

PHOTO BY NICOLE CAPPELLO



processing go awry in humans.”

The team uses networks of cultured rodent brain cells as the Hybrot’s brain and has essentially given the cultured neural networks a body in the form of a mobile robot. Potter’s group hopes the research will lead to advanced computer systems that could some day assist in situations where humans have lost motor control, memory or information-processing abilities. The neural interfacing techniques they are developing could be used with prosthetic limbs directly controlled by the brain. Advances in neural control and

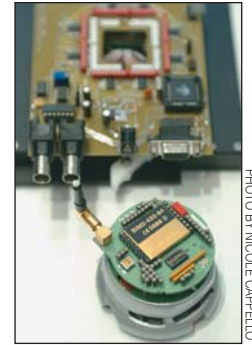


PHOTO BY NICOLE CAPPELLO

Left: Professor Steve Potter and his research team in the Laboratory for Neuroengineering at Georgia Tech created the Hybrot, (above) a small robot that moves about using the brain signals of a rat.

Rat-Brained Robot

The Hybrot, a small robot that moves about using the brain signals of a rat, is the first robotic device whose movements are controlled by a network of cultured neuron cells.

Georgia Tech researchers use lab cultures to control robotic device.

Steve Potter and his research team in the Laboratory for Neuroengineering at the Georgia Institute of Technology are studying the basics of learning, memory and information processing using neural networks *in vitro*. Their goal is to create computing systems that perform more like the human brain.

Potter, a professor in the Wallace H. Coulter Department of Biomedical Engineering at Georgia Tech and Emory University, presented his most recent findings this spring during the Third International Conference on Substrate-Integrated Microelectrodes.

As the lead researcher on a \$1.2 million grant from the National Institutes of Health, Potter is connecting laboratory cultures containing living neurons to computers to create a simulated animal, which he describes as a “neurally controlled animat.”

It is called a ‘Hybrot’ because “it is a hybrid of living and robotic components,” he says. “We hope to learn how living neural networks may be applied to the artificial computing systems of tomorrow. We also hope our findings may help cases in which learning, memory and information

information processing theory could have application, for example, in cars that drive themselves or new types of computing architectures.

— Larry Bowie

■ For more information, contact Steve Potter, Department of Biomedical Engineering, Georgia Tech, Atlanta, GA 30332-0535. (Telephone: 404-385-2989) (E-mail: steve.potter@bme.gatech.edu). The full-text, news release version of this article is on the Web at www.gatech.edu/news-room/release.php?id=125.

Controlling Cell Adhesion

Georgia Tech research reported in the journal *Nature* this spring provides the first experimental evidence for an unusual molecular bonding mechanism that could explain how certain cells adhere to surfaces such as blood vessel walls under conditions of mechanical stress.

Researchers provide first experimental evidence of “catch bonds” regulating cells under stress.

Known as “catch bonds,” the adhesion mechanism displays surprising behavior, prolonging rather than shortening the lifetimes of bonds between specific molecules as increasing force is applied. Proposed theoretically nearly 15 years ago, catch bonds could help explain how the body regulates the activity of white blood cells, which must flow freely through blood vessels — yet bond to injury sites despite blood flow forces.

“We call it the ‘Hybrot’ because it is a hybrid of living and robotic components.”

—Steve Potter

Professor Cheng Zhu of the School of Mechanical Engineering uses atomic force microscopy equipment to study “catch bonds,” a cell adhesion mechanism that may be responsible for making certain cells adhere to surfaces such as blood vessel walls under conditions of mechanical stress.

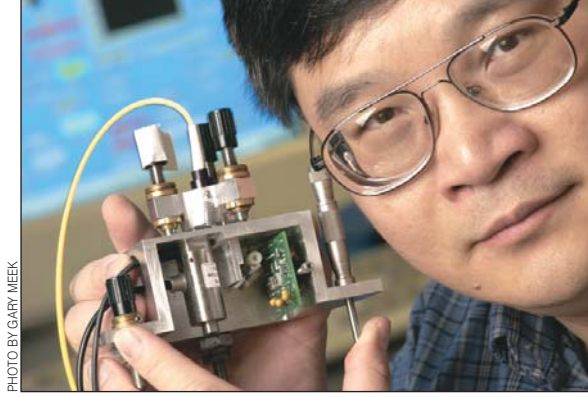


PHOTO BY GARY NIEEK

Right: Researchers Larry Bottomley and Mark Poggi adjust chemical force microscopy equipment being used to measure adhesion between bundles of carbon nanotubes and polymers being considered for use in new composite materials.



