Chemistry

Carbon ribbons go to greater lengths

A pencil glides easily over a piece of paper, thanks to the flat, slippery layers of carbon that make up its graphite tip. As a variation on those carbon layers, researchers have devised a strategy to make graphite in the form of thin ribbons.

Dubbed phenacenes, the long carbon molecules synthesized by Frank B. Mallory of Bryn Mawr (Pa.) College and his colleagues consist of many hexagonal benzene rings fused together. For decades, the largest number of rings anyone had linked together was six. Last year, Mallory and his group pushed that number to seven, and now they've broken their own record with an 11-ring molecule. They describe their latest achievement in the March 5 Journal of the American Chemical Society.

Because graphite conducts electricity well, these ribbons could potentially form molecular wires or other nanoscale electronic components. For now, though, the researchers are simply working on making longer phenacenes. This month, Mallory will present a new synthesis strategy at the American Chemical Society meeting in San Francisco. The plan would, in principle, enable them to make chains of up to 127 rings, he says.

"It's going to go by leaps and bounds now," says Lawrence T. Scott of Boston College in Chestnut Hill, Mass. "I think all the signs say that these should be stable molecules, and the chemistry should work."

Often, chemists synthesize molecules bond by bond, building them up a few atoms at a time, says Craig S. Wilcox of the University of Pittsburgh. However, the phenacenes are so large that "you can't do it linearly. There are too many steps." Instead, Mallory links several components together to form a larger one and then repeats the process. That way, the molecules roughly double in size with each repetition.

Wilcox is adapting Mallory's strategy to synthesize nanotubes chemically. Nanotubes are commonly made by passing a current through graphite (SN: 7/18/92, p. 36), but making them through chemical reactions would "give us better control of the solubility and other properties," he says.

Phenacenes probably won't behave exactly as graphite does, Mallory says, because the molecules don't lie flat. Chemical groups attached to the sides of the ribbons distort them but allow the phenacenes to dissolve more easily. Otherwise, they tend to crystallize and fall out of the solution, especially as they get larger. "The side chains prevent these molecules from snuggling up close to each other," says Scott. "They don't really affect the electronic properties of the central core."

Whether phenacenes will have practical applications remains to be seen, but this new class of compounds should give scientists a better understanding of how molecular properties change with molecular size. Chemists usually deal with either very small molecules or large biological ones like DNA, Mallory says. Phenacenes fall in between—a size range that's relatively unexplored territory. "Who knows what we're going to find?" he asks. *— C.W.*

New element monikers laid on the table

The heated debate over what to name six heavy elements at the end of the periodic table may soon be resolved. In February, the International Union of Pure and Applied Chemistry (IUPAC) released a new roster of proposed names for the elements numbered 104 to 109: rutherfordium (104), dubnium (105), seaborgium (106), bohrium (107), hassium (108), and meitnerium (109).

The slate represents a compromise over earlier ones, which drew protests from the U.S., Russian, and German research teams who made the discoveries (SN: 10/22/94, p. 271). Many chemists expect the IUPAC council to give its final endorsement to the name assignments in August. *— C.W.*

Materials Science

From a meeting in San Francisco of the Materials Research Society

More bang for the solar cell buck

A solar cell made of amorphous silicon has set a new record for efficiency, converting 13 percent of the light energy it absorbs into electricity. Higher efficiency means that fewer cells are needed to power a given device (SN: 4/16/94, p. 255).

The cell, made by United Solar Systems Corp. in Troy, Mich., consists of three component cells stacked on top of one another. Each component is designed to absorb a different color of light, with the top, middle, and bottom segments capturing blue, green, and red light, respectively. Improvements on the bottom component, on the junction between the top and middle components, and on a layer of indium tin oxide on the topmost surface of the cell helped boost overall efficiency, says Jeffrey Yang, a researcher at United Solar Systems.

Amorphous silicon solar cells are much less efficient than cells made of single-crystal silicon, but they are also much cheaper to make. United Solar Systems, Solarex in Frederick, Md., and Canon Japan in Tokyo plan to begin mass-producing amorphous silicon solar cells this year. *— C.W.*

Metal moves from helicopters to bikes

Another material has recently made the leap from the aerospace industry to the consumer market. Beryllium-aluminum alloys combine light weight, high strength, and malleability, but original formulations couldn't be melted and cast in a mold, says Chris Hinshaw of Nuclear Metals in San Jose, Calif. Adding small amounts of silver, cobalt, germanium, and silicon has overcome that limitation, expanding the material's usefulness. A bicycle made by Nuclear Metals, for example, uses one of the new beryllium-aluminum formulations.

Researchers can tailor the proportions of the added elements to obtain the desired stiffness of the material, Hinshaw says, but it will take further testing to work out exactly how each element contributes to the overall properties.

The new alloys were originally developed for a specific purpose—to form a large, complex part for a military helicopter. They cost at least three times as much as aluminum. *— C.W.*

Organic molecules guide crystal growth

Scientists at the University of California, Santa Barbara have been studying how abalones orchestrate the growth of their pearly shells. On both the atomic and macroscopic levels, abalones use proteins to direct the crystallization of inorganic material.

The abalone shell is made of calcite and aragonite, two forms of calcium carbonate with different atomic structures. To form its shell, the abalone first deposits a layer of calcite, then abruptly switches to aragonite. Negatively charged proteins synthesized by the abalone control which form the calcium carbonate takes, says biologist Daniel E. Morse. The proteins interact with the growing crystals, directing the placement of the atoms. To make the transition between the two forms, a genetic switch turns off production of the calcite's protein and turns on production of the aragonite's.

Multiple layers of flat protein sheets direct the macroscopic growth of the aragonite crystals. The crystals build up vertically through pores in the protein sheets, like coins of diminishing size stacked on one another. The pores in adjacent protein sheets are slightly offset from each other, so the coins are also slightly off-center. Although that offset makes the crystal columns look wobbly, it holds the key to the shell's strength. The columns eventually spread out laterally and lock together.

Using purified proteins, Morse and his colleagues can control the switch from calcite to aragonite in crystals grown in the lab. Ultimately, their goal is to replace the proteins with synthetic polymers and direct the structure of other inorganic materials. *— C.W.*

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