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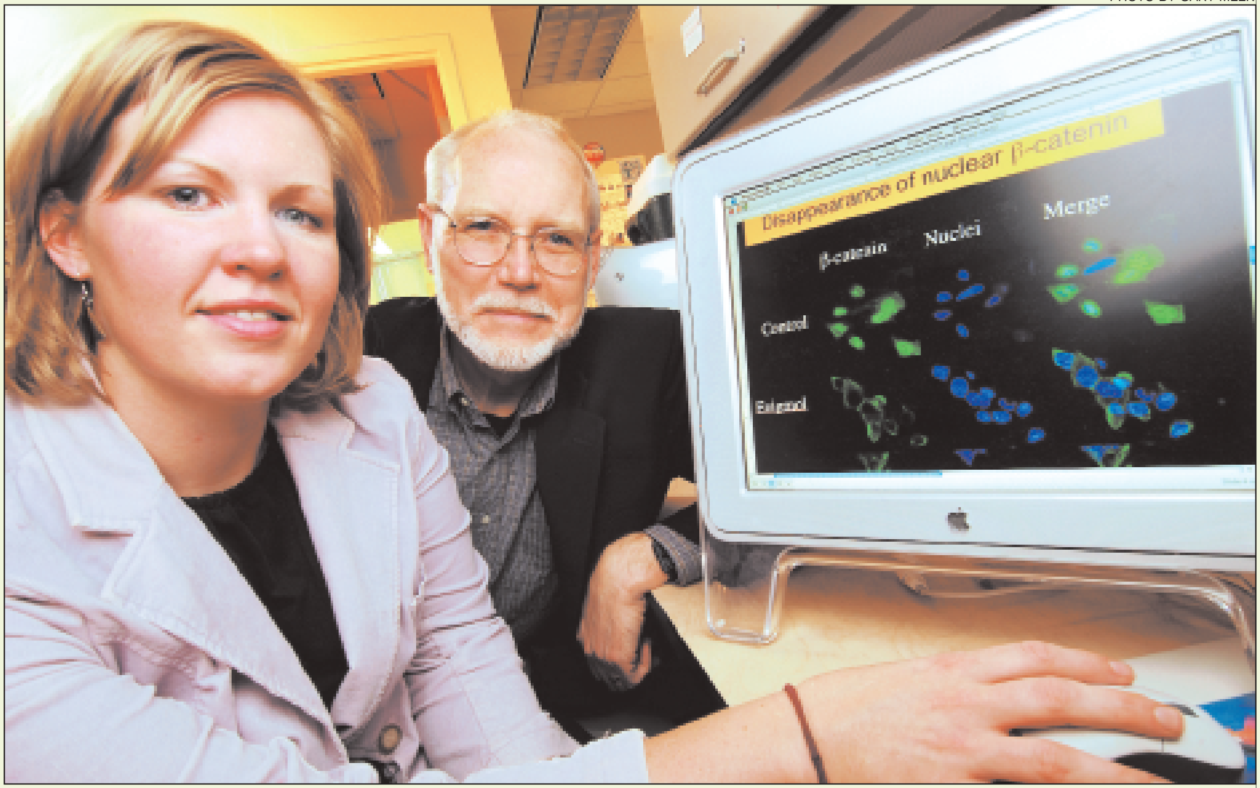
PHOTO BY GARY MEEK



ABOVE RIGHT: Professor Al Merrill and graduate student Holly Symolon review data from their study of the anti-cancer effects of novel compounds called Enigmols.

Targeting Cancer

Researchers find promising cancer-fighting power of synthetic cell-signaling molecule.

Novel anti-cancer compounds called Enigmols suppress the growth of human cell lines representing cancers of the prostate, breast, colon, ovary, pancreas, brain and blood, and reduce tumors in three animal studies, new research shows.

In addition, Enigmols do not show side effects at effective doses, according to the research conducted at the Georgia Institute of Technology, Emory University and Wayne State University. The studies were funded by the National Cancer Institute.

"Many agents suppress cancer cells in a Petri dish and then not in the whole animal, or have unacceptably high toxicity for normal tissues," says Georgia Tech Professor of Biology Al Merrill. "Finding that Enigmols are effective in three animal models leads us to hope these may be a new approach to treat cancer." However, human trials must still be done to determine safety and efficacy in people, the researchers cautioned.

The findings were presented by Georgia Tech postdoctoral researcher Qiong Peng at the American Association for Cancer Research 96th Annual Meeting this spring. After considering comments from other scientists at the meeting, the researchers plan to submit the results to a scientific journal.

Enigmols are synthetic analogs of sphingolipids, a group of cell-signaling molecules that help cells decide whether to grow or die via a controlled process called apoptosis. Cancer cells are usually defective in these regulatory pathways, so researchers hypothesized that structurally modified sphingolipid analogs might be even better at making cancer cells behave more normally.

