Hot Times for Buckyball Superconductors

As the pace of buckyball discoveries continues to accelerate, scientists report another major increase in the temperature at which compounds containing these soccerball-shaped molecules conduct electricity without resistance.

The 60-carbon buckyball is the most prominent member of a family of all-carbon molecules called fullerenes. By adding rubidium and thallium to a film of buckyballs, scientists at Allied-Signal, Inc., in Morristown, N.J., have now made a superconductor that works up to at least 42 kelvins. Just last month, Japanese scientists combined rubidium and cesium with buckyballs to create a compound that superconducts at 33 kelvins.

Physicist Zafar Iqbal of Allied-Signal described the latest increase last week at the University of Pennsylvania Workshop on Fullerites and Solid-State Derivatives. Another participant at the Philadelphia workshop, Paul W.C. Chu of the University of Houston, described growing large crystals of C_{60} and reported that buckyballs exerted unexpected and baffling effects on known superconductors.

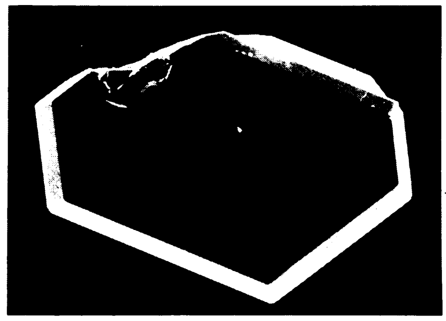
The Allied-Signal team created several samples of the thallium-rubidium-buckyball material, which remained superconducting to between 42.5 and 45 kelvins. They have yet to determine the exact ratios of these elements in the different samples, says Iqbal, but previous research suggests that a superconducting C_{60} compound should contain three "dopant" atoms for every buckyball. This is the first report of a buckyball superconductor that incorporates elements other than alkali metals such as cesium and potassium, Iqbal and others note.

"It's a very encouraging result," says Robert C. Haddon, a chemist at AT&T Bell Laboratories in Murray Hill, N.J., who helped develop the first buckyball superconductor (SN: 4/20/91, p.244). "It broadens the scope of materials that have been shown to dope C_{60}."

In the July 18 NATURE, K. Tanigaki and colleagues at NEC Corp.'s Fundamental Research Laboratories in Tsukuba, Japan, described a new superconductor that contained two cesium atoms and one rubidium atom for each buckyball. Their material maintained its superconductivity up to 33 kelvins, suggesting that the bigger the metal atoms, the higher the superconducting temperatures of the buckyball film.

In the same issue of NATURE, Charles M. Lieber, a Harvard University chemist, reported success in using alloys to make superconducting buckyball films that work up to 30 kelvins. This approach made it easier to combine cesium with buckyballs in the right proportions, he says. Unlike the the Allied-Signal scientists, Lieber and his co-workers added only one metal, cesium, into their buckyball lattice.

Chu, one of the pioneers in high-temperature ceramic superconductors, took a different tack in investigating C_{60}. While trying to create a new material, he put a niobium superconductor into a chamber filled with buckyballs and heated the two. Chu expected only a small amount of carbon to diffuse into the superconductor, and he thought that impurity might have a slight effect on the material's superconductivity. Such an effect would indicate that the buckyballs had entered the niobium.



Chu/Univ. of Houston

This single C_{60} crystal, grown by Paul C.W. Chu and his colleagues, measures 1.7 millimeters long.

But the buckyballs completely eliminated the compound's superconductivity, he reported at the workshop. The results were even more astonishing when he put the buckyball-niobium compound into a magnetic field. The field reinstated the compound's superconducting properties, Chu says. When he heated the material, the superconductivity vanished again – as expected – but lowering the temperature did not restore the property, as it does for most superconducting materials.

Chu repeated the experiment with a tiny niobium ring, which actually transported current with no resistance. This confirmed that something extraordinary occurred throughout the sample when he added buckyballs to the ring, he says. Furthermore, when he exposed the sample to air, it acted as if the buckyballs were not present.

"This really defies all the rules of physics and all the rules of chemistry," Chu told SCIENCE NEWS.

