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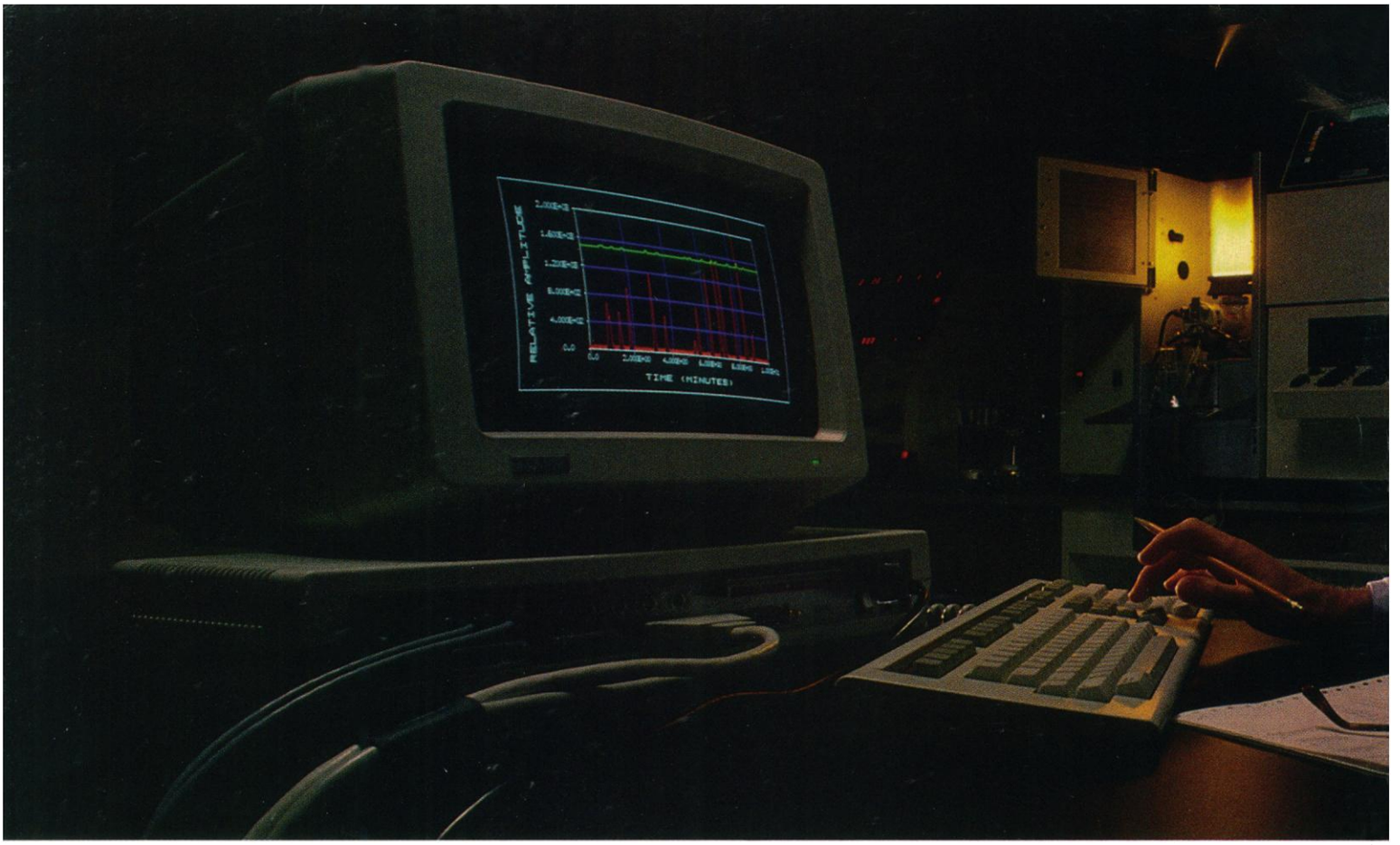

