Future brightens for conducting polymers

Electronically conductive polymers may soon leap from small-scale laboratory experiments to large-scale commercial applications ranging from airplane lightning protection to anti-static coatings for clothes and other items, predicted materials researchers this week at a meeting of the American Chemical Society in Dallas.

In a symposium resembling an adult form of show-and-tell, scientists reported advances in processing conducting polymers into usable fibers, films and other shapes. Until recently, attempts to marry the morphological, textural and mechanical versatility of polymers with metal-like electronic conductivity resulted in materials that resisted processing into usable forms.

By cleverly choosing reaction conditions and modifying the chemical building blocks, or monomers, that make up the huge polymer molecules, scientists have succeeded in creating conducting polymers they can manipulate with the same techniques used for processing such conventional polymers as nylon.

Hans H. Kuhn and his colleagues at Milliken Research Corp. in Spartanburg, S.C., say they have developed what Kuhn calls "an industrially feasible process" for depositing uniform films of polypyrrole or polyaniline — two of the most studied conductive polymers — onto the fibers of virtually any textile.

When the fibers absorb dilute solutions of the monomers pyrrole or aniline, monomer concentration increases at the fiber surface, where the monomers polymerize into a thin film. An oxidizing agent such as ferric chloride initiates polymerization. Treating nylon, polyester or other fabrics in this way makes them conductive without affecting their texture or strength, Kuhn reports.

Kuhn told SCIENCE NEWS that electrically conductive textile composites like these could prove useful as electromagnetic screening materials for securing, say, government offices from outside electronic surveillance. Instead of escaping to the outside, where they would be vulnerable to interception, internally generated electromagnetic signals would be trapped by the conductive textile composite, which could be built into office walls. Wherever static electricity poses problems — in clothes and on computer monitors, for example — these new textiles would help, he says.

Chemist John R. Reynolds and his colleagues at the University of Texas at Arlington have developed an electrochemical technique for making a water-soluble, more easily formable molecular composite involving the conducting polymer polypyrrole and Du Pont's tough and stable polymer known as Kevlar. The resulting conductive composite withstands higher temperatures and is tougher than the unblended polypyrrole, Reynolds says.

According to symposium organizer Paul Smith of the University of California, Santa Barbara, this technique and others reported at the symposium should usher conducting polymers into commercial application within five years. Like semiconducting materials, conducting polymers rest between metals and insulators on the scale of electronic conductivity. Semiconducting materials such as silicon led to the microelectronics revolution, Smith notes. Conducting polymers could have an equally unexpected payoff, he suggests. *— I. Amato*

All-out attack on deadly bone cancer

Total-body radiation and extra chemotherapy added to conventional treatment sounds like a drastic approach to a childhood cancer. Yet in the case of Ewing's sarcoma, the extra treatment may provide hope for patients at high risk of relapse and death, according to research presented last week at the American Cancer Society's 31st Science Writers' Seminar in Irvine, Calif.

Robert B. Marcus Jr. and his colleagues at the University of Florida in Gainesville have treated 20 high-risk patients with the experimental therapy; statistical projections indicate 60 percent will remain disease-free up to four years after the end of treatment. In contrast, 25 similar patients treated conventionally from 1977 to 1984 had only a 20 percent chance of disease-free survival after four years, Marcus reports.

Ewing's sarcoma, a particularly lethal cancer, usually strikes people between the ages of 10 and 25. Standard treatment involves radiation targeting only the primary tumor, followed by chemotherapy. But such treatment often fails to kill the microscopic seeds of cancer that have traveled to distant parts of the body. "Almost all of the patients are in complete remission as far as we can detect it after standard chemotherapy," Marcus says. "But we know from the cure rate that 80 or 90 percent will relapse."

To combat these odds, Marcus and his colleagues gave high-risk patients — those with tumors larger than 10 centimeters and evidence of cancer spread — five cycles of standard chemotherapy consisting of vincristine, cyclophosphamide and doxorubicin hydrochloride. Patients also got primary-tumor radiation. In addition, they received 800 centigrays of total-body radiation followed by a final chemotherapy dose.

