SCIENCE NEWS OF THE WEEK

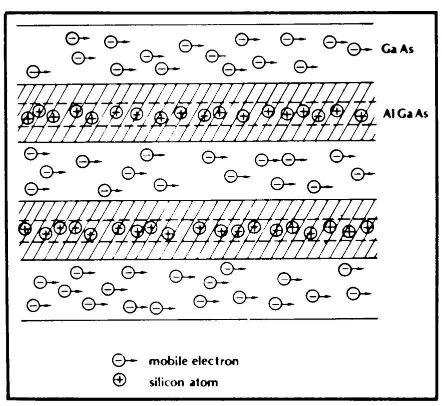
Fastest Electrons in a Semiconductor

The starship Enterprise is about to blow up because somebody has sabotaged the engines. Chief Engineer Scott, representing the seat-of-the-pants school of operations, is about to go down among the engines to try to find the damage. Second Officer Spock decides to go to the ship's main computer and run a comparison of everything in the ship's present state with the computer's memory of its ideal state. Scott fumes at him for trying so complex a way to solve the problem in the midst of an emergency: "There's no time." "I have time," says Spock. And he does.

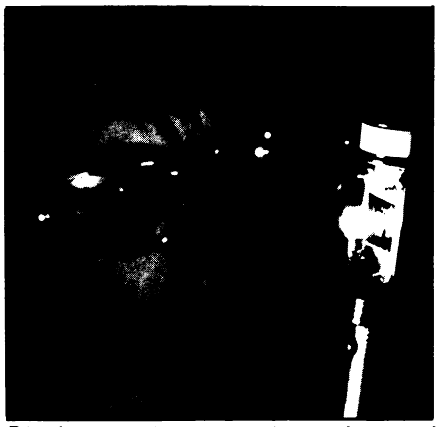
The speed of solid state circuitry has become a literary cliche. It is also an everyday convenience. Who remembers when a radio needed to warm up? The difference between waiting 30 seconds for the Andrews Sisters and getting instant Kiss may seem trivial, but in the real-time world of computer and communications traffic, even more speed than now available would be a distinct advantage. A recent development at Bell Telephone Laboratories that succeeds in speeding the flow of current carriers in semiconductors promises to give such speed to existing solid-state elements and possibly open the way to devices now unknown.

Semiconductors are substances that are neither good electrical conductors nor good insulators. They were largely ignored by early electrical technology, but a more mature technology found that when semiconductors are properly engineered, they can perform many useful functions in electrical circuits, some of which were already being done by thermionic tubes, some of which were entirely new. The results of the change are in almost everybody's pocket.

To get a semiconductor to work the way these devices need to have it work, free electrons beyond those normally available in the material have to be supplied. To do this, foreign atoms, often silicon, are introduced into, say, gallium arsenide. The



Electrons move more freely separated from ions in layered semiconductor.



Dingle examines experimental crystal (above). Störmer welds leads to it (below).

Photos: Bell Labs

silicon atoms contribute an electron each to the current carriers. But the remaining silicon ions then have an attraction for the electrons: They tend to slow the current and to try to recombine with the free electrons. The result is a constant tension between the silicon's contribution to the action of the semiconductor and its inhibition of it.

What the four Bell Labs researchers, Raymond Dingle, Horst L. Störmer, A. C. Gossard and W. Wiegmann, did was to use molecular beam epitaxy, a method of building crystals one layer of atoms at a time, to make a crystal in which the silicon ions are segregated from the flowing electrons. The crystal consists of alternating layers of gallium arsenide and aluminum gallium arsenide, each layer being 50 atomic layers thick. The silicon is concentrated in the aluminum gallium arsenide. Electrons are at a lower energy level in gallium arsenide than in aluminum gallium arsenide, so they spontaneously migrate to the gallium arsenide layers. There they are farther from the silicon ions than they would be in an ordinary semiconductor and they are further separated by neutral zones, because the technique seeks to keep the silicon in the centers of the aluminum gallium arsenide layers. The result is a doubling of the electron speed at room temperature. Similar procedures are expected to work with semiconductors other than gallium arsenide.

