Special Delivery

New family of biodegradable polymers shows promise for intracellular drug delivery.

by Jane M. Sanders

A newly developed family of biodegradable polymers has shown potential for use in intracellular delivery and sustained release of therapeutic drugs to the acidic environments of tumors, inflammatory tissues and intracellular vesicles that hold foreign matter.

These polymers have several advantages over existing biodegradable polymers, researchers say. Among them, the polymers — called polyketal — are biodegradable into Food and Drug Administration-approved compounds. Synthesis is a simple and easily customized process. Degradation of the polymer does not produce inflammation-causing acid, but instead generates membrane-permeable products that allow all of the polymer's byproducts to diffuse outside the cell. That means byproducts shouldn’t accumulate in a patient’s tissue and cause inflammation.

“We’ve known for 20 to 30 years that when cells take up particles, they move them to a part of the cell with a low pH — about 5.0,” says Niren Murthy, an assistant professor in the Wallace H. Coulter Department of Biomedical Engineering at the Georgia Institute of Technology and Emory University. “Researchers have been able to successfully exploit this process in cell culture and in animal models, but have done so using materials that generated acid degradation products and that hydrolyzed too slowly for chronic use. Thus, there has been very little clinical activity in this area.”

However, polyketal nanoparticles use the cell’s acid to hydrolyze into hydrophilic compounds that can release encapsulated therapeutics at an accelerated rate in the acidic environments to which they are targeted, Murthy explains. Also, unlike polyester-based biomaterials, polyketal nanoparticles do not generate acid when they degrade. Researchers don’t know yet whether polyketals will be less inflammatory than current polymers used for drug delivery, but expect to evaluate this response within the next year.

Murthy presented information on the development and potential applications of polyketals at the 231st American Chemical Society National Meeting in Atlanta in March. His colleagues are Emory University immunologist Bali Pulendran, University of Rochester physician Robert Pierce, and Georgia Tech graduate students Michael Heffernan and Stephen Yang. Their research is under way for the past two and a half years and is funded by the National Institutes of Health and the National Science Foundation.

Development of the polymer was a surprisingly straightforward process, Murthy says.
“There is a reaction that is well known in synthetic organic chemistry called the acetal exchange reaction,” he explains. “We can change this reaction a little bit and use it to make these polymers. It’s normally a reaction used to protect alcohols, but when you make it react with a molecule with two alcohols, it makes this polymer.”

Because this chemical process is a simple one, it is feasible for production of the polymer on an industrial scale, potentially making it widely available, Murthy says.

“We have a lot of flexibility in terms of the types of alcohols we incorporate into the polymer,” he adds. “We can tailor the polymer’s hydrolase rates and mechanical properties, which would broaden its medical applications. For example, in some cases you want drug delivery faster than others. With acute liver failure, you want drug release in one to two days, whereas with arthritis, you want release over one to two months.”

In addition to its simple synthesis, another advantage of polyketals is their degradation process, which generates membrane-permeable products, Murthy says.

“The problem with using polyesters as drug delivery vehicles is that most of the illnesses being treated are chronic diseases requiring weekly injections, yet polyesters take months to degrade,” he notes. “Polyketals hydrolyze in a week, diffuse out of the cell and are then excreted outside of the cell.”

Researchers hope to test polyketals in clinical trials within five years if animal model studies show potential.

Potential applications of polyketals include the delivery of antioxidants to treat acute liver failure in people who have suffered an alcohol or acetaminophen overdose. In these patients, the liver stops functioning because macrophage cells in the liver create reactive oxygen species. One of the treatments is the delivery of superoxide dismutase, an enzyme that essentially detoxifies superoxide.

Other applications include the use of polyketals in any type of protein-based vaccine, Murthy says, adding that researchers have not yet pursued this possibility. Yet another application is protein delivery for a wide range of therapeutics, including insulin delivery for Type 1 diabetics — alleviating the need for multiple injections.
Taking Care of Bio-business

Despite metropolitan areas’ fierce competition for attracting bioscience companies, Atlanta is experiencing growth in the industry.

By T. J. Becker

Atlanta may not be a hotbed for life-sciences companies on the scale of San Diego or Boston, but things are heating up here. Among recent milestones:

- CardioMEMS, a company formed from Georgia Institute of Technology intellectual property, won a thumbs up from the Food and Drug Administration (FDA) to market its first commercial product, the EndoSure™ sensor, an implantable device that monitors blood pressure in aneurysm patients.
- Emory University received $525 million for selling its royalty interest in an AIDS drug developed by three Emory research scientists.
- AtheroGenics signed a licensing agreement with pharmaceutical giant AstraZeneca for AGI-1067, a drug that AtheroGenics is developing to treat atherosclerosis. Now in its third round of clinical testing, the drug has potential for blockbuster status (more than $1 billion in annual sales) if it wins FDA approval.
- Ernst & Young’s 2006 Global Biotechnology Report ranked Georgia seventh among U.S. states for its number of bioscience companies.

“There has always been good science and engineering in Atlanta, but what has changed is the commercial mindset,” says Garheng Kong, a partner at Intersouth Partners, a venture capital company in Durham, N.C. “Today, there are more entrepreneurs working with scientists — and more scientists who are thinking entrepreneurially.”
That’s music to Susan Shows’ ears. “Our universities are very skilled at producing intellectual property,” says Shows, vice president of the Georgia Research Alliance (GRA). “What we’ve been trying to do in the past 10 years is convert those discoveries into viable companies.”

