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SCIENCE

The Bell Laboratories Revisited

On each of my many visits to the Bell Laboratories, I have learned of new activities. Among those described to me on a recent visit, two types of efforts were particularly notable: experiments on new forms and structures of matter and further developments in photonic transmission of information.

Molecular beam epitaxy continues to be a very useful technique in creating new structures. When beams of more than one element are used, the composition of the deposited surface can be varied at will. Measuring equipment permits detection of a thousandth of a monolayer. A major objective is to find a big improvement over present-day technology. One set of molecular beam experiments involves building a part-Si, part-Ge layer on silicon. It has already been possible to create a transistor whose performance is equivalent to state-of-the-art. Another application of molecular beam epitaxy is the deposition of CaF_2 on silicon (100) surfaces. The two lattices match. The CaF_2 is an insulator and would be employed instead of SiO_2 in some structures when the high temperature of formation of SiO_2 is incompatible with other features of the device. In creating new epitaxial structures, the experimenters ask the question, "What will nature allow us to get away with?"

Another study is devoted to creating clusters of atoms and examining their properties. The clusters range in size from 2 to 100 atoms, and clusters of a given number of atoms can be selected. In effect, one is dealing with a state of matter intermediate between gas and solid.

Another effort is devoted to investigating the behavior of tiny solid-state structures. With electron beam lithography, it has been possible to make items with a width of 300 angstroms (150 atoms across). One of the items is a narrow-channel MOSFET (metal oxide semiconductor field effect transistor). At low temperatures, the effect of single electrons can be noted. The group of physicists involved make tiny new structures that enable them to explore new physical phenomena. At the same time, they learn how to create the technology necessary to produce the structures and thus make possible further engineering development.

A major objective of AT&T must be to improve on its already high proficiency in photonic transfer of information. It is possible now to transmit at the rate of 2 gigabits per second through a fiber 130 kilometers long with an error rate of less than 1×10^{-9}. The older digital coaxial cable required a repeater station at 1-mile intervals and could transmit only 270 megabits per second. One approach to further progress is to sharpen the laser pulse. This has been achieved in the laboratory with the use of 0.2-micrometer diffraction grating within the laser. With this device, laser side bands are suppressed, and an extremely sharp peak is obtained. It is now possible to transmit simultaneously pulses from ten lasers with differing wavelengths. In the laboratory, data have already been transmitted through a fiber at the rate of 20 gigabits per second.

Progress is also being made on high-speed photo detectors. An InGaAs detector with a mesa 1 to 2 micrometers thick produces an avalanche of electrons with a half-width of detector pulse of 40 picoseconds. Another important development is that of high-speed optical switching. For this, an electrooptic crystal, lithium niobate, is employed. The device is 1 centimeter long with a wave guide 6 micrometers across. Switching voltage is 5 to 10 volts. Still another area of research is on solitons. The propagation and the optical amplification of solitons in fibers has been demonstrated and, thus, the possibility of forming an all-optical system.

The Bell Laboratories have recovered from the trauma occasioned by the break-up of the Bell system. The staff has been assured by words and deeds that top management of AT&T believes that successful research and development are crucial to the company's future. Morale among scientists is excellent.—PHILIP H. ABELSON