NBS Research Reports

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
NBS SPECIAL PUBLICATION 680-5

Cover photo: A new computing machine invented at NBS performs complex processing of video images in "real time" for artificial vision systems. Here, the "gray scale" value of every point in the picture is rescaled over the range 0 to 2-Pi, the sine and cosine are taken, multiplied together, and doubled to produce a new value. See page 10.

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U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards
Gaithersburg, MD 20899
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National Bureau of Standards
Boulder, CO 80303
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RESEARCH UPDATE

EXXON AND NBS AGREE ON JOINT MATERIALS RESEARCH AND FACILITY

Exxon Research and Engineering Company and NBS have signed an agreement for cooperation in research and construction of an important materials science and engineering facility at NBS in Gaithersburg, Md. The 3-year agreement provides for the funding and expertise needed to develop a new small-angle neutron scattering (SANS) instrument at the NBS reactor cold neutron source. SANS is a method of using relatively low-energy neutrons as probes to measure the structure of materials in very great detail. It is a nondestructive technique that has a diversity of applications ranging from the study of density variations in alloys to the determination of the size and shape of large molecules such as in polymer chains or proteins. The new instrument will offer a more extensive range of capabilities than the existing SANS instrument at NBS.

The program is intended to cover the design, construction, and maintenance of the SANS instrument. Exxon and NBS each will have the right to one-third of the available time on the instrument and the remaining one-third will be available for use by third parties under suitable agreements with NBS. NBS will own the completed instrument, which is expected to cost an estimated $1 million to be shared equally by Exxon and NBS.

OPTICAL TECHNOLOGY FOR ELECTRIC UTILITY MEASUREMENTS FOCUS OF STUDY

Are there economic or technical advantages to using optical and optical-fiber techniques to measure voltage and current? Such measurements—traditionally made using bulky but accurate transformer systems—are crucial to ensure proper operation of power stations and substations. Converting to new optical technology to make these electrical measurements could prove advantageous to electric utilities. A government/industry study involving NBS, the Bonneville Power Administration (Ore.), the Electric Power Research Institute (Calif.), and the Empire State Electric Energy Research Corporation (N.Y.) will focus on these questions.

The first part of the NBS study began last year at the Bureau's Boulder, Colo., site and is focusing on the technical feasibility of producing high-accuracy optical sensors. The second phase, just begun, is being conducted at the NBS high-voltage testing laboratory in Gaithersburg, Md. It will compare the benefits of optical methods with conventional technologies and will identify additional research required to develop cost-effective devices.

NEW 10-FOLD QUASICRYSTAL STRUCTURE FOUND

A new type of quasicrystal structure has been found at NBS by Dr. Leonid Bendersky, a guest worker from Johns Hopkins University. Bendersky's 10-fold quasicrystal is a totally different kind of aperiodic crystal from the first one of its kind discovered at NBS 3 years ago by Dr. Daniel Shechtman, a guest worker from the Israel Institute of Technology, Haifa. The discovery by Bendersky proves that other types of nonperiodic crystal structures exist and can be made in materials with the possibility of producing new materials with radically different properties. The 10-fold crystal was found in an alloy of aluminum and manganese produced by the same rapid solidification technique that Shechtman used at NBS. The crystal structures in these alloys defy a 100-year-old theory in crystallography that is based on the assumption of periodicity, which requires all crystal structures to have only 2-, 3-, 4-, and 6-fold symmetry axes in various combinations to fit in one or another of the 32 classical diffraction pattern symmetries.

ACID RAIN ANALYSES SHOULD BE IMPROVED WITH NEW SOLUTIONS

Simulated Rainwater, a new Standard Reference Material (SRM 2694), has been developed by NBS at the urging of the Environmental Protection Agency to improve the reliability of rainwater analyses. The new material is intended for use as a control standard to check accuracy by calibrating instruments and assessing analytical methods used in investigating such factors as acidity and pH levels in rainwater.

A stable, homogeneous material packaged in polyethylene bottles, the SRM is certified for acidity, pH, specific conductance, and concentration of a variety of elements and constituents such as sodium and sulfate. It consists of four 50-milliliter bottles of solution—two each of pH levels of 4.3 and 3.59. SRM 2694 is available for $158 from the Office of Standard Reference Materials, B311 Chemistry Building, National Bureau of Standards, Gaithersburg, MD 20899, 301/921-2045.

X-RAY SPECTROMETER INSTALLED AT THE NBS SURF-II

A team of researchers from NBS, Oak Ridge National Laboratory, and the University of Tennessee has installed a new, extremely sensitive, x-ray spectrometer at the NBS Synchrotron Ultraviolet Radiation Facility (SURF-II). The new instrument was specially designed to measure very-low-intensity radiation with efficiencies 1,000 to 10,000 times higher than conventional spectrometers. This allows measurements to be made either with weaker sources, at much better resolutions, or in much less time (e.g., minutes instead of days). It is particularly well suited for experiments on fragile materials, including alloys, surface layers, and organics. Initial experiments have been on radiation-damage mechanisms in the alkali halides that are often used as windows for UV excimer lasers. The new spectrometer measures radiation in the range from 50 nm to 1.2 nm (20 eV to 1 KeV).

LOW-TEMPERATURE PROCESS DEVELOPED FOR THE PRODUCTION OF CERAMIC POWDERS

Scientists at NBS have developed a technique that offers ceramic producers a new way to make high-technology ceramic powders at low temperatures with anticipated improvements in product reliability and durability. Current chemical processes used to make silicon carbide, titanium diboride, and boron carbide powders for electronic and structural ceramics applications are difficult to control and require temperatures of 1500 °C. A patent application has been filed for this new process which uses a chemical reaction between silicon and carbon tetrachlorides and sodium to generate a precursor or starting material for silicon carbide powder at 130 °C. This type of molecular chemistry permits other advanced boride and carbide ceramic powders to be chemically generated at low temperatures. The scientists also are investigating the new process for use in producing composite ceramic powders.

RADIONUCLIDES FOR CANCER THERAPY CALIBRATED

Yttrium-90 and Samarium-153, two short half-life beta-particle-emitting radionuclides being evaluated for use in cancer therapy, have been calibrated by NBS. There is renewed interest in such short-lived radionuclides because better methods for "targeting" the radioactive agents are being developed. Yttrium-90, for example, is being incorporated in tumor-specific monoclonal antibodies which carry this high-energy beta emitter directly to the cancerous tissue. It is being studied for use in the treatment of colon carcinomas, and accurate measurement of the doses being administered is critical. Nuclear Regulatory Commission regulations require no more than 5 percent uncertainty in the injected dose. In calibrating the solutions for the Oak Ridge National Laboratory and the University of Missouri Research Reactor, two major suppliers of these radionuclides to pharmaceutical researchers, NBS arrived at a measurement uncertainty of less than 1 percent.

NUCLEAR WASTE CONTAINER DESIGNS BEING EVALUATED

NBS materials researchers are helping the Nuclear Regulatory Commission (NRC) to evaluate the design of containers for permanent storage of spent fuel rods from civilian power plants, along with other forms of high-level nuclear wastes. The container packages are being developed by the Department of Energy (DOE) under the Nuclear Waste Policy Act of 1982. That law requires DOE to develop container designs to isolate the material within the waste package system to protect human safety over a 300- to 1000-year span. The design proposals are to be submitted to the NRC by 1991 for review and licensing approval.

The information prepared by NBS from reviews of the DOE documents will be used by NRC to evaluate the waste package systems before granting licensing approvals. Among the many materials the NBS scientists will evaluate for the effects of both general and localized corrosion are ferrous metals, including low-carbon and stainless steels, nickel-based alloys, and copper alloys. They also will study the effects of moisture on borosilicate glass used to encapsulate reprocessed fuel pellets and military wastes in the event ground water penetrates the storage container.

UNITED STATES AND FRANCE SIGN AGREEMENT FOR ADVANCED MATERIALS RESEARCH AND STANDARDS

A memorandum of understanding signed in January by the United States and France is the first step toward an international accord between the United States and other nations participating in the Versailles Project on Advanced Materials (VAMAS). VAMAS is one of 18 cooperative technical projects established at the Economic Summit of Heads of State at Versailles in 1982. The agreement was signed by John P. McTague, acting director of the Office of Science and Technology Policy, Executive Office of the President, and by France's Minister of Research and Technology, Hubert Curien. NBS is the U.S. representative to VAMAS. The memorandum will go into effect when signed by all the participating nations.

The principal aim of VAMAS is to stimulate the introduction of advanced materials into high-technology products and engineering structures and to encourage international trade through agreement on codes of practice and performance. The technical working areas include surface chemical analysis, weld characteristics, polymer composites, ceramics, polymer blends, and bioengineering materials.

STANDARD REFERENCE MATERIALS TO HELP PETROLEUM REFINERS, MANUFACTURERS, AND ENGINEERS

NBS has developed two new measurement reference materials to help analyze the chemical makeup of lubricating base oils and similar materials. One of the new measurement tools, being sold by NBS as a Standard Reference Material (SRM), will be of special assistance to chemical engineers and environmentalists analyzing the total concentration of chlorine in these oils. Environmental Protection Agency regulations require used oils with more than 50 parts per million of chlorine to be analyzed for the presence of polychlorinated biphenyls (PCB's), a hazardous material. The NBS reference material will help screen out used base oils that do not have to be examined for possible PCB's, thereby saving both time and expense. Standard Reference Material 1818, Total Chlorine in Lubricating Base Oil, consists of a series of five different 20-gram ampoules of re-refined lubricating base oils having total chlorine concentrations ranging from 30 to 600 parts per million.

The other SRM is a quality control standard for petroleum refiners and manufacturers. It will help calibrate instruments to determine the total sulfur content in lubricating base oil. Use of sulfur-containing additives is one way producers improve the performance of automotive engine lubricants, and the new SRM will help the industry to better understand how the additive affects the lubricant's performance. Standard Reference Material 1819, Sulfur in Lubricating Base Oil, consists of a series of five different 20-gram ampoules of virgin lubricating base

oils with sulfur concentrations ranging from 300 to 10,000 parts per million and costs $165 per set. Both SRM's can be purchased from the Office of Standard Reference Materials, B311 Chemistry Building, National Bureau of Standards, Gaithersburg, MD 20899, 301/921-2045.

VOLUNTARY INDUSTRY STANDARD PROPOSED FOR USE BY FEDERAL AGENCIES

A voluntary industry standard for the BASIC programming language for computers is being proposed by NBS for adoption as a Federal Information Processing Standard. The proposed standard, adopted by a committee accredited by the American National Standards Institute (ANSI), will bring major changes, improvements, and additions to the specifications for BASIC that are relied upon by federal agencies. It would replace the current federal standard for BASIC to take into account broader provisions included recently in the ANSI standard.

Federal Information Processing Standards are designed to give federal agencies more effective control over the production, management, and use of the government's information resources. A family of programming languages, which include COBOL, FORTRAN, Pascal, and Ada, is covered by the standards. They are expected to help agencies make better use of programmers by ensuring that skills acquired in one job can be applied in other positions, thereby minimizing programmer retraining. Other benefits include increased programmer productivity and reduced software costs.

MEASUREMENT STANDARD FOR RADON IN WATER DEVELOPED

NBS scientists have developed a new standard for measuring the concentration of the radioactive gas radon in water. The standard was developed for the Environmental Protection Agency, which believes that radon in domestic water supplies is one of the chief sources of indoor radon pollution. Exposure to the decay products of radon, particularly inside modern, well-insulated houses, is thought to be a significant cause of lung cancer. The new NBS standard is a radon generator consisting of a sealed radium-226 source in a partially automated system which dispenses measured samples of water with radon-222 in solution. The generator, which is about 2 feet tall, can be calibrated and certified in terms of the radon-222 concentration in the dispensed samples when detailed operating procedures are followed. The overall uncertainty of the calibration is estimated to be about ±4 percent.

