 1155 Sixteenth Street N.W., Washington, D.C. 20036; telephone (202) 872-4600; telex 440159 ACS PUI. U.S. customers can call toll free (800) 424-6747.

• **Applied Polymer Science (2nd Edition)**, edited by Roy W. Tess and Gary W. Poehlein; ACS Symposium Series No. 285, 1,342 pages, ISBN 0-8412-0891-3.

This new edition has been extensively revised to include overviews and definitions of polymer terms, to cover previous omissions, and to explain new developments. Topics include polymerization and its mechanisms; physical phenomena of polymers; polymer products and their uses; and plasticizers, solutions, and solvents. Various aspects of coatings are also discussed.

• **Polymer Wear and Its Control**, edited by Lieng-Huang Lee; ACS Symposium Series No. 287, 422 pages, ISBN 0-8412-0932-4.

Twenty-six chapters cover polymer wear mechanisms and controls; tribological behaviors of polymers; biomaterials, and polymer composites; characterization and measurement of wear; and degradation and wear of films and filaments. Chemists, tribologists, and engineers will find an up-to-date survey of scientific aspects of polymer wear phenomena and the promising outlook for controlling such wear.

• **Materials for Microlithography: Radiation-Sensitive Polymers**, edited by L. F. Thompson, C. G. Wilson, and J.M.J. Fréchet; ACS Symposium Series No. 266, 496 pages, ISBN 0-8412-0871-9.

This 24-chapter volume provides an in-depth review of the physics and chemistry involved in working with radiation-sensitive polymers at the heart of the new technologies, from radiolysis, laser-induced polymerization, and polymer degradation by high-energy radiation to resist materials and applications. Invited experts provide three introductory chapters, making the book a solid introduction to the practical and fundamental aspects of lithography.

• **Materials Science of Synthetic Membranes**, edited by Douglas R. Lloyd; ACS Symposium Series No. 269, 494 pages, ISBN 0-8412-0887-5.

This 21-chapter book is devoted to the materials science aspects of synthetic membranes. The first chapter provides an overview of membrane materials science. Subsequent chapters cover (1) membrane *material selection and evaluation*; (2) membrane formation, modification, and production; (3) membrane characterization; and (4) specific applications. Membrane scientists will find the book an excellent review of the materials science aspects of synthetic membranes, and they will benefit from the discussions of current research efforts and evaluations of the state-of-the-art in membrane materials science. This book is also a useful guide to membrane selection and evaluation.

Direct Capacitance Measurements Can Aid Design of Advanced ICs

A capacitance measurement technique that could play a key role in the reliable design of new integrated circuits (ICs) with features that are less than one micron (4/100,000ths of an inch) in diameter has been perfected at Sandia National Laboratories. The new techniques can directly probe capacitance in very large-scale integrated (VLSI) circuit transistors.

Developed by Kyle White, the technique is 1,000 times more precise than standard benchtop capacitance measurements. Identified values are in the femto-farad range (10^{-15} farads). It uses standard semiconductor facility equipment and test key structures, eliminates the expense of making wafer test dies, and performs at 1 MHz. These advantages could make it the industry standard as it becomes known.

VLSIs with submicron features contain substantially more than 100,000 transistors on a fingernail-size chip. They are expected to become computer workhorses in the 1990s. Designers, however, require clear, reliable understanding of capacitance in order to insure the ultra-precise circuit timing critical on ICs with such small features and so many signal paths. White's technique both shows and eliminates inaccuracies (especially from edge effects) in current methods of measurements.

A flat circular probe card is lowered over a standard five-inch-diameter wafer with ICs and test transistors on it. The two disks are aligned so that thin pin-like probe tips touch the wafer on pads of a test transisitor.