The result will be speedier operation of current semiconductor devices, especially in computers and communication. Dingle stresses, however, that there will be "a qualitative difference between what exists now" and what is likely to exist then. In these new crystals the current is carried in multiple layers, and, says Dingle, "There is a possibility of etching things on top of each other," circuitry in three dimensions — that would save a lot of space. □

U.S.-USSR exchanges reviewed

The U.S.-USSR science exchanges repeatedly have forced a mixing of the oil and water of science and government. And according to scientists' testimonies last week at a review of the exchanges by a House subcommittee, the less the two mix, the better off Soviet dissident scientists will be. Or, as Lipman Bers of Columbia University and Amnesty International more diplomatically put it, most scientists prefer a policy of "benign neglect": "I would like the government to be neutral — in a positive way."

The government should not tell scientists where to visit and when, Robert S. Adelstein of the Committee of Concerned Scientists, Inc., said. Instead, it should "allow individual scientists to use the channels which the government has set up to aid persecuted scientists," he told the Subcommittee on Domestic and International Scientific Planning, Analysis and Cooperation. In addition, Bers said, government officials should be discouraged from telling U.S. scientists not to visit Soviet dissidents in their homes. According to chairman James H. Scheuer (D-N.Y.), the subcommittee was unaware of such a policy and will determine in future investigations whether or not it exists.

Above all, the scientists said, the exchanges must not be halted. Government suspension of the exchanges would be "irresponsible and counter-productive, and would make matters far worse for Soviet scientists," William D. Carey, executive officer of the American Association for the Advancement of Science told the subcommittee. Spontaneous individual boycotts in response to specific human rights violations are far more effective and visi-

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ble than a "quarantine which isolates the Soviet scientific community."

"Indeed, breaks in scientific exchange would destroy the method by making such refusals irrelevant," Jeremy J. Stone of the Federation of American Scientists said. "By keeping the movements obviously based on individual and grassroots activity, a maximum of credible pressure is placed on authorities, in whatever country, to comply with human rights standards."

As evidence for the effectiveness of selective boycotting, several witnesses noted there have been fewer arrests and detentions of scientists and a higher rate of Soviet Jewish emigration in recent years.

After some equivocating, Frank Press, the President's science adviser, said that government should "facilitate" the exchanges and allow private scientists to make their own decisions. Government scientists, however, should bow to the administration's policies concerning human rights, he said. Both the administration's cancellation of his trip to Moscow and private scientists' boycotts carry "a message of concern to the Soviets," Press contended.

The major nonpolitical governmental role in the exchanges is determining which programs are scientifically profitable and should continue, Press said. Based on reports from the National Academy of Sciences on the scientific benefits of the exchanges, the government has revised its guidelines to ensure "that we are getting out of the cooperation as much as the Soviet Union is getting." The "guiding principle" he said, is to find areas "where the Soviets are doing advanced work and where we can benefit from an exchange. There are more than enough fields where the Soviets are so advanced that we can get something."

Though Press said there are few fields where the Soviets are so far ahead that there would be "an absence of mutuality," Scheuer noted such an attitude contradicts the meaning of an exchange. "I would hope we would not structure a scientific program so it is only meaningful where we are on par," he said. "That means the big payoff—where one country moves substantially ahead — will never be reached." □

Lab fertilized baby #2

From Calcutta comes word of the birth of a second baby girl conceived in laboratory glassware. Physicians S. K. Bhattacharya, Sunit Makherjee and Subhash Mukherjee announced the egg was removed from the ovaries of a woman with blocked Fallopian tubes. Unlike the first "test tube" baby, Louise Brown, the identity of this child is being kept secret, perhaps to protect her marriage prospects in the Hindu society. □

Three in one: A mouse with six parents

The mouse with the yellow face, black ears and white patch around the middle has three mothers and three fathers. It is the product of aggregation of three early embryos. While thousands of so-called chimeric mice have been raised in laboratories studying development, those patchwork animals have derived from just two embryos. In the Oct. 6 Science, Clement L. Markert and Robert M. Petters report the first "hexaparental" mice.