SYNTHETIC BODY 'PHANTOM' EVALUATES TISSUE HEATING PATTERNS

A new synthetic-organic material that performs like living body tissue when exposed to electromagnetic waves from medical instruments has been developed by NBS polymer scientists. This material will be a "phantom" substitute for living muscle tissue in studies by the Food and Drug Administration (FDA) to evaluate heating patterns of various medical devices used in diathermy and hyperthermia treatments. These machines generate electromagnetic waves that heat body tissue for physical therapy, rewarm animals after low-temperature surgery, and treat many types of cancers. The NBS formulation will provide FDA with a more stable material that has a much longer "shelf life" than currently available biopolymers. The material can be used over the entire range of electromagnetic frequencies for dielectric heating and it is free from attack by mold, bacteria, and corrosion. The FDA will place the "phantom" in test kits for the National Cancer Institute and others to use in checking the quality assurance of their medical devices.

OLD PHENOMENON TAKES ON NEW MEANING AS CRYSTAL SURFACE PROBE

Research in the NBS Center for Chemical Physics has cleared up an old misunderstanding in electron spectroscopy, and thereby developed a useful new tool for surface science. Spectral peaks in x-ray photoelectron spectroscopy (XPS) and Auger electron spectroscopy (AES) of crystals are enhanced in directions along the principal axes of the crystal, a phenomenon long thought to be related to the "channeling" of electrons along the rows of atoms in the crystal. NBS researcher Dr. William Egelhoff has demonstrated that, in fact, this XPS "searchlight effect" is not due to the deep structure of the crystal, but rather to interference effects caused by atoms on or near the surface of the crystal. As a result, the searchlight effect is now seen as a surface probe which gives direct, easily analyzed information on the structure and, in particular, the depth of features in the first few atomic layers of a crystal. The searchlight effect, says Egelhoff, can be an important complement to other surface science tools for such problems as developing more efficient catalysts or understanding the electrical nature of metal/semiconductor contacts.

MEDICAL LEVELS OF SODIUM, POTASSIUM FOCUS OF JOINT PROJECT

The measurement of two elements—sodium and potassium—important in clinical tests because of their roles in high blood pressure, heart disease, and general health, is the focus of a new joint agreement between NBS and industry. The National Committee for Clinical Laboratory Standards (NCCLS), on behalf of a consortium of corporations interested in bettering clinical measurements, has sent researcher Chandrani Gunaratna to NBS as part of the agreement. She will examine a chemical relationship that is presently not known but is of great interest to clinical professionals: the difference between total and ionized concentrations of sodium and potassium in biological fluids such as blood serum. Since some instruments that analyze samples for the two elements read only levels of ionized elements, the analysis the instrument produces may differ from the total elemental concentration contained in the sample. And because medical diagnoses may be based on total levels, it is important for ensuring accuracy that a distinction be made between ionized ("active") elements and nonionized ("bound") ones. Gunaratna will study this distinction using direct potentiometry with ion-selective electrodes. ■

A Perspective on the Future of NBS

Research chemist Joe Ritter (l.) and physical science technician Norman Adams are shown with the reactor they designed for synthesizing advanced ceramic powders at low temperatures.

The following is excerpted from testimony of NBS Director Ernest Ambler before the Subcommittee on Science, Research and Technology of the Committee on Science and Technology on Authorization of Appropriations for Fiscal Year 1987, on March 5, 1986.

These hearings come at a crucial time for the United States. This subcommittee is fully aware of our unsatisfactory trade position. You have appreciated for a long time the need for the United States to improve productivity, and one component of accomplishing that is developing and applying technology rapidly. Technology is one of the few areas in which this country has an advantage over our competitors. That is why our budget proposal for FY 1987 gives top priority to support for the U.S. economy.

Because our mission of aiding U.S. industry and science is so broad, many people expect NBS to be all things to all people. Operating in the kind of fiscal environment the federal government is faced with today, we simply cannot do that. Those of us who have formulated this budget recognize that, and our initiatives focus on the areas where we are likely to have the biggest impact in helping U.S. industry to compete and to do better in international trade.

In FY 1987, we are asking Congress for $123.953 million—essentially level with last year's appropriation, but including Gramm-Rudman-Hollings reductions for 1986 and, we are told, those expected for 1987. This includes increases in several key research programs that are vital to U.S. trade competitiveness.

Cold Neutron Research Facility

Our proposal calls for $10 million to establish a cold neutron research facility adjacent to the NBS reactor.

This will be a unique national facility which is critical in advancing materials science and engineering in the United States. This country is behind other nations, particularly Germany, France, and Great Britain, in the development of cold neutron research facilities. About $150 million has been invested in the Grenoble, France, facility. Japan recently made a $50 million commitment to establish its own cold neutron facility.

Beams of neutrons produced by specially-designed nuclear reactors are one of the fundamental tools of materials science. They are highly penetrating, making it possible to probe deep within materials to observe, for example, micro-cracks or voids. Other common probes, such as x rays or electron beams, can examine only very thin layers near the surface of materials. "Cold" neutrons' relatively slow speed allows researchers to conduct experiments that are impractical or even impossible with more conventional neutron beams.

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Fortunately, since the NBS reactor already is designed to produce cold neutrons, this is one area where we don't have to match the competition's investment to match a critical research capability.

Secondly, this facility, which has been accorded top priority by a high-level committee of the National Academy of Sciences, will be equipped in part by industry. In fact, we recently signed our first agreement with industry to establish a participating research team using the cold neutron source at the NBS reactor. These kinds of investments mean scores of U.S. companies and universities will have access to this national facility when we build the necessary guidehall.

Advanced Ceramics

We are nearly halfway through the first fiscal year in which Congress has appropriated funds for increased NBS work in advanced ceramics, and we are making good progress. For example, our scientists recently developed a technique that offers ceramics producers a new way to make high-technology ceramic powders at low temperatures. We anticipate that this new technique will significantly improve ceramic product reliability and durability. The requested increase of $783,000 will bring our spending for advanced ceramics to the $3 million level. This will permit us to continue our development of critically needed measurement methods and standards, data, and predictive concepts to assure reliable performance of advanced ceramics.

This new generation of materials, which is particularly well-suited for high-technology applications, possesses unique properties, especially resistance to corrosion, high temperatures, and wear. Advanced ceramics open up an array of applications in advanced heat engines, cutting tools, sensors, biomedical devices, and electronic and optical components. But the inability to control production processes so that ceramic products possess uniform and predictable performance characteristics remains a major obstacle. Our FY 1987 request would bolster our efforts to address the measurement problems which make up a large part of that barrier.

There's a huge market for advanced ceramics. If we don't make the effort now to solve the measurement problems which stand in the way of the development of ceramics, you can be sure our top competitors, like the Japanese—who have been working on these problems for years already—will fill the void and take over another important market.

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Fiber Optics

In another area of emerging technology and intense competition, fiber optics, the situation is the same. The FY 1987 request of $950,000 will enable NBS to provide critical measurement technology and services for fiber optics components of modern communications and computer systems.

Fiber optics are the basis for a new industry which uses light and hair-thin glass filaments rather than electricity and copper wire to transmit information. This "lightwave technology" is undergoing rapid international growth. The current world market is more than $1 billion per year and is growing more than 30 percent annually.

The core components of the lightwave communication industry, optical fibers and laser diodes, were invented in the United States. But in what sounds like an all-too-familiar story, our lead is challenged in several important areas by rapidly growing international competition. Japan and several European countries are moving ahead to produce and deploy these technologies. To compete successfully,

U.S. industries must deliver technically advanced, cost-effective components and systems and prove their performance and compatibility in the marketplace. Based on our experience working closely with industry on the optical fibers themselves, we know that today's challenge is to make the measurement advances and provide the services for the other components and systems which send, receive, and process signals sent over the fibers.

Other Increases, Decreases

We are requesting $550,000 to enable us to improve the productivity of the Department of Commerce Consolidated Scientific Computer System. This new supercomputer serves NBS, the National Oceanic and Atmospheric Administration, and the National Telecommunications and Information Administration. It is already operating 24 hours a day at more than 75 percent of its capacity after just 7 months of operation. But present staffing levels can provide only minimum user support. To improve the computer's productivity and the productivity of the people using the system, we must hire more computer scientists and systems specialists.

The NBS FY 1987 budget proposes several reductions. Both the NBS Center for Building Technology (−$3.1 million) and the Center for Fire Research (−$5.1 million) would be eliminated. The federal government has invested a total of nearly $100 million in these two programs over the past 10 years, and it now is appropriate for this effort to be assumed by the private sector and state and local governments.

It also proposes decreases for the Institute for Computer Sciences and Technology (−$4.7 million), recognizing the need for greater private sector involvement in this area. We would terminate R&D in several areas and concentrate on standards and guidelines development activities in areas that support the ADP needs of the federal government. Our remaining resources would focus on networking, information management, com-

This supercomputer facility at NBS was installed to meet its large-scale scientific computing needs as well as those of the Environmental Research Laboratories of the National Oceanic and Atmospheric Administration and the Institute of Telecommunication Sciences of the National Telecommunications and Information Administration.

puter software management, end user computing, and computer security.

Other decreases are for the technical competence program (–$1.5 million) and for the Postdoctoral Research Associate Program (–$1.6 million).

Cooperative Technology Transfer

This is a time of great budget constraints. It also is a time of great trade competition and pressure. I've had good cause lately to try to reconcile these two facts of life. Looking at where we are today and where we want to be—both for NBS as an institution and the nation

. . . our scientists recently developed a technique that offers ceramics producers a new way to make high-technology ceramic powders at low temperatures.

as a whole—one basic fact keeps coming to mind. Our knowledge and technology are this country's major asset and advantage, both in ensuring domestic strength and health and in competing with other nations. That means we have got to make the most of our research resources—our equipment as well as our people. Cooperation in research and development is one obvious answer.

This is something that we at NBS have been doing right from the start. We have made cooperation with industry a way of doing business, and we have served as a model for cooperative arrangements which are becoming more popular today as industry, universities, and government form research partnerships all across the country. We are using cost-sharing arrangements with others whenever and wherever possible.

But cooperation in R&D won't be enough. Doing the research is only half the battle. The results of this research must be incorporated into new ideas, new processes, and new products. New technology must diffuse throughout our industries, and diffuse more rapidly than it does now. We need to think about cooperation in the transfer and diffusion of technology in the same way that we have addressed cooperation in research and development.

NBS is taking a lead here, too. We spend a good deal of time with visiting scientists, engineers, and managers from industrial firms. About 200 of these specialists work at NBS each year as research associates, with their sponsoring organizations paying their salaries. They come to NBS to conduct research, but they also come to learn how they can put our work to use.

We have taken other steps to encourage technology transfer, by holding literally hundreds of conferences, workshops, and seminars each year, by encouraging our staff to publish results of their work as broadly as possible, and by working actively with professional and technical societies and standards organizations.

We are using videotapes to explain our research so that others can take advantage of our work. We now are making many of our databases and experts available through computers, and we are considering expanding this service so that industry will be able to tap into even more of our information.

We are looking for new outlets, new ways to disseminate our research results and services throughout the U.S. economy. And I am convinced that as a nation we must all join together to develop creative ways to transfer technology, just as we now seem to be developing the capacity to conduct research together. There isn't much choice if we want this country to be competitive in a changing world economy.

Our proposal calls for $10 million to establish a cold neutron research facility adjacent to the NBS reactor. This will be a unique national facility which is critical in advancing materials science and engineering in the United States.

I stress the importance of cooperative R&D and technology transfer because I see it as a way for us to deal with the dual problem of tight federal budgets and growing trade deficits.

We have had to make hard decisions on priorities for NBS. Our proposed budget, including increases to expand certain programs and reductions for others, represents a careful review of those priorities. Facilities like our proposed cold neutron research facility are crucial, and we give it top priority. I know that there are conflicting views on where the federal government should and should not be spending its scarce resources. But I also know that we must find a way for the system to work so that we can move forward with the cold neutron research and other measurement work this nation sorely needs.