Merrill and his collaborators have been studying sphingolipids for more than a decade, having first shown that sphingolipids in food, such as low-fat dairy products and soybeans, suppress tumors in mouse models for colon cancer.

Encouraged by these findings, Emory University Professor of Chemistry Dennis Liotta and his colleagues at Emory prepared almost 100 sphingolipid-based analogs that led to the discovery that the Enigmols were the most potent. The lead compounds were named "Enigmols" because sphingolipids were named after the Sphinx for their enigmatic properties. Emory University holds the patent on compounds of this type.

In addition to being more potent than naturally occurring sphingolipids, the researchers have also found that Enigmols can be administered orally and appear in often-difficult-to reach organs such as the prostate. "This is what suggested to us that Enigmols should be tested against other cancer types," Merrill explains.

Subsequently, the researchers found that

Enigmols suppress the growth of human prostate tumors implanted in mice, which is a commonly used model to test new anti-cancer drugs. They were also effective in two other mouse models for colon cancer.

"We do not know why Enigmols affect such a wide range of tumor cell types," Merrill says. "But it may be due to the involvement of sphingolipids in multiple cell-signaling pathways. This means a compound may affect several different targets, rather than just one."

In essence, Enigmols may act like a multi-drug combination therapy, the investigators speculate. Enigmols are also being tested in combination with other cancer chemotherapeutic drugs using funds from EmTech Bio — a life sciences technology business incubator operated by Georgia Tech and Emory. This research is coordinated with Slainte Bioceuticals, a start-up biotechnology company in metro Atlanta that is helping to bring this potential drug to market.

— Jane M. Sanders

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Replacing Lead-Based Solder

Electrically conductive adhesive (ECA) materials offer the electronics industry an alternative to the tin-lead solder now used for connecting display driver chips, memory chips and other devices to circuit boards. But before these materials find broad application in high-end electronic equipment, researchers will have to overcome technical challenges that include low current density.

Using self-assembled monolayers — essentially molecular wires — and a three-part anti-corrosion strategy, researchers at the Georgia Institute of Technology have made significant advances toward solving those problems. At the 229th national meeting of the American Chemical Society earlier this year, the researchers described improvements that could allow ECA materials to conduct electrical current as well as the metal alloy solders they are designed to replace.

"In certain applications that require high current densities, conductive adhesives still do not measure up to metallic solders," notes C.P. Wong, a Regents Professor in Georgia Tech's School of Materials Science and Engineering. "However, by using these self-assembled molecular wires and controlling corrosion at the interface, we can significantly increase the current density."

For environmental reasons, manufacturers are moving away from the tin-lead alloys now used to make the connections for integrating devices into such products as computers, PDAs, and cell phones.

Those alternatives fall into two categories:

- Alloys that combine tin with such metals as silver, gold, copper, bismuth or antimony, and
- Conductive adhesives that combine flakes of silver, nickel or gold with an organic polymer matrix.

Conductive adhesives could simplify electronics manufacture by eliminating several processing steps, including the need for acid flux and cleaning with detergent and water. Because the materials can be cured at lower temperatures — about 150 degrees Celsius and potentially even room temperature — they would produce less thermal stress on components, require less energy and use existing circuit board materials.

"Conductive adhesives have a lot of advantages, but there are a few challenges," Wong notes. "After you attach a component to a board with conductive adhesives and then cure it, you must test the connections under conditions of high humidity and heat. When you do that, electrical resistance in the joints increases and conductivity drops. That is a major problem for the industry."

At first, scientists and engineers believed the problem was caused by oxidation. But Wong and his colleagues showed that galvanic corrosion, caused by contact between dissimilar metals in the adhesive and tin-lead alloys used in device contacts, was the real culprit. They have since published numerous papers describing strategies for fighting corrosion.

— John Toon

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PHOTO BY GARY MEEK

ABOVE: Samples of electrically conductive adhesive are tested in the laboratory of Professor C.P. Wong in Georgia Tech's School of Materials Science and Engineering.

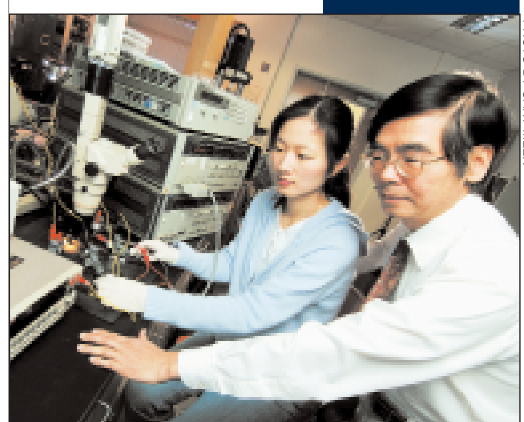


PHOTO BY GARY MEEK

ABOVE: Researchers C.P. Wong (right) and Grace Yi Li test properties of electrically conductive adhesives in their Georgia Tech laboratory.