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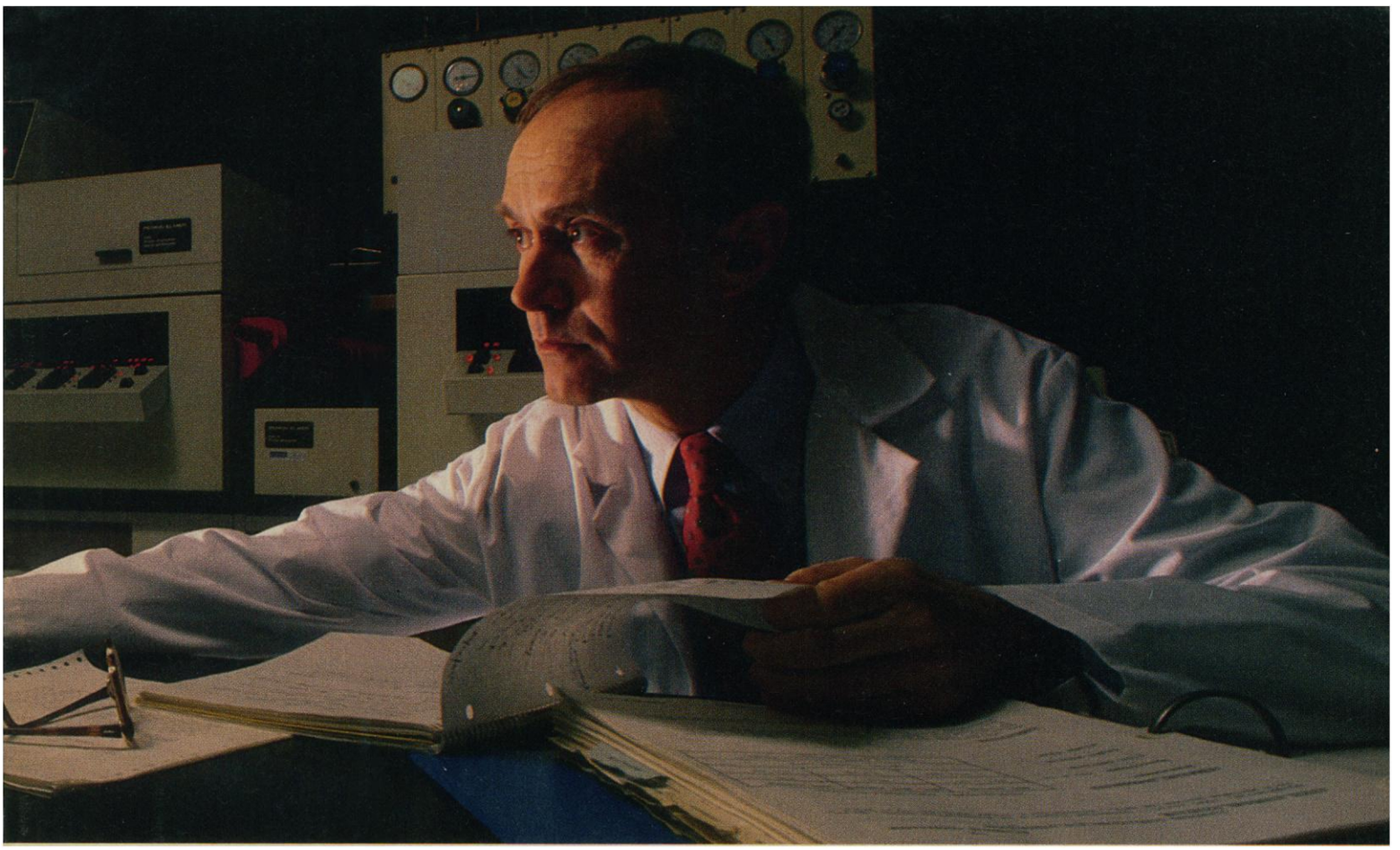

