Technology

AT A GLANCE

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On the Inside:

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National Institute of Standards and Technology

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Holograms Boost Light Quality

A new type of holographic light diffusing technology developed by Physical Optics Corp. (POC), Torrance, Calif., promises to improve lighting in a wide range of applications from flat panel computer screens to specialized flashlights.

Developed with co-funding from the NIST Advanced Technology Program, the technology provides a way to shape normally unruly light beams by bending off-target rays in useful directions, while smoothing out differences in intensity. The transmission of light through the clear diffusers is 90 percent compared with 30 to 50 percent for conventional frosted-glass light diffusers now used in instrument displays. A notebook computer screen fitted with a POC holographic diffuser would be up to 15 times brighter, allowing both better viewing and longer battery life.

In 1993, the company had a way to embed hologram diffusers and reflectors one at a time into a volume hologram a few centimeters on a side. The ATP funding helped the company come up with a practical manufacturing technology that

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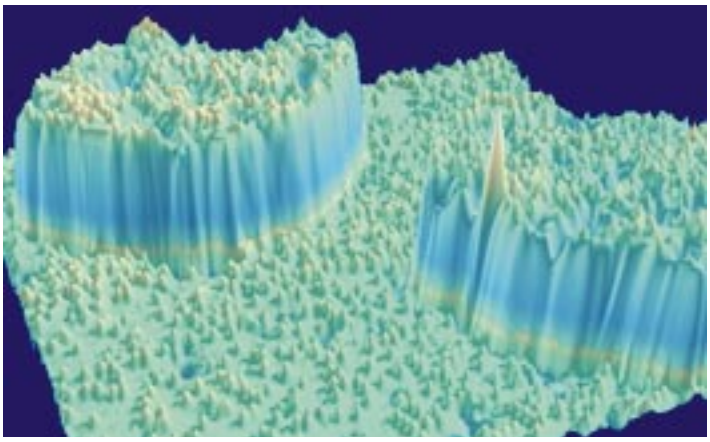


Trading Places Atomic-Style

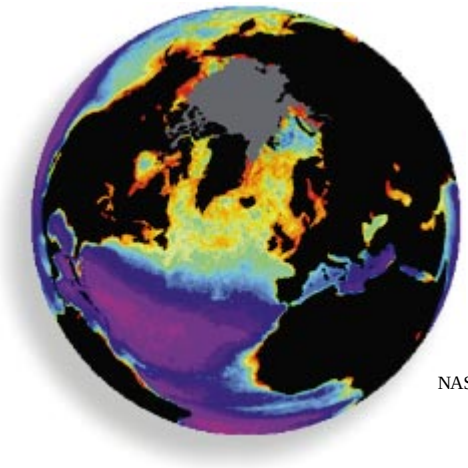
This surreal looking landscape is actually an atomic-level view of chromium deposited on iron. The image was made by NIST researchers to better understand new magnetic recording and storage materials.

Magnetic and non-magnetic metals can be stacked in very thin layers to make heads for reading magnetic data bits on computer disk drives. These "magneto-resistive" read heads can sense much smaller changes in magnetic direction than conventional heads. Consequently, magneto-resistive heads allow much denser packing of data on disk drives.

NIST researchers are studying the deposition of chromium on iron as a model system that may yield clues to the best ways to grow layers for enhanced magneto-resistance effects.The raised mesas in the scanning tunneling microscope picture above are composed of iron atoms, one layer thick,that have been displaced from the solid iron base material by the deposited chromium atoms.

Using a special form of surface spectroscopy in conjunction with an STM built at NIST, the researchers were able to identify individual iron and chromium atoms.They found that the bumpy surface is formed by alternating atoms of chromium (peaks) and iron (valleys). This pattern indicates that the chromium is alloying with the iron during deposition, rather than simply laying on top. The researchers now are trying new growth methods to control the intermixing and optimize the material's magnetic properties.

Contact: Angela Davies, (301) 975-3743.



NASA/GSFC

Color is Clue to Ocean Organisms

A new portable light source and detector system developed by NIST researchers is helping assess the accuracy of field instruments used in global warming and climate research.

The rugged, table-top instrument is a specialized light source designed for use aboard seafaring research vessels. It provides a stable source of white light and uses high-accuracy detectors to monitor the source. British and American researchers aboard the British vessel, *James Clark Roth,* currently are using the radiometer to calibrate submersible light-measuring instruments. Such instruments determine the color and magnitude of light reflected from and within the depths of the oceans. Scientists use such data to map concentrations of chlorophyll and phytoplankton, microorganisms essential to the absorption of carbon dioxide from the atmosphere.