PHOTO BY GARY MEEK

ABOVE: Researchers Marcus Weck and Amy Meyers examine vials containing dilute solutions of polymers with functionalized Alq_3. By allowing the fluorescent material to be applied as a polymer the researchers could help lower the cost of manufacturing organic light-emitting diodes.

Next-Generation OLEDs

The Georgia Institute of Technology and Virginia-based Albemarle Corp. have signed a collaborative research agreement to develop new polymer precursor materials for use in next-generation aluminum-based, organic light-emitting diodes (OLEDs).

A global supplier of specialty chemicals and chemical intermediates, Albemarle will support research on new polymer precursor materials that could lower the cost of producing OLEDs based on aluminum tris(8-hydroxyquinoline), also known as Alq_3. The research is being done in the laboratory of Marcus Weck, an assistant professor in Georgia Tech's School of Chemistry and Biochemistry.

Alq_3 is one of the most stable and fluorescent solid-state materials, which makes it attractive for use in the emission and electron-transport layers of OLEDs used in equipment such as computer displays. Weck and his colleagues have developed improved polymeric materials that will allow Alq_3 to be applied onto substrate materials using simple solution processing techniques. Previously, the material had to be applied using costly vacuum deposition equipment.

The researchers recently demonstrated that their Alq_3-functionalized polymer system can be tuned to produce yellow emissions at a wavelength of 560 nanometers, in addition to blue (440 nanometer) emissions. This proof-of-principle shows that the system can be modified to provide the selection of colors needed for next-generation display systems, Weck says.

The Albemarle funding will support further development of the polymer system, which could help facilitate production of low-cost OLED devices. "Using this system, the industry will be able to fabricate the devices without expensive equipment," Weck says. "We could potentially print our materials with ink-jet printers."

As part of the effort to drive down production costs, Weck's team has recently developed what is believed to be the first poly(styrene)-functionalized system for Alq_3.

"This material will certainly be of interest to the industry from a price standpoint," he notes. "We have a fully-controlled system for which we have good characterization data."

Weck says the relationship with Albemarle will be collaborative, with the company's scientists working closely with Georgia Tech researchers. The company is pursuing new applications for its aluminum materials and offers custom synthesis and process development services to the OLED industry.

— John Toon

@ Contact: Marcus Weck at 404-385-1796 or marcus.weck@chemistry.gatech.edu. Read more at: **gtresearchnews.gatech.edu/newsrelease/albemarle.htm**

BELOW: This vial contains a dilute solution of polymers with functionalized Alq_3.

PHOTO BY GARY MEEK

High-Tech Expansion

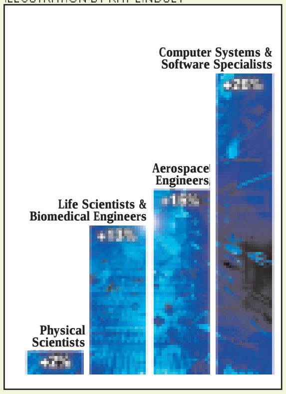
Georgia shows growth in high-tech, high-wage jobs that require more education.

Though Georgia's technology industry has been in a downturn since 2001, the number of state residents employed in high-tech occupations — paying high wages — has actually grown during that time, a new Georgia Institute of Technology analysis of employment and wage data shows.

The apparent contradiction can be explained by the growing demand for workers with high levels of knowledge and skills, even in organizations not traditionally considered "high tech." An example would be network and computer specialists who help improve productivity within "low-tech" manufacturing operations.

"Computer system and software specialists are enabling a lot of different industries, not just information technology services firms," says Jan Youtie, a research associate in Georgia Tech's Community Research and Policy Services. "When you are trying to define a state's position in the high-tech economy, it can be useful to examine high-tech occupations as a complement to looking at high-tech industries."

ILLUSTRATION BY KAY LINDSEY



LEFT: Employment in high tech occupations requiring higher levels of education grew in Georgia from 2001 to 2003.

Analyzing data from both federal and state sources, Youtie and collaborators Philip Shapira and Jue Wang found that jobs requiring high levels of education grew 12 percent in Georgia from 2001 to 2003. While these high-tech occupations added about 9,000 jobs to the state's economy, employment in the rest of the state's occupations declined by 2 percent.

The growth took place among high-tech occupations with average wage rates of more than $32 an hour. That job category added more than 11,000 jobs, while high-tech occupations with lower average pay rates lost about 1,500 jobs. Youtie suspects that may reflect a decline in technician-level positions.

"When we focused on the high-tech occupations, it seemed that the technician-level occupations tended to have more of a decline, while occupations that paid higher wages — such as computer systems and software specialists, aerospace engineers, life scientists and biomedical engineers — had some growth," she says.

While that trend needs more study to determine whether it affects all occupations, it nevertheless points out the demand for a better educated workforce, Youtie adds.

