Sandia Scientists Observe Transistor Failure Mechanism on Television

Tests at Sandia National Laboratories' Center for Radiation-Hardened Microelectronics are producing the first live TV pictures of silicon chip transistors as they experience a potentially catastrophic surge in current called snapback. If left uncorrected, snapback can ruin the integrated circuit (IC) contained on the chip.

The pictures show a 1/100th-inch-square portion of a quarter-inch-square IC. During snapback, microscopic transistors appear as short bright lines on an infrared TV image. The brightness is caused by high-energy electrons flowing through the transistor

Snapback attacks n-channel metal oxide semiconductor (MOS) transistors. Some microelectronics experts believe that without proper planning and understanding, snapback could become a problem for the next generation of extremely small ICs, which will have individual features of 1.5 microns or less.

Snapback occurs only if two conditions are present: (1) the transistor must be operating at or above a certain voltage, called the snapback voltage, and (2) an initiating event (for example, weapon-produced x-rays or simple static electricity that can occur during wafer testing) must trigger snapback by producing an over-abundance of electrons in a transistor.

If allowed to continue, this excessive current can melt metal wires that connect an IC to its ceramic package or metal wires that interconnect all devices on an IC. Snapback also can cause electromigration, which can lead to short or open circuits in ICs.

Snapback is triggered in the Sandia experiments by raising a test IC's power supply voltage above the snapback voltage, then shining a microsecond-pulse of laser light on selected portions of the IC.

Sandia's computer-controlled snapback test setup includes a 750-watt pulsed xenon laser (typically used for cutting metal and polysilicon lines on ICs, but used here to simulate the snapback triggering event), an automated probe station (typically used for obtaining a variety of electrical measurements on wafers), an infrared microscope TV camera and monitor, and appropriate voltage and current measuring instruments.

The nondestructive testing involves carefully positioning a wafer with many ICs on the probe station, powering up an IC above the snapback voltage, and pulsing the laser. The pulse deposits enough energy on a 10-micron-square region of the IC to initiate snapback, thus permitting the minimum voltage required for sustained snapback to be measured."In order to understand the snapback mechanism for a particular IC, we've determined that it is necessary to individually excite each transistor that is susceptible to the phenomenon," Jerry Soden, of Sandia's IC Process Development & Failure Analysis Division, said. "This had never been attempted before."

Use of the TV camera and monitor also is unique because it provides a real-time picture of transistor snapback behavior on a chip.

NKK Produces Sialon/Boron Nitride Composite for Commercial Use

NKK (Nippon Kokan) has commercially produced a fine ceramic sialon and boron nitride composite by a reaction sintering process in which the base metal powder is lightly pre-sintered, followed by machining and a nitride reaction at high temperatures.

Minoru Hashimoto, president of NKK America, Inc., the company's U.S. subsidiary, said that this was the first time the reaction sintering process had been used with these materials, and that machining costs were cut to one-tenth that of the conventional process.

The process does not produce any significant volume change and permits the production of ceramic structural parts of complicated shapes where high precision is essential.

Sialon is composed of silicon, aluminum, oxygen and nitrogen. While NKK has applied the reaction sintering process to silicon nitride, the company originally found it difficult to achieve uniform sintering and minimal firing shrinkage with sialon/boron nitride because of the alumina, silica and/or boron nitride aspects. But according to Mr. Hashimoto, NKK solved the problem in a research project, in collaboration with Kyushu Institute of Industrial Science and Technology. NKK is now working jointly with Tokyo Yogyo Co., Ltd., in the commercial application of the product.

The new composite features excellent toughness and oxidation resistance. It also demonstrates higher corrosion resistance than reaction-bonded silicon nitride for ordinary stainless, and Cr-Mo steel and is expected to be widely used for process parts such as nozzles which come into direct contact with molten steel and high-temperature heating furnace parts.

In particular, the sialon and 10% boron nitride composite has exhibited a high thermal shock resistance value of 600°C in water immersion tests.

Sialon has been conventionally produced through normal sintering or hot pressing, which produce ultra-high strength and hardness, but necessitate costly grinding to finish the material into net shapes. In the reaction sintering process, machining is nearly completed in the metallic state.