Light measurements taken by researchers on ships in the ocean are correlated with data taken by satellites orbiting Earth. By monitoring changes in data gathered remotely, scientists can gather important information about fluctuations in ocean currents and microorganisms that affect the amount of carbon dioxide in the atmosphere and thus global warming. The graphic above shows the amount of chlorophyll and phytoplankton in the Northern Hemisphere where red represents the highest levels followed by orange, yellow, green, blue, and purple.

The National Aeronautics and Space Administration soon will launch a new satellite called SeaWiFS (sea-viewing, wide field-of-view sensor) that will increase greatly the amount of ocean color data collected. NIST recently held a workshop to validate the accuracy of SeaWiFS instruments and is working with NASA to help ensure the accuracy of SeaWiFS data.

Contact: Carol Johnson, (301) 975-2322.

Technology AT A GLANCE

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SHORTS

A Clock that Resets Itself?

You know the drill. A thunderstorm knocks out your power, and afterward you trek from room to room resetting the time on clocks, appliances, and VCRs. Someday these clocks may be able to reset themselves with time and frequency signals broadcast from NIST.

The Institute has boosted the power of time and frequency signals broadcast from its radio station, WWVB, located in Ft. Collins, Colo. New equipment installed in September increased the power of the signal four-fold and now provides more reliable coverage to the far corners of the continental United States, Mexico, and southern Canada. WWVB signals can be used to set clocks to a few hundredths of a second. The station improvements will provide a signal strong enough to be picked up with much smaller antennas than the bulky ones previously required for distant locations. The signal is so strong, in fact, manufacturers now should be able to build automatic, WWVB-controlled clocks into all kinds of appliances, even wristwatches. Contact: Wayne Hanson, (303) 497-5233.

A Boost for Smaller Food Processing Firms

A new effort to help smaller manufacturers in the food industry improve their competitiveness has been launched by NIST's Manufacturing Extension Partnership. The MEP provided a matching grant award of about $100,000 to the Center for Advanced Food Technology at Rutgers University, New Brunswick, N.J., to carry out the program. The Rutgers center will help MEP extension centers in Delaware, Maryland, New Jersey, New York, Pennsylvania, and Virginia to provide better outreach services and resources to smaller food manufacturers and also will analyze how to reach MEP affiliates in other states. The program aims to better understand the needs of food manufacturers and the services and service providers that are available, design a food manufacturing training program to meet these needs, and define plans to coordinate use of appropriate resources. Workshops and demonstrations at Rutger's Food Manufacturing Technology Facility also will be provided. With sales exceeding $400 billion, the processed food industry is the nation's largest manufacturing sector; about 95 percent of the companies in this sector have fewer than 500 employees. Contact: Jack Rossan, (908) 445-6133.

Holograms

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could "press" the holograms into much larger, thinner sheets similar to the security holograms on credit cards.

The company's project, just completed this summer, has already found initial applications including: replacement lenses for the flashlights used by aircraft inspectors (strong, even illumination makes it easier to spot flaws); a diffuser for the machine-vision system used by a semiconductor equipment manufacturer (better quality light with fewer parts and fewer quality control problems); and a diffuser for a colorimeter used to calibrate video screens (producing more reliable measurements). Potential applications include screens for projection TV and notebook computers.

Contact: Patty Shaw, (310) 782-1369.

Fire Retardants Consortium Formed

Nylon, polypropylene, and other polymers are often used in building furnishings like upholstered furniture, electrical cables, and insulation materials. To lower flammability and improve fire safety, chemicals are generally added to these materials. Some of the most common additives contain halogens, chemicals that have raised environmental concerns, especially in Europe. U.S. manufacturers are seeking new, environmentally friendly flame retardants in order to manufacture the same products for export as well as domestic sale. NIST recently launched a new industry/government consortium to help in the search. One strong contender is the combination of silica gel and potassium carbonate. When added to nylon and other polymers, these chemicals reduce heat release rates by as much as two thirds, while significantly reducing production of smoke and carbon monoxide.The new flame retardant combination works by maximizing crosslinking of chemical bonds when exposed to heat, causing charring rather than burning. New polymer-silicate nanocomposites have also shown excellent promise. Contact: Takashi Kashiwagi, (301) 975-6699.