"Our economy requires more specialization, new ideas and more complex thinking," she says. "These high-tech occupations require higher education."

Beyond the economic impact from their higher wages, such highly educated workers also help keep the state's industries competitive, notes Shapira, a professor in Georgia Tech's School of Public Policy and co-author of the analysis.

"Not all jobs in industries defined as high tech actually require higher education or higher skills, while many jobs that do require those are in other sectors. That's why it's important to look beyond the traditional 'high-tech' industries," he says.

But the growth of these high-wage occupations raises a concern about a widening disparity between occupations based on educational levels, the researchers warn.

According to the U.S. Bureau of Labor Statistics, Georgia has a higher proportion of high-tech workers than the country as a whole — 2.4 percent for Georgia versus 2.2 percent nationally.

While these high-tech occupations were growing, Georgia industry classified as "high tech" lost about 1,400 jobs between 2002 and 2004. (The reporting periods for high-tech occupations and high-tech jobs are not identical).

Georgia's high-tech industry decline — though small — can be explained by the state's larger share of workers in high-tech sectors, such as software publishing and computer systems design, that experienced job losses nationally.

— John Toon

@ Contacts: Jan Youtie at 404-894-6111 or jan.youtie@edi.gatech.edu; or Phil Shapira at 404-894-7735 or philip.shapira@pubpolicy.gatech.edu. Read more at: **gtresearchnews.gatech.edu/newsrelease/occupations.htm**

BELOW: At the U.S. Centers for Disease Control and Prevention (CDC) in Atlanta, a scientist conducts laboratory research in a Biosafety Level 4 laboratory. Such occupations as life scientists and biomedical engineers grew in Georgia between 2001 and 2003.

PHOTO COURTESY CDC

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Concussion Detection

A player just took a hard knock to the head and is lying on the field. A coach rushes to his side, but the player sits up and seems fine.

He knows who the president is and how many fingers the coach is holding up. But is he ready to get back in the game?

More than 750,000 mild traumatic brain injuries (mTBI) occur in the United States each year. When a player or soldier with even a mild concussion is sent back to the field, another blow to the head can lead to additional lifelong problems or even second impact syndrome, which has a mortality rate of up to 50 percent. But the injury is difficult to diagnose, even with a quiet room and a several-hour-long test.

Michelle LaPlaca, an associate professor in the Wallace H. Coulter Department of Biomedical Engineering at Georgia Tech and Emory University, and David Wright, director of Emory University's Emergency Medicine Research Center, have developed a new device to detect brain injuries right on the sidelines of a football game, on a battlefield or in the emergency room.

Called DETECT (Display Enhanced Testing for Concussions and mTBI system), the device is a fast, easy-to-administer and sensitive system for assessing problems associated with concussions. The DETECT device is an integrated system that includes software applications run on a portable computer, an LCD display in the headgear and earphones that block external noise.

While a typical mTBI test requires a quiet room and one to two hours of testing, DETECT performs neuropsychological tests in an immersive environment in about seven minutes, regardless of surrounding noise and movement. So, a football player or soldier who just took a hard hit to the head can take the test and either be safely cleared to get back on the field or sent to receive medical attention.

The device blocks external stimuli that could interfere with testing, such as light and sound. This allows the test to be given in virtually any setting, even a bright football field with a roaring crowd.

When suffering from mTBI, a person will have difficulty with certain types of thinking controlled by different areas of the brain, such as working memory, complex reaction and multitasking. DETECT runs the wearer through three types of neuropsychological tests that measure the function of several parts of the brain as it attempts to perform the tests. In addition to the advantages of its speed and portability, DETECT can also be administered by a non-medical personnel.

While the device has already been tested in the lab and in a hospital emergency room, the Georgia Tech football program plans to test this new technology.

DETECT is expected to be commercially available in the next three to five years.

— Megan McRainey

@ Contact: Michelle LaPlaca at 404-385-0629 or michelle.laplaca@bme.gatech.edu. Read more at: **www.gatech.edu/newsroom/release.php?id=554**

BELOW: Biomedical Engineering Assistant Professor Michelle LaPlaca demonstrates DETECT with the help of Bryan Williams. The device helps quickly detect mild concussions in virtually any setting.