Papers Sought on Laser-Induced Molecular Physics at Surfaces for Journal of the Optical Society of America

A feature issue of the *Journal of the Optical Society of America, Part B* [*JOSA B*] on "Laser-Induced Molecular Physics at Surfaces" is scheduled to appear in late Fall 1986. Manuscripts should be submitted to the feature editor, Thomas F. George, 239 Fronczak Hall, State University of New York at Buffalo, Buffalo, NY 14260.

This feature issue will cover experiments and theory, with the main focus on the physics of molecules at gas-solid interfaces. Both dynamics and spectroscopy will be addressed, including the following topics: cw-laser and pulsed-laser excitation of adspecies-surface systems, laser-induced desorption, laser-induced chemical vapor deposition, laser-induced chemical reactions at surfaces, nonlinear optical effects at surfaces, surface waves, and laser-grating interactions and related problems in molecular physics. The types of surfaces (both smooth and rough) include metals, semiconductors, insulators and electrodes.

NSF Center for Composites Established at University of Delaware

The National Science Foundation has selected the University of Delaware as the location for a new Center for Composites Manufacturing Science and Engineering. The five-year NSF award will total $7.5 million. The Center will be headed by Byron R. Pipes, professor of mechanical and aerospace engineering.

With an affiliate program in ceramics at Rutgers University, the Delaware center will extend the scope of an existing smaller Center for Composite Materials to focus on cross-disciplinary engineering research and training on composites manufacturing. The center will focus on fundamental research issues which are barriers to the growth of the composites industry. Research will concentrate on polymer and metal matrix composites with an additional effort on ceramic-ceramic composites—processing, synthesis, modeling and testing.

Center for Fiber Optic Materials Research Established at Rutgers University

The Center for Fiber Optic Materials Research was formed recently at Rutgers University, serving as the nation's first cooperative program among the university, industry, and the state and federal governments for conducting fundamental research

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into the science and technology of materials used in the rapidly growing field of fiber optics. The three objectives of the center are: to conduct fundamental research of generic value on fiber optic materials which will benefit the entire industry; to provide a formal educational program in fiber optic materials; and to establish a forum for exchange of ideas among scientists and engineers.

Current plans for the center call for joint industrial, academic and military support for research in five major scientific glass fiber areas: stoichiometry, structure, mechanical properties, defects, and transport phenomena in fiber optic materials.The new center is the culmination of more than 25 years of cooperative research efforts directed by Sam DiVita between the School of Ceramics at Rutgers and U.S. Army Communications-Electronics Command (ECOM) scientists at Fort Monmouth, NJ. During that period, electronic ceramic research produced both a post-World War II high technology product and a vital defense material, as fiber optics is today.

MRC Offers Text on Sputtering and Dry Etching Technology

Materials Research Corporation (MRC) has published the transactions of its 1985 Sputter Schools at a reduced price of $45. The book, *Sputtering and Dry Etching Technology for VLSI and ULSI Devices*, includes articles such as: "The Art of Sputtering Process Development,""Advanced Aluminum Metallization," "Planarization of Sputtered Aluminum Films," and "Refractory Metals Silicides."

Contact Sputter School Office, Materials Research Corporation, Orangeburg, NY 10962; telephone (914) 359-4200, Ext. 351 or 352.

Physics News in 1985 Published by AIP

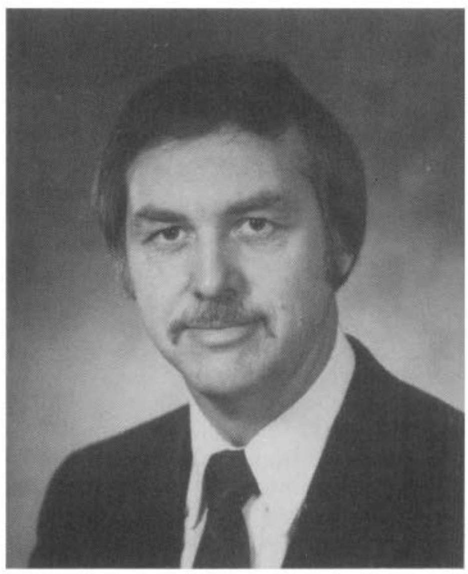
American Institute of Physics has published a booklet summarizing notable advances during the past year in 19 areas of physics. The 68-page booklet covers chemical physics, condensed matter physics, physics education, electron and atomic physics, physics applied to industry, nuclear physics, optics, polymer physics, and others.

