



"I think we've turned a corner":
James Hsiao, David Reisner and Danny Xiao.

THE OLD REDBRICK MILL ON RIVER ROAD IN Willington, Conn. recalls the textile factories that led American industry 200 years ago. Water from a bucolic pond drains into a sluice gate and rushes down a shallow millrace. A preserved power shaft still hangs from thick oak rafters.

Step inside, where a slight chemical odor pinches the nose, and witness a new kind of industrial revolution. A dozen researchers, speaking a medley of Asian accents, bustle between a bank of fume hoods, works in progress and box furnaces set in a 10,000-square-foot lab. In the middle of the floor a tattooed mechanic with a mullet assembles a piece of testing equipment. He and David Reisner, cofounder and chief executive of Inframat, are among the few Caucasians here—a small illustration of what you might call insourcing. "There just weren't enough [qualified Americans] around," Reisner says.

This is pretty specialized work. Some 30 men and women are developing nanostructured coating materials that vastly improve the mechanical features—durability and thermal

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A nanotech company starts small.

BY TOMAS KELLNER

properties, for instance—of parts made from conventional metals like steel and bronze. Working with compounds whose grains are as small as ten-billionths of a meter across, the engineers are toughening propeller shafts on Navy minesweepers as well as tooth implants and artificial joints. Inframat and its sister company, US Nanocorp (which builds battery and fuel-cell nanomaterials), are idea labs. In 2003 the companies pulled in \$3 million in revenue, only 10% from commercial sales. The bulk was government research money,

the main source of the \$20 million in grants and contracts Reisner has sucked up since 1996, when he started out, from the likes of the Navy, NASA, the National Institutes of Health and other agencies. Private capital abhors abstruse products that can take years to reach the market. Besides, he says, "We would have had to give away half the company for a few hundred thousand dollars."

Reisner pushes his folks to conduct research with commercial potential, then draft grant proposals. The vice president of R&D corrects their grammar and sends off the requests. "[Paid] research gives you the freedom to try stuff out," he says. Hundreds of old proposals are crammed in white cardboard boxes inside Reisner's office at the nearby Farmington headquarters. Two out of ten grant applications, he says, are approved.

The next step is selling discoveries to commercial clients. Last year materials scientist H. Amy Chen landed a \$750,000 grant from the U.S. Air Force for water filtration research. She found that nanofibers made from manganese oxide can be synthesized into bird's-nest-like matrices with high surface areas that trap most contaminants, including lead and arsenic. Today she's working with Omnipure to build manganese oxide filters for kitchen taps. Xing Ma, a materials scientist whom Reisner recruited from the Sorbonne in Paris, is working on a project with United Technologies' Pratt & Whitney, spraying jet engine parts with Inframat's thermal barrier nanocoatings; the material, zirconia dust, was originally developed for the Navy. Ma relies on a patent in his own name to turn zirconia into a solution, applying it with a rented plasma gun burning at 30,000 degrees Fahrenheit. The coat behaves like a thermal blanket, protecting parts such as turbine blades from a meltdown. That in turn allows an experimental jet to run hotter, boosting efficiency from 400 cycles to 1,200 cycles. So far the company's research has yielded 21 patents but no solid commercial deals. "I espouse a very Darwinian approach," says Reisner. "You throw things against the wall and see what sticks."

Reisner launched this business eight years ago with help from two University of Connecticut materials scientists, T. Danny Xiao and Peter Strutt, and onetime dean of the business school at Southern Connecticut State University James Hsiao. Reisner, 49, joined IBM in San Jose, Calif. after receiving a Ph.D. from MIT in physical chemistry. While working for

Electro Energy he visited UConn to consult with Xiao and Strutt about battery materials. They hit it off so well that Reisner called back soon after and suggested they start their own company.

They had a rough go of it. Reisner, who has three children, quit his job and lived off the income of his wife, who has an ob-gyn practice. Xiao left his position teaching materials science at UConn, moved in with his brother and lived on carrots and

for batteries—enough to lease lab space and pick up a raft of secondhand equipment for 10 cents on the dollar. The raw nanomaterial they got from China.

A big boost came from the Office for Naval Research in 1997. Lawrence Kabacoff, the Navy's project manager, had a problem with the fleet's minesweepers. The boats' foot-thick, bronze propeller shafts were succumbing to attrition. Steel shafts held up better but triggered the magnetic

As business expanded, the company scrambled for talent. It collected referrals and scoured American schools with good materials-science labs where Chinese-born students compete for placement. Reisner pays high wages, a prerequisite for the high-skill H-1B work visa, and he has a full-time personnel manager who deals with immigration lawyers. Three-quarters of the workers at Nano Group, as the combined companies are now called, are foreign born.

A 16-foot, stainless-steel spray dryer is cranking out nanopowder by the ton. At \$35 a pound the stuff will help pay the salaries of all those Ph.D.s. (Some of whom "understand when we miss the payroll by a few days," says Hsiao.) Powder sales have totaled \$100,000 in the last three years. They should climb this year, thanks to three new joint ventures: two in the U.S., where the company holds an equity stake, and one with a Chinese manufacturer, which pays a percentage of sales. Says Reisner: "I think we've turned a corner."

Some Ph.D. employees "understand when we **MISS THE PAYROLL** by a few days."

tomatoes from Strutt's garden. The founders took no salary for 18 months. They wrote dozens of grant proposals on Reisner's home computer for projects dealing with nanomaterials for fuel cells and rechargeable batteries for consumer electronics. The National Science Foundation coughed up \$75,000 for manganese oxide development; the U.S. Special Operations Command came up with \$100,000

detectors in mines. Reisner proposed spraying the shafts with a ceramic nanopowder—a blend of 83% alumina and 17% titania whose specks are a single micron in diameter—to form an extremely tough and pliant coating that would resist peeling and cracking. "I realized we were looking at something very different," says Kabacoff. He has since sent \$5 million worth of Navy work Reisner's way.