6 November 1981 • Vol. 214 • No. 4521 $2.00

SCIENCE

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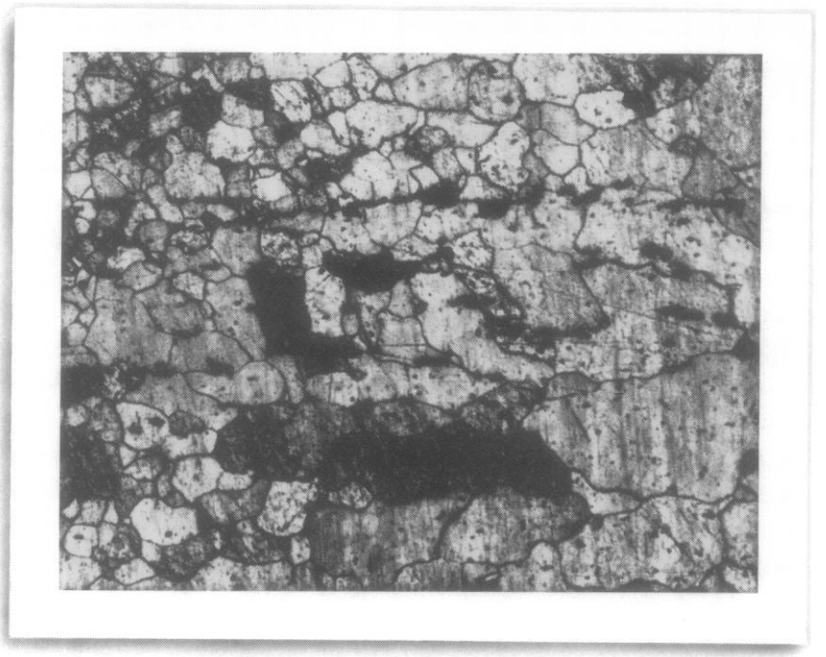
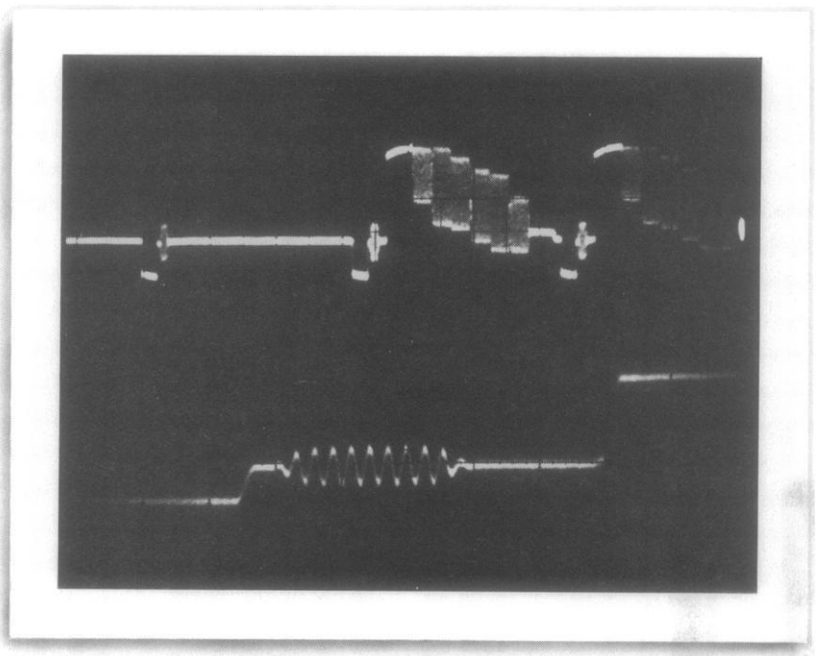


Steel solenoid frame.
80x magnification. Cross polarized. Bright-field reflected illumination with xenon source. Green filter.
20,000 ASA–
one-eighth-second exposure

Single sweep trace of wave forms from a television test signal generator on new Polaroid Type 612 20,000 ASA film.
Upper trace made at 20 μs/cm, lower trace made at 1 μs/cm.