Competition for bioscience business is fierce. Indeed, according to a 2004 report from the Biotechnology Industry Organization (BIO), 40 states have specifically targeted the biosciences in their economic-development efforts, hoping to bring more high-paying jobs to their communities.

Georgia has been steadily moving up in Ernst & Young’s ratings for its number of bioscience companies: Now seventh among U.S. states, Georgia was No. 8 in 2005 and No. 11 in 2003. Yet when counting its number of bioscience jobs, Georgia ranks lower as smaller entrepreneurial firms are driving bioscience growth instead of the relocation of large pharma companies. That’s not a drawback — in fact, entrepreneurial growth has many pluses — but it does take longer to bolster jobs and requires a different approach.

The right environment

The Advanced Technology Development Center (ATDC), Georgia Tech’s incubator program, has been assisting technology entrepreneurs since its inception in 1980. Yet in 2002, ATDC opened a special center for life-science startups.

“Bioscience companies face unique challenges, with real estate being one of them,” observes Lee Herron, ATDC’s general manager of biosciences. “Unlike a software startup, which can practically operate out of a closet, bioscience companies need special facilities.”

Located within Georgia Tech’s Ford Environmental Science & Technology Building, the ATDC Biosciences Center has wet labs equipped with special ventilation and purified water systems. Member companies also have access to clean rooms for micromanufacturing.

Those clean rooms were instrumental to CardioMEMS’ progress, says David Stern, senior vice president of research and development at the medical device company, which graduated from ATDC last year. “If we had to build our own clean room, it would have cost millions of dollars and held us up for months,” Stern says.

ATDC played a key role in CelLassys’ decision to locate in Atlanta, says Bill Reddick, CEO of the pharma startup, which is developing new drug compounds for cancer, inflammatory and autoimmune diseases.

“The ability for startups to raise money is critical,” Reddick explains. “When we first talked to investors, they asked, ‘Why Atlanta?’ But once we showed them our lab space at ATDC and the caliber of companies around us, there were no more questions. They saw the environment was one that could nurture successful bioscience companies...that we weren’t off an island.” (CelLassys closed on $5.7 million in initial funding in December 2005).

**TOP:** David Stern is senior vice president of research and development at CardioMEMS. The company, formed from Georgia Tech intellectual property, has developed an implantable device that monitors blood pressure in aneurysm patients.

**LEFT:** CelLassys senior scientist Hyun Kang, right, and lab technician Jinchal Huns work in wet labs equipped with special ventilation and purified water systems.

**INSET:** Ernst & Young’s 2006 Global Biotechnology Report ranked Georgia seventh among U.S. states for its number of bioscience companies.
In partnership with Emory University, Georgia Tech also operates a smaller incubator for bioscience entrepreneurs on Emory’s Briarcliff campus. Like the ATDC Biosciences Center, EmTech Bio lowers barriers for new companies by providing a quick-start environment with appropriate space, equipment and resources.

Complementing the work of these incubators is a new initiative — Technology Enterprise Park. Located just south of Georgia Tech’s Midtown campus, this new research park will comprise 600,000 square feet of space on 11 acres. Buildings will be designed specifically for bioscience and technology companies, and flexible space will allow tenants to expand as needed.

The park is being developed by Georgia Advanced Technology Ventures (GATV), a tax-exempt affiliate of Georgia Tech that promotes growth of bioscience and technology companies. Construction began in January, and officials expect to have the park completed by summer 2007.

Altea Therapeutics Corp., which is developing transdermal patches for drug delivery, has signed on as the anchor tenant.

“We’re trying to create facilities for the full continuum,” Herrn says. “Technology Enterprise Park will provide important post-incubation space. Once companies are ready to move out of ATDC or EmTech, they will have somewhere to go.”

Being part of a broader biotech community is especially helpful for startups, says Russell Medford, CEO of AtheroGenics and chair of the Georgia Biomedical Partnership. “An early-stage company is a new type of entity, and it’s hard to have a self-identity when you only have 10 or 15 people on board,” he explains. “It’s nice to be in a supportive environment with other companies that have common needs and goals.”

In addition to early-stage companies, Technology Enterprise Park also expects to attract established technology and bioscience companies, including multinational firms that are looking to set up shop in Atlanta. “The proximity to Georgia Tech researchers and facilities will be a big plus for more mature companies,” notes Scott Leviatan, vicepresident of real estate at GATV.

The mix of early-stage and established companies at TEP will create opportunities for each other, Leviatan says. “Smaller bioscience companies often prefer to license their technology rather than setting up marketing or manufacturing operations,” he adds. “And vice versa, large pharma firms may want to acquire IP as opposed to developing it in-house.”

The right science

Another component of a thriving bioscience community, according to BIO, is the involvement of research institutions.

---

**ATTRACTION TALENT**

In addition to investors, bioscience companies need a skilled labor force to flourish. When Celtaxsys, a biotech startup, was looking for a home base in 2004, Atlanta was a draw because three of its four founders were from the area. “At the same time, we were concerned about an adequate talent supply,” says Bill Reddick, Celtaxsys’ CEO, explaining that the company needed experienced molecular and cell biologists to implement its research and development plan.

“Could we get the right people? That question was answered when we posted our first job listing.”

The company received nearly 150 responses, with about two-thirds of those applicants possessing the skills and background Celtaxsys was seeking. About half of respondents hailed from the Atlanta region, and half were from out-of-state, Reddick recalls. “So being in Atlanta wasn’t a hindrance, either for finding talent or attracting it,” he says.
“You can have the greatest incubator in the world, but you’ve got to have great science behind it,” explains Herron, who points to GRA’s Eminent Scholar program as a lynchpin for innovation.