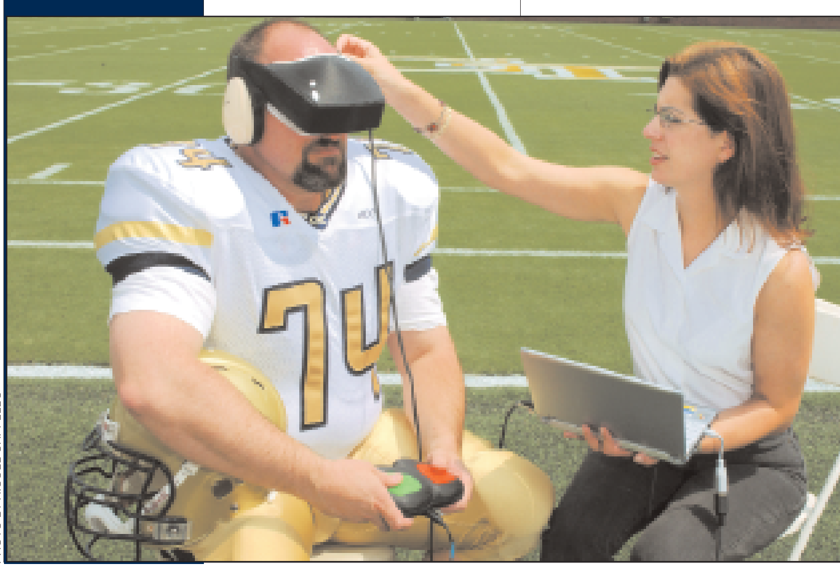


PHOTO BY NICOLE CAPPELLO

Beating the Heat

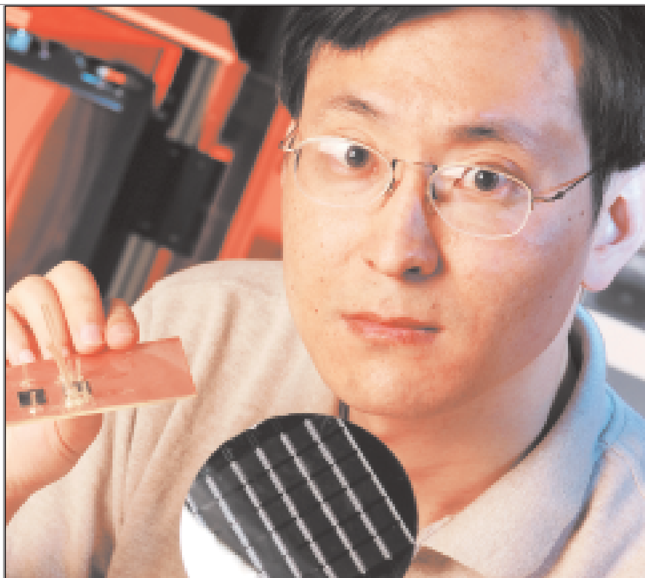
A new technique for fabricating liquid cooling channels onto the backs of high-performance integrated circuits could allow denser packaging of chips while providing better temperature control and improved reliability.

Developed at the Georgia Institute of Technology, the wafer-level fabrication technique includes polymer pipes that will allow electronic and cooling interconnections to be made simultaneously using automated manufacturing processes. The low-temperature technique, which is compatible with conventional microelectronics manufacturing processing, allows fabrication of the microfluidic cooling channels without damage to integrated circuits.

Researchers described the on-chip microfluidic technique in June at the eighth annual IEEE International Interconnect Conference. The research was sponsored by the Microelectronics Advanced Research Corporation (MARCO) and the Defense Advanced Research Projects Agency (DARPA).

"This scheme offers a simple and compact solution to transfer cooling liquid directly into a gigascale integrated (GSI) chip, and is fully compatible with conventional flip-chip packaging," says

PHOTO BY GARY MEEK



ABOVE: A low-temperature technique developed at Georgia Tech allows fabrication of microfluidic cooling channels without damage to integrated circuits, says doctoral candidate Bing Dang.

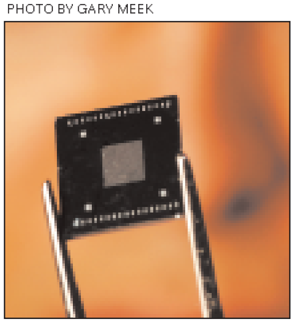
Bing Dang, a doctoral candidate in Georgia Tech's School of Electrical and Computer Engineering. "By integrating the cooling microchannels directly into the chip, we can eliminate a lot of the thermal interface issues that are of great concern."

As the power density of high-performance integrated circuits increases, cooling the devices has become a more significant concern. Conventional cooling techniques, which depend on heat sinks on the backs of ICs to transfer heat into streams of forced air, will be unable to meet the needs of future power-hungry devices — especially 3D multi-chip modules that will pack more processing power into less space.

High temperatures can cause early failure of the devices because of electromigration. By controlling average operating temperature and cooling hot-spots, liquid cooling can enhance reliability of the integrated circuits, Dang notes. Lower operating temperatures also mean a smaller thermal-excursion between silicon and low-cost organic package substrates that expand at different rates.

Some liquid-cooling techniques are already in production or at a research stage, circulating liquid through separate cooling modules attached to the integrated circuits, or through microchannels fabricated onto the backs of chips using high-temperature bonding techniques. These approaches have disadvantages, including limited heat transfer through the modules and potential thermal damage to the chips caused by bonding temperatures that range from 400 to 700 degrees Celsius.

