SCIENCE

8 JANUARY 1988
VOLUME 239
NUMBER 4836

Materials Science

Materials science is currently one of the most vital areas of research and development. This was evident in Boston in early December at the annual meeting of the Materials Research Society. A broad spectrum of topics was treated in 18 symposia, including those on superconductors, advanced processes for microelectronics, plasma deposition of diamonds, and catalysts.

The 90 K superconductors have captured attention around the world. Thirty percent of the 260 papers or posters on the topic were furnished by contributors from 22 countries. There have been few times in human history when a scientific finding has been replicated by so many investigators so rapidly in so many places. Many different preparative procedures were mentioned, and the products examined by a variety of instruments. Two impediments to some large-scale applications remain. Thin films of oxides such as $YBa_2Cu_3O_{7-x}$ can carry up to 10^6 amperes per square centimeter. But superconductivity vanishes when a substantial magnetic field is present. A second impediment is the difficulty of forming a flexible wire from the superconductors. Bell Laboratories announced a substantial advance (see Research News, 18 Dec., p. 1649). By melting the oxide and cooling it in a controlled way, they obtained a product that can carry 1,000 A/cm^2 in a magnetic field of 10,000 or more gauss. Many applications will require 10 to 100 times greater currents in larger magnetic fields. The Bell Labs people are optimistic that they can make further progress.

Information processing is becoming the largest industry in the world. Further rapid progress in microelectronics seems guaranteed. During the past 3 years, there has been a 400 percent increase in the density of memory bits, and the practical limit recedes as a result of the ingenuity of scientists and engineers. Excimer lasers employing XeCl, KrF, or ArF are being used to make experimental chips having features with dimensions as small as 0.5 micrometer. The use of molecular-beam epitaxy continues to grow, permitting the construction of complex sandwiches of differing materials with layers a few atoms thick. Ion beams of oxygen with energies of the order of 200 kiloelectron volts are being employed to form an insulating layer of SiO_2 within a silicon wafer. A beam of cobalt can yield an internal conducting layer of cobalt silicide within silicon.

The large-scale synthesis of diamonds has long been a goal of industry. Diamonds are employed extensively in machine tools, and were synthesis of diamonds easy, they might be used with advantage as semiconductors. Diamonds and graphite are both forms of pure carbon, but it is graphite that is stable thermodynamically. In the 1950s, scientists and engineers at General Electric were able to produce diamonds in an apparatus capable of 5500°C and pressures of 2.8 million pounds per square inch. Now diamonds are being produced using plasma in a partial vacuum. The Russian Deriagin was a pioneer, but his papers were largely ignored. From 1983 on, however, there has been intense activity in Japan and recently in the United States. When a mixture of CH_4 and H_2 is introduced into a plasma, highly active and metastable forms of carbon and carbon-hydrogen entities are produced. When these metastable forms are adsorbed on a surface whose temperature is about 900°C, the carbon atoms form a crystalline structure. Sometimes the structure will be that of diamond, sometimes graphite. When a large fraction of the gas in the plasma is hydrogen, copious amounts of atomic hydrogen are made which reacts about a hundredfold faster with graphite than with diamonds. Thus nearly pure diamonds are the net product.

Industrial catalysts take many forms, one of which is a cave-like structure present in zeolites. Once process molecules enter the caves, they encounter active sites that catalyze reactions. In the past, the size of the opening in zeolites limited the kind of molecule that could be processed. At the meeting, new structures having larger openings were described. These included pillared micas and a zeolite type of structure formed predominantly from alumina and P_2O_5.

At Boston many more topics were treated than those touched on above. A 564-page book devoted to the program and abstracts and of presentations provides a further indication of the international character and broad scope of the program.

—PHILIP H. ABELSON

*The Materials Research Society, *Final Program and Abstracts*, Boston, MA, 30 November to 5 December 1987.