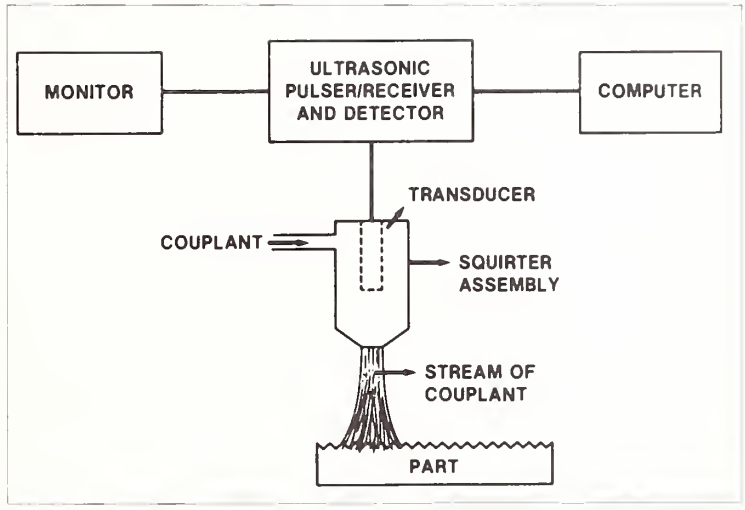
Surface Roughness Monitor for Advanced Manufacturing Developed

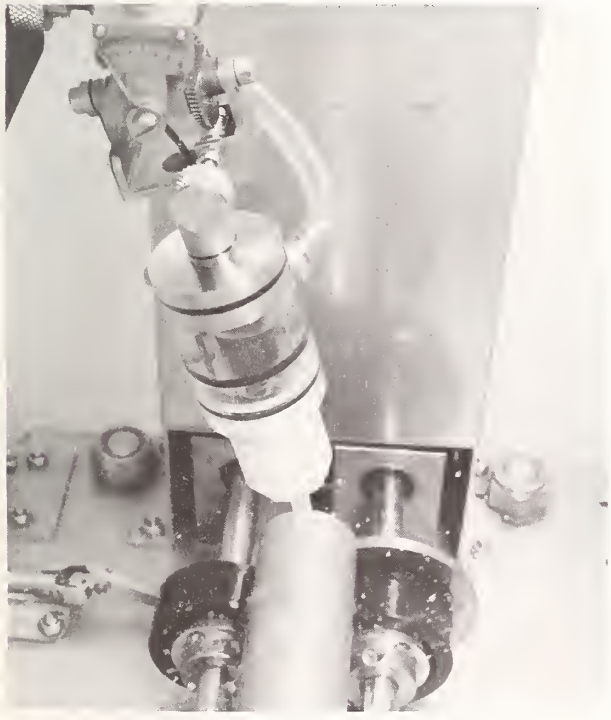
A laboratory model of an ultrasound probe that can monitor automatically the surface finish of a part while the part is being machined has been demonstrated by NBS engineers.

One important application of the device, says NBS engineer Gerald Blessing, is to maintain a constant check on the condition of the cutting tools in an automated machine tool, so that they can be changed when their cutting edges become damaged or too worn to produce acceptable parts.

Previous methods of checking surface finish, using either the tactile senses of the machine's operator or a stylus gauge drawn across a section of the part, are unsuitable for automated manufacturing operations, largely because they require manual intervention and interruption of the machining process.

The ultrasonic pulse-echo approach to monitoring surface roughness uses a special coolant nozzle to couple the sound between the transducer and the part.





This laboratory set-up ultrasonically monitors the surface condition on a rotating part by means of sound echoed from the part surface.

The NBS ultrasound probe was designed to take advantage of the cooling systems that are used commonly on high-speed metal-cutting machinery to flood the work piece with a cooling and lubricating fluid. The steady stream of coolant acts as a guide to "couple" the ultrasound to the surface of the part.

An ultrasonic transducer located in a specially designed coolant nozzle sends pulses of ultrasound down the coolant stream to the work piece. Some of the sound is reflected back up the coolant stream, where it is detected by the transducer.

The proportion of ultrasound returning back upstream is a measure of the roughness of the work piece.

The new probe has been tested on stationary objects, both flat and curved, with average surface roughness values ranging from 25 to more than 1000 microinches to a resolution of about 100 microinches. (For comparison, a newspaper has an average surface roughness of about 100 microinches, and a windowpane somewhat below 1 microinch.) Modifications should make it possible to achieve a resolution of about 25 microinches, according to Blessing.

Even more importantly, the technique works on curved, moving surfaces such as would be found in automated turning centers. Reliable surface finish measurements have been made on cylinders rotating with a surface speed of up to 1000 feet per minute (5 meters per second). Both tap water and cutting oil mixtures have been used as the fluid medium.

NBS is applying for a patent on the ultrasound surface finish probe. A prototype system is now being developed for testing in the Bureau's Automated Manufacturing Research Facility.

by Michael Baum
NBS Public Affairs Specialist

Artificial Vision Device Performs High-Speed Processing of Images

Researchers at NBS are testing a prototype of a new computing device for machine vision systems that continually processes images from a television camera at previously unheard-of levels of performance.

The device, called a Pipelined Image Processing Engine (PIPE), is expected to have applications in a wide variety of advanced image-sensing equipment where continuous, "real-time" processing is necessary. Examples range from artificial "eyes" for robots and robotic vehicles to improved medical diagnostic tools.

PIPE, according to its inventor, Dr. Ernest Kent, is a comparatively low-cost computing "engine" that handles the vast number of calculations necessary to pre-process a television image so that it can be understood by a computer. "PIPE does not actually 'recognize' the image it is working with. Rather, it handles all the analysis needed to recognize specific features of the image—for example, texture, shade, the presence or absence of an edge, and motion—at each point in the picture. It is modeled after the processes in the human visual cortex," says Kent.

A standard black-and-white digital video camera sends numbers corresponding to the levels of gray in a 256 x 256 point "frame" 60 times a second—65,536 points every 1/60 of a second.

PIPE . . . is a comparatively low-cost computing "engine" that handles the vast number of calculations necessary to pre-process a television image so that it can be understood by a computer.

For each point in each frame, PIPE can be programmed to do mathematical computations on not only the point itself, but also on its relationship to surrounding points in "neighborhoods" of varying sizes.

PIPE maintains several frames—up to 10 in the current prototype—simultaneously as they move through the computational "pipeline." As a result, it can also compare a point or its neighborhood with the equivalent points and neighborhoods both backwards and forwards in time, noting, for example, whether anything changes.

The current prototype PIPE performs approximately 450 million 8-bit operations per second, outpacing even supercomputers at its particular task.

PIPE was created for the NBS Automated Manufacturing Research Facility (AMRF) project to meet the need for a powerful, flexible vision processor that could handle data at

a.

b.

Inventor Dr. Ernest Kent demonstrates some of the capabilities of the Pipelined Image Processing Engine. Every point on the screen has a "gray scale" value ranging from –128 (black) to 127 (white). PIPE can perform calculations on each individual point, including its relationship to other points around it, or before or after it in time. First (a), the image is rescaled to expand the values near 0 to cover the full range, resulting in a high-contrast image. In the next image (b), only changes in intensity along the horizontal axis are displayed.

the speeds needed for practical applications on the factory floor. General-purpose computers cannot begin to do the calculations fast enough, and even though highly specialized image-analysis machines exist that can perform more calculations than PIPE, none is capable of the continuous, frame-after-frame calculations necessary to analyze a constant video signal in a rapidly changing situation.

A typical problem might be to detect moving objects from a robot arm or some sort of robot vehicle while the robot's camera "eye" is itself moving.

One way of solving this with PIPE is to compare an older neighborhood of points in the pipeline with its equivalent in a more recent image to detect horizontal motion, do the same thing to detect vertical motion, and combine the two calculations using trigonometric functions to get a number that represents the magnitude and direction of the motion. The processed image at this point, instead of showing the original view, shows the direction and amount of motion of each point in that scene. Further calculations then are done to detect "edges" in the scene. Anything which is moving on its own in the robot's field of vision shows up as a moving object against a dull gray background.

The current prototype PIPE performs approximately 450 million 8-bit operations per second, outpacing even supercomputers at its particular task.

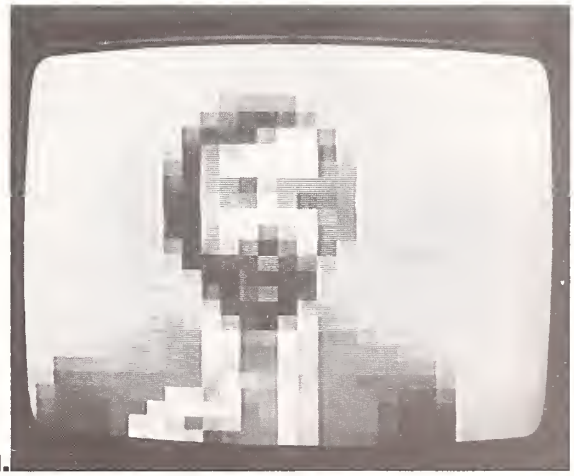
The entire set of calculations is repeated 65,536 times every 1/60 of a second.

PIPE features include a "multiple instruction-stream, multiple data-stream" (MIMD) facility that allows it to perform different types of analyses on the same frame, depending on the nature of each point, and the ability to do a wide variety of motion-analysis, and stereo operations. Other features include a sophisticated, graphics-oriented programming capability and a high-speed interface system that organizes the results of PIPE analyses in a convenient form in the memory of another computer.

PIPE is designed as a series of processing modules that can be assembled to provide the desired number of processing stages. The current prototype is a three-stage PIPE.

Prototype versions of PIPE were developed and built for NBS by Digital/Analog Design Associates, Inc., of New York City; PIPE is a registered trademark of Digital/Analog Design Associates, Inc. NBS is applying for a patent on the device. M.B.

c.



d.

Vertical lines are sharply defined, but horizontal lines are invisible. Here (c) logical operations are used to display only those points at which the gray scale value changes between negative and positive. These points are displayed in black. PIPE can "pyramid" images as well (d). In a process repeated three times, each 2 x 2 area of points on the screen is averaged, and the resulting value becomes a single point in an image half the size of the original. The final image is then magnified. PIPE is the only full-scale machine capable of doing this pyramiding in real time.

Taking the 'Guesswork' Out of Making Polymer Blends

Polymer scientists at the National Bureau of Standards are working to provide chemical producers, manufacturers, engineers, and designers with important new measurement tools to take the guesswork out of making products from blends of polymer materials.

"Most polymer blends on the market today were produced by intuition," says Dr. Leslie E. Smith, chief of the NBS Polymers Division.

Smith explains that industry lacks basic measurement information to predict whether two polymers will mix to form a new material. Instead of forming a homogeneous alloy, the molecules in many base polymers remain clustered together during the blending process and, much like oil and water, they retain their original characteristics.

These results will be used to develop information that will permit plastics producers to process blends. . . to "freeze in" the desirable microstructures.

Because the properties of polymer blends can be tailored to specific markets, blends represent one of the most rapidly growing fields in the industry. It is estimated that approximately 15 to 20 percent of the 47 billion pounds of plastic materials produced in the United States during 1985 was made from polymer blends.

Even though these blends offer opportunities for new materials without the cost of developing new classes of generic plastics, information is needed to explain why some polymer molecules will mix and others will not.

A number of these materials work well together to produce desirable products. For example, the tough plastics used in many automobile bumpers and other products are made from blends of plastics and rubber. It is the blending of rubber with a solid brittle plastic that makes the material impact-resistant.

"A successful blend has good adhesion between the two chemical systems, or phases, and it has a controlled size and shape of one phase within the other," Smith says. It is the various pairs of base polymers that do not mix that are of primary interest to Drs. Isaac C. Sanchez and Charles C. Han, NBS polymer physicists.

The NBS research strategy is to conduct a series of measurements on test films of a well-controlled blend system of polystyrene and poly (vinyl methylether) PS/PVME. These results will be used to develop information that will permit plastics producers to process blends for specific times at specific high temperatures, then rapidly cool or quench the material to "freeze in" the desirable microstructures.

The NBS scientists are using two research tools to obtain the basic measurements, small-angle neutron scattering (SANS) and temperature-jump light scattering (TJLS).