Finding Vinegar in the Milky Way

The recent discovery of acetic acid, the essence of vinegar, in a cloud near the center of our galaxy is another indication that simple chemical building blocks of life also could exist in space. Other compounds that could combine to form more complex organic molecules have been detected previously. Researchers from the University of Illinois working with a NIST chemist found acetic acid's spectral signature in a dust and gas cloud. Since acetic acid can combine with ammonia to form the simplest sub-unit of a protein, the amino acid glycine, it is possible that this chemical precursor to biological molecules may exist in space. The university and NIST now are continuing the search for glycine molecules in space. Much of this work would not be possible without accurate spectroscopic measurements made at NIST. When molecules absorb light, they emit energy of a specific frequency and intensity. Astronomers use Earth-based telescopes to detect the emitted energy, or spectral signature, which is as unique as a fingerprint. Contact: Frank Lovas, (301) 975-2385.

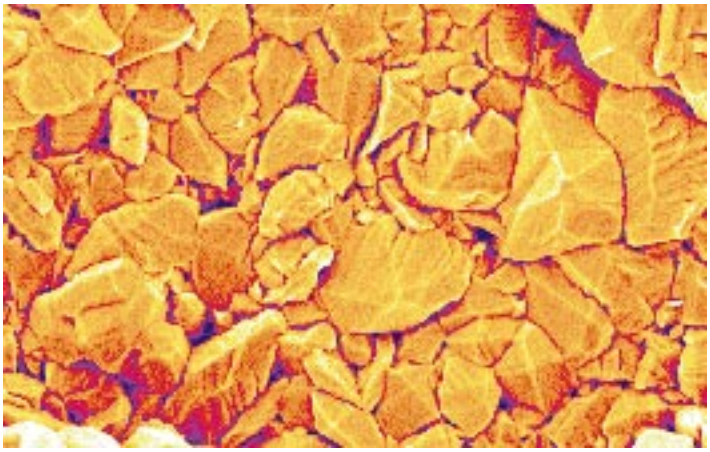
Four Firms Win Baldrige Award

On October 16, President Clinton and Commerce Secretary Mickey Kantor announced the winners of the 1996 Malcolm Baldrige National Quality Award. The winners are:

- ADAC Laboratories, Milpitas, Calif., (manufacturing);
- Dana Commercial Credit Corp., Toledo, Ohio, (service sector);
- Custom Research Inc., Minneapolis, Minn., (small business); and
- Trident Precision Manufacturing Inc., Webster, N.Y., (small business).

Managed by NIST, the award was established by Congress to enhance U.S. competitiveness by promoting quality awareness, recognizing quality achievements of U.S. companies and publicizing successful performance strategies.

Contact: Office of Quality Programs, (301) 975-2036.



Microsensors Sniff Out Gases

NIST researchers have devised microsensor arrays that show promise as a reliable, inexpensive method for detecting and quantifying gas concentrations in a variety of settings. Candidate applications for the new technology include real-time industrial process control, environmental monitoring, and analysis of vehicle emissions.

The NIST effort aims to produce compact, easily manufactured, integrated arrays tailored to specific gas-sensing applications. Each array contains a set of tiny sensors about 100 micrometers square, which together can detect gases like carbon monoxide, hydrogen, oxygen, ammonia, and methane.

The base for each sensing element is a NIST-designed "microhotplate." Made with a resistive heater and a temperature monitor, the microhotplates provide both a means for growing specific films on specific elements and for improving the selectivity of the array when it's in use as a sensor. During fabrication, an array of microhotplates is placed within a chemical vapor deposition vacuum chamber. By raising the temperature of individual microhotplates and adjusting the mixture of gases introduced to the chamber, the NIST researchers have deposited films of tin oxide, zinc oxide, and platinum on specific hotplates. Monitoring the change in conductance for each hotplate allows the process to be precisely controlled (and potentially automated) to produce films with optimized thickness and microstructure (see micrograph of tin-oxide crystal film above).

Once an array with different films has been made, the temperature of individual microhotplates can be either held constant or rapidly cycled to maximize the array's sensitivity to specific gases or gas mixtures. The detection of carbon monoxide, for example, might involve monitoring the change in conductance for multiple sensing elements to look for patterns consistent with the presence of this gas. Purposeful redundancy within an array can help eliminate false positive signals, a common problem with some previous sensor technologies.

NIST researchers now are testing a variety of different film compositions and structures to find those best suited to specific gases of interest. They hope the sensing arrays eventually may be incorporated into a credit-card sized device.

Contact: Steve Semancik, (301) 975-2606.