In his quest for a better understanding of buckyballs, Chu also spent three months trying to form a large single crystal of these carbon spheres. His 1.7-millimeter-long, nearly flawless specimen represents one of the biggest so far, he says. *– E. Pennisi*

NIH director faces congressional scrutiny

The continuing debate on scientific misconduct intensified last week with a dramatic confrontation between National Institutes of Health Director Bernadine P. Healy and Rep. John D. Dingell (D-Mich.), chairman of the House Subcommittee on Oversight and Investigations.

Dingell called the subcommittee hearing to address concerns about Healy's handling of the NIH Office of Scientific Integrity (OSI), which investigates allegations of scientific misconduct and fraud among NIH-funded researchers. At the hearing, he charged that Healy had "derailed" OSI investigations through several actions undertaken since she assumed the NIH directorship last April.

The brouhaha represents the latest eruption of a debate over whether scientists can adequately police their own ranks. Many scientists contend that Congress should not interfere with the scientific community's self-regulation. Many lawmakers argue that misconduct by federally funded researchers defrauds the agencies paying for the work, and that scientists too often have failed to investigate such cases rigorously.

Although the central aim of the hearing was to examine whether the new NIH director attempted to undercut OSI investigations, lawmakers started out by questioning her extensively on her own investigation last year of alleged scientific misconduct by a researcher at the Cleveland Clinic Foundation. Healy, who headed the clinic's research institute at the time, chaired an in-house panel that cleared the scientist of misconduct.

In a preliminary inquiry, Healy's panel found false statements in several grant applications written by the clinic scientist and sent to NIH. The scientist admitted that his applications contained descriptions of work he had not done, but he called those statements "honest mistakes," according to Healy's May 1990 report on the inquiry. The panel reprimanded him but concluded there was no evidence that he had intentionally misrepresented his research. "Rather, he exhibited a high level of carelessness and sloppiness that led to misstatements," Healy wrote in her report. She described those misstatements as "anticipatory writing."

At last week's hearing, Healy testified

that she had been "haunted" by the case and had assembled an entirely new inhouse panel to conduct a second inquiry the following month. That group, which did not include Healy, concluded in September 1990 that the scientist did "misrepresent the nature of experimental operations in his laboratory with the intent to mislead." The Cleveland Clinic notified OSI and set up another in-house panel to conduct a full-fledged investigation. That panel, which did not include Healy but considered her testimony, dismissed the charges against the scientist in October 1990.

OSI launched its own review of the case last December. Although NIH has not released the draft report, Suzanne Hadley – OSI's chief investigator at the time – testified last week that the federal probe revealed evidence of misconduct.

Furthermore, she said, "there were significant problems with that first inquiry [led by Healy at the Cleveland Clinic]." For one, Healy's panel included a scientist who had coauthored one of the questioned grant applications, creating a conflict of interest, Hadley said. "And then there was this rather curious concept of anticipatory writing.... The Cleveland Clinic Foundation, in the final analysis, didn't want to call something misconduct when it seemed to be manifestly misconduct as we know it," Hadley told the subcommittee.

Later in the hearing, Healy acknowledged that her preliminary inquiry was "inadequate." She said the scientist under scrutiny told her panel he had included some data that he "anticipated" obtaining before sending the proposals to NIH. Healy called this "inappropriate" but added that she still doesn't know whether the scientist deliberately misrepresented his work.

Dingell pointed out that OSI will next examine whether the clinic's research institute responded adequately to the allegations. "In this case, Dr. Healy's actions as director of the [Cleveland] institute and chairman of the first panel would necessarily be a subject of the investigation," he said. Healy removed herself from any decisions involving the Cleveland case when she joined NIH, but Dingell says the incident may color her judgment of other OSI investigations. Healy calls that suggestion "preposterous."

Several of her actions at NIH have raised concerns on Capitol Hill about OSI's functional independence. At a May 1991 meeting with Hadley and several others at NIH, Healy expressed strong reservations about the way OSI operates, referring to OSI staff as "the keystone cops" and characterizing OSI as "out of control," according to Hadley's testimony.

Hadley also told the subcommittee that Healy demanded a rewrite of a draft report on OSI's continuing investigation of Robert C. Gallo, a prominent AIDS investigator at the National Cancer Institute. Gallo's claim to the discovery of the AIDS virus has long been contested by a French research team. In early June, Healy told Hadley the draft report "reads like a novel," and instructed her to remove editorialized statements and to make it sound more like a scientific paper, Hadley said at the hearing. Hadley objected to the changes in a June 10 memo, saying they would "significantly vitiate the findings of the draft report." In a June 17 memo, Healy replied that she had never intended to change the substance or conclusion of the report, and had merely made some suggestions to improve its style.