Physics News in 1985 appeared in the January 1986 issue of Physics Today but can be purchased separately for $5.00 per copy ($3.00 per copy for orders of 10-20 copies, or $2.00 per copy for orders of more than 20 copies) from Public Information Division, American Institute of Physics, 335 East 45th Steet, New York, NY 10017; telephone (212) 661-9404.

NMAB Publishes New Catalog of Selected Reports

The National Materials Advisory Board has issued a new Catalog of Selected NMAB Reports. The Catalog, published in January, describes 147 reports available on completed NMAB studies and lists forthcoming reports. Pricing and ordering information for obtaining each report is provided. A subject index is also provided.

Request copies of the Catalog (Publication NMAB 13-C) from National Academy of Sciences, National Materials Advisory Board, 2101 Constitution Avenue, NW, Washington, D.C. 20418; telephone (202) 334-3488.



B. R. Appleton

B.R. Appleton to Direct Solid State Division at ORNL

Bill R. Appleton has been named director of the Solid State Division at Oak Ridge National Laboratory (ORNL), effective April 1. His appointment was announced by Alex Zucker, ORNL associate director for the physical sciences. As division director, Appleton will be responsible for programs of basic and applied research on crystal physics, ceramics and surfaces, particle-solid interactions, research materials, and solid-state theory. Activities of the 100-member division account for 22% of the $64 million annual operating budget of ORNL's Physical Sciences programs.

A member of the ORNL staff since 1967, Appleton is a recognized authority on surface physics, ion-solid interactions, ion channeling, and surface modification through ion implantation, ion beam mixing, and laser annealing. He will succeed Michael K. Wilkinson, Solid State Division director since 1972, who is to assume new responsibilities on behalf of the division and the Laboratory.

Currently, Appleton serves as director of the Surface Modification and Characterization Collaborative Research Center and head of Solid State's particle-solid interactions section. He holds a BS degree from the University of Missouri and a PhD in physics from Rutgers University. Appleton is a fellow of the American Physical Society and a member of the Solid State Sciences Committee of the National Research Council. He was a member of research teams that won U.S. Department of Energy (DOE) Materials Science Awards in 1981 and 1985 and a 1982 "I-R 100" award for one of the year's top 100 technical innovations. The co-editor of three books and author of more than 140 journal articles, reviews, and book chapters, Appleton serves on the editorial boards of four scientific journals—Radiation Effects, Materials Letters, Nuclear Instruments and Methods in Physics Research, and Nuclear Science Applications.

Appleton, a past vice president of MRS, is a member of MRS Council and has served on numerous Society committees, including the 1985 Publications Committee.

Exxon and NBS to Develop Neutron-Scattering Instrument

The National Bureau of Standards (NBS) and Exxon Research and Engineering Co. recently (December 12 and 13) signed a three-year agreement to jointly develop a new Small Angle Neutron Scattering (SANS) instrument at NBS. Under the Agreement, Exxon and NBS will each fund half the cost of the device, its maintenance and staffing. The $1 million instrument will be used in conjunction with a cold (slow) neutron source at the NBS research reactor in Gaithersburg, MD.

A SANS device is essentially a spectrometer that uses neutrons to nondestructively explore a range of features—from the density variations in alloys to the size and shape of large molecules, such as polymer chains and proteins. Because neutrons are highly penetrating, a SANS instrument can be used on large (bulk) samples.

NBS already has one SANS device which is being upgraded this year to handle higher intensity neutron beams and to take greater advantage of the Bureau's soon-to-be-completed cold-neutron source. The new Exxon/NBS device will offer an even more extensive range of capabilities than the existing SANS instrument.