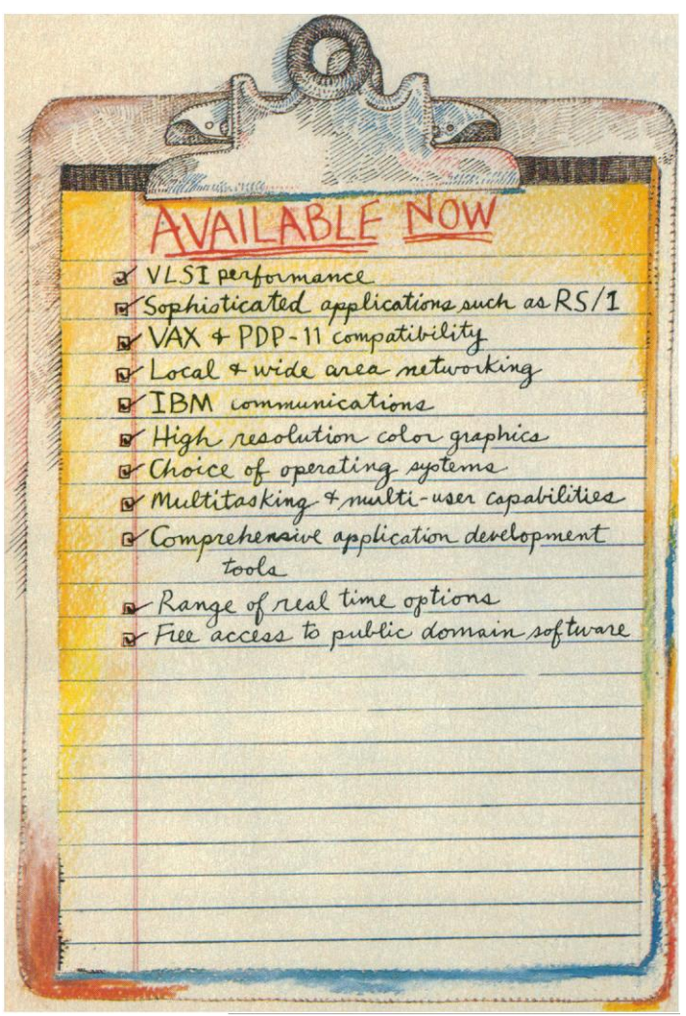

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COVER

(Left) The leaves of the Madagascar periwinkle (*Catharanthus roseus*) yield the anticancer drugs vincristine and vinblastine. [T. E. Hemmerly, Middle Tennessee State University, Murfreesboro; reproduced with the permission of Carolina Biological Supply Company, Burlington, North Carolina] (Center) Pyrethrum (*Chrysanthemum cinerariaefolium*) flower heads yield commercially important pyrethrin insecticides. [W. H. Bollinger, NPI, Salt Lake City, Utah] (Right) The berries of the chinaberry tree (*Melia azedarach*) yield insectidal limonoid compounds such as azadirachtin. [J. R. Martineau, NPI, Salt Lake City, Utah] See page 1154.

Martian climate

Global dust storms seem to affect the climate of the planet Mars. Mars is 1.5 times farther from the sun than is Earth and quite cold (page 1160). Widely fluctuating temperatures contribute to the strong winds and dust storms, particularly during the summer in the Southern Hemisphere. Mars has little atmosphere, mostly CO_2; it condenses as frost on the planet's surface. Data collected by the Viking orbiters (1976–1978) indicated that frost remains at the South Pole of Mars during much or all of the year but disappears during summer at the North Pole. This difference was unexpected, because both poles receive the same amount of sunlight during the year. Paige and Ingersoll explain this difference by showing that the frost at the North Pole is about 25 percent darker than frost at the South Pole. They suggest that frost in the north is more heavily contaminated by dust. It therefore absorbs more solar energy and enters the atmosphere more rapidly.

Eclipses on Pluto

The detection of eclipses on Pluto earlier this year confirms the existence of Pluto's moon (page 1193). In 1978 the existence of a satellite, unofficially called "Charon," was proposed, but Pluto's distance from Earth has made confirmation difficult. Astronomers have been preparing for years to detect eclipses in the Pluto-Charon system that should be apparent from Earth every 3.2 days for the next 5 to 6 years. Using powerful telescopes with light-detecting devices, Binzel and others in observatories in Texas, Hawaii, and California recorded changes in the light reflected from Pluto in January and February that were consistent with the occurrence of eclipses. These data should make it possible to determine the diameters of Pluto and Charon, the mass of the orbiting pair, the density of Pluto, and any idiosyncracies of Charon's orbital path around Pluto. Earth and Pluto will not again be properly aligned for viewing eclipses of Pluto and Charon until 2100.