At the hearing, Hadley described a recent series of events that she interprets as an attack on her integrity and a threat to her career. One involved her investigation of highly publicized allegations made in 1986 against Boston immunologist Thereza Imanishi-Kari. A draft OSI report, leaked to the press last March, concluded that Imanishi-Kari's lab notebooks contained bogus data (SN: 3/30/91, p.196). In early June, NIH legal adviser Robert B. Lanman asked Hadley for her notes on telephone conversations with Margot O'Toole, the whistleblower in the Imanishi-Kari case. Healy testified that she asked Lanman to obtain the notes because she was concerned that Hadley and O'Toole had developed a friendship that could compromise the ongoing probe. Hadley denied that suggestion and said contact with O'Toole is a necessary part of the investigation.

In late June, said Hadley, OSI Director Jules V. Hallum asked her to return all her files on the Gallo and Imanishi-Kari cases to the central OSI office (she had been working from a satellite office) and told her that Healy had ordered him to "rein in Hadley." The next day, Hadley stopped working on those cases, saying she could not pursue them effectively without her files.

Last week, Healy characterized her actions as managerial decisions necessitated by numerous leaks of confidential draft reports, including the March release of the Imanishi-Kari document. "Everything that I did with regard to OSI was within the context of fulfilling my obligations to the Constitution," she told reporters after the hearing. She added that leaks of preliminary misconduct reports can destroy scientific careers.

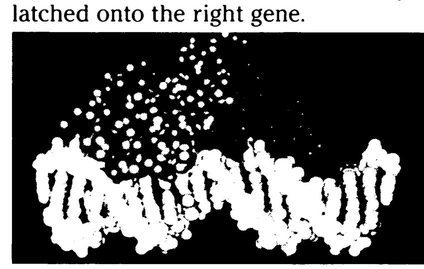
Whether her actions represent managerial solutions or a campaign to undermine OSI remains an open question. But subcommittee staffers say lawmakers have seen enough to make their next move. Several staffers told SCIENCE NEWS that Dingell plans to take steps to remove OSI from the NIH campus and place it under the aegis of the Inspector General's Office at the Department of Health and Human Services – a team known for its aggressive fraud investigations.

– K.A. Fackelmann

A 3-D image reveals a steroid-gene link

In their quest to understand how steroid hormones turn on genes, biochemists have created a picture truly worth a thousand experiments.

Steroids alter the rate of protein production in the body by relying on a separate receptor molecule to find the target gene. In the Aug. 8 NATURE, Paul B. Sigler of Yale University and his coworkers show how a gene fragment binds to the part of a steroid receptor that recognizes specific DNA sequences. Their three-dimensional, computer-generated image, based on X-ray crystallography, reveals that it is not only the binding between DNA and the steroid-receptor molecule, but also the spacing between binding regions, that tells these gene-activating molecules when they've latched onto the right gene.



Sigler/Yale Univ.

Target gene's DNA sequence (white) facilitates the match-up with the two-toned steroid receptor dimer.

Working with Leonard P. Freedman of the Sloan-Kettering Institute in New York City and Keith R. Yamamoto of the University of California, San Francisco, Sigler's team began by modifying the gene fragment: They added an extra unit of DNA, called a base pair, to the middle of its 15-base-pair sequence. Next they synthesized lots of the modified fragment and made multiple copies of the receptor segment that recognized this specific gene fragment.

When one receptor segment latches onto the first six base pairs of the gene fragment, the segment slightly alters its structure, thereby making it easy for a second segment to link with it – forming what is called a dimer. That second segment twists around to home in on the fragment's last six base pairs, whose sequence represents a symmetrical version of the first six. But with the extra base pair in between – making it four instead of three – the dimer fails to line up well with the DNA, so recognition is poor, says Sigler.

When his team repeated the work with unmodified gene fragments, they found that the segments did bind tightly to the DNA. This indicates that the three base pairs in between those that combine with the dimer create the correct spacing that lets the steroid receptor know it has found its target gene, Sigler says. *– E. Pennisi*