Experimentally Speaking

HIGH PRESSURE

The synthesis of diamond in 1954 by high pressure/temperature means startled the scientific community and caused it to take a new look at a neglected field. In 1954 there were fewer than six laboratories capable of performing experiments at pressures of 1,500,000 psi, and only one laboratory capable of operating at these pressures simultaneously with 2000°C temperatures. Today, however, with interest mushrooming, there are at least 150 laboratories with these capabilities.

Present laboratory research crosses many scientific disciplines. In chemistry, new compounds both inorganic and organic are being synthesized. In geology, minerals are being synthesized to ascertain how they were formed within the earth. Pressure-induced phase transformations in minerals are under study to determine their relationship to seismic discontinuities and earth movements. In physics, the effects of pressure on diffusion, melting, electrical resistance, nuclear phenomena, optical spectra, and so on, are under investigation. In biology, the effects of pressure on enzyme action are giving interesting results. In metallurgy, high pressure has produced new structures in old alloys and has resulted in the formation of hitherto unknown alloys.

Some of the effects produced by high pressure are very unusual. Nonmetals, such as sulfur, have been turned into metals. These metals revert to the original nonmetallic material on release of pressure. However, some semimetals have been permanently transformed into metals. Melting points of some substances have been increased by several hundred degrees. For example, the melting point of tin is 232°C at 15 psi, but at 1,500,000 psi is 540°C. In other instances melting points have been lowered. Germanium, which normally melts at 936°C, melts at 400°C at 1,500,000 psi. These melting points revert to normal upon release of pressure.

High pressure is very effective in producing new polymorphic forms of materials, particularly when combined with high or low temperature. There are, for example, six forms of ice that have been produced in the pressure/temperature field so far explored. Five forms are more dense than normal ice and, consequently, sink rather than float on water. Two very interesting SiO_2 materials, coesite and stishovite, with densities and refractive indexes far exceeding those of quartz, have been synthesized at high pressure. After discovery in the laboratory, these minerals were then found to exist in nature.

High-pressure, high-temperature research presents tremendous opportunity and challenge for workers in many scientific and engineering disciplines.

H. Tracy Hall
DIRECTOR OF RESEARCH
BRIGHAM YOUNG UNIVERSITY