PHOTO BY GARY MEEK



ABOVE: A new technique offers a simple and compact solution to transfer cooling liquid directly into a gigascale integrated chip.

The Georgia Tech approach allows a simple monolithic fabrication of cooling channels directly onto integrated circuits using a CMOS-compatible technique at temperatures of less than 260 degrees Celsius.

"Once the integrated circuit is fabricated, it cannot withstand high temperatures without causing damage," Dang says. "People are looking at liquid cooling in all forms to solve the thermal issues affecting advanced integrated circuits, and the goal is to prevent damage to the chips. We have invented a new way to do it."

The Georgia Tech research team includes Paul Joseph, Muhannad Bakir, Todd Spencer, Paul Kohl and James Meindl.

— John Toon

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Atmospheric Omens

Forget about the groundhog and his shadow. Scientists have discovered that the interplay between two layers of the atmosphere plays a major role in the arrival of spring — a finding that could lead to improved weather and climate forecasting.

"Our research indicates that the onset of spring is more rapid than suggested by the annual cycle of long-term daily averages and is linked to an event known as the stratospheric final warming," says Robert Black, an associate professor at the Georgia Institute of Technology's School of Earth and Atmospheric Sciences. Black presented his findings in June at the American Meteorological Society's 17th Conference on Climate Variability and Change.

He began the study last summer with co-researchers Walter Robinson, a professor of atmospheric sciences at the University of Illinois at Urbana-Champaign, and Brent A. McDaniel, a post-doctoral scholar at Georgia Tech. Results from this study, part of an ongoing project sponsored by the National Science Foundation (NSF), are expanding scientists' understanding of atmospheric interaction.

For many years, scientists believed that the troposphere (the lowest region of atmosphere where weather occurs) drove

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BELOW: These charts represent the longitudinally averaged wind-field at high latitudes. The figure on the left shows a sequence of long-term daily averages with Day 0 corresponding to April 13. The figure on the right represents a 40-year composite time evolution created by aligning seasonal final warming events, which are indicated as Day 0. Areas in red indicate westerly winds, and the areas in blue depict easterly winds.

changes in the stratosphere (atmospheric layer directly above the troposphere) without any feedback. Yet in the late 1990s, new studies found that the stratosphere can affect the tropospheric circulation.

These studies, however, focused on individual seasons. "Because the arrival of spring has a pronounced influence on the hydrological cycle, vegetative growing season and ecosystem productivity, we wanted to study the transition between seasons," Black says. To that end, his team gathered observational data derived from a variety of sources and constructed a composite picture of spring's arrival over a 40-year period.

As winter draws to a close, the westerly jet stream in the troposphere begins to weaken. At the same time, the westerly jet stream in the stratosphere above not only weakens, but eventually reverses direction to become easterly. Black and his colleagues discovered that this event, known as the stratospheric final warming, accelerates the weakening of the tropospheric winds.

"Instead of a gradual weakening over several weeks, it's as if someone flipped a switch," Black explains. "The transition from a winter to spring wind pattern occurs in about one week."

Stratospheric final warmings occur as early as mid-March or as late as mid-May. The researchers also found that these events vary in their intensity, and final warmings that take place earlier in the year are typically more abrupt.

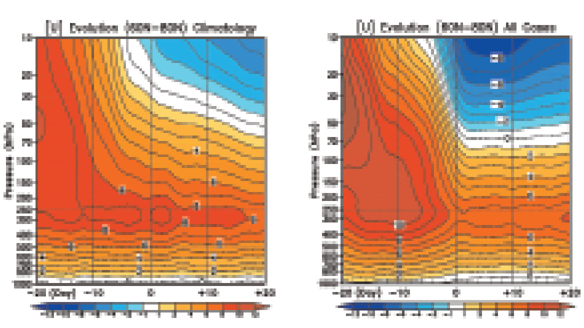
"Stratospheric final warmings explain a significant part of the seasonal transition, especially in the Arctic," Black says.

The next step is being able to accurately predict when a stratospheric final warming will occur.

"The ultimate goal is to provide concrete information for improving weather prediction models," Black says. "Our study shows the extent to which the stratosphere is influencing the troposphere. So if we want to accurately predict spring onset in the troposphere, we need to be concerned about the stratosphere."

— T.J. Becker

@ Contact: Robert Black at 404-894-1756 or rob.black@eas.gatech.edu.
Read more at: **gtresearchnews.gatech.edu/newsrelease/spring.htm**



IMAGES COURTESY OF ROBERT BLACK

PHOTO BY NICOLE CAPPELLO

ABOVE: Andrés García is an associate professor in the Woodruff School of Mechanical Engineering and the Petit Institute for Bioengineering and Bioscience at Georgia Tech.

Directing Cell Response

The body treats implanted medical devices — including everything from titanium hip replacements to blood vessel grafts — as invaders.