PHOTO BY GARY NIEEK

Understanding how catch bonds work could offer drug designers a new target for anti-inflammatory and anti-thrombosis compounds, and potentially provide a new approach to controlling the metastasis process that cancers use to spread.

“Before the experimental demonstration of catch bonds, we tended to think that force could regulate biochemical reactions only in one direction,” says Cheng Zhu, a professor in the Woodruff School of Mechanical Engineering. “This work demonstrates that force can alter the rate in the other direction, depending on the type of interaction. In this post-genome era, we need to know more about how proteins interact with one another and with DNA. This work illustrates a new regulatory mechanism for how proteins — which from a mechanical engineer’s perspective are nanomachines — operate.”

Supported by the National Institutes of Health (NIH), the research involves two teams of scientists, one at Georgia Tech and Emory University in Atlanta, and the other at the Oklahoma Medical Research Foundation and University of Oklahoma Health Sciences Center in Oklahoma City.

— John Toon

■ For more information, contact Cheng Zhu, School of Mechanical Engineering, Georgia Tech, Atlanta, GA 30332-0405. (Telephone: 404-894-3269) (E-mail: cheng.zhu@me.gatech.edu); or Dr. Rodger McEver, Oklahoma Medical Research Foundation. (Telephone: 405-271-6480) (E-mail: rodger-mcever@omrf.ouhsc.edu). The full-text, news release version of this article is on the Web at gtresearchnews.gatech.edu/newsrelease/catchbond.htm.

“The intent is to come up with two or three chemical groups that will give us the strongest interaction...”

—Larry Bottomley

Light, conductive and nearly as strong as steel, carbon nanotubes are being combined with lightweight polymers to produce composite materials with properties attractive for use on future space vehicles. But choosing the right polymer for optimal mechanical performance at the nanometer scale requires a lengthy trial-and-error process.

By adapting the tiny cantilever and position measurement systems used in atomic force microscopy (AFM), researchers at the Georgia Institute of Technology are helping their NASA colleagues shorten that process. Using chemical

force microscopy, they are producing detailed information about adhesion between single-walled carbon nanotubes (SWNTs) and molecules of candidate polymers with different functional groups.

“Our hypothesis is that the stronger the adhesive interaction between molecules and

nanotubes, the more likely it is that the polymer will fully wet the nanotubes, break up aggregations of nanotubes and form a mechanically sound composite,” says Larry Bottomley, a professor in the School of Chemistry and Biochemistry. “The intent is to come up with two or three chemical groups that will give us the strongest interaction and then incorporate these onto polymers for further studies.”

Details of the research were presented March 23, 2003 at the 225th American Chemical Society National Meeting. The Advanced Materials and Processing Branch of NASA’s Langley Research Center has supported the work under grant NGT-1-02002.

— John Toon

■ For more information, contact Larry Bottomley, School of Chemistry and Biochemistry, Georgia Tech, Atlanta, GA 30332-0400. (Telephone: 404-894-4014) (E-mail: lawrence.bottomley@chemistry.gatech.edu). The full-text, news release version of this article is on the Web at gtresearchnews.gatech.edu/newsrelease/nanocomposites.htm.

Nanocomposites

A microscopy technique originally developed to image the molecular-scale topography of surfaces is now helping engineers choose the right materials for a new generation of lightweight high-strength composites based on carbon nanotubes.

Chemical force microscopy helps choose right materials for future composites based on nanotubes.

Boosting Productivity

Academic scientists and engineers have long been encouraged to collaborate on research projects and papers, but until recently little information has existed about the benefits of these interactions. A new Georgia Institute of Technology study provides strong evidence that academic collaboration really does pay off in improved scientific productivity.

Supported by the National Science Foundation and the U.S. Department of Energy, the study shows that the number of collaborators is the strongest predictor of a scientist's productivity as measured by books and scholarly papers published.

"For many years, people have been trying to encourage collaboration, but we haven't had much research that actually demonstrates a beneficial effect on productivity," says Barry Bozeman, Regents Professor of Public Policy and lead author of the study. "Since developing and maintaining collaborations requires time, there is always a question about whether the benefits of collaboration outweigh the costs. The work we've done suggests that the benefits of collaboration are great, and that collaboration is one of the best predictors of publishing productivity."