The SANS measurements are being made at the NBS research reactor where low-energy neutrons

Because the properties of polymer blends can be tailored to specific markets, blends represent one of the most rapidly growing fields in the industry.

are used as probes to measure the structure of polymer chains in the test films from 10 to a few hundred angstroms, or roughly the distance between atoms in the polymer molecules. These measurements are made while the samples are heated over a range of temperatures up to 180 °C. The neutron scattering pattern is recorded on a two-dimensional detector linked to computers.

The SANS information is being used by the researchers to develop research phase diagrams, which guide their kinetic studies with the TJLS instrument, a computer-controlled light scattering photometer developed at NBS.

The TJLS instrument, which operates somewhat like a slide projector, has a movable sample holder and two temperature blocks for heating polymer film samples. Test films of the PS/PVME material are preheated at the first temperature block to melt them into a homogeneous blend. The sample then is mechanically moved into another block where a higher temperature "jumps" the material into a region where mixing cannot take place and phase separation begins.

The device permits the scientists to record the phase separation

behavior of the molecules in the samples over a period of several hours, as well as to measure the size of the phase-separated microstructures up to 1 micrometer.

The scientists are combining the measurement information from the SANS and TJLS experiments to develop a series of polymer phase diagrams, or "road maps," for use by industry and others. This information will help plastic producers to better understand the phase separation of molecules and how it affects the physical properties of the material.

The phase diagrams will be important measurement tools for the producers of raw materials, the engineers who develop industrial processes, and the designers who select materials for new products.

Han says, "We do not pretend to understand everything about the

This information will help plastic producers to better understand the phase separation of molecules and how it affects the physical properties of the material.

thermodynamic and kinetic behavior of the phase separation of molecules in polymer blends. And even though more experimental data are needed we believe that our procedures offer significant potential for providing a clear understanding of the problem."

by Roger Rensberger
NBS Public Affairs Specialist

Dr. Takahiro Sato, a guest scientist from Osaka University, Japan, uses the temperature-jump light scattering technique to record the phase separation behavior in molecules.

Standards and Global Trade: A Government Perspective

The following is excerpted from a speech delivered by Dr. Donald R. Johnson at the Executive Standards Briefing of the Instrument Society of America on October 22, 1985, in Philadelphia. Johnson is director of the NBS National Measurement Laboratory.

One of the most important economic issues facing the country today is balance of trade. From 1874 until 1977, this nation enjoyed a trade surplus. Since 1977, we have experienced a steadily increasing trade deficit. [Last year, it totalled $148.5 billion.]

The forces driving and sustaining this turnaround are many. But by and large, the biggest challenge to our dominant position in the marketplace is often the last one mentioned: fair and worthy competition from other nations.

In other words, the United States has to fight hard today to be first among equals in the world market. But we are not used to competing on those terms. We got used to preeminence, and now we are surprised to find ourselves struggling in some areas to stay on equal footing with our trading partners.

What puts competitors on equal footing in the global marketplace? Good manufacturing and marketing practices, beneficial government policies, fair global trade practices—these and other factors we are all keenly aware of. Rather than discussing production-line efficiency, or export controls, or dumping, I want to talk about an important but often overlooked factor in global trade: standards.

Why are standards important? Because they are the rules for converting all the terms of a buyer-seller equation to a common

As part of its responsibilities under the GATT Agreement on Technical Barriers to Trade, NBS operates the National Center for Standards and Certification Information which is the central repository of standards-related information in the United States.

denominator. If I'm a manufacturer and I don't understand the rules, I can't deliver the desired product.

But if standards are indeed so fundamental, how could we overlook their importance on the international level? For the very reason we could also underestimate the growing prowess of foreign competitors for so long: Because we easily dominated both the trade and standards arenas of the free world for a time, and we grew complacent. Deputy Secretary of Commerce Clarence Brown sounded the following warning at a Conference on International Standards held at NBS last summer. He said, "The United States faces increasing competition in trade and should not expect that its domestic standards will continue to be accepted worldwide."

What will this mean?

Consensus standards are the preferred means of communication between buyer and seller in both the domestic and international marketplace. And because U.S. technology was preeminent after World War II, this conferred an automatic advantage to U.S. standards. Our standards became the de facto standards of the world as a result.

Consensus standards are the preferred means of communication between buyer and seller in both the domestic and international marketplace.

Standardization usually follows technology development rather than keeping pace with it. So today, our standards still dominate, although our technology is no longer preeminent in many areas. Consequently, our standards now convey an advantage to our technology: Buyers feel they are on safe ground if they can procure what they want on the basis of standards that the people they are buying from understand. Since U.S. standards are still strong, U.S. manufacturers who helped develop them are in a favorable position.

But, as Deputy Secretary Brown warned, the competition in international standards is heating up. Standards-writing organizations around the world are vying to get their standards recognized or adopted internationally.

There are some 400 domestic consensus-standards organizations in the United States. Written standards other than consensus standards are produced by many organizations, especially the U.S. government. The Department of Defense is the biggest standards-writer in this country. It is responsible for nearly one-half of the approximately 80,000 U.S. written standards in place today. Over the last 4 or 5 years, however, the number of standards being developed within federal agencies has decreased. Wherever possible the federal government now seeks to adopt consensus standards for use in purchase specifications and regulations.

On the international level, there are two primary consensus standards groups: the International Organization for Standardization (ISO), with about 5,000 standards, and the International Electrotechnical Commission (IEC), which has adopted 1,800 standards. Other organizations have contributed to the total of nearly 10,000 international voluntary standards. These consensus standards, by the way, are adopted in many countries as national standards. Regional standards organizations and organizations created by international treaty also produce written standards, and these are intended for legal use by participating governments.

Rather than discussing production-line efficiency, or export controls, or dumping, I want to talk about an important but often overlooked factor in global trade: standards.

In spite of these realities, the United States historically has looked upon international standards development with indifference. In fact, as de facto standards writer for the world, we virtually ignored the subject altogether as long as possible. It took the shock of having American manufacturers shut out of parts of the European market to get our attention in the 1960's.

Gradually, the United States has developed policy on international standards. That is important because it gives us all a framework for actively influencing standardization on the international level. This policy comes in three parts, and part one is concerned with the role of the private sector.

People of other countries have a hard time figuring out our system, and so do we at times. They want to know who is in charge of standardization domestically and who represents the United States internationally. The answer is, our system is unique. Private sector organizations represent U.S. interests in non-governmental international standards bodies.

Part two of our U.S. policy on international standards concerns the legislated areas of involvement. Federal agencies represent the United States when our government is party to a treaty or agreement. There are about 70 treaty

NBS GATT Standards Code Activities

The GATT Standards Code, which went into effect on January 1, 1980, was designed to eliminate the use of standards, technical regulations, and certification systems as unnecessary barriers to trade. Four federal agencies oversee its implementation: Office of the U.S. Trade Representative, trade policy; Department of Commerce, domestic policy, inquiry point, and technical office for non-agricultural products; Department of State, diplomatic policy; and Department of Agriculture, technical office for agricultural products.

The Department of Commerce assigned to the NBS Office of Product Standards Policy several responsibilities in the areas of standards information and technical assistance. Specifically:

- The Bureau operates the National Center for Standards and Certification Information (NCSCI). NCSCI provides information on more than 250,000 domestic and international standards from all parts of the world. Write or call: NCSCI, A629 Administration Bldg., National Bureau of Standards, Gaithersburg, MD 20899, 301/921-2587.
- NBS maintains a GATT hotline for up-to-date information on notifications of proposed foreign regulations. Call 301/921-3200.
- NBS acts as the U.S. GATT Inquiry Point. Inquiry Point staff report proposed U.S. government technical rules that might affect trade to the GATT Secretariat in Geneva, Switzerland. They also circulate and publish notifications of proposed foreign regulations. For information, write or call Standards Code and Information, A629 Administration Bldg., Gaithersburg, MD 20899, 301/921-2092. A newsletter that informs readers of federal services available to industry in support of the GATT Standards Code can be obtained from the same office.
- In addition, the Bureau operates a technical office to provide assistance to U.S. exporters on specific technically-based, standards-related issues. The office also handles complaints from U.S. industry concerning current foreign standards and certification practices that are considered technical barriers to trade. For assistance, call 301/921-3272.

organizations concerned with standards, but three are probably of primary importance: the Treaty of the Meter, the General Agreement on Tariffs and Trade (GATT), and the International Organization of Legal Metrology (OIML). The National Bureau of Standards has been delegated responsibility in all three. Under the Treaty of the Meter, adhered to by all the developed nations of the world, we keep our country's basic measurement standards in harmony with those of other nations. These physical measurement standards are the underpinning for virtually all of the world's written technical standards.

The International Organization of Legal Metrology is an offshoot of the Treaty of the Meter. It was established in 1955, but the United States didn't join until 1972. NBS has managed this country's participation since that time. OIML deals with the generally regulated areas of metrology, like weights and measures, pollution monitoring and control systems, and medical instruments and products. The Bureau seeks advice from all major interest groups as it represents the U.S. position on OIML standards.

In particular, I want to focus on the General Agreement on Tariffs and Trade. NBS has been assigned a number of responsibilities under the GATT [see box], the system of free trade espoused by some 90 nations. The last round of the Multilateral Trade Negotiations under the GATT produced the GATT Agreement on Technical Barriers to Trade (popularly known as the Standards Code), which is a set of principles governing how a nation should set standards and regulations and test products. The intent is to make standards and certification "trade neutral." Signatories to the Standards Code are obliged to make their domestic standards consistent with international standards wherever possible. The Code also provides a means by which one nation can comment on another nation's proposed standards and a mechanism for resolving complaints concerning Code violations.

The GATT Standards Code is embodied in U.S. law through the Trade Agreements Act of 1979. Under this law, the Code is carried out by several government bodies, including the Office of the U.S. Trade Representative, the Department of Agriculture, and the Department of Commerce—in particular NBS—all in consultation with industry through an industrial advisory committee.

Finally, we come to part three of U.S. standards policy: policy of the Executive Branch, which is set out in circular A119 from the Office of Management and Budget. It complements the Gatt Code legislation, stating that it is government policy to rely on voluntary standards, domestic and international; to participate in voluntary standards bodies; and to coordinate agency participation in voluntary standards.

NBS has major responsibility for OMB A119. The Bureau is delegated authority, by the Secretary of Commerce, to coordinate and encourage adherence to A119 guidelines. NBS is also responsible

Standards-writing organizations around the world are vying to get their standards recognized or adopted internationally.

for managing the Interagency Committee on Standards Policy.

I have iterated in some detail all these various mechanisms for standards development and application. And now you're probably wondering. . . So what?

Let me phrase the question in perhaps a more productive way. Why should government and industry be interested in standards development? Especially why should government care about industrial standardization? Larry Eicher, secretary general of the International Organization for Standardization, addressed that question at the NBS Conference on International Standardization last summer. He gave four main reasons for government interest in standardization:

1) Governments are concerned about national economic well-being. Standardization is understood to affect production, output, quality, interchangeability, and so on.

2) Government wants to effect better safety, health, environmental quality, and so on. Most important, it can often do so by turning to standardization to accomplish its goal without regulation.

3) Standards help translate research into practice, and government is a big spender in R&D generally, so it has a vested interest in seeing this accomplished.

4) Finally, government can use standards conveniently and efficiently to procure items.

Now how about industry. Why should industry care about international standards—or domestic standards—enough to spend money to support their development.

NBS has been asking that question of many companies. They perceive that they need to participate in standardization, particularly international standardization, for the following purposes: for universal product or test method standards; for defensive action (to counter foreign competition); to minimize regulatory standards; to advance U.S. position in standards development; and for rapid state-of-the-art advance in technology.

Next, we see that companies feel a number of benefits accrue to them when they participate in standardization. Among them: standardization contributes to broader market base for exports; it is a source of information on foreign technology; higher quality standards result from U.S. presence; and participants achieve professional growth.

Now we know each other's reasons for participating in standardization. What is left to make a success out of our joint venture?

We—government and industry—must participate actively, effectively, and cooperatively, over time, in the domestic and international standards arenas.