GRA’s Eminent Scholars Program recruits world-class, entrepreneurially minded scientists to six Georgia educational institutions — Clark Atlanta University, Emory University, Georgia Tech, Georgia State University, the Medical College of Georgia and the University of Georgia. Of the 52 scholars now in residence, 34 work in bioscience disciplines.

“We have existing talent here in Georgia, but not enough,” says GRA’s Shows. “Recruiting these scholars has all kinds of ripple effects, such as federal grants and industry collaborations — it creates an ecosystem that leads to economic gains.”

Complementing its Eminent Scholar program is GRA’s VentureLab, which helps commercialize innovations being developed at research universities. Piloted at Georgia Tech in 2001, five of Georgia’s research universities now have VentureLab programs up and running.

VentureLab’s staff scouts the campus for promising technologies and helps faculty and students understand what’s required to form a company — and determine if a market need exists. The program also provides grants to help fledgling companies validate their technology and conduct proof-of-concept studies.

“Orthotics wouldn’t exist if weren’t for VentureLab at least not in its present form,” says CEO Steve Kennedy. Orthotics, which is developing novel biomaterials for orthopedic applications, was co-founded by Barbara Boyan, a GRA Eminent Scholar and Georgia Tech biomedical engineering professor.

“Bioscience companies require a lot of time and a lot of money to get to market,” says Kennedy, explaining that two VentureLab grants helped Orthotics prove its concept and paved the way to funding from a prominent New York venture-capital company. Orthotics is now a member of ATDC.

Critical collaborations

Atlanta’s bioscience community has also benefited from Georgia Tech and Emory’s joint Wallace H. Coulter Department of Biomedical Engineering, which blends the expertise of medical researchers at Emory with Georgia Tech’s engineering panache. U.S. News & World Report ranked the program No. 2 among 2005 biomedical engineering graduate programs.

Among those who praise the collaboration is Bruce Robertson, a managing director at H.I.G. Ventures, an

MO’ MONEY

Atlanta may not attract as much venture capital as bioscience meccas like Boston and San Diego, but investor activity is increasing. “We’re just at an earlier stage,” says Lee Herron, general manager of biosciences at Georgia Tech’s Advanced Technology Development Center.

“Venture capital follows; it doesn’t lead. We’ll get more VC opportunities as we create more companies.”
Atlanta venture-capital firm. “A top medical school and a top engineering school working together is a great match,” says Robertson, referring to potential innovations that can result from multidisciplinary research. “Too often you see startups that are one or the other — and they don’t understand each other’s worlds.”

At the time it was launched, the joint program was the first of its kind between a public and private institution. But other universities are now following suit, reports Larry McIntire, chair of the joint biomedical engineering department.

Admitting its first students in 2000, the department now has 750 undergraduates and 200 Ph.D. students. “That’s amazing growth by any standards,” McIntire says. “We’re turning out some of the brightest people in the country in the field of biomedical engineering — a talent pool that didn’t exist five years ago.”

Illustrating the ripple effect that GRA’s Shows mentioned, the joint department has also sparked two major funding success stories. A cancer nanocardiology research center led by Professor Gang Bao won $11.5 million from the National Institutes of Health (NIH), and a cancer nanotechnology center led by Professor Shuming Nie is scheduled to receive $20 million in NIH funding over a five-year period. What’s more, the NIH has designated both research initiatives as national “centers of excellence.”

Gaining critical mass

With a stronger bioscience infrastructure in place, Atlanta’s life-sciences community is poised for continued growth.

What would accelerate growth? More funding would certainly help, experts say, although strides are being made. Even though Atlanta may not have as large a concentration of investors as other parts of the country, more venture-capital dollars are starting to flow here. In fact, three out of the top four venture-capital deals in Georgia last year involved bioscience companies, notes Charles Craig, president of the Georgia Biomedical Partnership.

“Atlanta is no longer off the beaten path,” agrees Kong of Intersouth. “Investors are willing to fly to Atlanta and consider deals.”

Intersouth made its first investment in an Atlanta bioscience company two years ago when it led a $26.75 million round of funding for Alimera Sciences, a pharmaceutical startup that focuses on eye-care products. The deal marked one of the biggest rounds of initial funding in the Southeast during the past decade.

Entrepreneurs are buoyed to see more investor interest, but they would like to see more Georgia-based investors to

---

**CHANGE OF VENUE**

Moving can be a major pain, but Altea Therapeutics Corp. is happy to embrace the logistical headache. Having outgrown its present facility in Tucker, Ga., Altea spent more than two years hunting for new headquarters. Bioscience companies have special mechanical and electrical needs, notes Joe Medlin, vice president of finance, information technology and administration for Altea, which is developing a new breed of transdermal patch. “You can’t go into an existing commercial property and retrofit it very easily,” he adds.

Altea’s search for space ended with Technology Enterprise Park (TEP). When the new research park opens its first building in July 2007, Altea will move into 45,000 square feet on two floors. With wet labs and HVAC systems designed specifically for bioscience companies, TEP will be a pleasant change of venue for Altea.
prevent the kind of uprooting that can occur with out-of-state money. For example, when Richard Otto launched Corautus, an ATDC graduate company that is developing new gene therapies for cardiovascular disease, one of his early funding opportunities was with a California-based venture-capital firm. Yet the investors wanted Otto to move the company to Palo Alto, so he took a pass. “When startups relocate, the state loses out on a growing workforce,” Otto says.