The treatment is a harsh one. The radiation blast kills tumor cells, but it also destroys normal bone marrow and white blood cells, leaving patients vulnerable to life-threatening infection, Marcus says. The researchers take the bone marrow from each patient after the second chemotherapy cycle and transfuse it back into the patient's bloodstream after the final radiation treatment. Patients must remain in isolation for six weeks while the autologous transplant takes hold.

The researchers say they believe the transplanted marrow is cancer-free, pointing out that chemotherapy and freezing should kill any cancer cells. "We can't be 100 percent sure," Marcus notes, acknowledging that some patients have already relapsed. Other researchers, including Eli Glatstein at the National Cancer Institute, echo the uncertainty. Glatstein points to a trial, described in the March 1988 JOURNAL OF CLINICAL ONCOLOGY, in which he and his colleagues gave Ewing's sarcoma patients chemotherapy — with drugs that differed from Marcus' regimen — and total-body radiation followed by an autologous marrow transplant. The team's early success was marred by a high relapse rate three to five years after treatment, he says.

Marcus and his colleagues are tinkering with their regimen to make it safer and more effective. Long-range follow-up is needed to see whether these patients will survive the cancer and the treatment, Marcus says. *— K.A. Fackelmann*

Looking well beyond the Great Attractor

Over and above the motion associated with the uniform expansion of the universe, our own galaxy and its neighbors have an additional motion. They seem part of a large-scale flow toward a distant, vast region of space dubbed the Great Attractor. The name suggests the presence of a large concentration of mass that gravitationally draws matter toward it. Now a team of Italian astronomers has identified another massive aggregation of galaxies in roughly the same direction but three times farther away.

The finding has important consequences for theories attempting to account for the distribution of matter in the universe. "Detailed study of this region is very important, not only because no similar nearby concentration of [galaxy] clusters exists elsewhere, but also because of its direction," report R. Scaramella of the International School for Advanced Studies in Trieste, Italy, and his colleagues in the April 13 NATURE.

This newly discovered concentration of clusters packed with galaxies falls on a line nearly a billion light-years long that also runs through the Great Attractor, the local supercluster (which includes our own galaxy) and another large aggregation known as the Perseus-Pisces supercluster. Such a remarkable alignment on such a large scale is hard to interpret as mere coincidence, the researchers say.

"The issue is not whether these structures are lined up," says astronomer David Burstein of Arizona State University in Tempe. "They clearly are." What's more difficult to determine is whether the universe contains similar structures elsewhere. Burstein was a member of the international team of astronomers who first identified the large-scale galactic flow toward the Great Attractor (SN: 3/22/86, p.182).

"No definite conclusions can be drawn without a more complete picture of our surroundings," the Italian researchers say. Even the Great Attractor and the Perseus-Pisces region on opposite sides of the Milky Way are difficult to study, because dust surrounding and permeating our galaxy obscures the view in their directions. Nonetheless, the observation of such large features conflicts with theories suggesting the universe ought to be homogeneous on large scales.

Another question concerns whether the cluster containing our galaxy is actually moving toward the more distant aggregation. "It may be pulling us, but we don't see any evidence of that," says Burstein. Just as the moon, being closer though considerably less massive than the sun, exerts a greater tidal influence on the Earth, the Great Attractor's effect probably swamps any contribution from the more distant supercluster. There's also no evidence that objects in the Great Attractor region are themselves moving toward the supercluster.

Interpreting the observed motion of the galaxy clusters is complicated by the possibility that gravity may not be the only influence. On large scales, the structure of the universe itself comes into play. "To the degree that we can digest it, we have information here about conditions in the very early universe," says R. Brent Tully of the University of Hawaii in Honolulu. That leaves lots of room for theorists to try out their favorite cosmological models. *— I. Peterson*

Semiconductor studies get a rise from yeast

For years scientists have worked on making semiconducting crystals so tiny they begin to take on the properties of individual atoms or molecules — but now a simple yeast has produced some of the best specimens yet. Physicists plan to use the new "crystallites" to investigate the unusual properties of very small semiconductor particles.