We—government and industry—must participate actively, effectively, and cooperatively, over time, in the domestic and international standards arenas.

We have other alternatives, of course. We can refuse to participate, or do so ineffectively, or even try to impede the system. But we can count on one outcome whatever course we choose: International standardization will go on with us, without us, or in spite of us.

Finally, let's talk about commitment. I can't speak to yours, but I can speak for the commitment of the National Bureau of Standards to the consensus-standards process. We have 440 of our staff currently holding some 1,400 standards-committee memberships in domestic and international organizations.

Furthermore, we consider ourselves a national resource in support of the competitive interests of U.S. industry. We're ready, willing, and able to help you succeed in the global marketplace. I invite you to come to NBS for a visit, and we can go into detail about the many mechanisms NBS has for cooperative research and supporting services to industry.

I also urge you to carefully examine your commitment to standardization. Your goal, I know, is to remain successful in the world market. It takes company money and staff time to support standards making. But it is an investment in your competitive success, worldwide, and the economic health of this nation.

Counterfeit Chlorophyll, Artificial Algae—the Perfect Energy Device

For years, a certain group of research chemists have nursed this dream.

There is a black—well, blue-green—box lying in the sunlight. Water is piped into one end, and hydrogen and oxygen are pumped out the other. Later that night, the hydrogen and oxygen are combined to recreate the water and release the Sun's energy in the form of heat or electricity.

The perfect energy device. Physicists have been very visible in their search for ways to use the Sun's energy, either with solar heating units or photoelectric cells, but chemists know there is another way, one that's been used by Nature for billions of years.

Photosynthesis. For 3 years now, Anthony Harriman of London's Royal Institution, Pedatsur Neta of the National Bureau of Standards' Center for Chemical Physics, and their colleagues in London and Gaithersburg, Md., have been working to improve a technology invented by Nature. Plants do fairly well, but their end product is really not the best fuel. What would be really nice is a neat, simple system, completely controlled, with nothing to add but water, and no waste products to worry about.

Such a chemical quest is an arcane-sounding undertaking, but for the researchers involved, it boils down to a long, long time spent trying one chemical combination after another, analyzing the results—looking for clues to the most efficient, practical system.

"Breaking down water into hydrogen and oxygen, there are really two reactions to consider," explains Neta at a chalkboard. "They are the oxidation of two water molecules to an oxygen molecule, plus four hydrogen ions, plus four electrons, and the complementary reaction, where two hydrogen ions plus two electrons are reduced to a molecule of hydrogen gas.

"In all plants you can isolate these two reactions," Neta says.

The first complication is that water does not by itself absorb light to power these reactions. Something must be added to absorb light energy. This, Neta, explains, leads to another pair of reactions.

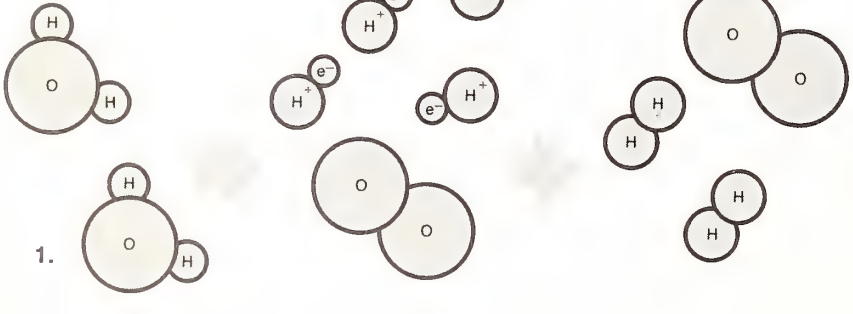
Some molecule called a "donor" receives a photon of light and becomes a donor with excess energy—chemists call it a molecule in an "excited state." It resolves this by "donating" an electron to another molecule, called an "acceptor." We're left with a donor shy an electron, and an acceptor with one too many electrons. The whole game is played by shuffling electrons around.

Now that we have electron-shuffling agents, we can go back to the original problem. The acceptor molecules, now each with an extra electron, promote the production of hydrogen molecules from water, because that reaction requires additional electrons.

This leaves the ionized donor molecules each looking for an additional electron, but they can be used in the production of oxygen molecules from water because that reaction produces extra electrons.

If everything works out just right, the donor and acceptor molecules are left back in their original states, ready to begin the cycle over again. (They are called catalysts,

Counterfeit Chlorophyll—As Easy As One, Two, Three...



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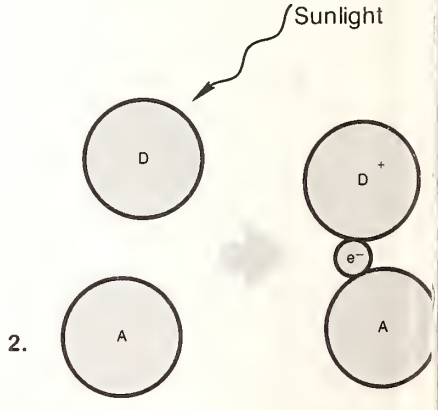

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1. Breaking down water molecules into their component gases involves two basic events. The creation of an oxygen gas molecule (with two oxygen atoms) releases four electrons. The creation of a hydrogen gas molecule (with two hydrogen atoms) requires two electrons. The two reactions balance, but the process requires adding energy.

because they promote the reactions without themselves being changed.)

Oddly enough, Harriman explains, the critical difficulty is not to produce the fuel, but rather to produce the oxygen molecules. "The problem isn't on the acceptor end. Many people have produced hydrogen gas from water molecules, but they allow the donors to react with something other than water. That ends up costing you energy and money, because whatever you react with the donor gets transformed and lost to the system. You have to keep supplying more of it.

"It looks unimportant, because you don't need any extra oxygen; when you want to burn the hydrogen, there's plenty of oxygen to be had. But if you don't balance the system, producing oxygen as well as hydrogen, it costs you."

Green plants manage this trick by using chlorophyll, which is fine for them, but chlorophyll is too unstable for use on an industrial scale. Still, it might be possible to use some simplified form of chlorophyll.

A number of photosynthesis researchers thought of a group of chemicals called porphyrins, which are basic constituents of both chlorophyll and hemoglobin, but after a great deal of work at several different laboratories, there was still no conclusive evidence that one could oxidize water using a porphyrin. The main problem was that the positively charged (electron-poor) ions of porphyrin were very unstable. They didn't last long enough to get involved in the oxygen-producing reaction.

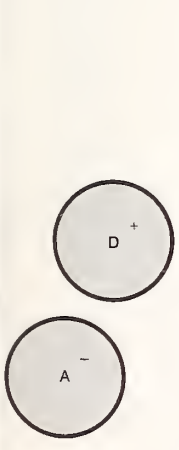
The NBS-Royal Institution collaboration, with support from the U.S. Department of Energy, brought exacting analysis techniques to bear on the problem. Royal Institution chemists are conducting painstaking experiments to measure the oxygen produced in reactions with each possible porphyrin—a challenging piece of lab work, because any atmospheric oxygen in the system will contaminate the experiment and lower the accuracy of the results.

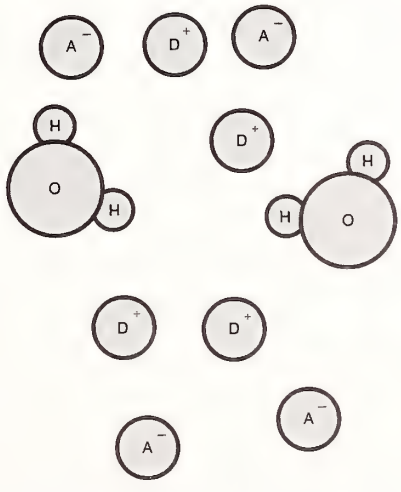
Neta at NBS contributes pulse radiolysis analyses—an advanced measurement technique that allows the researcher to create, almost instantaneously, a quantity of a specific reactant under controlled conditions and observe the progress of the reaction. Pulse radiolysis analysis is capable of observing chemical reactions over amazingly short periods of time; some that Neta works with take just a few thousandths of a second. NBS is one of only a handful of institutions in the world with a laboratory for pulse radiolysis experiments.

"We set out to prove that it is possible to take a porphyrin as a model for chlorophyll and use it for oxygen generation, something which had never been done before," explains Harriman. Based on their reaction studies, they selected a zinc porphyrin, a porphyrin-based compound built around a zinc atom.

Which brought up the second, even trickier, problem: getting all the components of the reaction together in one place long enough for the reaction to occur.

"That problem hasn't anything to do with the photochemistry," says





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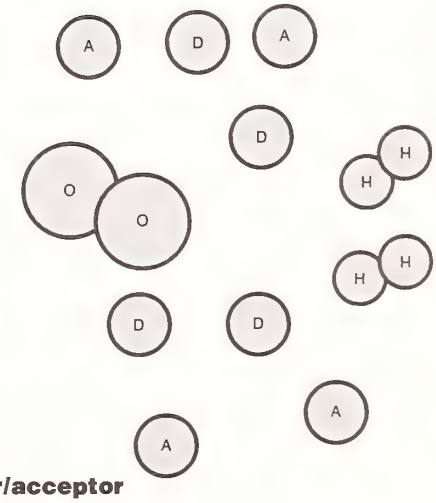
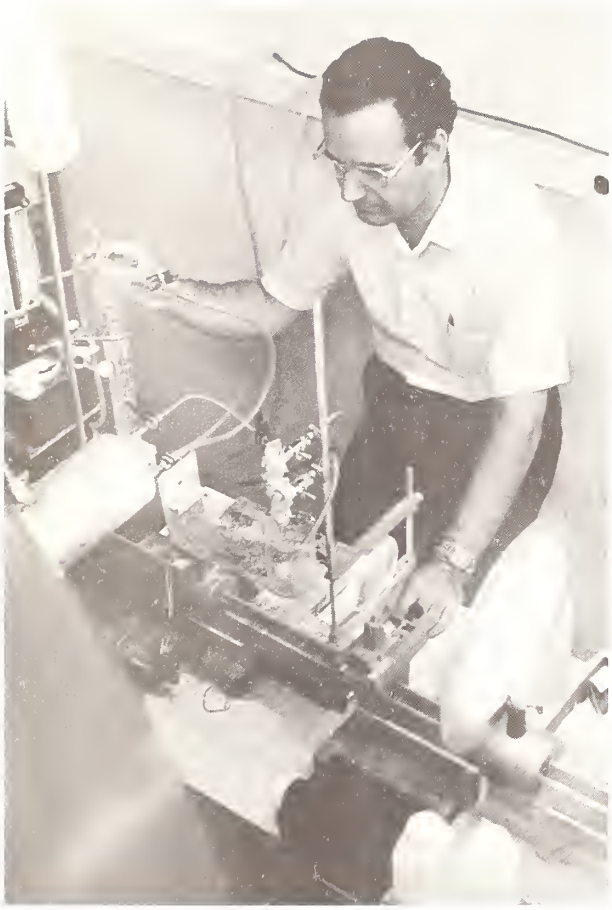


2. Since water doesn't absorb energy from sunlight very efficiently, special "donor" and "acceptor" molecules are used. The donor absorbs energy from sunlight, and uses that energy to release an electron, which is captured by the acceptor.

3. Combining the proper donor/acceptor system with water molecules gives a balanced system that converts sunlight into the energy needed to separate water into its component gases, in theory.



Dr. Pedatsur Neta uses pulse radiolysis analysis to observe chemical reactions that take place in just a few thousandths of a second.

Harriman. "You can generate the donor ions at near 100 percent efficiency. The problem is that the basic photochemical reaction involves only one electron at a time. But you can see from the reaction equations that you have to get four positively charged donors together at the same place, at the same time, so that the electron exchange can occur."

What's needed is a sort of matchmaking catalyst that fastens down four ionized zinc porphyrin molecules close enough to each other to attract the attention of a water molecule.

"The catalyst we arrived at, ruthenium oxide, was identified by electrochemists 40 or 50 years ago as being good for generating molecular oxygen," Harriman continues. "The trick was to get it in a colloidal form so that it would be a good catalyst for the photochemical process."