Cells surround and attack foreign material, resulting in an inflammatory response. This unfriendly reaction prevents implants from integrating into the body and functioning as well as they could.

While implanted biomaterials can be designed with different surface chemistries and roughness to influence inflammatory responses, the process is not well understood. Now, researchers from the Georgia Institute of Technology have discovered how cells "sense" differences in biomaterial surface chemistry. These differences in communication between the cell and the biomaterial result in changes in cell behavior, according to findings published recently in the Proceedings of the National Academy of Sciences.

In addition to explaining how biomaterials influence cells, the findings could be used to develop new classes of materials to improve device integration and function. For example, these findings could be used to direct responses in stem cells, controlling their differentiation into mature, functional cell types.

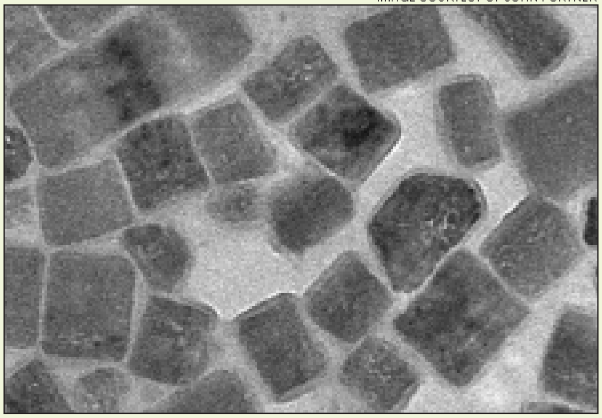
The research was led by Andrés García, an associate professor in the Woodruff School of Mechanical Engineering and the Petit Institute for Bioengineering and Bioscience at Georgia Tech. Benjamin Keselowsky, a postdoctoral fellow in Mechanical Engineering, and David Collard, an associate professor in the School of Chemistry and Biochemistry at Georgia Tech, also collaborated on the project.

(Continued on page 38)

Fate of Nanowaste

Researchers study how to make the nano-material industry environmentally sustainable.

IMAGE COURTESY OF JOHN FORTNER



Research into making the emerging nanomaterial industry environmentally sustainable is showing promise in a preliminary engineering study conducted at the Georgia Institute of Technology and Rice University.

Under the auspices of the Rice University Center for Biological and Environmental Nanotechnology (CBEN) funded by the National Science Foundation (NSF), researchers have been investigating the potential environmental impact of nanomaterial waste. Specifically, they want to know if they can predict the fate and transport of nanomaterial waste in natural systems, and whether nanomaterials will behave the same as common environmental pollutants. In addition, they want to determine if nanomaterials can be treated before they enter the environment to minimize impact.

Previous research provided information on how structures such as fullerenes clump together in water to form larger particles. This study is the first to show what factors affect the size of these aggregate particles.

Researchers picked fullerenes, molecules composed of 60 carbon atoms, as their model carbon-based nanomaterial. Fullerenes have a potentially broad range of applications, including their use in pharmaceuticals, as lubricants, as semiconductors and in energy conversion. Mass commercial production of fullerenes may get under way internationally in just two years.

"This research is providing the information to make practices sustainable when fullerene production comes on line," says John Fortner, a Georgia Tech research scientist and Rice University Ph.D. student. "It's our goal to minimize environmental impact in contrast to the pollution caused in the past by, for example, dry cleaning industry practices."

Fortner presented findings of the research team earlier this year at the American Chemical Society's 229th national meeting. The team includes Joe Hughes, chair of the Georgia Tech School of Civil and Environmental Engineering and a former Rice University professor.

Though much is known about fullerenes, little is known about their fate when released into the environment because they have not been produced on an industrial scale.

"Fullerenes are virtually insoluble in water, yet most biological and environmental systems are based around water," Fortner notes. "Researchers thought fullerenes couldn't be transported by water because they are so hydrophobic. We thought they would simply stick to soil or other organic material. But research shows this is actually not the case. When fullerenes, such as C60, come in contact with water, they form aggregates at the nanoscale. We call it nano-C60."

In their study, Fortner and his colleagues devised several novel applications of imaging techniques to characterize the physical and chemical formation of nano-C60 particles in water mixed with the organic solvent THF. Using cryoTEM (transmission electron microscopy), researchers froze samples of the solution and examined slices of them to determine the effects of various parameters on particle size.

The nano-C60 particles that formed were 20 to 500 nanometers across and retained the same properties as C60 molecules — a determination researchers made using nuclear magnetic resonance imaging. This finding is significant because pure C60 is recoverable, therefore enhancing the promise of sustainable fullerene production practices, Fortner notes. Also, electron and powder diffraction techniques revealed that nano-C60 has a particular crystalline structure. These findings reinforced previous research done elsewhere.

