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Materials Science and Engineering

Ability to compete in high technology will be an important determinant of success in the competition between nations and regions. In turn, success in technology is crucially linked to leadership in materials science. The development of new or improved materials permits the creation of new technologies, better quality control, less costly products, and, in some instances, less dependence on imports of scarce elements. To advance materials science requires close collaboration of physicists, chemists, and engineers. Laboratory experimentation is stimulated by theoretical physicists or chemists. Scientific advances also come as a result of stimuli generated by engineering needs. Interesting developments in materials science are occurring; some of these are portrayed in this issue of *Science*.

For the most part, the chemistry of the substances available for use as materials is well known. However, the behavior of substances at surfaces and interfaces is not well understood. Microstructures, both in the interior and at the surface, can have a large effect on properties. One method of markedly altering a surface is ion implantation, which is widely used in the semiconductor industry. It is also increasingly being used in other applications to provide surfaces that differ radically in composition from the bulk of an object. Intense, but short-period, laser irradiation can almost instantaneously melt a shallow layer at a surface; this is followed by a comparably fast solidification. This treatment can freeze into place microstructures with superior resistance to friction, wear, and corrosion. Laser treatment of engine parts is now widely used in the automobile industry.

Research on the surficial interactions between living tissue and prosthetic devices has led to potentially improved performance of the millions of implants that are done each year. Particularly useful are glasses or ceramics containing some calcium phosphate. At the surface of the prosthetic device in the presence of body fluids, hydroxyapatite is formed. Cells recognize this substance, are compatible with it, and form connections to it.

In many applications, engineers seek materials that maintain their tensile strength at high temperatures and that are resistant to corrosion. Many of the alloys now in use contain imported chromium as an essential constituent. Research reported in this issue discusses the properties of Ni₃Al. Ordinarily this intermetallic alloy is brittle and unworkable. However, with the addition of boron (200 parts per million), it becomes ductile. Its strength actually increases with temperatures up to 900°C, and it is comparatively free from corrosion.

Plastic composites seem destined for very large-scale applications in the aircraft and automobile industries. Already one manufacturer of airplanes has announced a new model to consist largely of plastics. There will be great savings in weight as well as fewer parts to assemble. A large fraction of the Pontiac Fiero will consist of composites. Intrinsically, some polymer molecules are extremely strong. To use them advantageously requires a knowledge of their behavior during processing. Once strong fibers are formed, composites may be created to meet engineering specifications.

Two of the articles in this issue describe theoretical studies and research aimed at revolutionizing computers and data transmission. The impetus for part of this work comes from the successful development of optical means of communication with the use of glass fibers. It also is based on the development of lasers that are capable of delivering extremely short pulses. In principle, computers based on photon processing could operate much faster than the current semiconductor devices.

Efforts to advance materials science will continue to be driven by opportunities and international competition. Students who have an aptitude for the physical sciences and a desire to participate in research with obvious payoffs in meeting societal needs will find work in the materials sciences rewarding.—PHILIP H. ABELSON