Hepatitis vaccine

New data suggest that it may be beneficial to add another viral component to hepatitis vaccines (page 1195). In conventional vaccines, the S component, a large molecule on the surface of the virus, induces antibody in many hosts and protects humans against hepatitis. Milich *et al.* show that the pre-S(2) component of the viral surface readily elicits large amounts of antibody reacting with the hepatitis virus and even helps stimulate antibody production to S in many of the animals that cannot respond to S alone. Pre-S(2) is a peptide that seems to be similar in all known isolates of human hepatitis viruses. Because the pre-S(2) region can be chemically synthesized, it also has great potential for use in diagnostic tests.

AIDS and sperm antibody

Antibodies that bind to human sperm and are almost ubiquitous in blood samples from healthy and hospitalized individuals ranging in age from 1 day to 40 years are missing from the samples of many people with AIDS, the AIDS-related complex, or who are at risk for AIDS. The antibodies react specifically with protein components of the sperm's head. Rodman, Laurence, Pruslin, Chiorazzi, and Winston find in two patients that this subset of antibodies disappears from serum during disease progression and reappears during remission (page 1211). In experimental systems, when these proteins are released from intact sperm, they can interfere with activation of cells that are critical to immune regulation. Investigators will now search for causal associations between the immune deficiencies developing in AIDS, sperm proteins (prevalent in many AIDS patients), and naturally occurring host antibodies to sperm components.

Surface receptor control

Coupled "on" and "off" signals may control the production of an important growth-regulating receptor on the surface of normal cells (page 1215). Overproduction of this receptor and perhaps ensuing growth deregulation in tumor cells may result because the signal does not get switched from "on" to "off." Krönke *et al.* invoke the possibility of signal deregulation to explain why mitogenic substances that turn on a burst of interleukin-2 (IL-2) receptor production in normal human T cells abruptly turn off IL-2 receptor production in leukemic T cells. No other differences could be found in molecular studies. The cells had the same amount, composition, and arrangement of genetic information for the receptor and the same messenger molecules for translating the genetic information into functional receptors.

Visual perception

Different visual processes are used for detecting where an object is and identifying what it is. Sagi and Julesz showed observers a dense array of short parallel lines with one to five lines not parallel to the rest (page 1217). The visual image was then removed, and a "masking" array of scrambled lines was shown. After a few milliseconds of exposure to the test array, observers could accurately say where the disoriented lines were. When three target lines were used, the kind of triangle they formed (right or nonright) could also be assessed in the short "preattentive" period. However, to answer other questions, such as whether aberrant lines were horizontal or vertical, observers had to scrutinize the visual image; for each new feature, more evaluation time was needed. The amount of focal attention used for learning about the target lines was directly related to the number of attributes considered.

Scanning Tunneling Microscopy

IBM

To: Robin
From: Roger
Subject: IBM Technology

I've been reviewing some of our past and present technological achievements, and it occurred to me that the scientific, engineering, and academic communities might like to know more about them. Will you select a topic from the following list or suggest another one? Thanks.

- Vacuum tube digital multiplier
- IBM 603/604 calculators
- Selective Sequence Electronic Calculator (SSEC)
- Tape drive vacuum column
- Naval Ordnance Research Calculator (NORC)
- Input/output channel
- IBM 608 transistor calculator
- FORTRAN
- RAMAC and disks
- First automated transistor production
- Chain and train printers
- Input/Output Control System (IOCS)
- STRETCH computer
- "Selectric" typewriter
- SABRE airline reservation system
- Removable disk pack
- Virtual machine concept
- Hypertape
- System/360 compatible family
- Operating System/360
- Solid Logic Technology
- System/360 Model 67/Time-Sharing System
- One-transistor memory cell
- Cache memory
- Relational data base
- First all-monolithic main memory
- Thin-film recording head
- Floppy disk
- Tape group code recording
- Systems Network Architecture
- Federal cryptographic standard
- Laser/electrophotographic printer
- First 64K-bit chip mass production
- First E-beam direct-write chip production
- Thermal Conduction Module
- 288K-bit memory chip
- Robotic control language
- Masterslice and the Engineering Design System

Roger -
IBM's researchers have developed a powerful new technique for studying surfaces at the atomic level: let's tell this story!
Robin

Figure 1. *This three-dimensional representation of a silicon surface was obtained by scanning tunneling microscopy, developed by IBM. The individual hills or bumps indicate actual atoms separated by as little as six angstroms. (One angstrom is one ten-billionth of a meter.)*