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6 November 1981

Volume 214, No. 4521

SCIENCE

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COVER

Frog-eating bat (*Trachops cirrhosus*) about to capture a frog (*Eleutherodactylus fitzingeri*) on Barro Colorado Island, Panama. Recent studies demonstrate major influence of bat predation on frog behavior. Infrared beam and high-speed flash were used to photograph bats catching frogs. See page 677. [Merlin D. Tuttle, Milwaukee Public Museum, Milwaukee, Wisconsin 53233]

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Molecule-size electronic devices? Why not? Nature does it.

Nevertheless, it won't be easy.

In scarcely the time of a single generation, the human environment in this and similar countries has changed in that so many of us must make and keep our places in society by use of our wits instead of our muscles. Technology, whether worshipped or scorned, did it. To scorn the "computer age" becomes a bit pathetic. Too late. We can't make a phone call, or engineer a gene, without the computer.

The computer age was made possible by refining the crude technology of lithography, the drawing of pictures on stone with a greasy ink enabling multiple copies to be created. The refinements involved more facile media than "stone" and "grease," the ability of photons to draw details finer than the human hand, and finally, more complex ideas about what to draw. Further development of these refinements continues in thousands of minds and laboratories. Results of progress take virtually invisible form—so incredibly small have those silicon chips become.

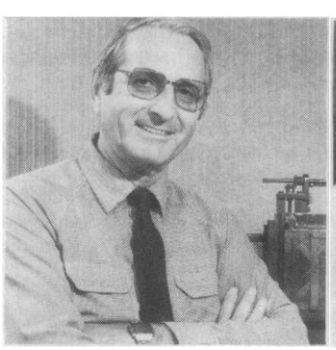
But so what? Is there meaning to the seeing of a single molecule, in the sense that we see an elephant at the zoo? No, the laws of physics being what they are, the seeing must be more intellectual than sensory.

At the Kodak Research Laboratories, where chemistry made a considerable contribution to launching the art of microelectronics through photolithography, a crew works to explore the potential for finer and finer detail, one of those refinements mentioned above. This crew finds it necessary to work as scientists rather than technologists. As scientists, they publish.* Scientists need the stimulation of other scientists they don't lunch with every day. Here some members of the crew enunciate basic truths on which discourse in this particular field rests.

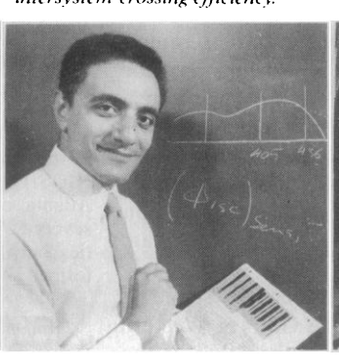
Kodak

*e.g.:
Pure & Appl. Chem. 49: 523-538 (1977)
Pure & Appl. Chem. 51: 241-259 (1979)
Prog. Polym. Sci. 5: 61-93 (1977)

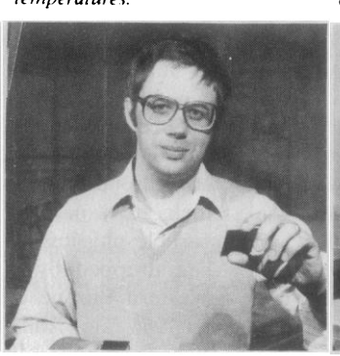
J. L. R. Williams: *"The mobility of a solute in a polymer matrix controls both its photophysics and its photochemistry."*



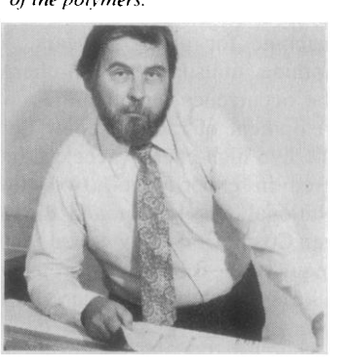
S. Farid: *"The photographic response of light-sensitive polymers depends on the sensitizer photophysics, particularly intersystem-crossing efficiency."*