A strong management team is a cornerstone of any startup’s success. In the past, the fact that Atlanta was not a biotech hub meant local managers with life-science expertise were in short supply, and it was difficult to import CEOs. Out-of-towners, quite naturally, want back-up options if something goes wrong.

Bill Johnston, CEO of Inhibitex, admits that he was a bit gun-shy about moving to Atlanta in 1998 because of the lack of large biotech firms here then. Recruited from Baxter Healthcare Corp. in Chicago, Johnston initially joined Inhibitex on a part-time basis. (Inhibitex relocated from Texas to Atlanta in early 1998 after it received funding from Alliance Technology Ventures.)

“Yet a lot has changed since 1998 … slow, but meaningful changes,” Johnston says. He points to an increase in publicly traded companies, private companies that are attracting significant venture-capital funding and state support that has “gone from verbal to real dollars.”

As a result, Johnston believes it’s getting easier to recruit management talent. “It’s a lot of little things, but when you stack them up, it points to a pattern of real growth,” he says.

Underscoring that growth, BIO has selected Atlanta to host its 2009 international convention — an industry event expected to attract more than 20,000 life-science professionals from around the globe.

Hosting the convention is a major coup. “The Southeast and Georgia specifically are now viewed as real players in the industry,” Johnston says.

Reddick at Celtaxsys agrees: “We’ve certainly progressed beyond the point of explaining ‘Why Atlanta?’”

Read online at: gtresearchnews.gatech.edu/reshor/rh-ss06/bio-business.html

RIGHT: Technology Enterprise Park will be located south of Georgia Tech’s Midtown campus. The new research park will comprise 600,000 square feet of space on 11 acres.

**BETTER LIFESTYLE, MORE SUPPORT**

Biotech hotspots like Boston may have a greater concentration of investors and critical mass, but Atlanta has plenty to offer biotech businesses, says Rafael Andino, founder of Biosfisica, a medical device company that Andino launched in 2000. “The standard of living is high here, while the cost of living is relatively low compared to other cities — something I don’t see Atlanta playing off as much as it could,” Andino says. The weather is also decidedly better than for many other bioscience clusters, he adds.

From an infrastructure perspective, being a member of ATDC’s Biosciences Center is another plus of being in Atlanta. “Besides the exposure to funding sources and service providers, it’s great to be in a facility where almost everyone is in the same situation — growing their companies from scratch,” Andino explains. “There’s a tremendous level of energy and excitement. If I could clone myself, I would love to work on two or three other projects that are going on here.”
New Electronics

Circuitry based on graphite may provide a foundation for devices that handle electrons as waves.

By John Toon

A study of how electrons behave in circuitry made from ultrathin layers of graphite — known as graphene — suggests the material could provide the foundation for a new generation of nanometer-scale devices that manipulate electrons as waves — much like photonic systems control light waves.

Researchers at the Georgia Institute of Technology and the Centre National de la Recherche Scientifique (CNRS) in France have measured electron transport properties in graphene that are comparable to those seen in carbon nanotubes. Unlike carbon nanotubes, however, graphene circuitry can be produced using established microelectronics techniques, which allows researchers to envision a "road map" for future, high-volume production. The research was published in the May 26 issue of the journal Science.

"We have shown that we can make the graphene material, that we can pattern it and that its transport properties are very good," says Walt de Heer, a professor in Georgia Tech’s School of Physics. "The material has high electron mobility, which means electrons can move through it without much scattering or resistance. It is also coherent, which means electrons move through the graphene much like light travels through waveguides."

The results should encourage further development of graphene-based electronics, though de Heer cautions that practical devices may be a decade away.

"This is really the first step in a very long path," he says. "We are at the proof-of-principle stage, comparable to where transistors were in the late 1940s. We have a lot to do, but I believe this technology will advance rapidly."

Their research, begun by de Heer’s team in 2001, is supported by the U.S. National Science Foundation and the Intel Corporation.

In their paper, the researchers report seeing evidence of quantum confinement effects in their graphene circuitry, meaning electrons can move through it as waves. "The graphene ribbons we create are really like waveguides for electrons," de Heer says.

Because carbon nanotubes conduct electricity with virtually no resistance, they have attracted strong interest for use in transistors and other devices. However, the discrete nature of nanotubes — and variability in their properties — pose significant obstacles to their use in practical devices. By contrast, continuous graphene circuitry can be produced using standard microelectronics processing techniques.

"Nanotubes are simply graphene that has been rolled into a cylindrical shape," de Heer explains. "Using narrow ribbons of graphene, we can get all the properties of nanotubes because those properties are due to the graphene and the confinement of the electrons, not the nanotube structures."
De Heer envisions using the graphene electronics for specialized applications, potentially within conventional silicon-based systems.

“We have shown that we can interconnect graphene, put current into it, and take current out,” he says. “We have a very promising electronic material. We see graphene as a platform, a canvas on which we can work.”

De Heer and collaborators Claire Berger, Zhimin Song, Xuebin Li, Xiaosong Wu, Nate Brown, Tianbo Li, Joanna Hass, Alexei Marchenkov, Edward Conrad and Phillip First of Georgia Tech and Didier Mayou and Cecile Naud of CNRS start with a wafer of silicon carbide, a material made up of silicon and carbon atoms. By heating the wafer in a high vacuum, they drive silicon atoms from the surface, leaving a thin continuous layer of graphene.