The two disks form a micro-Faraday cage, a conductive "box" that shields its contents from outside influences. The probe card attaches directly to a switch matrix and then to a Hewlett Packard 406A semiconductor parameter extraction setup which features a super-sensitive capacitance meter. Special procedures including exhaustive signal averaging, background capacitance canceling, and AC and DC biasing of adjacent features are used to determine capacitances between transistor elements and between IC interconnections — gate, drain, source, and p-well, for example. The unique physical setup and precise test procedures insure that spurious information and external capacitances down to the femto-farad level, both of which would compromise results, are filtered out.

Cornell's Electronic Materials Major is a First

Cornell University has established a new course of undergraduate study — the first of its kind in the United States — that combines the high-technology fields of electrical engineering and materials science.

According to Arthur L. Ruoff, director of the Materials Science and Engineering Department at Cornell, the new electronic materials major will expose undergraduate students to the latest research in fabricating and packaging electronic devices. "The joining of these two fields is essential if the United States hopes to regain its leading position in the semiconductor field," Ruoff said. "Just as we need increased university, industry, and government cooperation in scientific and engineering research to improve the quality of our manufactured products and the efficiency of their production, we also need new and imaginative education programs to meet the growing electronic and computing needs of the information society," he said.

The new program, based in Cornell's College of Engineering, is being administered by John M. Blakely, associate director of undergraduate studies in materials science and engineering, and by Benjamin Nichols, associate director of undergraduate studies in electrical engineering.

Five students who completed the course requirements for the new major before the program was formally adopted graduated in June 1985 with double-major BS degrees in electrical engineering and materials science. About 12 students are expected to graduate with the double-major degree this spring. No new courses were created for the program, but students participating in the new dual-major must study a core curriculum that emphasizes mathematics, chemistry, physics, computing, engineering distribution, materials science, electrical sciences, and probability and statistics. The dual-major can be completed within the typical eight semesters of full-time study. "It has always been possible to major in one field and take several electives from the other," said Ruoff. "This new program, though, allows students to graduate as fully qualified electrical engineers and as materials science engineers."

"These students are attractive to companies seeking traditional electrical engineers, typical materials scienctists, and those with extensive knowledge in both areas," stated Ruoff.

The growing demand for more powerful, efficient, and smaller chips had placed an equally growing demand for scientific specialists with a knowledge of both high-tech materials and electronics. Explained Ruoff, improvements in both electrical interconnection techniques and the use of new materials will be needed for the ICs of the future.

"An electrical engineer whose curriculum stresses circuit and transistor design theory receives surprisingly little instruction on the processes and materials used to form an integrated circuit," said Ruoff. "The curriculum in the new program covers basic electrical design and solid state theory. . . . We are training the type of student that industry wants and needs."

Light Mass Holes Measured in SLS Material

Measurements completed at the Sandia National Laboratories suggest that it may be possible to make strained-layer superlattice (SLS) semiconductor devices that will operate much faster and at lower power than those made from silicon or bulk gallium arsenide (GaAs).

The recent measurements showed for the first time the presence of light mass holes (lightweight, high-speed positive charge carriers) in specially prepared samples of GaAs/InGaAs SLS material. Light holes are required in combination with light electrons if high-speed, low-power complementary logic devices are to be developed.

"We are planning to use this effect to demonstate the feasibility of fast-switching low-power devices," said Roger Chaffin, manager of Sandia's Device Research Department. "Power consumption becomes more important as the electronics industry increases the number of transistors it can put on a chip," he added. "If there are one million transistors on a chip, a power dissipation of one milliwatt per transistor is equivalent to 1,000 watts overall. "

Sandia researchers confirmed that the internal strain in SLS semiconductors alters the material's electronic band structure, allowing conduction by light holes. Holes in electronic devices made with conventional GaAs have a nominal mass of 0.5 (where 1.0 represents the mass of a free electron). In the light-hole InGaAs/GaAs SLS material, the active holes typically have a mass of 0.12-0.17. The electrons have a mass of about 0.07 in GaAs and 0.26 in silicon. The effective mass of holes in silicon is 0.5.

