

AT&T INNOVATION BRIEFS

Innovation Briefs are summaries of recent discoveries and developments within Bell Labs. AT&T readers who would like to contribute future innovations are encouraged to contact the Technical Journal editor.

Lead-Free Solders: A Win-Win Proposition

Most electronic component and device interconnections still require solder, and most solder alloys still include lead. Concerns about lead's effect on people and their environment have motivated Bell Labs researchers to develop substitutes that are both lead-free and at least as effective as solders containing lead. Three generic varieties using more benign metals have been developed: stronger, highly ductile tin-silver-zinc alloys; mixtures of bismuth, tin and iron whose strength and creep resistance permit use at higher temperatures than similar solders having lower melting points; and tin-zinc-indium alloys whose melting temperatures are essentially the same as their leaded counterparts, but which exhibit greater strength and creep resistance. Continuing research on solders that are lead free, as well as reliable and cost effective, helps push forward our understanding of basic materials science. At the same time, technological and manufacturing changes brought about by these new solders will benefit AT&T—and the entire electronics industry—while protecting public safety and the environment.

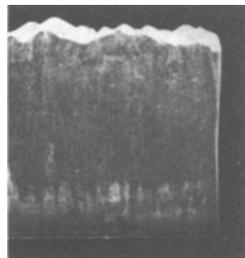
Record-Setting Magnetic Fields

Strong magnetic fields can overwhelm other types of energy, such as thermal fluctuations and semiconducting and superconducting energy gaps. To help AT&T researchers investigate physical processes in a wide range of materials, Bell Labs scientists have designed a multi-turn solenoid magnet that produces the highest non-destructive magnetic field ever created in a multi-turn solenoid. The magnet, operated at Bell Labs, has generated pulsed fields of 72 tesla (1 tesla is equal to roughly 25,000 times the earth's magnetic field). Each pulse has a duration of 80 milliseconds. With a pulsed field of this magnitude, researchers can pursue a broad range of experiments that are not attainable with traditional magnetic coils. The pulsed-field facility is unique in industry, and allows the researchers to investigate new materials without having to rely on rare experiments at the National Magnet Laboratory. A large cross section of copper-niobium composite wire, unique to this application, is used in the Bell Labs magnet. As strong as steel, the wire nevertheless remains nearly as conductive as copper. The magnet is cooled with liquid nitrogen, to reduce recycling time, and can be pulsed every 25 minutes.

Fiber Lasers May Lead to Many Uses

Bell Labs scientists have developed a variety of rare-earth-doped fiber lasers that can emit light over a wide spectrum of visible and near-infrared wavelengths. One of these, an erbium-doped fiber laser, is only three centimeters long and has refractive index gratings at either end. Integrated into the fiber's core, the gratings *precisely* determine the wavelength of coherent light emitted by the laser after it has been energized. In tests, its pulses have been nominally error-free—when modulated at five gigabits per second and transmitted through 86 kilometers of fiber. These characteristics could meet the needs of future communications systems, particularly those that will incorporate several wavelength channels, thereby allowing greatly increased communication capacity.

New Diamond-Shaping Process



Scanning electron micrographs of a CVD diamond before, top, and after shaping by the molten metal technique.



Bell Labs researchers have recently discovered a simple, cost-effective process for thinning, polishing, shaping and patterning films made of the hardest material on earth—diamond. The new process, which relies on a chemical diffusion reaction that coaxes carbon atoms from the diamond and into solid or molten metals, such as cerium or lanthanum, accomplishes in hours what would otherwise require days or weeks of grinding. This discovery was an outgrowth of research focused on the use of chemical vapor deposition (CVD) diamond films as heat sinks. But other potential applications, such as in diamond semiconductors and in optics, are suggested. The process makes the shaping of diamond films, even the rounding of corners and the etching of wells with clearly defined smooth edges, easier, faster and less costly than other known methods, such as laser or plasma machining.