Next, they spin-coat onto the surface a photo-resist material of the kind used in established microelectronics techniques. Using electron-beam lithography, they produce patterns on the surface, then use conventional etching processes to remove unwanted graphene.

“We are doing lithography, which is completely familiar to those who work in microwaves,” de Heer says. “It’s exactly what is done in microwaves, but with a different material. That is the appeal of this process.”

Using electron beam lithography in Georgia Tech’s Micromachining Research Center, they’ve created feature sizes as small as 80 nanometers. The graphene circuitry demonstrates high electron mobility — up to 25,000 square centimeters per volt-second — showing that electrons move with little scattering. The researchers expect to see ballistic transport at room temperature when they make structures small enough.

So far, they have built an all-graphene planar field-effect transistor. The side-gated device produces a change in resistance through its channel when voltage is applied to the gate. However, this first device has a substantial current leak, which the team expects to eliminate with minor processing adjustments.

The researchers have also built a working quantum-interference device, a ring-shaped structure that would be useful in manipulating electronic waves.

Read more at gtresearchnews.gatech.edu/newsrelease/graphene_science.htm

ABOVE: Researchers Xuebin Li and Claire Berger monitor high-temperature graphene growth in an induction furnace.
A First Responder’s Best Friend

The Chemical Companion helps hazmat teams make critical decisions.

When dealing with hazardous materials — whether from a truck spill or a terrorist attack — information is critical. Before first responders can begin to aid victims and decontaminate a scene, they must determine what substances are present and understand the inherent risks to humans and the environment.

To help first responders and hazardous materials (hazmat) teams, researchers at the Georgia Tech Research Institute (GTRI) have developed the “Chemical Companion.” This software tool, which operates on Windows CE-based personal digital assistants, provides detailed information on 130 of the most common chemicals associated with hazmat incidents.

“Knowing the characteristics of a chemical, such as its boiling point or density, tells us different things about how to approach the scene,” says project co-director Christina Baxter, a senior research scientist in GTRI’s Health and Environmental Systems Lab (HESL). “Suppose there’s a fire. With some flammable substances, water might make the fire burn even hotter, and foam is needed to suppress the blaze.”

Sponsored by the federal government’s Technical Support Work Group, the Chemical Companion helps first responders make decisions about:

- **Protective equipment.** Different chemical agents require different protective clothing and respirators.
- **Chemical reactivity,** which can result in toxic fumes, fires and explosions. For example, if bleach (sodium hypochlorite) and ammonia come into contact with each other, they can create a deadly gas.
- **Isolation and protective zones.** Distances will vary depending on chemicals involved, the size of a spill, weather conditions and time of day. For example, cloud cover doesn’t allow a chemical substance to travel as well, and heat will hold it closer to the ground.
- **Appropriate medical aid,** ranging from basic to advanced life support.

“With some chemicals like Orthene®, which is a fire-ant killer, administering oxygen to a victim would have a detrimental effect,” notes Amy Cook, a chemist in GTRI’s Electro-Optical Systems Lab (EOSL).

First responders may be able to identify chemical agents from the shape of containers, shipping papers or signs posted at the hazmat scene. But if there are no solid clues, the Chemical Companion enables responders to identify an unknown chemical by entering details about the substance’s physical appearance, such as color or state.

Another option for pinpointing unknown chemicals is to report medical symptoms displayed by victims. For example, twitching, constricted pupils, excessive sweating and confusion might indicate the presence of the nerve gas sarin.

*By T.J. Becker*
“The Chemical Companion makes it easy for first responders to access information quickly from multiple paths,” says Gisele Bennett, director of EIOL and co-principal investigator. “The system is also very robust and easy to update so we can continue to add more chemicals.”

Although there are existing software tools for hazmat teams, these programs can cost as much as $2,000 per license. In contrast, the Chemical Companion will be free to the military, law enforcement officers and fire departments.

Besides price, other hallmarks include greater depth of information on chemicals and more detailed medical advice. What’s more, the Chemical Companion features a calculator to help responders determine “stay times” — how long they can remain in a contaminated zone — based on what type of protective equipment they're wearing.

“Being able to accurately project stay times saves money as well as lives,” says Baxter, noting that hazmat suits are expensive — about $1,000 each. “These suits can only be worn once. If we pull a first responder from a hot zone after 15 minutes when he or she could have remained safely for 45 minutes, that’s a considerable cost.”

Hazmat equipment also presented a design challenge for GTRI researchers. “The whole concept of user design changes dramatically when you’re dealing with this kind of environment,” Bennett explains.

Indeed, to get a taste for the conditions that first responders work under, GTRI engineers donned protective gear and participated in training exercises at the Douglas County Fire Department.

“When you’re in a hazmat suit, even simple tasks, like picking up a penny can be very difficult,” says Benjamin Medlin, a GTRI software development specialist. “So you can imagine how difficult it might be to use personal digital assistants — which aren’t the easiest devices to use under normal conditions.”

To minimize the amount of typing required to use the Chemical Companion, the GTRI team incorporated lots of dropdown menus and automatic fill-ins in the software. The program also features large lettering and shading between columns to make numbers and words easier to read from under bulky hazmat masks.

Beta-testing for the Chemical Companion began in the fall of 2005 with a number of fire departments around the country, including units in New York City, Los Angeles, Seattle and Douglas County, Ga. Researchers expect the Chemical Companion will be ready for distribution later this year.