Old Paint Becomes New Lead SRM

A small loss for Akron, Ohio, is a big gain for chemists monitoring lead in the environment. NIST's newest Standard Reference Material (SRM) for measuring lead in paint was made from paint scraped from old homes in Akron. The paint, mostly from homes built before 1945, contains high levels of lead and, therefore, was an ideal choice to become NIST's highest level lead in paint SRM. The paint, ground to a very fine powder, contains 10 percent lead by mass.

Environmental chemists will use the new SRM to calibrate their instruments and verify the accuracy of their analytical methods. Developed in conjunction with the Environmental Protection Agency, the SRM is one in a series designed to help monitor lead in paint, soil, and dust.

NIST also sells a very low level lead powdered paint SRM and expects to offer 0.5 and 4 percent lead powdered paint SRMs by the end of the year.

Contact: SRM Program, (301) 975-6776.

C O - O P C O R N E R

Computer Security—Civilian federal government agencies now have quicker access to expertise and support services they need to protect their electronic information from security threats such as computer viruses and hackers. With start-up funding from the Government Information Technology Services Innovation Fund, NIST has established the Federal Computer Incident Response Capability. The new initiative combines NIST experience and expertise with that of Defense Advanced Research Projects Agency and Department of Energy computer incident response teams. FedCIRC expands their reach to offer coordinated incident-response services to the whole civilian federal government. FedCIRC is expected to be self-funding through subscription fees by the end of the second year. Contact: Marianne Swanson, (301) 975-3293.

Smokies Go Solar—A novel NIST solar water-heating system that uses photovoltaic cells in combination with computer technology is now hard at work in Tennessee's Great Smoky Mountains National Park. The system, installed recently at the park's visitor center, is a joint project involving NIST, the U.S. National Park Service, the Tennessee Valley Authority, and the Sevier County Electric System. Participants hope the year-long test of the solar heating system will reduce considerably the visitor center's water heating energy consumption, while providing on-the-job field data to researchers looking to improve the technology. Contact: Hunter Fanney, (301) 975-5864.

Safer Cars—NIST and General Motors are teaming up in a two-year project to improve motor vehicle fire safety. The two organizations will evaluate the fire safety aspects of vehicle crash and fire tests, identify potential mechanisms by which fires could start, and then create laboratory models of these mechanisms. This new knowledge will be used to characterize fire properties of potential combustibles in vehicles, determine fire growth paths and time lines, and evaluate fire hazards to vehicle occupants. GM and NIST then will study both passive protection measures (such as less flammable materials in critical locations) and active fire suppression technologies. Contact: Richard Gann, (301) 975-6866.

Heat Measurements—NIST and Conductus Inc., Sunnyvale, Calif., have joined forces to produce an extremely sensitive high-temperature superconducting bolometer for infrared imaging purposes. A bolometer is an instrument for measuring radiant heat. The NIST/Conductus instrument is cheaper, easier to use, and faster than commercially available bolometers. It should be useful to NASA and the European Space Agency, which use such instruments in infrared video cameras on Earth-orbiting satellites that monitor greenhouse gases and global warming. It may also be useful in specialized night vision equipment and as a detector to help pilots spot turbulence in clear air. Contact: Erich Grossman, (303) 497-5102.

Detector Improves Chemical Analysis

NIST recently filed a patent for an X-ray microcalorimeter that fits easily onto existing scanning electron microscopes and can provide chemical composition information with at least 10 times better energy resolution than most commercially available instruments.

The NIST instrument determines the chemical composition of a sample based on the energy of X-rays given off as the sample is scanned with a beam of electrons. Its improved resolution stems from the use of a superconducting detector that

undergoes a rapid change in electrical resistance when heated by the absorption of a single X-ray. The instrument uses a NIST-developed mini-refrigerator that cools the detector chip to an operating temperature near absolute zero (0.1 K). Such cold temperatures are necessary to achieve high resolution, especially for lower energies.

Commercially available X-ray spectrometers used in industry provide either ease of use by detecting a broad range of X-ray energies or high energy resolution (10 to 20 electron volts). The NIST instrument achieves both.

Although the instrument will be useful to a wide range of industries, semiconductor manufacturers have been following the NIST project closely and will be a prime first customer for the new technology. Better resolution of X-ray energies should translate into improved chemical analysis of contaminant particles in semiconductor processing, an increasingly important quality control problem as circuit dimensions continue to shrink. The NIST system fully discriminates the nearly overlapping X-ray emission spectra of silicon and tungsten important for identifying tungsten silicide, a common material in integrated circuits. It also improves identification of "light" elements such as carbon, aluminum, and silicon.

NIST currently is looking for industrial partners to share in the commercial development of the new instrument.

Contact: John Martinis, (303) 497-3597.