The finding sprang from two seemingly disparate research efforts. Physicists at AT&T Bell Laboratories in Murray Hill, N.J., had been seeking the size limits below which various materials lose their semiconductor properties and investigating what happens below those limits. At the same time, biochemists at the University of Utah Medical Center in Salt Lake City noted some curious properties in the minuscule (200- to 1,000-molecule) cadmium sulfide crystals that yeast organisms make when subjected to cadmium metal. It was not until the Utah biochemists contacted the AT&T physicists that the two groups realized the yeast had created the first known biologically produced specimens of just the sort of particles the physicists were investigating. The physicists, headed by Louis E. Brus, and the biochemists, led by Dennis R. Winge, describe their discovery in the April 13 NATURE.

An individual molecule, or even several molecules, of semiconducting material will behave differently from an ordinary "bulk" semiconductor, explains Brus. In a normal semiconductor, electrons need an energy boost to free them from atoms, allowing them to flow and thereby to conduct electricity. The free electrons may have any amount of energy within a given range. In a solitary molecule or atom, quantum mechanical rules restrict electrons to specific energy states. Somewhere in between lies the "quantum" crystallite. Like the bulk semiconductor, it contains electrons that can be freed, and like the atom, it is constrained to specific energy states.

The energy boost that frees electrons to conduct must be delivered in the form of photons with more than a certain minimum energy. When the particle is extremely small, Brus says, this threshold energy suddenly increases and becomes dependent on the particle size. Winge noticed that in his yeast-produced particles, the threshold energy was both size-dependent and greater than that of a bigger chunk of the material.

Another quality helping the groups characterize the crystallites was the way they absorb and emit light. Winge sent a spectrum of the specific absorbed energies to Brus, who found it corresponded to the spectrum he would expect from quantum semiconducting crystals.

Winge's yeast-created crystallites were more uniform in size than their synthetic counterparts — a property critical for physicists trying to study the size-dependent behavior, says Brus. Winge explains that a special protein in the yeast curbs particle growth between about 17 and 23 angstroms. He says he has now extracted this protein and used it alone to halt growth at this size.

The yeast organisms convert cadmium to cadmium sulfide in order to detoxify the poisonous metal, Winge says. He suspects they may also utilize the semiconductor properties of a material, possibly for transferring energy or electrons. *— F. Flam*

Dying aphids obey wasp's commands

Pity the poor, parasitized aphid. A tiny wasp, *Aphidius nigripes*, has injected a batch of eggs into the hapless bug's body. For days the eggs develop: first into larvae that consume their host's innards and eventually kill it, then into dormant pupae that incubate in the aphid mummy before hatching as adult wasps.

Playing the perfect, edible host for some wasp's larvae seemingly would drive any insect mad. In fact, aphids often jump to their death soon after becoming parasitized — a "host suicide behavior" entomologists attribute not to psychosis but to an aphid's instinctive sense that by dying immediately, it will kill the wasp eggs too, reducing the chances of other aphids becoming infected. Now researchers have documented an even more complex set of behavioral changes in parasitized aphids, but in this case working to the wasp's advantage. The findings, described in the April 14 SCIENCE, highlight the subtleties of host-parasite interactions among even the tiniest insects.

Jacques Brodeur and Jeremy N. McNeil of the Université Laval in Sainte-Foy, Quebec, examined the behavior of *A. nigripes*-parasitized potato aphids living on greenhouse plants. Adult *A. nigripes* usually emerge from aphid mummies after a two-week incubation. But if the days are short enough, indicating autumn, they remain in the mummies for months and emerge in the spring. Brodeur and McNeil manipulated "day lengths" with artificial lighting to get overwintering and non-overwintering varieties of wasps. They found that aphids infected with the overwintering variety of wasp generally wandered from their plants to die in protected places ideal for the wasp pupae's long hibernation. Aphids infected with non-overwintering wasps remained on plant leaves to die. The researchers suggest the parasites somehow induce host behavioral changes beneficial to pupal survival.

Researchers know of several chemical and hormonal changes induced by insect parasites, and some may trigger specific behaviors in bugs, says Bradleigh Vinson, an entomologist at Texas A&M University in College Station. "The evidence here suggests that the parasitoids are in control in some ways."

Art Shapiro, a zoologist at the University of California, Davis, notes that in an evolutionary sense, host-parasite relationships are in a constant, competitive flux resembling an arms race. He says the new finding complements observations of host suicide behaviors in other aphids and represents a moment in evolutionary time where the parasite seems to have the upper hand. *— R. Weiss*