Bozeman and doctoral student Sooho Lee based their conclusions on surveys returned by 437 academic scientists and engineers working at major research centers in the United States. They also used curriculum vitae (CV) provided by the same set of scientists and engineers to help obtain measures of collaboration and productivity.

The study relates the number of books and refereed journal articles published by each of the respondents over a five-year period to the number of collaborators, considering not only the total number of books and papers, but also a "fractional count" in which each publication was assigned a score based on the number of authors. Bozeman and Lee also looked at other factors related to publishing productivity, including scientists' rank, age, gender, collaboration strategies and job satisfaction.

— John Toon

■ For more information, contact Barry Bozeman, School of Public Policy, Georgia Tech, Atlanta, GA 30332-0345. (Telephone: 404-894-0093) (E-mail: barry.bozeman@pubpolicy.gatech.edu). The full-text, news release version of this article is on the Web at gtresearchnews.gatech.edu/newsrelease/collaborate.htm.

New study shows strong association between academic collaboration and scientific publishing productivity.

Nanocomputing

Researchers at the Georgia Institute of Technology have demonstrated a new type of nanometer-scale optoelectronic device that performs addition and other complex logic operations, is simple to fabricate and produces optical output that can be read without electrical contacts.

Based on arrays of individual electroluminescent silver nanoclusters, the quantum devices could provide a foundation for new forms of specialized molecular-scale computing. The research, sponsored by the National Science Foundation was reported in the March 18, 2003 issue of the journal *Proceedings of the National Academy of Sciences*.

"In effect, we are demonstrating optoelectronic transistor behavior," says Robert Dickson, a professor in the School of Chemistry and Biochemistry. "Instead of measuring current output as in standard electronic transistors, we measure electroluminescent output for a given voltage input. Our devices act in a way that is analogous to a transistor with light as the output instead of electrical current."

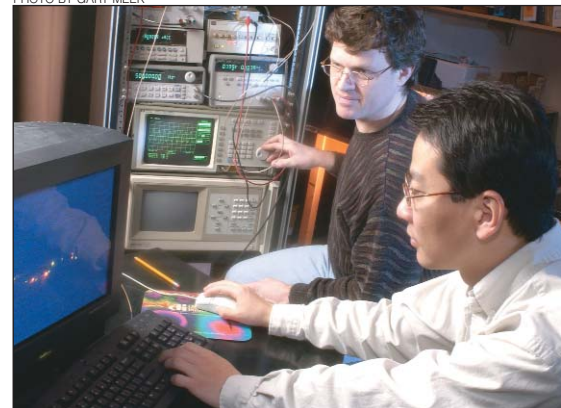
Because the nanoclusters possess different energy levels, they can be addressed individually by varying the voltage injected into the array of clusters with a simple two-terminal system. Avoiding the need for isolated electrical connections to each nanocluster makes the system far easier to fabricate at the nanometer scale than electronic devices of traditional design.

Key to the new devices developed by Dickson and collaborator Tae-Hee Lee is the specific voltages at which the clusters – which contain between two and eight silver atoms – emit light when electrically excited.

— John Toon

■ For more information, contact Robert Dickson, School of Chemistry and Biochemistry, Georgia Tech, Atlanta, GA 30332-0400. (Telephone: 404-894-4007) (E-mail: dickson@chemistry.gatech.edu). The full-text, news release version of this article is on the Web at gtresearchnews.gatech.edu/newsrelease/nanocomputing.htm.

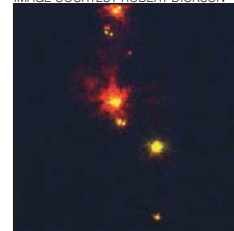
PHOTO BY GARY MEEK



Simple optoelectronic devices based on electroluminescent silver nanoclusters perform logic operations.

Georgia Tech researchers have demonstrated a new type of nanometer-scale optoelectronic device that performs addition and other complex logic operations. Shown (l-r) are researchers Robert Dickson and Tae-Hee Lee.

IMAGE COURTESY ROBERT DICKSON



This microscope image shows the use of individual electroluminescent silver nanoclusters for addition and other complex logic operations.