Nanomaterials researchers to study self-assembly by electrical and optical fields

November 22 2005

A University of Delaware-led research team has received a $1.3 million grant from the NSF to fund research on nanoscale directed self-assembly in electrical and optical fields. The team will be laying the groundwork for new technologies by directing tiny particles to create materials such as crystal arrays and wire-like structures that can then, in turn, be used to create even more complex materials, according to principal investigator Norman Wagner, Alvin B. and Julia O. Stiles Professor of Chemical Engineering at UD.

Co-investigators on the four-year project are UD's Eric Kaler, Elizabeth Inez Kelley Professor of Chemical Engineering and dean of the College of Engineering, and Eric Furst, assistant professor of chemical engineering, as well as Orlin Velev, assistant professor of chemical and biomolecular engineering at North Carolina State University, and John Brady, Chevron Professor of Chemical Engineering at the California Institute of Technology.

The funding is through NSF's Nanoscale Interdisciplinary Research Team program, which Wagner said is part of a national campaign to develop nanomaterials and nanotechnologies known as the National Nanotechnology Initiative. "It is not quite the Manhattan Project, but it certainly is an enormous national effort," he said.

The UD team will be looking at new ways to take nanoscale "building blocks" and assemble them into "highly structured, highly functional materials," Wagner said.

Among the potential future uses of the technology are tiny and highly specialized sensors with applications in health care and security and advances in photonics, or the generation and control of light to carry information. “One grant challenge for the future is photonics and the ability to make an optical computer that is driven by light rather than by electricity,” Wagner said. “That will lead to a quantum leap in the power of the computer.”

Wagner said that in working with nanoscale particles, scientists must put “billions and billions and billions of pieces together,” and because the materials are so small, they must develop new methods for the manufacture of nanomaterials. “We must come up with a new science, really, as we learn how to manipulate and control the particles,” he said.

The only way to create nanomaterials, Wagner said, is through self-assembly, in which the materials essentially build themselves. “Nature works through self-assembly,” he said, adding, “Biological systems are wonderful examples of self-assembly, from seashells, which grow through the use of nanoparticles and polymer secretions, to human beings.”

Wagner said that through self-assembly, nanoparticles form structures that can then perform “more complex tasks and create even more complicated structures, like you and I.”

Engineers are interested in conducting self-assembly much as nature does but without the limitations--natural self-assembly is generally slow and the number of materials limited--and with the ability to manipulate and control the processes. “We recognize the power of self-assembly but we want to do it on our own terms, controlling it, directing it, speeding it up,” Wagner said.

The team will be considering how to undertake nanoscale self-assembly through the use of electrical and optical fields. In electrical fields, scientists can move and assemble nanoparticles into functional materials, sometimes driving them to electrodes to create crystal arrays that can be made functional as displays or sensors.

Also, the team will be studying the use of optical fields in the creation of nanostructures through human manipulation. UD's Furst has developed "laser tweezers" that can physically grab onto and direct nanoparticles.

"By combining laser tweezers in optical fields and directed self-assembly in electrical fields, we believe we will be able to create new materials," Wagner said.

Wagner said the team would be conducting basic research to "understand the mechanisms and develop a new technology."

"This will be an enabling technology that we and others will use to make things in the future," he added.

The NSF is interested in using the NIRT grants to stimulate multidisciplinary and multi-institutional research, Wagner said. Velev is a former UD researcher who now has a well-recognized research program at North Carolina State, and Brady is a renowned chemical engineer.

The grant will provide research opportunities for three doctoral students at UD and one each at North Carolina State and Cal Tech, and for undergraduates at the participating institutions. Students and faculty will work together at all three institutions, as well as with industrial partners who are interested in developing technologies from the basic research.

Source: University of Delaware