Listen to a podcast on this project at: gtresearchnews.gatech.edu/podcast/chemical_companion.mp3
Fake Pharmaceuticals

Increase in counterfeit anti-malarial drugs prompts call for crackdown and better detection.

By Jane M. Sanders

A worsening epidemic of sophisticated anti-malarial drug counterfeiting in southeast Asia and Africa is increasing the likelihood of drug-resistant parasites, yielding false-positive results on screening tests and risking the lives of hundreds of thousands of malaria patients, mostly children, researchers say.

The situation has prompted an international group of researchers to urge national and international authorities to combat the problem with stringent regulations, law enforcement and the provision of inexpensive medicines to undercut the counterfeiters. Based on their own research and other scientists’ studies, they outline the problem and make recommendations for addressing it in a paper published June 13, 2006 in the Public Library of Science journal PLoS Medicine. The researchers’ work was funded by the Wellcome Trust of Great Britain and the Bill & Melinda Gates Foundation.

“The manufacture and distribution of counterfeit drugs, including anti-malarias, is a massive international problem, and few agencies are investigating it,” says Facundo Fernandez, an assistant professor of chemistry and biochemistry at Georgia Tech and an author on the paper. His close collaborators include scientists Paul Newton from the University of Oxford in the United Kingdom and Michael Green from the Atlanta-based Centers for Disease Control and Prevention.

Malaria is a widespread international problem, primarily in poor and developing countries in the tropics — though some cases have been reported in Florida in the United States. The disease — transmitted by mosquitoes infected with the parasite Plasmodium falciparum — infects 300 to 500 million people a year. Each year, about 1.5 million of those — mostly children — die even though genuine anti-malarial drugs are quite effective. One of the most efficacious drugs is artemisin derived from the Artemisia annua plant native to China.

The percentage of over-the-counter counterfeit artemisin tablets containing no artemisin apparently increased from 38 to 53 percent in southeast Asia between 1999 and 2004, according to a study led by Newton and Professor Nicholas White at Oxford. In some countries, the majority of the available artemisin is fake, according to the Oxford studies, which are cited in the PLoS Medicine report.

Meanwhile, identifying counterfeit tablets has become increasingly difficult as counterfeiters have implemented sophisticated manufacturing and packaging strategies — such as including low, but ineffective, levels of the proper active ingredients and applying counterfeit holograms to packaging — to deceive investigators and consumers. In fact, Fernandez, a bioanalytical chemist, and his collaborators found that some counterfeit artemisin anti-malarial drugs contain up to 10 milligrams of the active ingredient — compared to the 50 milligrams that genuine artemisin tablets contain.
“We make no apology for the use of the term ‘manslaughter’ to describe this criminal lethal trade,” the authors write. Indeed, some might call it murder. Somewhere people are directing a highly technical and sophisticated criminal trade… in the full knowledge that their ineffective ‘product’ may kill people who would otherwise survive malaria infection.”

Serious implications exist for the relatively new practice of incorporating ineffective levels of active ingredients in artesunate tablets, the authors note. Exposure of malaria parasites to low concentrations of artesunate in patients taking counterfeit products will greatly increase the risk for the selection and spread of malaria parasites that are resistant to artemisinin derivatives. That could lead to a loss of effectiveness for these essential medicines and an avoidable failure of malaria control, they write. In addition, the presence of small quantities of artesunate in tablets may mean that the Fast Red dye test, widely used for screening the quality of artesunate tablets, yields false-positive results, depending on how much artesunate is present in the fakes.

Also, many fake artesunate tablets contain other drugs, possibly because the counterfeiters are trying to further deceive patients and doctors by possibly producing an initial, limited benefit, Fernandez says. “For example, some of the counterfeit tablets we analyzed contained acetaminophen that would reduce a fever, or the antibiotic erythromycin, or even early-generation anti-malarials that are no longer effective.”

The researchers’ analyses determined there are now at least 12 different types of fake artesunate, classified by Oxford researchers based on the counterfeit holograms affixed to artesunate packaging. Evidence suggests that production is on an industrial scale, according to research by Newton and Green published in 2001 in the British medical journal *The Lancet*. For example, a non-governmental organization in Burma purchased 100,000 counterfeit artesunate tablets from one large pharmacy, the researchers note.

“At this point, we believe there are probably multiple sources, but they may be using the same distribution network,” Fernandez adds.

The authors also cite serious implications of this public health problem for tourists in malaria-prone countries. Visitors often buy unregulated artemisinin derivatives in the tropics or on the Internet. It is inevitable that counterfeit artesunate will seep into this trade, the authors predict.

The greater concern, they note, is for sub-Saharan Africa. Since 2001, artemisinin derivative-based combination (continued on page 19)
Counterfeit Contents
Novel analytical techniques are targeting fake anti-malarials.

Researchers led by the Georgia Institute of Technology are developing novel analytical chemistry techniques to detect and quantify the contents of counterfeit anti-malarial drugs and other fake pharmaceuticals. The manufacture and distribution of these fake medications is a growing problem in third-world countries, where the mosquito-borne illness malaria is widespread.

A report on this research — funded by the Society of Analytical Chemists of Pittsburgh and the Wellcome Trust of Great Britain — will be published this summer in the journal ChemMedChem.