In return for their investment in the new device, NBS and Exxon will each have access to the instrument one third of the time; the remaining third is to be shared among other qualified researchers from throughout the country. (See details on SANS in the next issue of the **BULLETIN**.)
J.R.

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Industrial Laser Handbook to be Published

The 1986 Industrial Laser Annual Handbook will be published shortly by PennWell Books/Laser Focus. This First Edition of the Handbook is a single reference source which includes a laser material processing database, an annual survey of processing, and the Industrial Laser Manufacturers and Systems Directory.

The Handbook provides information and data supplied by laser manufacturers and compares laser and non-laser processes. The Directory includes listings of companies and product lines for industrial laser material processing technology.

For subscription information, contact PennWell Publishing Company, 1421 South Sheridan, P.O. Box 1260, Tulsa, OK 74101; telephone (918) 835-3161.

ACerS Offers New Publication Catalog

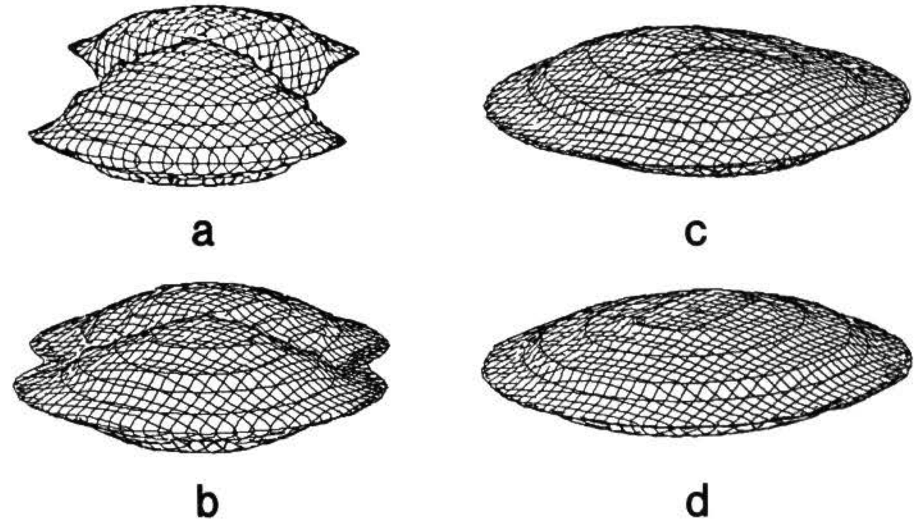
The American Ceramic Society (ACerS) has published an edition of its Book Service Catalog, featuring 33 new volumes. The catalog describes over 200 volumes available from the Society and other internationally recognized scientific publishers. ACerS publications include the Advances in Ceramics series, Ceramics and Civilization, Phase Diagrams for Ceramists, Cements Research Progress, as well as six periodical series.

The catalog includes handbooks, dictionaries, classic references, encyclopedia and periodicals in categories ranging from advanced ceramics to testing.

Request the catalog from Book Service Department, American Ceramic Society, 65 Ceramic Drive, Columbus, OH 43214; telephone (614) 268-8645.

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** is an example of materials research on a truly planetary scale. It comes from Alan P. Boss of the Department of Terrestrial Magnetism, Carnegie Institution of Washington, Washington DC, USA. By computer simulation, it follows the shape evolution of a rapidly rotating viscous protoearth as it relaxes from an initially defined state of large distortion (a) back to the equilibrium shape of a flattened disc (d). Viscosities of the order of 1015 poise are assumed. By including viscoelastic effects in such simulations, one finds it less likely that the Moon formed as a result of a dynamical fission instability in the protoearth. A full account of this work can be found in Science, Vol. 231, p. 342 (January 1986) and references cited therein.

ERRATA

The photo on page 42 of the January/February issue of the **MRS BULLETIN** ("Materials Research Facilities Dialogue") was incorrectly labeled. The discussants shown in the photo are (left to right) R.A. Laudise and A.I. Bienenstock. P.M. Eisenberger does not appear in the photo.