Of fibers clear, and pearls and beer

Rose Martin, who was a professor at Middlebury (Vt.) College, once said that effective communication should be "light and clear, like pearls and beer — neither of which has ever touched my throat." The fibers that carry communications in the form of pulses of light must be even lighter and clearer than pearls. At last week's European Conference on Optical Communications held in Stuttgart, West Germany, scientists from AT&T Bell Laboratories reported development of the most transparent such fiber yet. At Bell Labs' Holmdel, N.J., facility they have used the fiber to establish new records for long-distance, unboosted transmission of high-density optical signals.

In a different but potentially related development, other Bell Labs researchers, at the Murray Hill, N.J., facility, have fabricated a semiconductor device that they say is the fastest switch in the world.

According to Suzanne Nagel, head of the Glass Research and Development Department at Bell Labs, the most transparent glass would be pure silica. However, to make a fiber that guides light, scientists have to provide the proper relationship between the refractive properties of the core that carries the light and those of whatever cladding is around that core, usually a slightly different kind of glass. It is at the interface between the two that the action takes place that keeps the light signal inside the fiber core.

Designers have to add chemical dopants to the core to get the proper refractive balance. These dopants tend to scatter and absorb the light and so degrade the signal. Circuit elements called repeaters have to be inserted to boost the power and restore the shape of the signal. An important goal of this kind of research is to get longer and longer repeaterless distances, since repeaters are significant items in both first cost and maintenance.

The group led by Nagel succeeded in making a fiber with an ultratransparent core — a minimum of dopants — by surrounding it with an extra-thick cladding of fluorine-doped glass. Nagel says this gave losses as low as 0.16 decibels per kilometer; or to put it another way, a signal emerging from this fiber after a passage of 200 km is "10 times stronger than it would be through most previous fibers." With the new fiber they conducted experiments that gave repeaterless transmissions of 2 billion bits per second over 130 km and 420 million bits per second over 203 km. (A bit is a digital information unit — a single digit in a numerical code, for example.) Both these achievements significantly surpass previous records for such high-density traffic.

One of the most important applications foreseen for this new fiber is in submarine cables. Repeaters for underwater use have to be more rugged than those used on land, and fishing them up for maintenance is extra expensive. However, according to a Bell Labs representative, the laboratory's design for the first transatlantic optical cable (for which AT&T is competing with several European telecommunications agencies) was completed before this fiber was developed, so the new fiber will probably have to wait for the next application.

When it comes to switching information into such a high-density carrier, the new semiconductor circuit element called a selectively doped heterostructure transistor (SDHT) could find application. The basic technology of this device was discovered by Raymond Dingle, Horst Störmer and Arthur Gossard (SN: 10/14/78, p. 260). The material of which it is made consists of alternate layers of gallium arsenide and aluminum gallium arsenide. Silicon atoms are added as a dopant because they provide extra free electrons to enhance the current-carrying properties of the material.

One of the problems with this kind of doping has been that, although the extra electrons donated by the silicon enhanced the current, the attraction between them and the holes they left behind (which act like positive charges) also slowed it. This material is carefully engineered so that the silicon atoms are deposited in the aluminum gallium arsenide layers. Electrons are naturally at a lower energy state in gallium arsenide, so the donated electrons migrate into the gallium arsenide layers. Here they are far enough from the holes (associated with the silicon atoms in the other layers) that they can move with less hindrance. At room temperature they move twice as fast as they otherwise would; at liquid nitrogen temperature (77 kelvins) they move 20 times as fast.

With these advantages the material has now been made into ultrafast circuit elements. One of these is a ring oscillator, a type of switch. A Bell Labs representative told SCIENCE NEWS that the group has just surpassed what engineers consider a significant limit in this kind of technology, the "10-picosecond barrier," by achieving a switching speed of 9.4 picoseconds. A picosecond is a trillionth (10^{-12}) of a second; 9.4 picoseconds corresponds to a little more than 100 billion (10^{11}) switching moves per second. Another new device of this material is a frequency divider (which divides by two or counts binary numbers) that operates at 10 billion (10^{10}) cycles per second at liquid nitrogen temperature, or about twice the speed of the fastest silicon divider circuit.

Applications of such circuit elements obviously include high-speed computer operations as well as modulating and multiplexing of communications. However, Dingle does not foresee them replacing silicon in computer systems where ultrahigh-speed operation is not the most important desideratum. *—D. E. Thomsen*

An enzyme commits chemical suicide

When confronted with a stressful situation, powerful substances — the "fight or flight" chemicals, including adrenaline and noradrenaline — are released into the bloodstream, speeding up the heart and priming muscles for action. But there's a down side. High levels of some of these substances have been linked to a number of illnesses, including the most common form of hypertension. Now scientists at The Pennsylvania State University in University Park have taken an approach that may lead to new drugs for stress-based illnesses: They induce a crucial chemical in the synthesis of these substances to commit suicide.

Chemist Joseph J. Villafranca and his co-workers have synthesized for the first time three classes of "suicide inactivators," molecules that act by stopping the process that produces adrenaline and its precursor, noradrenaline. Villafranca described his group's findings in Philadelphia at a recent meeting of the American Chemical Society.

In a biological pathway, compound A is converted by an enzyme to compound B, which is converted by an enzyme to compound C, and so on. In the synthesis of adrenaline, the suicide inactivators work by tying up dopamine-beta-hydroxylase, an enzyme instrumental in the conversion of dopamine to noradrenaline. This renders the enzyme chemically dead and halts synthesis.

Villafranca and his group synthesized the first suicide inactivator for dopamine-beta-hydroxylase in 1980, but it wasn't a candidate for drug use because it contained a poisonous cyanide group. By learning more about the mechanism of the enzyme, the scientists were subsequently able to make more than 20 distinct chemical inactivators. "The ideal compound can make it through the body, going only to the target enzyme and having the desired effect," Villafranca says.

Several of the new compounds have been tried successfully in mice, Villafranca says. And while there is potential for use of one or more of these compounds as a medicine to lower levels of noradrenaline, he says, "we still don't know which compounds work as well in the body as in the test tube."

Another and possibly more immediate use of these compounds may be in the creation of disease models. Many genetic diseases are caused by enzyme deficiencies, and by inhibiting a specific enzyme, researchers could create in animals physiological conditions that mimic a genetic defect. Such a model could help scientists study Down's syndrome, which is associated with decreased levels of dopamine-beta-hydroxylase. *—S. I. Benowitz*