The Science of Small
Zack O’ Malley Greenburg 12.24.07, 12:00 AM ET

Every Weekday Morning C. Jeffrey Brinker gets up at half past five and makes cappuccinos for himself and his wife. The windows of the mountainside home they designed afford 80-mile views of Albuquerque and the pink-orange desert beyond. Equally expansive is the amount of thought that goes into each cappuccino. Brinker, 57, is one of the world’s leading materials scientists at the nanometer scale, a nanometer being about the width of the human DNA helix. A cup of coffee, for him, is an engineering experiment. At least with coffee, you can see what’s going on. In nanotechnology, you can’t.

Brinker explains as he brews that if the espresso beans are ground too coarsely, they’ll make flavorless espresso. Too fine, the coffee will taste burnt. To make the milk froth, Brinker rests the head of the steam nozzle at the surface of the milk for a few seconds, explaining that he’s squeezing air into small bubbles in a type of Venturi effect. Smaller bubbles make for a stable, uniform layer of foam. “That’s why I hate Starbucks. Those guys hit a button and all this stuff just happens. They don’t even understand what goes into it,” he says.

Brinker, a professor of chemical engineering at the University of New Mexico, is turning out some of the most intricate nanomaterials the field has seen. Many of these materials build themselves. One is a protective sheath that keeps cells alive for months outside a host body, nourished by a layer of fat. Another has perfectly arrayed pores 3 nanometers across, a mesh so fine it is used to filter individual amino acids in the DNA sequencing process. The Department of Energy has provided Brinker’s lab, run as a partnership between UNM and Sandia National Laboratories, with $2 million to develop nanostructures that can purify water and others that can extract greenhouse gases like carbon dioxide from flue gases released by coal-fired power plants. The Air Force has tossed him another million to develop coatings that will keep metal from corroding. The National Institutes of Health has thrown in $400,000 to adapt Brinker’s nanostructures for drug delivery and therapy. General Motors is paying Brinker’s lab to develop films for use in automotive fuel cells.

“He is a visionary in his scientific work,” says Bernd Smarsly, a former Brinker student, now a professor of physical chemistry at the University of Giessen in Germany. “This ability brings him to ideas that are unreachable by ‘normal’ scientists.” Says Eric Carnes, one of Brinker’s grad students at UNM: “In most cases your brain needs several minutes just to catch up with the basics of what Jeff has just suggested.”

Yet Brinker remains accessible, and a little more colorful than most scientists. At an October lecture to an audience of high school students and doctoral candidates, Brinker compared the formation of aerogel, an ultralow-density solid, to a crowd of drunken French sailors looking for a Marseilles brothel. He takes weekly 15-mile bike rides with his grad students and has torn both of his anterior cruciate ligaments slide-tackling undergrads in soccer games. He races around Albuquerque in a six-speed supercharged Mini Cooper.

Brinker’s fame in the scientific community was cemented in the early 1990s when he literally wrote the book on solgels, an arcane substance that can be used to form some of the lightest materials known to man. Solgels are colloids, or liquids with uniformly dispersed solid particles (like milk) that are converted to gel form. They’re used to thicken tires, to prevent caking in Whole Foods curry powder and substances that can be described in terms of relationships of love and hate,” Brinker says. “That’s sort of how I see science. I encode these two simple forces into the molecules I use.”

One of Brinker’s recent projects was inspired by the Namib Desert beetle, which survives by collecting the dew drops that roll down the...
channels on its extremely hydrophobic back. Brinker one-upped the bug by designing a coating for the Air Force so hydrophobic that water bounces off surfaces like a tennis ball.

Even before Sept. 11 set off a rush of antiterror technology research, Sandia and the Defense Advanced Research Projects Agency (Darpa) had the zany idea of using honeybees to stand in for humans when collecting traces of bioweapons and explosives. Brinker stepped in and had the idea of extracting living cells from genetically modified organisms and grafting them onto the backs of cockroaches controlled by pheromones. The cells would be reengineered to fluoresce in the presence of bioweapons and bombs.

The cockroach part was doable, but keeping cells alive outside of a host was something no one had succeeded at for too long. Darpa was only able to keep cells alive for two days. It cut the funding on its insect army in 2002.

But Brinker kept on pursuing the idea of preserving living cells outside their host, and the Air Force threw in $500,000 for research. This year he showed how, by injecting the cells into a matrix made from silica nanotubes wrapped in a sol-gel, he was able to keep a cell alive for six months. The structure is so sturdy that Brinker and his students left mammalian cells in broiling car trunks without any damage. These same silica nanostructures with other cell recipes inside them could be used to detect cancer. Someday that engineering feat may turn into a commercial reality.

Sidebars:
A Love-Hate Relationship
Life on the Roach

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