— Jane M. Sanders

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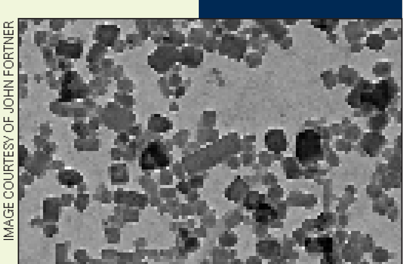
LEFT and BELOW: Transmission electron microscopy shows nano-sized particles that form when fullerenes clump together in water. Research is showing what factors affect particle size.

IMAGE COURTESY OF JOHN FORTNER



ResearchHorizons

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"From a molecular perspective, we now have a better idea of how cells interact with materials and how materials can direct cell responses," García says. "And now that we understand that, it may be possible to engineer novel, rationally designed biomaterials that can control those interactions."

Cells interact with biomaterials using specialized adhesion proteins. These adhesion proteins on the cell bind to target proteins adsorbed on the biomaterial surface. In addition to anchoring cells, these adhesion proteins trigger signals that control many cell functions, including growth and protein production. These adhesion proteins only recognize a small number of target proteins.

"That's how the cell makes sense of a very complicated environment like the body," García explains.

He and his colleagues showed that the biomaterial surface chemistry altered the types of adhesion proteins that cells used to adhere to the biomaterial. As the surface chemistry of the material changed, so did the types of adhesion receptors that the cells used for binding. These differences in the binding of adhesion proteins changed the signals in the cell and resulted in different cellular responses.

— Megan McRainey

@ Contact: Andrés García at 404-894-9384 or andres.garcia@me.gatech.edu. Read more at: **www.gatech.edu/newsroom/release.php?id=549**

Gold Nanoparticles

Binding gold nanoparticles to a specific antibody for cancer cells could make cancer detection much easier, suggest researchers at the Georgia Institute of Technology and the University of California Medical School at San Francisco.

"Gold nanoparticles are very good at scattering and absorbing light," says Mostafa El-Sayed, director of the Laser Dyanamics Laboratory and a Regents Professor of chemistry at Georgia Tech. "We wanted to see if we could harness that scattering property in a living cell to make cancer detection easier. So far, the results are extremely promising."

Many cancer cells have a protein, known as Epidermal Growth Factor Receptor (EFGR), all over their surface, while healthy cells typically do not express the protein as strongly. By conjugating, or binding, the gold nanoparticles to an antibody for EFGR — suitably named anti-EFGR — researchers were able to get the nanoparticles to attach themselves to the cancer cells.

"If you add this conjugated nanoparticle solution to healthy cells and cancerous cells and you look at the image, you can tell with a simple microscope that the whole cancer cell is shining," El-Sayed says. "The healthy cell doesn't bind to the nanoparticles specifically, so you don't see where the cells are. With this technique, if you see a well-defined cell glowing, that's cancer."

In the study published recently in the journal Nano Letters, researchers found that the gold nanoparticles have a 600 percent greater affinity for cancer cells than for non-cancerous cells. The particles that worked the best were 35 nanometers in size. Researchers tested their technique using cell cultures of two different types of oral cancer and one non-malignant cell line. The shape of the strong absorption spectrum of the gold nanoparticles also distinguishes cancerous and non-cancerous cells.

This technique is promising because it doesn't require expensive high-powered microscopes or lasers to view the results, as other techniques require, El-Sayed notes. All it takes is a simple, inexpensive microscope and white light.

Also, the results are instantaneous. "If you take cells from a cancer-stricken tissue and spray them with these gold nanoparticles that have this antibody, you can see the results immediately. The scattering is so strong that you can detect a single particle," El-Sayed says.

Finally, the technique isn't toxic to human cells. Collaborating with El-Sayed was his son Ivan El-Sayed, a head and neck surgeon at the University of California at San Francisco Comprehensive Cancer Center, and Georgia Tech graduate student Xiaohua Huang.

— David Terraso

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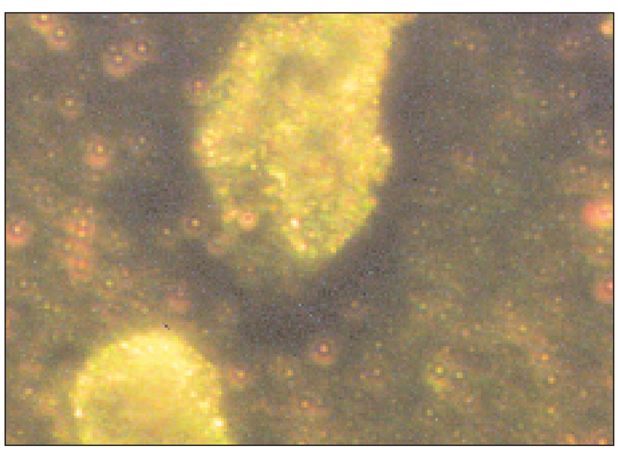

RIGHT: Gold nanoparticles stick to cancer cells and make them shine.