Advanced Research on Sodium/Sulfur Battery

Sandia National Laboratories and Chloride Silent Power Limited (CSPL), Runcorn, U.K., have signed a three-year, $8.5 million contract calling for further development of a sodium/sulfur advanced battery system. Sandia's part of the contract falls under the U.S. Department of Energy's Battery Exploratory Technology Development and Testing (ETD) Project, for which Sandia is the lead laboratory. CSPL is jointly owned by Chloride Group PLC, a worldwide organization dedicated primarily to the development and manufacture of rechargeable batteries and related products, and the U.K. Electricity Council. Sandia will supply program management and technical support, including in-house research; CSPL will perform the bulk of the engineering work.

Also known as the "beta battery" because it uses a unique ceramic electrolyte, the sodium/sulfur battery is a leading candidate for an advanced energy system capable of meeting the requirements imposed by both stationary and mobile applications. This system, which operates at 350°C, can store three to four times more energy per unit of weight than conventional lead-acid batteries.

Besides the development of the core technology for stationary and mobile power applications, the contract also calls for the engineering of a battery for stationary energy storage. Researchers plan to design a subscale 50-kWh battery that will contain cells of the same design and size as those of a full-scale 500-kWh unit to be built under an anticipated additional contract between CSPL and the Electrical Power Research Institute. Two subscale units should be built by 1988, one for testing by CSPL and one for independent testing at a laboratory to be designed by Sandia. Plans call for the full-scale 500-kWh unit to be delivered to the Battery Energy Storage Test facility in Hillsboro, New Jersey, in 1990.

Jacob Hanker Cited One of "Top 100" by Science Digest

Jacob S. Hanker, professor of oral and maxillofacial surgery and bioengineering at University of North Carolina, Chapel Hill, was designated one of *Science Digest's* "Top 100" Innovators of 1985. The December issue of *Science Digest* applauds Dr. Hanker's work in developing a permanent, biocompatible substitute for bone. Dr. Hanker was principal investigator in the development of the artificial bone made of a mixture of fired ceramic particles of hydroxylapatite and plaster of paris.

During the past year, the material has been used to improve the jaw function of more than 25 patients, and Hanker foresees use of the material to repair skull fractures and spinal-column defects, and for some cosmetic surgery.

Hanker's work is funded by the U.S. Naval Medical R&D Command and in part by the USG Corporation.

Hanker reported on his work at MRS's first symposium on Biomedical Materials (Symposium G) at the recent MRS Fall Meeting in Boston. His paper, "Composite Plaster/Hydroxylapatite Intraosseous Implants," was co-authored by Bill C. Terry, Myron R. Tucker, Beverly L. Giammara, and Reynolds A. Carnevale, all from the University of North Carolina, Chapel Hill.