A colloid is a very fine collection of particles suspended in a fluid—not unlike a gel. The ruthenium oxide promotes the oxygen-generating reaction by providing a surface where the four zinc porphyrin molecules and the two water molecules can get together. The greater the surface area, the better the reaction works. Colloidal suspensions have a lot of surface area.

"One big problem has been that the catalysts made in any one lab have tended to be unique for one reason or another—people couldn't reproduce the work done in other labs. One of our major contributions has been the development of this very basic ruthenium oxide catalyst: It's effective, readily available, not horrendously expensive, and anyone can make it and get the same results," Neta observes.

At the end of last year, the team produced the first examples of oxygen generated from water by a catalyzed zinc porphyrin.

So is the vision a reality now? "We're about half finished," Harriman estimates. "we need to know much more about the kinetics of these reactions—how they happen, and at what rates—and about the basic mechanisms of the catalysts. Although we can describe it quite simply, we really need a much more basic understanding.

"The pulse radiolysis analysis is very helpful for just that reason, it allows you to observe the kinetics of the reaction. As a matter of fact, we're now in a position to help the electrochemists, because it's very difficult for them to do these kinetic measurements. We can give them some information back in return for having stolen the idea of using ruthenium oxide," says Harriman.

"We are now trying different catalysts and different porphyrins to try and optimize the reaction," says Neta. "One problem at present is that the rate of oxygen production improves as the solution gets more alkaline. Right now we're working at about pH 10. The hydrogen production goes the other way, however, so ideally you'd want to work with a nearly neutral solution—about pH 7.

Neta at NBS contributes pulse radiolysis analyses—an advanced measurement technique that allows the researcher to create, almost instantaneously, a quantity of a specific reactant under controlled conditions and observe the progress of the reaction.

"The number of combinations and experiments is almost limitless, but the pulse radiolysis technique at least shows what direction to move towards. It's surprising, too. There are porphyrins that, based strictly on chemical energy considerations, should work very well; when you examine the reaction kinetics with pulse radiolysis, you discover that they don't interact with the ruthenium oxide catalyst."

Careful, cautious measurements are necessary to sort through all the possible combinations of reactants and catalysts to find the best solution, Neta and Harriman agree. A long task, and challenging, but there's a certain air of exciting competition.

"It's sort of a battle, or maybe a race," remarks Harriman, "to see where the best solar energy system will come from—chemical photosynthesis or solid-state electronics." M.B.

Burgers, Fries, Pizza Pies: All Part of Massive Study of Worldwide Diets

The scientist pulls a slice of pizza out of a freezer and drops it into a large blender.

He does the same with frozen samples of cooked steak, french fries, spinach, eggs, and other staples of the American diet. Even water. Tossing in some "cocktail" made of whiskey, beer, and other commonly consumed beverages, he revs up the blender and the blades start whirring.

The resulting creamy broth is a research "recipe": an accurate composite that represents the average daily food intake of a 25- to 30-year-old adult male in this country. About 3,075 grams—roughly 15 coffee cups full—make up this portion. At this point, the 201 different foods that make up breakfast, lunch, and dinner are now a scientific material that will be freeze-dried, then studied, and studied again.

The scene is the National Bureau of Standards. Here, NBS scientists, along with researchers from the Food and Drug Administration (FDA) and the Department of Agriculture (USDA), have joined forces with the Vienna, Austria-based International Atomic Energy Agency (IAEA), which has initiated an elaborate study of diets in 11 countries, including the United States. Dubbed the "Coordinated Research Program on Human Dietary Intakes of Biologically Important Trace Elements," the project is what Dr. Venkatesh Iyengar, chief scientist of the U.S. portion of the study, calls "an unusual meeting of minds in which each agency's expertise is a crucial link for making the program a success." Iyengar brings his dietary experience to the project from a 1983 international nutritional study of mother's milk sponsored by the World Health Organization and the IAEA.

The IAEA's main motivation for starting the new study and involving the U.S. experts is that very little nutritional information, especially for trace elements, exists for many different foreign countries or population groups. Also, much of the available information is of unknown reliability because of poor or no quality control in sample collection and analysis.

On the other hand, the United States holds a leading position in several aspects of nutritional sciences. For example, over a period of about 40 years, the concept of Recommended Dietary Allowances (RDA), which are daily requirements deemed necessary for good health, has evolved. This list of numbers is often found on packaged food products sold in the United States and is used in numerous government-sponsored food programs, such as school lunches and food stamps, to determine allocations.

NBS is developing analytical methods for measuring trace element concentration with emphasis on assuring the quality of data collection.

The current dietary study will examine 24 biologically important trace elements. These include well-known ones such as calcium, iron, and zinc; beneficial elements like chromium and selenium, which can be toxic in large doses; and other components such as aluminum, arsenic, cadmium, and lead, which besides being part of the daily diet are considered potential health hazards at elevated concentrations. Also to be measured will be food energy, fiber content, and phytates (which affect nutrient absorption).

Each country is developing mixed total diet samples representative of foods consumed by typical families in each of three target population groups. . . .

In addition to examining the U.S. diet, the study will analyze diets from Brazil, Canada, China, Iran, Italy, Spain, Sudan, Sweden, Thailand, and Turkey (all chosen by the IAEA). Each country is developing mixed total diet samples representative of foods consumed by typical families in each of three target population groups—high, average, and low incomes. Sampling procedures, sample preparation, and data evaluation all are being rigidly controlled.

An international network of reference laboratories around the world will perform analyses after being checked for accuracy with NBS food composite standards. Some freeze-dried diet composites are being bottled at NBS as standards for determining the reference labs' performance. Bureau scientists are banking others periodically in liquid nitrogen freezers—at about −150 °C—as "yardsticks" to track future trends in nutrient intake.

The idea of freezing biological samples for future analysis is one NBS has been practicing for several years. The Bureau entered

Drs. Venkatesh Iyengar (l.) and Rolf Zeisler drop food specimens into a blender that will mix them into composite diet samples representing the daily dietary intake of the average 30-year-old male in the United States.

the field of biological monitoring in 1978 with the establishment of its Pilot Environmental Specimen Bank. This project, initially supported by the Environmental Protection Agency and now funded by other agencies as well, has developed methods for selection, collection, analysis, and storage of biological specimens such as human livers and marine mussels for future examination. Experience gained from specimen banking is proving valuable to the human dietary study.

Dietary project researchers eventually hope to build a scientific database of food composition and intake that will help pinpoint nutritional deficiencies, especially in the

developing countries included in the project. "When we get enough data of selected population groups, we plan to compare actual dietary intakes with present estimates of requirements to detect possible imbalances in trace element consumption," Iyengar says. "This will open the way to linking health problems to nutritional inadequacies

Dietary project researchers eventually hope to build a scientific database of food composition and intake that will help pinpoint nutritional deficiencies, especially in the developing countries included in the project.

and will set the stage for intervention if necessary to improve the health of the target population group."

Though such a study can have important global importance, very little federal money has been needed for this project. Iyengar, a visiting scientist at NBS whose salary is split by the three federal agencies, says, "The beauty of our project is that the resources already existed in the different agencies, and we merely had to pool them."

He adds that another advantage of involving several agencies and countries is that "we get the contributions of different scientific disciplines, and after the work is done, the things we have all learned will be shared with participating countries."

The primary contributions of the participants are as follows:

□ The IAEA is in charge of coordinating the entire program and ensuring reliable sample collection in the countries involved in the project. Dr. Robert M. Parr, who heads the IAEA's medical applications department, is supervising this work.

□ The FDA will collect the U.S. food samples for delivery to NBS. An FDA program, called the Total Diet Survey, already exists in which foods are purchased from grocers across the country and evaluated for exposure to factors such as nutritionally important elements, industrial pollutants, and pesticides. Dr. James Tanner, an FDA specialist in nutrient surveillance, is coordinating his agency's contribution.

□ The USDA is responsible for analyzing the phytate levels of all the samples and for developing procedures to evaluate the project's research data. USDA research chemist Dr. Wayne R. Wolf is at the helm of this part of the project.

□ NBS is developing analytical methods for measuring trace element concentration with emphasis on assuring the quality of data collection. As the nation's measurement reference laboratory, NBS practices this type of chemistry in a variety of applications. Food analysis is a fairly new addition to the Bureau's chemical specialties. Iyengar and Dr. Rolf Zeisler, a Bureau specialist in analysis of inorganic trace elements, will handle the NBS duties.

Zeisler recalls that at about the time the project began in the early 1980's, NBS was planning to use its newly established Environmental Specimen Bank—which was already slated to bank human livers

The current dietary study will examine 24 biologically important trace elements.

and marine mussels—for storage of food samples. At the same time, the IAEA was interested in starting a global dietary study but needed help. With NBS' interest and the addition of the FDA and USDA, the project is now under way.

Several of the 201 foods being analyzed for the human dietary study are shown. The small disc is a compressed sample of freeze-dried food composites that will be analyzed for concentration of certain trace elements.

"This is an excellent opportunity for NBS to share its expertise in a nutritional study by developing improved analytical procedures and standards," Zeisler says. "This is only a pilot project, but it gives us a chance to test our skills and think about what needs to be done to achieve more reliable measurements."

Zeisler adds that the experience gained from the study will allow further dietary investigations that would examine factors such as organic nutrients (vitamins) or potential contaminants.

by John Henkel
NBS Public Affairs Specialist

JILA Astronomers First to Detect Magnetic Fields on a Flare Star

Astronomers at the Joint Institute for Laboratory Astrophysics (JILA) in Boulder, Colo., have for the first time detected the presence of strong magnetic fields on the surface of a flare star. Their finding should aid in the understanding of stellar activity, such as flares, "spots," and hot coronas on some stars.

Dr. Jeffrey L. Linsky and Mr. Steven H. Saar made their discovery based on observations made in March 1985 with the National Optical Astronomical Observatories' (NOAO) 4-meter Fourier Transform Spectrometer located at Kitt Peak National Observatory near Tucson, Ariz. Their results were reported in the December 1, 1985 issue of the *Astrophysical Journal*.

. . . result may provide the key as to why flares observed on the flare stars are vastly more energetic than on the Sun.

JILA is a joint operation of the National Bureau of Standards and the University of Colorado (CU) and is located on the university campus in Boulder. Linsky is an NBS astronomer; Saar is a CU graduate student.

The presence of magnetic fields on the Sun has been known for more than 60 years, and strong magnetic fields were presumed to exist on other stars. Measuring those fields, however, has been extremely difficult. Normal spectrographic techniques that measure the circular polarization produced by magnetic fields, one aspect of the so-called Zeeman effect, do not work because the magnetic fields are randomly oriented and the circular polarizations from different portions of the stellar surface are cancelled out in the light from the whole star.

In 1979 Richard Robinson of NOAO's Sacramento Peak Observatory proposed a different measurement technique. He suggested that the magnetic field on a star could be measured from spectra in unpolarized light by comparing pairs of dark lines, one with large magnetic broadening (the other aspect of the Zeeman effect) and one with lesser broadening. This technique works in measuring solar magnetic fields because dark lines are broadened both when the magnetic field is pointed towards and away from the observer. Also, on the solar surface away from dark sunspots, the magnetic field appears to be clumped into thin tubes, most of which appear to have the same magnetic field strength (about 1500 gauss, or some 3000 times the Earth's field).

Robinson and his coworkers, Drs. S. Peter Worden and John Harvey of the National Solar Observatory, applied this new technique to the star Xi Bootis A, a star similar to but somewhat younger than the Sun, and detected a magnetic field of 2550 gauss covering about 30 percent of the stellar surface. Subsequently, Dr. Geoffrey Marcy of the University of California at Santa Cruz and several other astronomers have measured fields in a number of stars similar in temperature to the Sun.

