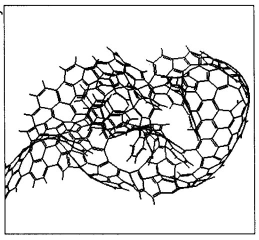
Materials Science

Carbon sieves for small molecules

Foley



Computer simulation of the molecular structure of a carbon film.

Thin sheets made of jumbled, haphazardly linked fragments of carbon molecules show promise as tough and efficient molecular sieves for separating nitrogen from oxygen. Henry C. Foley of the University of Delaware in Newark and Mark B. Shiflett of the DuPont Experimental Station in Wilmington, Del., report their findings in the Sept. 17 SCIENCE.

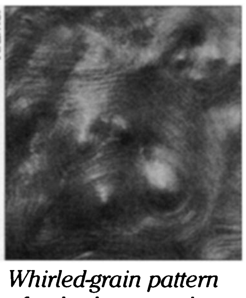
The researchers use high-frequency sound waves to disperse a liquid polymer into tiny droplets, which settle gently onto a perforated stainless-steel tube. A blast of heat reduces the polymer to a porous carbon membrane that has holes about 0.5 nanometer wide. The resulting film is flexible enough to resist cracking, yet thin enough to strain out small molecules.

Because oxygen molecules travel through the material's tiny pores 30 times faster than nitrogen molecules do, the carbon membrane can readily remove much of the nitrogen from an air sample. To begin developing these nanoporous carbon films into a commercial product, "we have automated the deposition process and are experimenting with new thermal treatments," Foley says. The researchers are also trying to make the membrane layers thinner to increase throughput.

At the same time, Foley and his coworkers are investigating how the new carbon membranes discriminate between oxygen and nitrogen. They are also developing computer methods to obtain improved models of these complex materials. —I.P.

From swirl to defect in wood grain

Kramer



Whirled-grain pattern after bark removal from a cottonwood log.

When physicist Eric M. Kramer looked at the complex spirals and whorls sometimes visible in wood just under a tree's bark, he was reminded of patterns that can occur in liquid crystals or magnetic systems. Now at Simon's Rock College in Great Barrington, Mass., Kramer has applied theory developed for understanding inorganic pattern formation to the problem of tree growth. "Observations of wood grain and tree growth can provide important clues to growth processes taking place at the cellular level," he contends. Kramer describes his approach in the September JOURNAL OF THEORETICAL BIOLOGY.

The vascular cambium is the layer of cells just beneath a tree's bark. As the tree grows, these cells divide and the cambium layer moves outward. The daughter cells left behind turn into xylem, or wood. The xylem structures are typically aligned parallel to the axis of the trunk or tree branch, forming a pattern known as straight grain. More complicated arrangements can also occur, including a chaotic structure described as whirled grain.

Kramer focused on whirled-grain patterns seen in knot calluses of eastern cottonwood trees. Such sharp discontinuities in grain direction look like defects in a partially ordered liquid-crystal system, Kramer says. He categorized the types of defects that can occur. To clarify how defects form and how they are eventually eliminated from the vascular cambium, Kramer's next step is to study how a whirled-grain pattern changes as a tree grows. The ultimate goal of this research is a thorough understanding of the factors governing the direction of wood grain, Kramer says. —I.P.

Physics

Twice-magic metal makes its debut

A team of nuclear physicists believes that a certain isotope of nickel is so special that it spent a dozen years developing the ability to make the isotope.

On Sept. 24, researchers at the Grand Accélérateur National d'Ions Lourds in Caen, France, announced that they have made the first sample of nickel-48. Ten days of bombarding a nickel target with a stable nickel isotope yielded two of the short-lived atoms.

What's so important about nickel-48? First of all, "it is doubly magic," says team spokesman Bertram Blank of the Centre d'Études Nucléaires in Bordeaux-Gradignan, France.

A nucleus enjoys greater stability if it has "magic" numbers of protons or neutrons—that is, just enough to fill concentric shells of nuclear particles—theorists say. The number of neutrons, 20, and of protons, 28, in nickel-48 both fit the bill.

Only nine others of the roughly 2,500 known atomic nuclei are doubly magic, and nickel-48 stands out even in that exclusive crowd. While naturally occurring atoms have nearly equal numbers of neutrons and protons, nickel-48 weighs in with the greatest percentage excess of protons of any nucleus. Because it's rich in protons, which repel each other, but it fills its shells, the isotope teeters between disintegration and stability.

Researchers have long waited to test models of nuclear structure on such a substance. Blank says future experiments will explore whether nickel-48 emits a type of radioactivity predicted but never seen before—ejection of two protons at once. —P.W.

New view solves semiconductor puzzle

By delicately parting curtains of electrons, scientists have gazed for the first time into channels on a crystal of the semiconductor gallium arsenide (SN: 8/16/97, p. 102).

Their images, plus computer models, of the uneven landscape settle a decade-long debate, say Vincent P. LaBella of the University of Arkansas in Fayetteville and his colleagues. The terrain is where microcircuit makers grow tiny lasers and high-speed electronics vital to cell phones and other communications gear.

Until now, scientists were uncertain which of four possible patterns the surface atoms of gallium arsenide assume. The arrangement of arsenic atoms seen in the channels favors a pattern known as beta-2, which earlier X-ray studies had suggested, the researchers conclude. The scientists also present supercomputer calculations supporting the beta-2 finding.

"What you really need today is agreement from many different techniques to pin it down," LaBella says.

Microelectronics makers will find it easier to craft new devices by knowing the true arrangement of atoms on the gallium arsenide surface, researchers say. By using an atomic-resolution, scanning tunneling microscope (SN: 10/24/98, p. 268) at low voltage, the team peered past electron clouds into channels, a technique that also promises to be effective for other materials whose surfaces have remained unresolved, such as indium phosphide.

The researchers describe their method and results in the Oct. 11 PHYSICAL REVIEW LETTERS. —P.W.

Collider can't cause cosmic calamity

A new particle accelerator slated to start smashing gold ions together next month in an effort to recreate matter from the early universe poses no threat of destroying Earth or the cosmos.

So concludes a three-physicist panel that reviewed fears that the Relativistic Heavy Ion Collider (RHIC) may unleash an insatiable black hole, a universe-altering transition, or strange matter that transforms all it touches (SN: 8/7/99, p. 95).

The "catastrophe scenarios at RHIC are firmly excluded," the panel says in its Sept. 28 report. Brookhaven National Laboratory in Upton, N.Y., certified RHIC as fully operational on Oct. 4. —P.W.