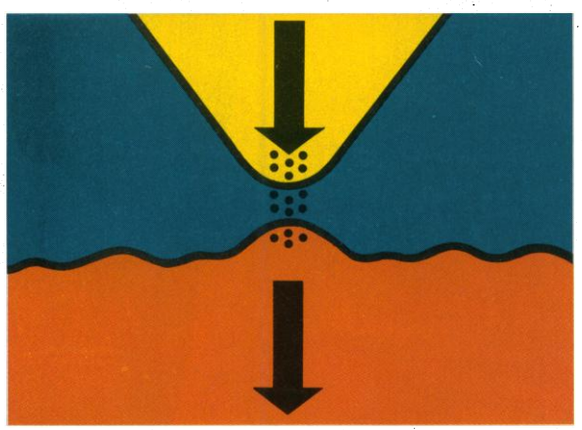

Figure 2. *IBM's new microscopy technique makes use of a phenomenon called vacuum tunneling, which involves the passage, or tunneling, of electrons between two conducting or semiconducting solids that are narrowly separated by a vacuum. Tunneling occurs because electrons have wavelike properties as well as particle properties. This means, according to quantum theory, that electrons appear as electron clouds that spill out slightly beyond the surfaces of the solids in which they originate. As a result, there is a finite probability that electrons will tunnel through the vacuum.*

Miniaturization is the driving force behind the computer revolution. As computer chips continue to evolve, their structural details are becoming so small that it is vital to understand them at the atomic level.

Recently, IBM researchers have succeeded in examining structures at the atomic level by developing an absolutely new kind of microscopy technique—scanning tunneling microscopy, or STM. Specifically, they have produced three-dimensional images of the surface topography of solids that show vertical position differences as small as 0.1 angstroms (one angstrom is one ten-billionth of a meter) and horizontal position differences as small as six angstroms. Such simultaneous resolution is unprecedented.

The new microscopy technique makes use of a quantum-mechanical phenomenon called vacuum tunneling, which involves the passage, or tunneling, of electrons between two conducting or semiconducting solids that are narrowly separated by an insulator or a vacuum.

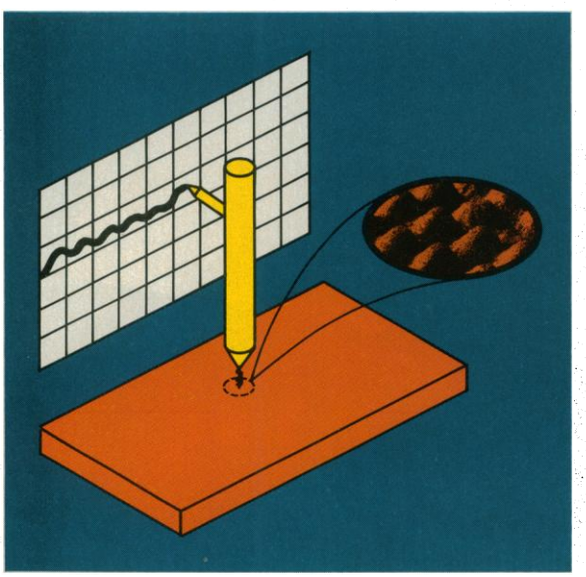

Figure 3. *The principle of the scanning tunneling microscope is quite simple. As a probe tip is scanned across a surface's microscopic hills and valleys, its vertical position is adjusted to maintain a constant tip-to-surface distance (by keeping tunnel current constant). The probe consequently follows the surface contour as it moves, so that monitoring its vertical position can be used to yield a two-dimensional representation of the surface contour for each scan. The full three-dimensional image is obtained by assembling an entire sequence of scans.*