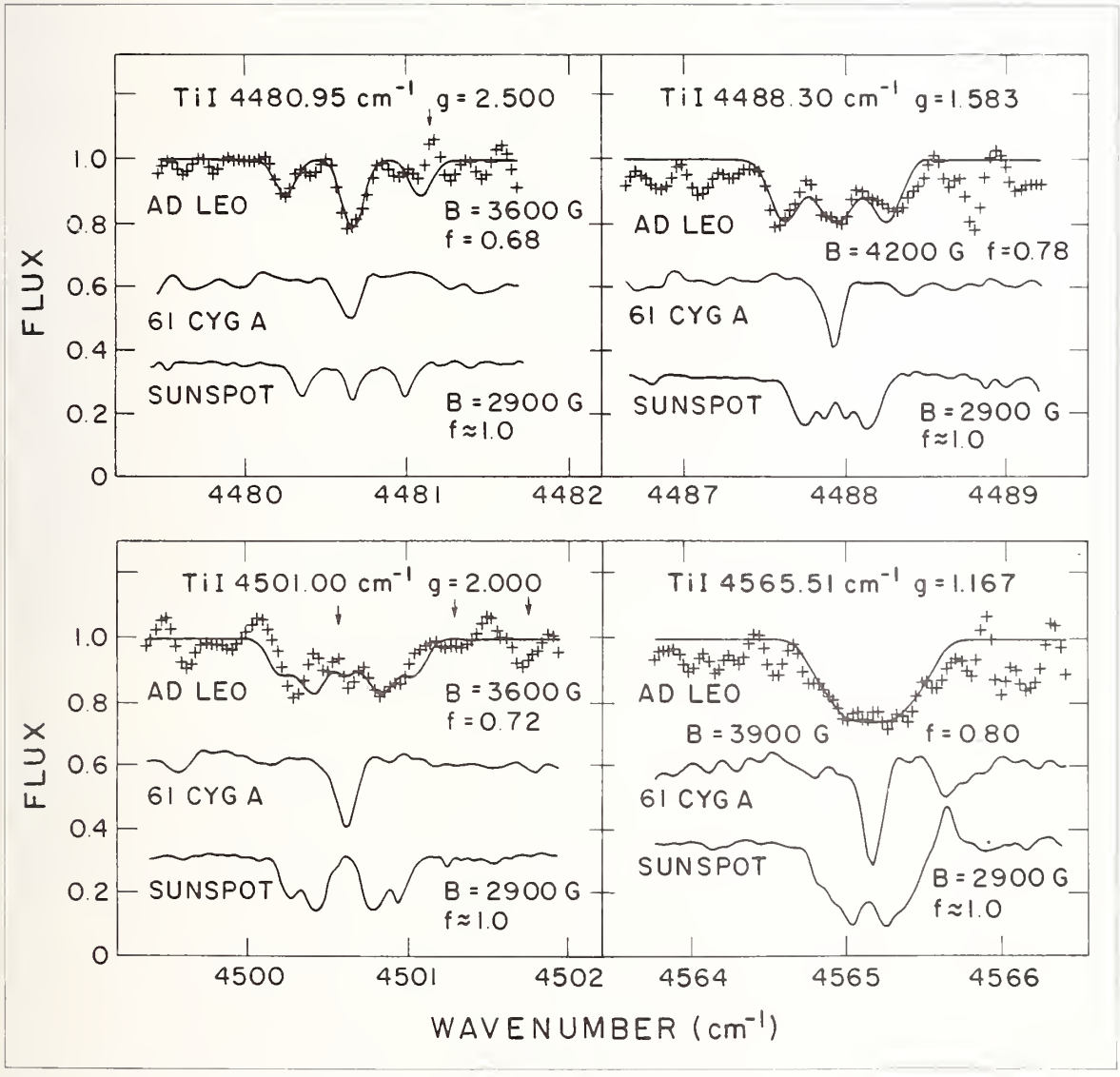
The next logical step would be to measure fields in the stars for which the largest fields have been predicted. These are the flare stars, so called because these cool red dwarf stars are known to suddenly increase in brightness during flares that are thousands of times more energetic than analogous flares on the Sun. Several previous attempts to measure fields on these stars have been unsuccessful because these stars are very faint and their spectra are very complex.

"To understand solar activity, we must understand magnetic fields and how they interact with hot plasmas in the solar atmosphere," Linsky says.

To accomplish their goal of measuring the magnetic field on a flare star, Linsky and Saar selected AD Leonis, one of the nearby members of this class. They elected to examine the star in the infrared because red dwarf stars like AD Leonis are brighter and the magnetic broadening of spectral lines is greater in the infrared than in the visible. Their analysis technique was an extension of Robinson's, except that they solved exactly the equations governing the formation of spectral lines.

Linsky and Saar detected the presence of strong magnetic fields with an average strength of 3800 gauss on AD Leonis in active regions outside of dark spots. This value of the field strength is very interesting because the resulting pressure of the magnetic field equals the gas pressure at the deepest layers of the star visible optically, a phenomenon found earlier on the Sun. The magnetic fields on AD Leonis and presumably the other flare stars are much stronger than on the Sun because the gas pressure in the visible layers is much greater. The result may provide the key as to why flares observed on the flare stars are vastly more energetic than on the Sun.

Knowledge of magnetic fields is considered of prime importance to astronomers. On the Sun, for example, many of the most interesting phenomena such as flares, hot coronas, microwave emissions, and variable ultraviolet radiation are



The spectra of the flare star AD Leonis (crosses) are compared here with similar spectra of the magnetically inactive star 61 Cygni A and a sunspot. These data were obtained using the 4-meter Fourier Transform Spectrometer at Kitt Peak National Observatory. The magnetic Zeeman splitting of the four spectral lines of titanium is clearly present in the sunspot spectra and the AD Leonis spectra, but not in the spectra of the magnetically inactive star 61 Cygni A. The solid line through the spectra of AD Leonis is a theoretical fit to the magnetic Zeeman pattern for that star.

magnetically connected. "To understand solar activity, we must understand magnetic fields and how they interact with hot plasmas in the solar atmosphere," Linsky says. He adds, "We presume the same happens on the most active stars, the flare stars. This observation of a strong field on the star AD Leonis is the first direct and unambiguous piece of evidence that such fields exist."

by Fred McGehan
NBS Public Affairs Specialist

NEW PUBLICATIONS

MEASUREMENT NEEDS OF CHEMICAL AND PROCESS INDUSTRIES

Hord J., ***Survey of Measurement Needs in the Chemical and Related Industries,*** *Natl. Bur. Stand. (U.S.), NBS Tech. Note 1087, 104 pages (July 1985). Order by stock no. 003-003-02671-9 from GPO, $3.75 prepaid.*

A survey of the measurement needs of the chemical and related processing industries has been conducted by the NBS Center for Chemical Engineering. The survey was part of a continuing effort to help instrument manufacturers and users as well as government agencies focus available national resources on the most pressing measurement problems of these industries, in order to improve product/process quality and reduce costs. Survey questions were answered by 65 recognized experts from the chemical, oil and gas, pharmaceutical, electronic chemicals, energy, instrument manufacturing, food, and plastics sectors of industry. They identified 133 measurement problems; the most frequently cited areas in need of improvement were flow, composition/concentration, and temperature.

FUTURE OF U.S. ADVANCED CERAMICS INDUSTRY

Schneider, S.J., ***A National Prospectus on the Future of the U.S. Advanced Ceramics Industry,*** *Natl. Bur. Stand. (U.S.), NBSIR 85-3240, 147 pages (July 1985). Send a self-addressed label to Samuel J. Schneider, B309 Materials Building, National Bureau of Standards, Gaithersburg, MD 20899, 301/921-2891.*

In July 1985, a group of 140 leaders in ceramics from industry, government, and universities agreed they must aggressively exploit the potential for cooperative industrial research and development if industry is to take advantage of new markets estimated to be tens of billions of dollars annually by the end of the century. They met at NBS to assess the competitive position of the U.S. advanced ceramics industry and to develop approaches for improving growth and productivity. Participants concluded that some markets may be lost, but future opportunities exist for high-performance ceramics in heat engines, cutting tools, and advanced electronics. This publication reports on the July conference sponsored by NBS and the Department of Commerce. The proceedings contain remarks by keynote speaker Rep. Don Ritter, R-Pa., and industry overviews and assessments by Albert R.C. Westwood of Martin Marietta Laboratories, Sy L. Blum of Charles River Associates, Inc., and Julius Harwood of Ovonic Synthetic Materials Co. At the request of conference attendees, the Department of Commerce has agreed to work with an industrial steering committee to promote cooperative research in this area.

SURVEY OF WORLDWIDE OPTOELECTRONICS INFLUENCE

Tassey, G., ***Technology and Economic Assessment of Optoelectronics,*** *Natl. Bur. Stand. (U.S.), Planning Report 23, 84 pages (October 1985). Send a self-addressed label to Dr. Gregory C. Tassey, A1002 Administration Building, National Bureau of Standards, Gaithersburg, MD 20899, 301/921-3872.*

Japan is currently ahead in the worldwide race to commercialize the optoelectronic products that constitute major components of fiber-optic and other information-handling systems. However, the United States, through its superior science base, can catch up if industry and government programs concentrate on transferring products to market quicker. This NBS report projects the impacts of optoelectronics technology on the economy between now and the turn of the century. (Worldwide research and development in this technology is projected to reach $1 billion annually by 1987.) The study also estimates that the federal government's contribution to optoelectronics measurement technology could save the economy $100 million to $200 million a year by 2000. But the report cites other studies that suggest industry will likely underinvest in measurement despite the critical importance of such technology in boosting U.S. competitiveness in marketing optoelectronics. The Bureau study urges a strong liaison between NBS, the nation's primary supplier of nonproprietary measurement and test methods, and industrial firms to bolster this crucial optical measurement technology.

HIGH VOLTAGE, RESISTANCE CALIBRATION REPORTED

Misakian, M., ***High Voltage Divider and Resistor Calibrations,*** *Natl. Bur. Stand. (U.S.), NBS Tech. Note 1215, 31 pages (July 1985). Order by stock no. 003-003-02672-7 from GPO, $1.25 prepaid.*

Industrial and government laboratories that have devices calibrated as standards for measuring high direct current (dc) voltages and resistances should find this NBS report useful. It is a guide to the NBS calibration service for determining dc voltage ratios and total resistance of voltage dividers and resistors. Typical applications of calibrated high dc voltages include x-ray machines, paint sprayers, and transmission of electrical energy. The publication contains diagrams and photographs of the Bureau's calibration apparatus, including descriptions of the Wheatstone bridge circuit and standard resistors that form the heart of the calibration system. Also discussed are the operating procedures NBS used to maintain the apparatus and to perform the calibrations.

THEORY OF MEASUREMENT OF LASER PULSE ELECTRIC FIELD

Johnson, E.G., Jr., ***Direct Measurement of the Electric Field of a Laser Pulse—Theory,*** *Natl. Bur. Stand. (U.S.), NBS Tech. Note 1084, 60 pages (August 1985). Order by stock no. 003-003-02697-2 from GPO, $2.25 prepaid.*

NBS has begun to develop a system to measure the time and spatial features of the electric field of a laser pulse with at least 1 percent accuracy. The principal features of the system include use of a computer-generated spatial filter to convert the laser beam into a form suitable for fiber-optic processing; an optical fiber located at each selected measurement point in the filtered beam—these fibers contain a "pinched" section to eliminate all but the fundamental modes; and a detector to measure the power from each fiber. The theoretical basis for the methodology and instrumentation is described in this report.

DIRECTORY TO STANDARD REFERENCE DATABASES PUBLISHED

Sauerwein, J.C. and Dalton, G.R., ***Standard Reference Data Publications, 1964-1984,*** *Natl. Bur. Stand. (U.S.), NBS Spec. Pub. 708, 143 pages (December 1985). Order by stock no. 003-003-02705-7 from GPO, $5 prepaid.*

NBS through the National Standard Reference Data System (NSRDS) has prepared a new directory of publications and computerized databases for scientists, engineers, and others in industry, government, and universities who need reliable evaluated data on the chemical and physical properties of substances. The directory lists reprints and supplements from the *Journal of Physical and Chemical Reference Data,* other NSRDS data compilations and critical bibliographies, computer programs for handling technical data, and magnetic tapes in the National Standard Reference Database series. Authors, materials, and properties indexes as well as ordering information and price lists are included.

