Buckyballs' Supercool Spring Surprise

For sports fans, spring brings on baseball mania; for scientists this year, it's the season of the buckyball. Doped, bounced, enlarged, decorated, modified, even chilled, this 60-atom member of the fullerene family of all-carbon molecules shows promise as a chemical All-Star.

At the American Chemical Society meeting in Atlanta this week, researchers fueled the fullerene fever with reports that the soccerball-shaped C_{60} becomes superconducting when chilled and that the fullerenes are so hospitable to chemical substitutions and additions that they could lead to a entirely new class of materials. Scientists also described a more efficient way to make fullerenes and detected a family member with 200 carbon atoms.

"It's the biggest, cheapest hollow molecule we've ever seen," Richard E. Smalley of Rice University in Houston told SCIENCE NEWS. "We're going to be making fullerenes in truckload quantities for a few dollars a pound, and that will make all sorts of things possible."

Physicist Arthur F. Hebard of AT&T Bell Laboratories in Murray Hill, N.J., surprised scientists at the meeting with evidence that C_{60} films "doped" with potassium become superconductors when chilled to 18 kelvins – a much higher temperature than he and his colleagues expected, he says. Graphite, another carbon material, needs much colder conditions to lose all electrical resistance. Hebard and others speculate that the fullerene film's three-dimensional structure enhances its superconductivity. However, "there's not much incentive to think about [practical] applications," notes Arthur W. Sleight of Oregon State University in Corvallis. Ceramics have already shown superconductivity at higher temperatures, and potassium is so reactive that the doped film cannot be exposed to air.

Doping is the process of adding impurities to an otherwise homogeneous material. The Bell Labs researchers, who detail their experiments in the April 18 NATURE, added potassium to C_{60} molecules in thin films, creating mixtures in which the potassium atoms settled in the spaces between the buckyballs.

Using a different kind of doping, Smalley has succeeded in replacing some carbon atoms with impurities in the soccerball structure itself without destroying the integrity of the molecule. He calls the results "dopyballs." So far, he says, he has managed to tuck three, and perhaps four, boron atoms and a few nitrogen atoms into the molecule. This impurity-inserting process makes silicon a semiconductor, and it could do the same for fullerene crystals, Smalley says.

After observing half a dozen reactions between fullerenes and other chemicals, organic chemist Fred Wudl of the University of California, Santa Barbara, reports that fullerenes "love electrons" and bond easily with substances that readily give them up. "The bottom line is you can attach [a fullerene] to anything," he says. "It's a new starting material for making a whole new family of organic compounds."

Wudl says he plans to publish blueprints for a simplified, benchtop fullerene reactor assembled in less than a week with store-bought equipment and about $60 worth of laboratory glassware. "Any chemist can do it," he says.

Other advances have yielded larger molecules and improved the efficiency of fullerene production. At the University of California, Los Angeles, physical chemist Robert L. Whetten uses an apparatus that resembles a lightbulb with a graphite filament. When heated by electrical current, the filament gives off a soot containing about 40 percent fullerenes – up from about 15 percent in earlier techniques. About half of these fullerenes contain more than 60 carbons, he says.

By dissolving the soot in solvents with ever-higher boiling points, Whetten has extracted ever-larger fullerenes – up to 200 carbon atoms. His spectroscopic studies confirm that these molecules, which vary in color from golden to red, are related to the magenta C_{60}.

In other work, Whetten accelerated fullerene molecules to about 15,000 miles per hour and crashed them against stainless steel barriers, only to find that the molecular balls simply bounced back. These tests show that charged fullerenes are rugged enough to stay intact if used as propellants in space vehicles. "It's resilient beyond any particle that's been known," Whetten says. *– E. Pennisi*

Alcohol's fetal harm lasts a lifetime

Pregnant women who abuse alcohol may hand down a lifetime legacy of disabling mental and behavioral problems to their offspring, according to the first systematic study of the long-term consequences of fetal alcohol syndrome (FAS).

Adolescents and adults assigned a diagnosis of FAS during childhood often appear alert and verbal, but they cannot live independently, hold down jobs or succeed at school because of poor concentration, social withdrawal, impulsiveness, failure to consider the consequences of their actions, and related problems, report psychologist Ann P. Streissguth of the University of Washington in Seattle and her colleagues. Mental retardation also persists among a majority of those with FAS, they point out. However, the debilitating behavioral problems plague those with normal and low IQs alike.

FAS, a mix of physical, mental and behavioral abnormalities afflicting many babies born to mothers who drink heavily during pregnancy, represents the leading known cause of mental retardation in the United States.

"[FAS] is not just a childhood disorder," Streissguth's team writes in the April 17 JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION. "There is a predictable long-term progression of the disorder into adulthood."

The researchers studied 38 males and 23 females ranging in age from 12 to 40 years. A total of 43 received an FAS diagnosis before age 12; the other 18 had prior diagnoses of "possible fetal alcohol effects." American Indians made up three-quarters of the sample.

Study participants displayed little evidence of the facial abnormalities (such as malformed lips and misaligned teeth) and low body weight typical of children with FAS. But many remained short for their age, with unusually small heads. One 29-year-old woman stood only 4 feet tall.

IQs for the group ranged from 20 (severely retarded) to 105 (normal). Academic achievement fluctuated from second- to fourth-grade levels, with arithmetic deficits most common. Nearly the entire sample lived under some type of supervision, usually with parents, relatives, or adoptive or foster parents. According to caretaker reports, every participant exhibited significant behavioral problems, such as consistently poor judgment and concentration. Problems with lying, cheating and stealing also turned up frequently.

The long-term problems associated with FAS make these individuals unsuitable for current job training programs, the researchers argue. Prenatal brain damage may permanently disrupt the ability to concentrate, think abstractly and function independently, even among those with normal intelligence, the scientists add. Nevertheless, they call for the development of more effective remedial programs for adult FAS victims. *– B. Bower*