Scanning Tunneling Microscopy

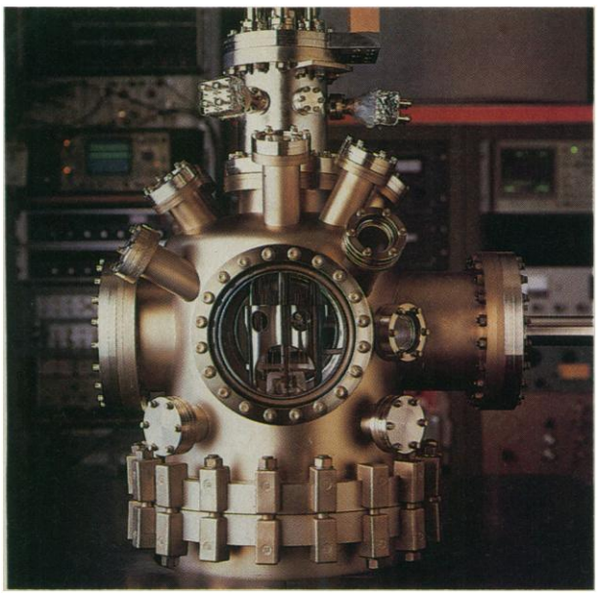

Figure 4. *The scanning tunneling microscope is contained inside this chamber. The electronics (background) collect and process the measurements and then display the results on a screen or plotter. An absolute necessity for making measurements is a vibration-free suspension, which also had to be specially developed by the IBM researchers.*

Tunneling through solid insulating barriers was first demonstrated in 1957; it was only early in 1982 that controlled vacuum tunneling was demonstrated by IBM in an experimental configuration suitable for microscopy.

In principle, the scanning tunneling microscope takes advantage of the strong dependence of the tunnel current on the separation between two solids. One solid has its surface under investigation; the other, a metal tip, is a probe electrode. As the probe moves laterally across the surface (while separated from it by about ten angstroms), the tunnel current will vary in accordance with changes in the tip-to-surface distance. The tunnel-current variation in effect is a measure of the surface topography.

In practice, the vertical position of the probe is changed to keep the tunnel current, and thus the tip-to-surface distance, constant for all points. In that way, monitoring the position of the tip while scanning yields a topographic picture of the surface. The technique is so sensitive that a change in tip-to-surface distance by the diameter of a single atom produces a tunnel-current change by a factor of 1,000.

By providing a more detailed view of surface structures, STM has already significantly advanced the understanding of important materials such as silicon. However, STM is more than a surface structural tool with atomic resolution: it also images surface parameters (such as composition and oxidation state) and can determine electronic properties. This opens fascinating possibilities in many areas of science and technology.

STM can be performed at ambient pressure and can see surfaces covered by nonconducting liquids. The ability to operate under such conditions makes STM attractive in many different fields, from engineering to biology.

Scientists at the IBM Zurich Research Laboratory developed the world's first scanning tunneling microscope. Their contributions are only part of IBM's continuing commitment to research, development, and engineering.

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For free additional information on STM, please write:
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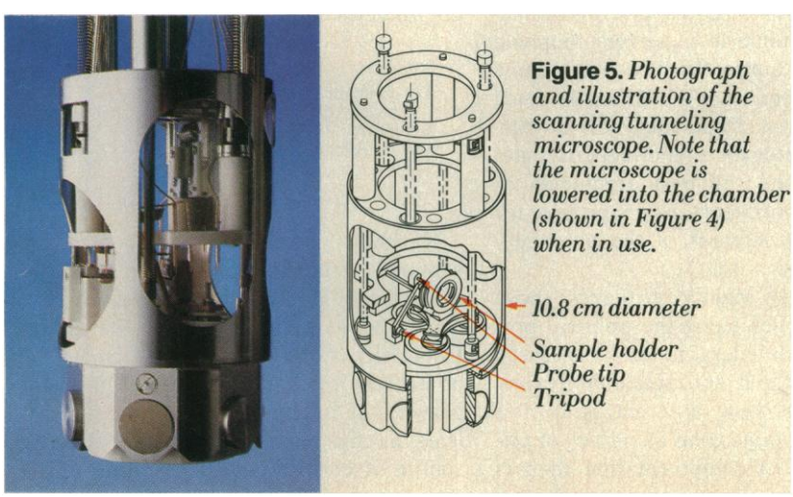

Figure 5. *Photograph and illustration of the scanning tunneling microscope. Note that the microscope is lowered into the chamber (shown in Figure 4) when in use.*

