Fullerenes: Stacked, squeezed, polymerized

No one can say that speculation about practical applications for those hollow all-carbon molecules called fullerenes is all talk and no action.

Several research groups have now demonstrated that they can use fullerenes as lubricants and can coax these molecules to form pure polymers and three-dimensional structures.

Not only do fullerene molecules work as well as other lubricants, but they also can protect surfaces under conditions present in space, says Bharat Bhushan, a mechanical engineer at Ohio State University in Columbus.

To study this new lubricant, he and his colleagues first deposit a thin fullerene film onto a silicon surface. They then roll a steel ball back and forth along that surface and measure the amount of friction generated under different temperatures and humidities. The engineers have also evaluated these friction forces in a vacuum and in a nitrogen environment. After each test, the Ohio State group examines the surfaces of the steel ball and the fullerene film with a scanning electron microscope and a scanning tunneling microscope (STM).

As with other solid lubricants, the film breaks down slightly because of friction. As a result, clusters of carbon molecules bond loosely into larger balls that resemble raspberries. These clusters then roll, like ball bearings, between the silicon and the steel ball, Bhushan says. The fullerenes worked best at 110°C and in low humidity and inert environments, the researchers will report this spring in APPLIED PHYSICS LETTERS.

Two other research groups have created new materials out of the 60-carbon buckyballs.

Zapping buckyball films with visible or ultraviolet light causes their molecules to bond together into a polymer, says Peter C. Eklund of the University of Kentucky in Lexington. Other researchers had created fullerene polymers by attaching the carbon molecules via hydrocarbon bridges, but his polymer is pure fullerene, Eklund adds.

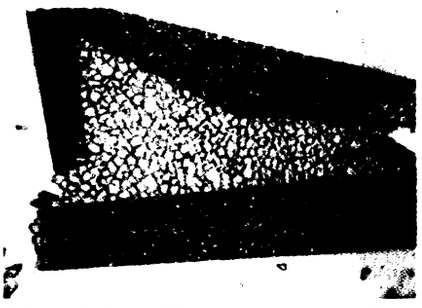
First he and his colleagues deposit a thin C_{60} film onto quartz, silicon, or stainless steel, at the same time minimizing the film's exposure to oxygen. After exposing the film to light, they boil the sample a few minutes in a hydrocarbon solvent. The film, looking a little like molecular plastic wrap, breaks free and, in places, folds onto itself, the researchers report in the Feb. 12 SCIENCE.

Based on their chemical analyses, they suggest that adjacent buckyballs link up when one of the double bonds between a pair of carbon atoms in a molecule breaks and those carbon atoms reach across to neighboring carbon atoms.

A different research team uses "guest" molecules to get buckyballs to assemble into a film or even a three-dimensional structure. The process involves building up the buckyball structure by alternately coating a substrate with guest molecules and then dipping the substrate into fullerene solutions, says Chad A. Mirkin, a chemist at Northwestern University in Evanston, Ill.

Initially, they use guest molecules whose bottom ends bond to an oxide surface and whose tops attract buckyballs, explains Mirkin. Thus, a single, tightly packed layer of carbon molecules assembles on top, the Northwestern team reports in the Feb. 10 JOURNAL OF THE AMERICAN CHEMICAL SOCIETY.

To add more layers of buckyballs, the researchers coat that carbon layer with piperazine, a ringed molecule both of whose ends attach to buckyballs. Consequently, scientists can vary the fullerenes or the type of guest molecules to control the chemical identity of each layer. "It allows greater versatility in terms of properties," Mirkin says. —*E. Pennisi*



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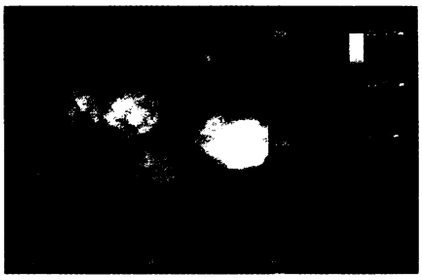

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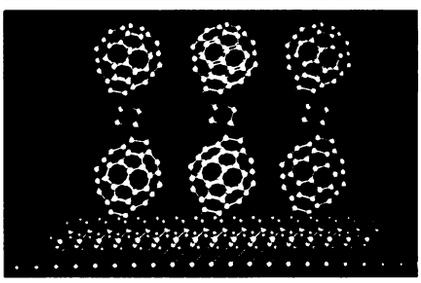

Mirkin/Northwestern Univ.

Above: Edges of buckyball polymer film curl up and away from white quartz underneath. Top right: STM reveals "raspberries" of worn fullerene lubricant. Right: Simulation shows guest molecules (blue) layering buckyballs (white).

Immune syndrome remains mysterious

The strange immune system illness that surfaced last year at the International Conference on AIDS appears to represent a grab bag of different diseases, according to several scientific reports.

Last summer, doctors reported they had discovered a few people who suffered from a puzzling AIDS-like illness but who were not infected with HIV, the virus that causes AIDS (SN: 8/1/92, p.70). Those reports ignited the fear that an unidentified virus might cause the new malady, which was characterized by a depletion of CD4-positive T-lymphocytes, the infection-fighting white cells that are also targets of HIV.

Six scientific reports published in the Feb. 11 NEW ENGLAND JOURNAL OF MEDICINE offer the general public some reassuring news about the syndrome.

"It's rare and it's not AIDS," says Scott D. Holmberg of the Centers for Disease Control and Prevention in Atlanta. "We think we're looking at a number of different things that manifest as low lymphocyte counts."

The syndrome now has a name: idiopathic CD4-positive T-lymphocytopenia, or ICL. The term means that a person has fewer than 300 T-lymphocytes per cubic millimeter of blood and that this count cannot be explained by immunosuppressive drugs or other factors. Healthy people have between 500 and 1,600 such cells in the same amount of blood and thus can fight off common microbes that cause infections.

Holmberg and his colleagues conducted an all-out search for examples of this syndrome. After combing through 230,179 cases in the federal AIDS files, they found just two people who were HIV negative but who suffered from low white cell counts. When the researchers asked doctors to report cases that looked like ICL, they found another 45.

To determine whether the disease is contagious, the researchers interviewed many of the people suffering from ICL, as well as people closely associated with them. None of the roommates, spouses, children, or sex partners showed any sign of low white blood cell counts.

In addition to the article by Holmberg, five other reports rounded out the picture of ICL. All argued against the theory that ICL can be pegged to one infectious agent. In addition, the experts stressed that the syndrome appears to follow a variable clinical course: While some people with ICL died, others showed spontaneous improvements in their white cell counts and appeared healthy.

Despite the progress, scientists still don't know what causes ICL, Holmberg adds. —*K.A. Fackelmann*