NEW SCALE CODES NOW IN PLACE

Warnlof, O.K., editor, ***Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices,*** *Natl. Bur. Stand. (U.S.), NBS Hdbk. 44-1986, 289 pages (September 1985). Order by stock no. 003-003-02679-4 from GPO, $12 prepaid.*

The work of hundreds of state and local inspectors who regulate weighing and measuring devices will be made easier now that the new "Scales Code" described in this handbook became effective January 1, 1986. Service and sales personnel, manufacturers, and users of these devices also will benefit from the new code, which is a major revision to the handbook. It provides a new tolerance structure based on the value and number of scale divisions and established classes of scales. The new code requires that scales manufactured after January 1, 1986, be marked to show the class designation for which they are designed. The new scales code has been adopted by the National Conference on Weights and Measures (NCWM), an organization of state, county, and city weights and measures enforcement officials and assorted business and consumer representatives. Through its Office of Weights and Measures, NBS provides technical assistance to NCWM and its committees.

NEW FIELD MANUAL FOR STATE AND LOCAL INSPECTORS

Brickenkamp, C.S., Hasko, S., and Natrella, M.G., ***Package Checking Field Manual to Accompany NBS Handbook 133, "Checking the Net Contents of Packaged Goods,"*** *Natl. Bur. Stand. (U.S.), NBSIR 83-3172, 128 pages (August 1985). Order by stock no. PB 86-108776/AS from NTIS, $16.95 prepaid.*

Manufacturers and producers of goods who must comply with the rules for anything put into a container, wrapped, branded, or labeled as to quantity should be interested in this supplement to NBS Handbook 133. Based on feedback from 30 workshops conducted by the NBS Office of Weights and Measures on packaged products compliance testing,it is an important field manual for both the experienced and novice inspector. It contains information on what industry needs to know about field and plant inspections and will assist users in maintaining quality control and assurance for packaged goods in the marketplace.

OPEN DATING REGULATION IN NBS HANDBOOK

Brickenkamp, C.S., editor, ***NBS Handbook 130-1986, Uniform Laws and Regulations,*** *Natl. Bur. Stand. (U.S.), NBS Hdbk. 130, 155 pages (September 1985). Order by stock no. 003-003-02676-0 from GPO, $7 prepaid.*

This edition contains important information for food producers and retailers on the new uniform open dating regulation adopted by the 70th National Conference on Weights and Measures (NCWM). Developed by NCWM and the Association of Food and Drug Officials, the regulation resolves differences in previous regulations produced by both organizations. It provides the states with two options: one requires open dating on all perishable foods, while the other sets a standard that must be followed by those who voluntarily use open dating. Another change in the handbook provides the states with options for adopting all recommended NCWM weights and measures regulations by reference and/or by automatic adoption of supplements or revisions of an NCWM regulation. NBS provides technical assistance to NCWM, an organization of state, county, and city weights and measures enforcement officials and associated business and consumer representatives.

STANDARD REFERENCE MATERIAL USERS GUIDE

Taylor, J.K., ***Handbook for SRM Users,*** *Natl. Bur. Stand. (U.S.), NBS Spec. Pub. 260-100, 98 pages (September 1985). Order from the Office of Standard Reference Materials, B311 Chemistry Building, National Bureau of Standards, Gaithersburg, MD 20899, 301/921-2045.*

NBS has published a handbook for users of its more than 900 different Standard Reference Materials (SRM's). Used as primary standards in science, industry, and technology, SRM's include materials such as environmental pollutants, cements, ores, glasses, foods, and metals. Though numerous journal articles and technical reports are available on the subject, this 85-page guide offers a detailed review of SRM use. Sections are included on quality assurance, precision and accuracy, reporting analytical data, and NBS services related to SRM's. Important factors such as calibration, statistical control, traceability, and data uncertainty also are covered.

ORDERING INFORMATION

To order publications from NTIS, send request with payment to: National Technical Information Service, Springfield, VA 22161. Publications can be ordered from GPO by mailing order with payment to: Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. ■

CONFERENCE CALENDAR

Workshop on Quantitative X-ray Diffraction Analysis, NBS, Gaithersburg, MD

June 23-24, 1986

This workshop will cover fundamental aspects of quantitative x-ray diffraction analysis and how they should be applied in the development of methods for quantitative analysis. Instrumentation, analytical techniques, and standards for quantitative x-ray diffraction will be discussed. Speakers will describe quantitative analysis of a number of specific materials, such as portland cement, ceramics, and clays. The expected participants are technical and research staff from a wide variety of industries. Sponsored by NBS. Contact: Leslie J. Struble, B348 Building Research Building, NBS, Gaithersburg, MD 20899, 301/921-2635 or Dr. Camden R. Hubbard, A247 Materials Building, NBS, Gaithersburg, MD 20899, 301/921-2845.

Conference on Precision Electromagnetic Measurements, CPEM 86, NBS, Gaithersburg, MD

June 23-27, 1986

CPEM 86 is the world's premier international conference for those in the fields of electromagnetic metrology and related fundamental physical constants. Papers describing original work, not previously published or presented, covering the theory, design, performance, simulation, or application of electromagnetic standards, measurements, techniques, instruments, or systems will be presented. Topics will include the following. EM-related fundamental constants and standards; direct current, low frequency, and RF; time, time-interval, and frequency; antennae and fields; microwaves and millimeter waves; infrared, visible, and ultraviolet radiation; lasers; electro and fiber optics; cryo-electronics; automated measurements; and technical calibration services.

The 1985 Nobel laureate in physics, Klaus von Klitzing, will give a talk on his award-winning work in solid-state physics. Von Klitzing, who directs the Max Planck Institute for Solid State Research in Stuttgart, West Germany, was given the Nobel prize for his discovery of the quantization of the classical Hall effect in certain semiconductor devices at cryogenic temperatures and in the presence of a strong magnetic field. Sponsored by NBS, IEEE Instrumentation and Measurement Society, and Union Radio Scientifique Internationale. Contact: Norman Belecki, B146 Metrology Building, NBS, Gaithersburg, MD 20899, 301/921-2715.

10th Triennial Congress of the International Council for Building Research, Studies, and Documentation (CIB), Convention Center, Washington, DC

September 21-26, 1986

The technological and social issues facing the international building industry in advancing building technology in the coming years will be the focus of this congress. The conference theme will be addressed by examining three sub-themes: for the computer age, the challenges of advanced computation and automation to the building industry; for shelter for the homeless in developing countries, the development and implementation of appropriate technologies using local materials and building practices; and for translating research into practice, the results of CIB's technical working commissions and international building research and practice organizations in producing improved building practices. Over 600 abstracts have been approved for this congress.

CIB is an international building professional organization through which the international building community develops and exchanges findings on building research and practices. Its members come from 64 countries. The congress will interest the building industry worldwide—engineers, architects, builders, owners, developers, manufacturers, policymakers, regulatory officials, representatives from professional organizations, academia, and research laboratories. Sponsored by the Building Research Board, National Research Council of the National Academies of Sciences and Engineering and NBS. Contact: Noel J. Raufaste, CIB.86 Director, B226 Building Research Building, NBS, Gaithersburg, MD 20899, 301/921-3106.

1986 Meeting of the National Conference of Standards Laboratories, 25 Years of Measurement Progress, NBS, Gaithersburg, MD

October 6-9, 1986

Emphasis at this conference will be on new developments in metrology, new management techniques to efficiently utilize resources, as well as the emerging role of the metrologist in contributing to improved product quality and reliability. In addition, the program will give timely recognition to the pioneers of measurement science, and will take a look at the progress in measurement science over the past 25 years. Workshops will include special hands-on sessions to keep the metrology manager and engineer abreast of technological advances and new innovative ideas. Since the National Conference of Standards Laboratories (NCSL) will be celebrating its 25th anniversary during 1986, the program will include a special session dealing with the history and progress of the organization. Sponsored by NCSL and NBS. Contact: Ernest L. Garner, B362 Physics Building, NBS, Gaithersburg, MD 20899, 301/921-2805.

Thirty-Second Annual Conference on Bioassay, Analytical and Environmental Radiochemistry, NBS, Gaithersburg, MD

October 21-23, 1986

The ability to quantify minute amounts of radionuclides in a variety of difficult matrices continues to be important for the study and protection of humans and the environment. In this informal conference, researchers and analysts from government, industry, and academia will discuss new, improved, or even problem, analytical methods, interpret subsequent data, and evaluate health and environmental implications. The scope for the conference will include in vivo and in vitro bioassay, analytical method development, distribution and partition of radionuclides in the environment, and modeling and health significance of radionuclide pathways to humans. Sponsored by NBS, the U.S. Environmental Protection Agency, the U.S. Nuclear Regulatory Commission, and the U.S. Department of Energy. Contact: Kathy Stang, A353 Physics Building, NBS, Gaithersburg, MD 20899, 301/921-2255. ■

The National Bureau of Standards was established by an act of Congress on March 3, 1901. The Bureau's overall goal is to strengthen and advance the nation's science and technology and facilitate their effective application for public benefit. To this end, the Bureau conducts research and provides: (1) a basis for the nation's physical measurement system; (2) scientific and technological services for industry and government; (3) a technical basis for equity in trade; and (4) technical services to promote public safety. The Bureau's technical work is performed by the National Measurement Laboratory, the National Engineering Laboratory, the Institute for Computer Sciences and Technology, and the Institute for Materials Science and Engineering.

THE NATIONAL MEASUREMENT LABORATORY

Provides the national system of physical and chemical measurement; coordinates the system with measurement systems of other nations and furnishes essential services leading to accurate and uniform physical and chemical measurement throughout the nation's scientific community, industry, and commerce; provides advisory and research services to other government agencies; conducts physical and chemical research; develops, produces, and distributes Standard Reference Materials; and provides calibration services. The laboratory consists of the following areas:

- Standard Reference Data
- Measurement Services
- Basic Standards
- Radiation Research
- Chemical Physics
- Analytical Chemistry

THE NATIONAL ENGINEERING LABORATORY

Provides technology and technical services to the public and private sectors to address national needs and to solve national problems; conducts research in engineering and applied science in support of these efforts; builds and maintains competence in the necessary disciplines required to carry out this research and technical service; develops engineering data and measurement capabilities; provides engineering measurement traceability services; develops test methods and proposes engineering standards and code changes; develops and proposes new engineering practices; and develops and improves mechanisms to transfer results of its research to the ultimate user. The laboratory consists of the following centers:

- Applied Mathematics
- Electronics and Electrical Engineering
- Manufacturing Engineering
- Building Technology
- Fire Research
- Chemical Engineering

THE INSTITUTE FOR COMPUTER SCIENCES AND TECHNOLOGY

Conducts research and provides scientific and technical services to aid federal agencies in the selection, acquisition, application, and use of computer technology to improve effectiveness and economy in government operations in accordance with Public Law 89-306 (40 U.S.C. 759), relevant Executive Orders, and other directives; carries out this mission by managing the Federal Information Processing Standards Program, developing federal ADP standards guidelines, and managing federal participation in ADP voluntary standardization activities; provides scientific and technological advisory services and assistance to federal agencies; and provides the technical foundation for computer-related policies of the federal government. The institute consists of the following centers:

- Programming Science and Technology
- Computer Systems Engineering

THE INSTITUTE FOR MATERIALS SCIENCE AND ENGINEERING

Conducts research and provides measurements, data, standards, reference materials, quantitative understanding, and other technical information fundamental to the processing, structure, properties, and performance of materials; addresses the scientific basis for new advanced materials technologies; plans research around cross-country scientific themes such as nondestructive evaluation and phase diagram development; oversees Bureau-wide technical programs in nuclear reactor radiation research and nondestructive evaluation; and broadly disseminates generic technical information resulting from its programs. The institute consists of the following divisions:

- Nondestructive Evaluation
- Inorganic Materials
- Fracture and Deformation
- Polymers
- Metallurgy
- Reactor Radiation

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