Coat color was the key to distinguishing which mouse pup parts came from which mouse parents. The Yale researchers combined three eight-cell embryos—one from black, one from albino white and one from yellow parents. When the embryos are placed in a triangular configuration under specific conditions, the cell clusters gradually merge and develop into a single blastocyst, a 64-cell hollow ball. The chimeric embryo can then be transferred into a foster mother.

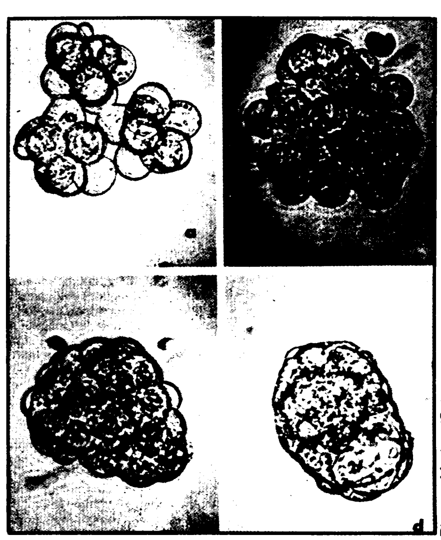
One 3-colored, six 2-colored and three 1-colored pups resulted from 40 chimeric blastocysts placed in two females. Another experiment aggregating four embryos produced no quadruples, but another triple chimera, four double chimeras and three single-colored offspring. The patches of black, yellow and white hair demonstrate unequivocally that the triple chimeras arose from three different embryos, Markert and Petters say.

A mouse with a coat of many colors is not in the offing with this embryo-merging technique. The researchers believe that three colors is probably the limit. Most of the 64 cells in the blastocyst develop into placenta, yolk sac and other extraembryonic structures; only a few contribute to the fetus and thus to the adult mouse. The successful manufacture of triple chimeras sets a clear lower limit: At least three cells must be allocated to form the adult organism. Statistical analyses of the many

Multi-hued mouse produced in the lab.

double chimeras have suggested that the number of cells contributing is just three.

The color patterns of chimeric mice are valuable research clues to cell movement during development. Markert and Petters see evidence for extensive, imprecise movements, very different from the fixed pattern observed in insects. Triple chimeras should also provide finer resolution in revealing the developmental roots of each adult cell. □



Photos: Markert/Science

Time lapse photography shows how, in 25 hours, three embryos aggregate.

DES task force report

A task force review of studies of the effects of diethylstilbestrol concluded last week that, although there is a "clear link" between the hormone and vaginal or cervical cancer in daughters of exposed women, the risk is not as high as previously believed.

According to the report released by Health, Education and Welfare secretary Joseph A. Califano Jr., the task force estimates the risk to DES daughters as no more than 1.4 cases per 1,000 daughters and possibly as low as 1.4 per 10,000. In addition, the review panel found no "established" increased risk of breast or gynecologic cancer in women who took the drug during pregnancy. The reviewed studies show "no evidence ... to suggest" that children of DES daughters will have birth defects and no "firm evidence" of an association with testicular cancer in DES sons. DES sons do, however, show an "excess of abnormalities" of the genital and possibly of the urinary tracts.

Califano urged women exposed to DES to avoid further use of the hormone or other estrogens and announced a "major program to alert" both physicians and exposed women, as well as their sons and daughters. The committee was appointed by the surgeon general last February and chaired by Diane J. Fink, director of the National Cancer Institute's division of cancer control and rehabilitation. □