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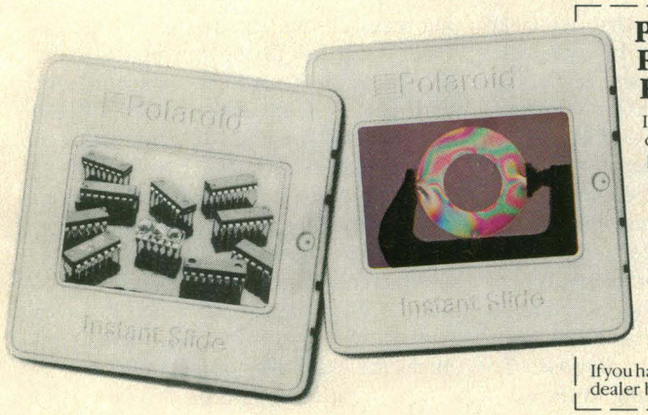

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7 June 1985, Volume 228, Number 4704 **SCIENCE**

Waste Management

Our society generates an enormous amount of solid waste. Most of it is municipal in origin; a substantial part is industrial. For decades little thought was given to possible toxicity. Today, the public is increasingly concerned about danger to health, especially from contaminated drinking water.

In 1976, Congress passed a Resource Conservation and Recovery Act to regulate existing industrial waste dumps. This was followed by a Comprehensive Environmental Response, Compensation, and Liability Act in 1980 to provide for cleanup of abandoned dumps. Included was a tax on feedstocks that was designed to produce $1.6 billion (Superfund) to be spent in the following 5 years and administered by the Environmental Protection Agency (EPA). In preparation for renewal of the Superfund Act, the House Energy and Commerce Committee and the House Science and Technology Committee requested that the Office of Technology Assessment (OTA) prepare a report on Superfund.*

The report takes the position that the magnitude of the cleanup that will be required is much greater than had been thought. Earlier EPA estimated that 2000 sites would ultimately be placed on a National Priorities List (NPL). The OTA asserts that at least 10,000 sites will eventually be on the NPL, but it includes in its total some sites that are not now under Superfund responsibility. Experience during the last 5 years indicates that the costs of cleanup will be enormous. The OTA estimates that it may be necessary to spend several hundred billion dollars in an effort requiring as long as 50 years.

The report criticizes the way that the EPA has operated. For the most part, toxic waste has merely been moved from one place to another. Landfills are known to be subject to leaching, and the EPA is said to have been slow to establish monitoring procedures. Little has been done to achieve permanent solutions to the toxic waste problems, and the EPA has only begun to foster innovative approaches.

The OTA has made a number of recommendations to Congress. One suggests a substantial research, development, and demonstration fund. Another is to create a well-funded, high-priority interagency program whose purpose would be to deal expeditiously with the problem of obtaining more complete information on the health effects of toxic wastes. The report also recommends a waste-end tax to provide funding to complement other sources. The tax would also be designed to slow the creation of still more uncontrolled waste sites.

One of the major chapters of the report is devoted to clean-up technologies. The present conventional techniques include capping the wastes with an impermeable layer and installing drains to monitor and recycle leachate. Some of the widely used processes for treating wastewater include carbon adsorption, flocculation, sedimentation, filtration, ion exchange, and reverse osmosis. More interesting are the innovative technologies designed to destroy wastes.

The major environmental toxic wastes are halogenated organic chemicals. These can be destroyed completely by incineration at high temperatures. The off-gas acids can be trapped. An interesting alternative is pyrolysis to form an insoluble char and harmless gases that can be burned. Another method, which seems quite attractive, is oxidation in supercritical water. Still another method, already in wide use in industry, is biological treatment followed if necessary by carbon adsorption. Altogether, 26 methods are described. Given encouragement and financial inducements, methods superior to landfill could be demonstrated. Their first cost might be higher than those of present methods, but they would not give rise to continuing costs and ineffective disposal or be a burden to future generations.—PHILIP M. ABELSON

*Office of Technology Assessment, *Superfund Strategy* (DTA-ITE-252, Washington, D.C., April 1985).

Call for Symposium Proposals
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Speakers should *not* be confirmed at this time; however, sufficient information about probable speakers and their topics should be provided to allow for evaluation of the proposal. Please note that AAAS does not pay honoraria to speakers.

Some Deadlines

October: You will be notified about acceptance, conditional acceptance, or non-acceptance of your proposal. Further information will be provided at that time.

November: Preliminary programs with confirmed speakers are due.

January: Final program copy, suitable for publication, is due.

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