Georgia Tech Assistant Professor of Chemistry and Biochemistry Facundo Fernandez began studying counterfeit anti-malarials two years ago using conventional analytical chemistry techniques based on liquid chromatography and mass spectrometry. But these methods required more than two hours to analyze just one sample. So he and his graduate students developed new, high-throughput ionization techniques that now allow them to complete the same analyses in just five seconds per sample.

“This is a new generation of techniques in mass spectrometry,” Fernandez says. “We don’t probe our samples under vacuum like you normally do with mass spectrometry. We can hold a solid sample under atmospheric pressure and use one of our new tools to ionize its surface components. The ionized particles are subsequently analyzed by mass spectrometry. This method eliminates the time and costs associated with sample preparation.”

Specifically, Fernandez and his students have worked to improve two recently developed analytical chemistry techniques — desorption electrospray ionization (DESI) developed by Purdue University and direct analysis in real time (DART) developed by the Japanese company JEOL.

The researchers use DESI to screen anti-malarials in hopes of quantifying the amount of the active ingredient artemesunate in counterfeit pills. In DESI, researchers use a high-speed, charged spray containing alcohol and water. Typically, this solvent mixture reacts with a solid sample, such as a tablet, picking up molecules from its surface and transferring them to a detector. But artemesunate is a relatively unstable molecule that fragments easily and causes DESI to lose its sensitivity. So Fernandez and his students have now added an alkylamine compound to the alcohol-water mixture to form a stable molecular species, preventing artemesunate fragmentation and thereby increasing sensitivity. They call this process “reactive DESI.”

DART, on the other hand, involves an ionizing beam of marginally stable helium atoms generated by an electric discharge. The DART ionization mechanism is still not completely understood. In ongoing research, Fernandez and his students are working to interface DART with other instruments to help understand the chemistry behind the methodology. To date, they have interfaced DART with a mass spectrometer, but the latter is typically too bulky and expensive to use in a field setting. So researchers plan to interface DART with a similar instrument called an ion mobility spectrometer (IMS), which is used in airports to detect explosives. They hope the pair of techniques could be used in the field to screen solid samples of anti-malarial drugs.

“Our findings not only demonstrate the usefulness of DART for rapid screening of counterfeit drugs, but also have unprecedented implications for malaria control,” Fernandez and his co-authors report in ChemMedChem. “We foresee that both DART and DESI will have a tremendous impact in a variety of scientific fields, ranging from drug quality control, screening and discovery to biological applications, such as metabolomics and proteomics.”

Read online at: gtresearchnews.gatech.edu/newsrelease/detect-fakes.htm

CONTACT:
Facundo Fernandez at
404-385-4432 or facundo.fernandez@chemistry.gatech.edu

By Jane M. Sanders
therapy (ACT) has increasingly become the first-line malaria treatment in Africa. Authorities estimate that 130 million courses of ACT will be used in Africa in 2006.

“The high cost and shortage of ACT provide a favorable situation for the spread of fake artemisins that could put the lives of thousands of African children at risk,” the authors write. They urge authorities to implement tighter controls on drug importation, as well as a subsidy of up to $500 million a year to ensure that ACTs provided through the private sector are relatively inexpensive and locally affordable so there is no financial advantage in unwittingly purchasing a fake.

“It will be an avoidable tragedy if a lack of political will and action allows fake artesunate to compromise the hope that artemisinin derivative-based combination therapy offers for malaria control in Africa and Asia and results in the emergence and spread of resistance to the artemisinin drugs, shortening the useful life of these vital medicines,” the authors add. “As global efforts to control malaria rely heavily on these drugs, these issues deserve urgent action to prevent a public health disaster in the malarious world.”

In related research, several of the authors, led by Fernandez, are studying new, high-throughput screening techniques to detect and quantify the contents of counterfeit anti-malarial drugs and other fake pharmaceuticals. This research will be published in an upcoming edition of the journal ChemMedChem.

Read online at: gtresearchnews.gatech.edu/newsrelease/fakes.htm
Conversion Experience

Subsurface bacteria release phosphate to convert uranium contamination to immobile form.

By Jane M. Sanders

Research that could help control contamination from the radioactive element uranium, scientists have discovered that some bacteria found in the soil and subsurface can release phosphate that converts uranium contamination into an insoluble and immobile form.

Based on laboratory studies, Georgia Institute of Technology researchers report promising results using bacterial species from three genera isolated from subsurface soils collected at a U.S. Department of Energy (DOE) Field Research Center site in Oak Ridge, Tenn. Researchers conducted preliminary screenings of many bacterial isolates and found several candidate strains that released inorganic phosphate after hydrolyzing an organo-phosphate source the researchers provided.

The bioremediation research project, funded for three years by DOE’s Environmental Remediation Sciences Division, is in its early stages. Research team member Melanie Beazley, a Ph.D. student in the Georgia Tech School of Earth and Atmospheric Sciences, presented preliminary findings at the 231st American Chemical Society National Meeting in Atlanta in March.
“These organisms release phosphate into the medium, but the precipitation (of uranium phosphate) occurs chemically,” explains Assistant Professor of Earth and Atmospheric Sciences Martial Taillefert, co-director of the study. “That is the biomineralization of uranium and the novelty of this approach.”

The process begins when the bacteria — from the genera Rhodanella, Bacillus and possibly Arthrobacter — degrade an organo-phosphate compound such as glycerol-3-phosphate (G3P) or phytic acid (IP6), which can be present in subsurface soils.

“During their growth, the organisms liberate phosphate they derive from the organo-phosphate compound,” says project co-director Patricia Sobeky, an associate professor of biology. “The free phosphate is released to the surrounding media, which is a solution in the lab. Then we conduct assays to see how much uranium is mineralized by the phosphate released by the bacteria.”