R. C. Daly: *"Syntheses of photopolymers require careful tailoring of compositions, molecular weights, and glass transition temperatures."*



D. P. Specht: *"The structural features of optical sensitizers are designed to match the physical and photochemical requirements of the polymers."*



ULTROPHOR

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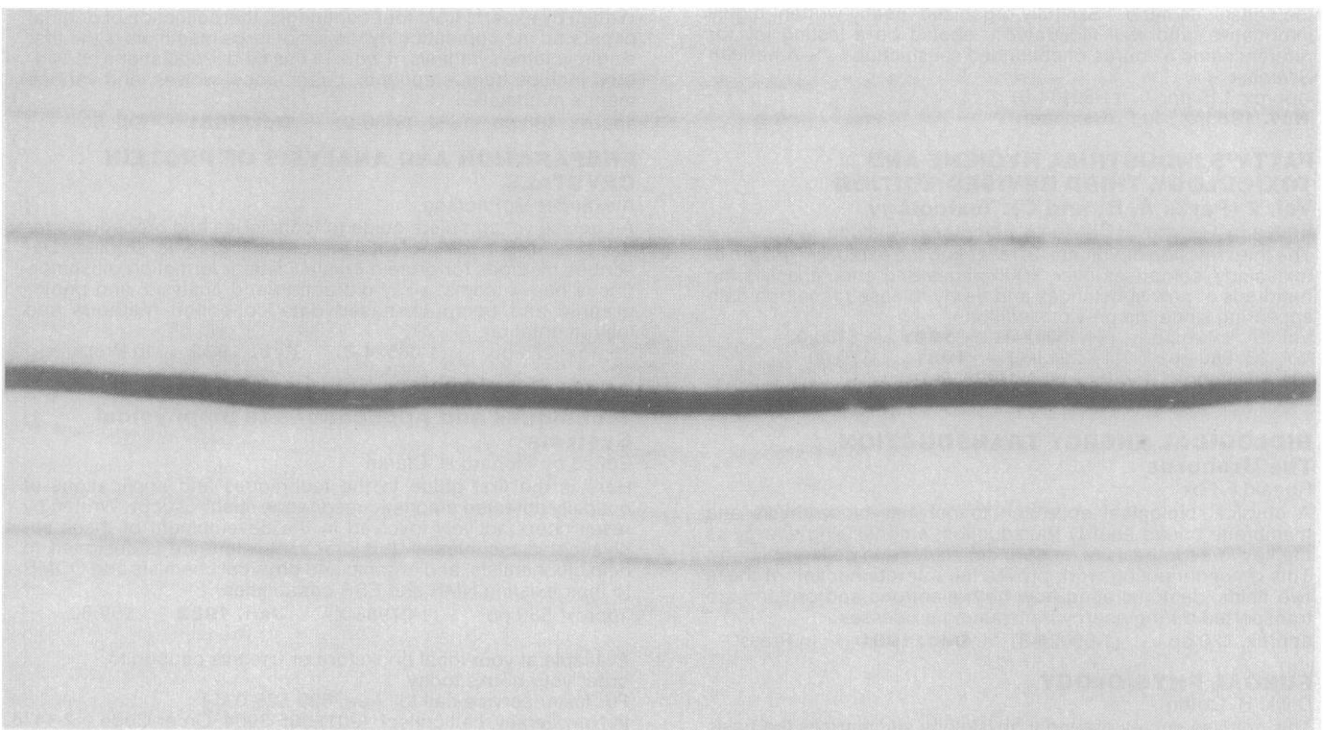