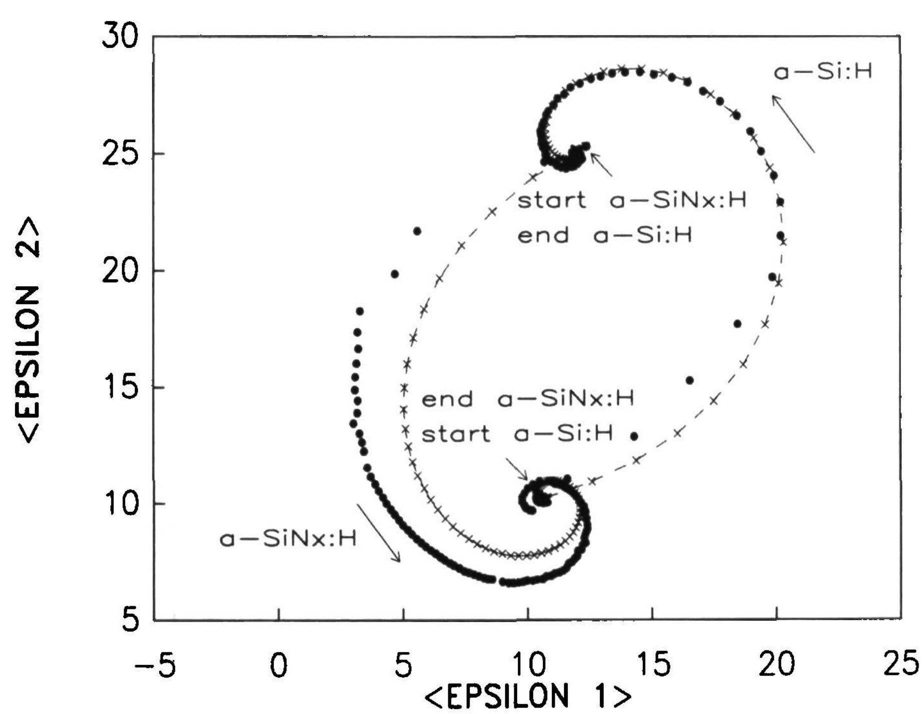
Osbourn Receives E. O. Lawrence Award

Gordon C. Osbourn, Sandia National Laboratory, is one of the nine individuals to receive a 1985 E.O. Lawrence Award by the U.S. Department of Energy.

Osbourn was cited "for his work in the field of strained-layer superlattices. . . (and) the first theoretical calculations predicting their unique electrical and optical properties." Osbourn was the first to propose that useful and optical properties could be obtained from superlattices made from thin mismatched semiconductors, and he predicted a series of these properties. In 1982 he proposed that the band gap and lattice constant of a strained-layer superlattice could be independently varied; he suggested that the inherent strain could be used to reduce the band gap of certain infrared strained-layer superlattice materials. He predicted new direct-band-gap semiconductors that could be fabricated from indirect-band-gap layered materials. In addition, he proposed in 1984 that inherent strain could be used to reduce the effective mass of holes. Osbourn, a division supervisor at Sandia since 1983, was co-organizer of the 1985 Fall Meeting symposium on Layered Structures and Epitaxy with J. M. Gibson and R. M. Tromp.

EDITOR'S CHOICE

(Figures appearing in the EDITOR'S CHOICE *are those arising from materials research which strike the editor's fancy as being aesthetically appealing and eye-catching. No further criteria are applied and none should be assumed. Submissions of candidate figures are welcome and should include a complete source citation, a photocopy of the report in which it appears (or will appear), and a reproduction-quality original drawing or photograph of the figure in question.)*



The EDITOR'S CHOICE for this issue of the **BULLETIN** comes from R. W. Collins of the Standard Oil Company Research Center, Cleveland, Ohio, USA. It traces the evolution of the complex (pseudo-) dielectric function, measured by optical ellipsometry, as sequential layers of amorphous silicon:hydrogen and amorphous silicon nitride are deposited. The broken line is a prediction which assumes sharp interfaces and fixed optical constants throughout the thickness of the films. A full report of this work will be published in the Proceedings of the Conference on Amorphous Semiconductors for Microelectronics (SPIE Conference No. 617, January 21-22, 1986, Los Angeles).

SHORT COURSE

Transmission Electron Microscopy of Materials
June 9-13, 1986
Massachusetts Institute of Technology
Cambridge, MA

The purpose of this short course is to present a comprehensive view of modern electron microscopy with an emphasis on transmission methods. The course comprises both lectures and laboratory exercises which provide the background and training necessary to bring the beginning microscopist to state-of-the-art practice. The laboratory sessions will treat manipulation of the instruments, information to be gained from diffraction patterns, bright-field and dark-field microscopy, and microanalysis. Examples will be drawn from the areas of metals, ceramics, semi-conductors, and polymers.

This short course will be of interest to industrial personnel engaged in microstructural analysis for research, development, or quality control purposes. In addition, the course may be of interest to university researchers, students, staff, or faculty who wish to be made aware of current developments in electron microscopy. It can also serve as an effective introduction to a more advanced course on analytical electron microscopy.

Application forms are available from: The Director, Summer Session, MIT, Room E19-356, Cambridge, MA 02139; or from Professor Linn Hobbs, (617) 253-6835.