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EDITORIAL

Materials Research and Applications

Tens of millions of U.S. manufacturing jobs depend on the availability of advanced materials at affordable costs, and improvements in the quality of computers, motor vehicles, airplanes, and many other products often hinge on improvements in their component materials. The federal government is aware of the importance of materials research and development (R&D). In 1994, nine federal agencies supported such activities at a total level of over $2 billion,* and about half of this work was conducted in federally owned facilities. One of the many federal initiatives currently under way in materials R&D is a program jointly conducted with major U.S. automobile companies, which aims to produce motor vehicles with low emissions and greatly enhanced fuel efficiencies.

Reasons abound for optimism about future societal benefits from research on materials. Some of the most competent experimental and theoretical chemists and physicists are now engaged in it, and their capabilities are enhanced by the use of computers and high-quality powerful instrumentation of many kinds. Advances continue in computer technology, in the creation of new lasers, and in laser applications. Physicists and chemists have been creating nanometer-sized objects and observing their properties, and it is now possible to construct clusters one atom at a time. (Aspects of the synthesis and behavior of clusters were described in a special issue of *Science* on 16 February 1996.)

Reactions among metals have led to the creation of many important compounds. Some can withstand high temperatures—Ni_3Al melts congruently at 1673°C. Other intermetallic compounds also have useful properties (the most powerful superconducting magnets are built with Nb_3Sn) and applications (as lasers, light-emitting diodes, solar cells, optical switches, and thermoelectric devices). Many additional applications were mentioned in a recent review,† which pointed out that only a tiny fraction of potential intermetallic compounds have been synthesized and even fewer have been thoroughly studied.

Two new methods for synthesizing diamond have the potential to provide important benefits to society. In the method used by Rustum Roy and colleagues,‡ finely ground metal and ground graphite are intimately mixed and then exposed to a plasma of pure hydrogen at a temperature of 1000°C. A liquid of composition $C_xNi_yH_z$ is created, which when cooled toward 400°C forms small crystals of diamond. When diamond grit was included in the starting mixture, beautiful large crystals were obtained. In a second method, described by Pravin Mistry and colleagues,§ beams from three different types of lasers interact with CO_2 and N_2 to create a plasma at and near the surface of an object to be coated. Depending on the adjustment of some parameters of the irradiation, various proportions of diamond crystals or of tetrahedral noncrystalline carbon are formed. When coated with these forms of carbon, tool inserts used in manufacturing have greatly improved resistance to wear.

Methods of preparing thin films, some of which have unique and useful properties, were reviewed in *Science* on 16 August 1996. One of the articles described the many novel structures that can be created by laser bombardments of substrates, the formation of plasmas, and the collection of emitted molecules on targets other than the substrates. Such methods have formed unique high-temperature superconductor films, for example.

A source of major excitement in materials R&D is the meetings conducted by the Materials Research Society, which serve as forums for leading researchers from many countries. From 2 to 6 December 1996, about 4200 presentations will be made at a gathering in Cambridge, Massachusetts. Foreign participants will contribute a third of the total, and East Asia and Europe will be heavily represented. Many of the foreign visitors are scheduled to present new results that are likely to be exploited later in important practical applications.

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1995 Federal Research and Development Program in Materials Science and Technology,* National Science and Technology Council (Office of Science and Technology Policy, Washington, DC, December 1995). †K. Masumoto and W. A. McGahan, *Mater. Res. Soc. Bull.* **21, 44 (1996). ‡R. Roy *et al.*, *Innovations Mater. Res.* **1**, 65 (1996). §P. Mistry *et al.*, *ibid.*, p. 193.