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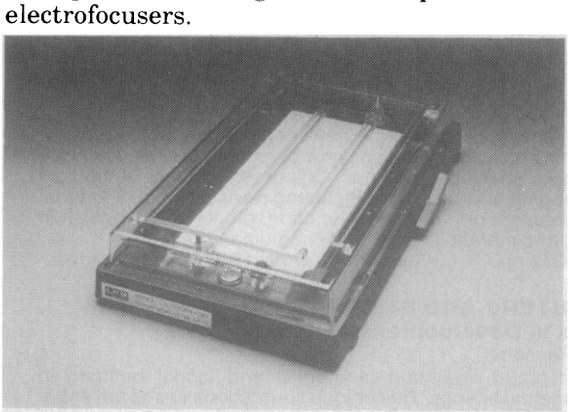

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6 November 1981, Volume 214, Number 4521 **SCIENCE**

Science and the National Security

In an open society the relationship between science and the military authorities is a touchy business at best. Science is rightly expected to enhance the national security, and it responds willingly. Equally, the military authorities are expected to respect the values, standards, and methods of science as an open and productive process. Yet, when the climate of national security is overtaken by hyperanxiety this qualitative balance is easily destabilized by judgmental mistakes, and that is what has now happened.

The brochure on *Soviet Military Power* that has been released with much publicity by the Department of Defense goes beyond documenting the U.S.S.R.'s formidable military assets. It addresses what may be termed collateral sources of Soviet military know-how. These sources, in the department's opinion, include high technology that has been transferred by the industrialized free world. Also helpful to the Soviet military, we are informed, are bilateral scientific exchanges initiated under *détente*. Next come "student exchanges," along with the inter-academy exchanges that predate the government-to-government agreements. Omitting nothing, the Defense Department's distress blankets scientific conferences and symposia, unclassified research reports, and the "professional and open scientific literature." The military authorities seem convinced that the infrastructure supporting the U.S. scientific and technical enterprise caters to Soviet military power and comprises a large pane in the window of vulnerability.

If all this actually reflects the view from the Pentagon, it calls for swift revision. What is sadly missing is the recognition, which surely exists in thoughtful quarters of the defense establishment, that lively but responsible communication in science is essential to the growth and development in science on which both national security and economic potential rely. "National security" is not the simplistic proposition that it is made out to be, and it is in the best interests of those directly responsible for it to realize that laying heavy hands upon scientific discourse is counterproductive and self-denying. Even the maligned exchanges with the Soviets have their uses, and no one supposes that they should or do involve sensitive information. To put it more strongly, it is only sensible to carry on these exchanges where both sides hold first-class rank, including such areas as condensed matter physics and astrophysics. It is a profoundly disturbing mistake to put out the notion that Soviet scientific capability is inferior to ours. We know better.

The operative premise of our military leaders is that the U.S. window of vulnerability must be closed with all possible speed. That premise is buttressed by a substantial national consensus. But if, beyond rebuilding strategic and tactical military assets, it extends to clamping down on legitimate scientific conferences and symposia as well as the open literature of science, the quality of science's interface with the military will go downhill swiftly and tragically. Scientists are well aware that information of genuine national security value must be protected. That is not the point. What is at issue is the balance between protection and overprotection. Difficult as that riddle may be to untangle, it must be dealt with responsibly and by no means solely from a military mind-set. One wants to believe that the Defense Science Board would have taken a different view of these matters had it been asked.

The issues raised here ought to be pondered, as well, by the Commerce and State Departments, where work goes on behind closed doors on regulations to tighten controls on the international transfer and exchange of scientific and technical information. Slamming the window may indeed stop the draft, but at the expense of fresh air and light. More than 30 years ago, Senator Brien McMahon, sponsor of the Atomic Energy Act of 1946, spoke eloquently of the need for a sane balance between two necessary but competing types of security: "by concealment" and "by achievement." Burying knowledge in silos of secrecy serves the one well, the other very badly.—WILLIAM D. CAREY

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SPEAKERS (Partial List)

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University of California, San Francisco

Marvin Caruthers
University of Colorado

Pierre Chambon
Centre National de la Recherche Scientifique

Gerald Fink
Cornell University

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