Technology

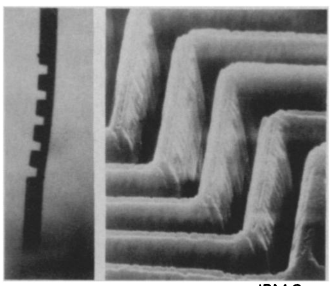
Ivars Peterson reports from Baltimore at the Conference on Lasers and Electro-Optics

Clean cuts for notched hairs

Scientists have discovered that an intense, far-ultraviolet laser beam can cut notches into a single human hair or etch a fine-lined pattern onto the surface of a plastic film without charring the material. This etching technique is based on a newly discovered photochemical phenomenon that its discoverer, R. Srinivasan of the IBM Thomas J. Watson Research Center in Yorktown Heights, N.Y., called "ablative decomposition."

The effect depends on the ability of high-intensity ultraviolet laser light (with a wavelength less than 200 nanometers) to break chemical bonds between atoms in organic materials. This produces smaller molecules that vaporize at relatively low temperatures. If the laser pulse intensity exceeds a threshold value, the fragments explosively burst out of the irradiated volume. The evaporating molecules carry away the excess energy imparted by the laser pulse so that no heating effects occur.

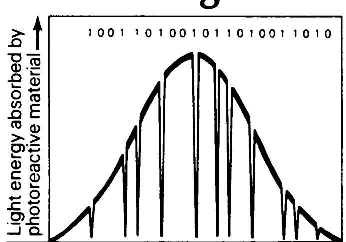
While conventional lasers, like those used in surgery, produce intense visible or infrared light that burns organic materials, sufficiently intense, repeated ultraviolet pulses cleanly remove considerable thicknesses of polymeric or biological materials. A single pulse, lasting only 12 billionths of a second, removes material down to a depth of several thousandths of a millimeter over an area defined only by the laser beam's shape.



IBM Corp.

The first photograph shows the exceptionally clean notches that can be cut into a single human hair. Each cut was produced by approximately 120 repeated laser pulses in less than 10 seconds. The scanning-electron micrograph shows a pattern of 5-micrometer-wide, laser-etched lines on a plastic film.

Memories of optical hole-burning



IBM J of R&D, © 1982 by IBM Corp.

An optical memory for a digital computer is usually seen as a densely packed, laser-punched array of pits in the thin-film surface of a glass or plastic disk. The presence or absence of pits corresponds to the 1s and 0s (bits) of a computer's binary code. Scientists at the IBM Research Laboratory in San Jose, Calif., are taking this storage technique a step further by looking at ways of packing additional information into each spot on a disk. One potential method involves photochemical bleaching of dyes (which appear colored because their molecules absorb light from part of the visible spectrum).

Dye molecules dissolved in a solid, transparent host material occupy a variety of different sites within the host, and, as a result, do not all absorb light at exactly the same frequency. Consequently, the dye shows a broad absorption band. The IBM team uses a finely tuned laser beam to bleach molecules in one particular type of site while leaving others unaffected. This "spectral hole-burning" at selected frequencies modifies the shape of the dye's absorption band (see graph). Thus, within each spot of dye (corresponding to the pits on a conventional optical storage disk), information is also stored in the absorption band or "frequency domain." Another laser beam, too weak to bleach the dye, can later read the memory.

Researchers estimate that about a thousand bits can be stored in the frequency domain, so that a storage disk could hold as many as 100 billion bits per square centimeter.

Biology

Pesticides and the microbial palate

Chemicals intended to control agricultural pests may provide a steady food source for inflated populations of soil microorganisms, and thus the chemicals may be broken down before performing their intended function. Donald D. Kaufman of the U.S. Department of Agriculture in Beltsville, Md., told the Agricultural Research Service annual symposium that the effectiveness of these chemicals is sometimes reduced from months to days by a buildup of soil microorganisms that rapidly degrades the chemicals. This problem was first encountered about eight years ago. Midwestern corn growers reported that certain herbicides used against nutsedge and grasses and insecticides used against rootworm were not acting effectively. Now a group of at least eight insecticides, herbicides, fungicides and fertilizers, all sharing a similarity in chemical structure, have lost efficacy in some soils. Kaufman reports that populations of pesticide-degrading microbes can be several times higher in soils where there is a history of pesticide use. He finds two classes of soil fungi (Verticillia and Fusaria) and several new bacterial species most active in decomposing the pesticides. Kaufman says that chemical companies have begun to include other pesticides, which block this breakdown, to extend the active life of their pesticide mixtures.

Electron microscopy goes 3-D

A technique that revolutionized medical imaging has now been applied to biological microscopy. Physicians rely extensively on computerized tomographic (CT) scanning for producing detailed images of internal structures. Scientists at Oak Ridge National Laboratory in Oak Ridge, Tenn., have devised a computer system for determining the three-dimensional structure of biological specimens viewed in an electron microscope. The technique is expected to reveal shapes and positions of such microscopic structures as components of cells, even if the structures are asymmetrical.

In the new procedure, a series of micrographs are made as the specimen is rotated through various angles in the microscope. The micrograph negatives are viewed with a scanning television camera attached to a computer. Gold particles applied to the specimen surface provide reference points for the computer to line up the images. It then makes a representation of the three-dimensional structure. This structure can be viewed on a TV screen with red-green 3-D glasses or represented in a wooden model. In the first application of the electron microscope tomography, reported in the April 29 SCIENCE, Donald and Ada Olins and colleagues looked at the arrangement of newly synthesized RNA in an active gene of the water insect called a midge.

Gene complexity extends to alligators

Maturation of the immune system involves complicated manipulations of genetic material, including the multigene family called the immunoglobulin variable regions. Little is known about the evolutionary origin and diversification of these complex processes. Scientists now report the first complete sequence of an immunoglobulin variable (V_H) gene for a species other than mammal. It is from *Caiman crocodylus,* a modern representative of an ancient reptilian group. "It preserves basic features found in the mammalian V_H gene family even though the *Caiman* and mammalian lineages may have diverged as long ago as 200-225 Myr [million years ago]," say G. W. Litman of Sloan-Kettering Institute for Cancer Research in New York, B. W. Erickson of Rockefeller University in New York and colleagues in the May 26 NATURE. They find "considerable organizational and structural homology" between the reptilian and mammalian DNA both in the region coding for the protein and in areas believed to be involved in rearrangements during development.