would. Instead, says Ameisen, "The cells are primed to die when they are stimulated."

And it's not just any kind of death. They succumb to "apoptosis," which is also known as programmed cell death. Since superantigens are known to induce programmed cell death in CD4 cells, Miedema says, the finding of apoptosis suggests that they could account for the selective loss of the cells in AIDS patients. He notes, however, that opportunistic pathogens might be a source of the superantigens, as well as HIV itself.

The priming of T cells for programmed cell death could also explain another aspect of AIDS that's just beginning to be appreciated. "Most people didn't realize that before you lose a lot of T cells, the immune system is already dysfunctional," Miedema points out. And it certainly would be if helper cells die when they encounter antigens. In addition, stimulation of programmed helper cell death might be one way that cofactor pathogens could contribute to AIDS development.

What's still unclear, however, is how HIV infection might prime CD4 cells for programmed death. The researchers have suggested several possibilities. The viral infection might, for example, cause disturbances in the production of the many molecules that regulate immune cell activities, causing an aberrant response. Or the HIV envelope protein gp120, which has already been shown to impair T cell function, might be involved.

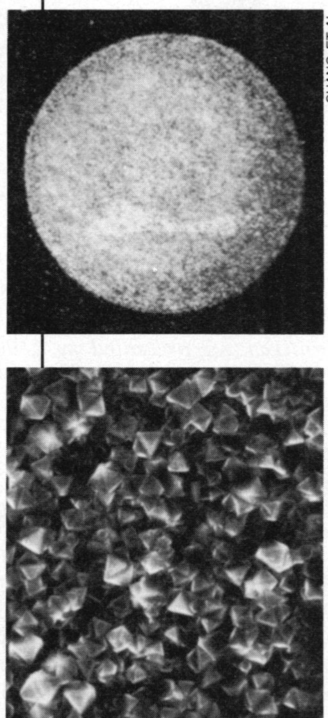
Nobody expects a definitive answer on just what kills T cells in AIDS patients any time soon, but when it comes the information should, as Fauci says, help in the design of better therapies. If drug therapies can't eliminate the AIDS virus from the patients' bodies, then it may at least be possible to mitigate its devastating effects on the immune system. But the current work suggests that therapy needs to begin early since the immune cell abnormalities start early. As Miedema puts it, "Once you lose a lot of T cells, you are already over the hill."

The information is also important for vaccine development. "People are trying to develop vaccines using virus proteins," Primi says. "But suppose you inject into people a protein with superantigen properties. The damage could be big."

And then there's the strong possibility of a major complication. According to the researchers, HIV may well cause T cell depletion in more than one way. "Everything about the virus is bad," says Janeway. "It has adopted every mechanism previously known for evading the immune system." And that makes the virus an extremely formidable adversary. ■ JEAN MARX

# When Diamonds Met Buckyballs

Synthetic diamond coatings have become a superstar of materials science. Superstrong and superhard, they should be just the thing for armoring the business ends of drills, mining equipment, machine tools, even kitchen knives and razor blades; meanwhile, other properties have caught the eye of microelectronics and optics researchers. In fact, it was all this promise that led *Science* to name diamond films "The Molecule of the Year" last year (21 December 1990, p. 1640). But there was always a catch: The films won't grow from the parent carbon-containing vapor unless the surface to be covered has been pretreated with a polish of diamond grit—an impractical requirement, in many cases. Now salvation may be on its way from another superstar material, the cage-shaped carbon molecules called buckyballs. In the world of materials science, this mating must be the equivalent of movieland's marriage of Liz Taylor and Richard Burton.


CHANG ET AL.

**Well met.** *A 0.2-millimeter $C_{70}$-coated spot hosts a film of diamond* (bottom).

In a forthcoming issue of *Applied Physics Letters*, Northwestern University researchers R.P.H. Chang and Manfred Kappes and their colleagues report that diamond films grow eagerly on a specially prepared layer of $C_{70}$ clusters—a relative of the original buckyball, $C_{60}$. That result should enhance not only the luster of diamond films but the box-office value of buckyballs. Since the discovery of the molecules in 1986, they have resembled unemployed celebrities. Oh, there's been plenty of promise—widespread speculation in the trades about possible roles—but no scripts have materialized. Which is why this first hint of a practical application has cheered buckyball enthusiasts. "My guess is that this discovery will assist the development of practical applications," says Rice University chemist and buckyball codiscoverer Richard Smalley.

Before the Northwestern University team tried buckyballs, many other researchers had been searching desperately for an alternative to diamond-grit polish to encourage the growth of diamond films. But their casting was lousy. None of the substances tried, including pump oil and various cage compounds made of hydrocarbons, possessed two key qualities: stability—enough to withstand the high temperatures of diamond growth—and an intricate three-dimensional structure that could provide a template for diamond's molecular architecture.

About a year ago, Chang recalls, he realized that the famed carbon clusters might offer a solution. "I thought, 'These are real beauties,'" says Chang. "They are chemically inert, resilient compounds and they contain a lot of structure, a lot of dimensionality." As it happened, buckyballs became available in gram quantities at about the same time, opening the way for Chang and his colleagues to test his hunch.

The group deposited buckyballs on a surface and bombarded them with carbon and hydrogen ions, breaking open the cage structure and exposing some free ends of the buckyballs' carbon network. These free ends, the Northwestern researchers theorized, would provide ideal templates for nucleating diamond growth. Their first effort to grow films on layers of $C_{60}$ met with only limited success, but the $C_{70}$ stand-in, with its slightly different geometry, made buckies look great. A base layer of ion-activated $C_{70}$ was about 10 orders of magnitude better at seeding diamond-film growth than an untreated surface.

That's fast enough for practical diamond-film growth, says Chang, but he and Kappes are eager to see whether other buckyball relatives might do even better as stand-ins. They're now trying larger carbon clusters, such as $C_{84}$ and $C_{90}$, as well as fragments of such clusters. On theoretical grounds, though, they think the ideal molecule may lie in an even larger size realm.

These material matchmakers, it seems, won't rest until they find diamond's perfect partner—which is, of course, what Liz may have done, after repeated tries. Then again, perhaps no one will ever equal Richard. ■ ANNE SIMON MOFFAT