The bacteria’s role is crucial in this process because uranium cannot dissociate the organo-phosphate compound chemically, Taillefert explains. So uranium in the presence of organo-phosphate alone does not result in significant uranium precipitation.

Sobeky and her Ph.D. student Robert Martinez are conducting the microbiological and physiological component of the research, while Taillefert and Beazley study the uranium chemistry and analyze distribution of different forms of uranium during incubation in the lab.

“The devil’s in the details with the chemistry of uranium: There are numerous forms of uranium in the environment, which are all influenced by the natural properties of soils and groundwater,” Taillefert says.

Sobeky adds, “What we’re doing now is optimizing the assay conditions and the techniques to analyze the distribution of uranium species in the lab.”

Traditionally, DOE has funded research investigating the chemical reduction of uranium contamination. But there are two approaches to immobilizing uranium. One strategy reduces uranium (VI) to uranium (IV), which is, in principle, immobile. But the uranium can re-oxidize even with traces of oxygen from rainwater seeping into the groundwater. The Georgia Tech approach biomineralizes uranium (VI) into an insoluble form of uranium via phosphat precipitation.

As they work toward a bioremediation strategy that will work in the field, researchers must design a mechanism to deal with competing organisms in the soil that might sequester the free phosphate, Sobeky notes. Though their current grant does not cover the cost of a field study, researchers hope to obtain funds in the future to test their strategy at Oak Ridge and potentially other DOE sites.

Uranium contamination is a concern at DOE sites because it can migrate to groundwater in surrounding areas, Taillefert notes.

“At this point, we know the organisms we’re studying are active in precipitating uranium phosphate,” he says. “Now we need to determine how chemically stable it is.”

Researchers also have learned that when the bacteria are releasing phosphate from G3P, the bacteria can tolerate the toxic uranium and can continue to grow once the uranium is precipitated by the released phosphate.

“Our challenge now is fine-tuning the conditions around the bacteria so eventually it can thrive and work chemically in a natural setting,” Taillefert says.

*Read online at: gtresearchnews.gatech.edu/newsrelease/uranium.htm*
Inside View

Molecular imaging yields information on childhood respiratory virus, may lead to earlier diagnosis.

By Jane M. Sanders

Scientists have used a powerful molecular imaging technique to see inside living cells infected with the most pervasive and potentially fatal childhood respiratory virus known to medicine — respiratory syncytial virus (RSV).

The technique is yielding insight on viruses — such as RSV, human influenza, hepatitis C, West Nile virus and severe acute respiratory syndrome (SARS) — that replicate with the help of proteins encoded by ribonucleic acid (RNA) inside the cell. Ultimately, the research could lead to early and rapid detection of viral infection and the design of new antiviral drugs.

Scientists and engineers at the Georgia Institute of Technology and the University of Georgia are studying bovine and human RSV with molecular-scale probes — called molecular beacons — that are engineered oligonucleotides (short sequences of RNA or DNA) shaped like a hairpin with a fluorescent dye molecule on one end and a quencher molecule on the other end. They are designed to fluoresce only when they bind to a complementary target — in this case, RSV genomic RNA.

"For the first time, we were able to visualize an important part of the RSV virus — its genome — in live, infected cells," says Phil Santangelo, a research engineer in the Wallace H. Coulter Department of Biomedical Engineering at Georgia Tech and Emory University. "Our molecular beacons attach to the virus and glow inside infected cells as the virus grows, replicates and infects other cells. We can now see that happen in real time in cultures in the lab.

“That’s very different from how scientists have studied viruses in past; they’ve looked at viruses in fixed (or preserved) cells," he says. "... Within the first week of studying human RSV in living cells, I learned something new because I was looking at it live.”

Molecular beacons were originally developed at the Public Health Research Institute in New York in the late 1990s. They were initially used for in vitro assays outside cells. But Santangelo and former Georgia Tech Ph.D. student Nitin Nitin, now a postdoctoral researcher at Rice University, devised methods for getting the beacons inside the cell without destroying the probe and without changing the cells.

Santangelo gave an invited presentation on his research in April at the Materials Research Society meeting in San Francisco. The research is funded under a National Institutes of Health grant to Professors Shuming Nie and
Gang Bao — both in the Department of Biomedical Engineering at Georgia Tech and Emory — to develop new, high-sensitivity, live-cell probes. In this study, Santangelo, who works for Bao, collaborated with Amelia Woolums, an associate professor of large animal medicine at UGA. They determined their molecular beacon techniques deliver high-sensitivity and high-specificity results in both bovine and human RSV strains. The RSV genome is interesting in that it is 15,000 nucleotides long, and one of its RNA sequences repeats itself nine times,” Santangelo explains. “So we were able to bind up to nine probes to that sequence, and that helped us achieve very high sensitivity to the virus. In the human virus, in fact, we were able to see a single RSV virion.”

Also, researchers were able to detect virion aggregates in bovine RSV within the first day in culture, Santangelo notes. Typically, veterinarians cannot detect RSV until after five or six days of incubation.

Bovine RSV can be a major problem in cows, which represent a good animal model for human RSV. Calves have RSV symptoms similar to those in human babies, and the disease pathology is similar. So studying bovine RSV yields information about the strain that infects humans, he adds.

Also in this study, researchers used confocal microscopy to view very thin sections of the RSV viral genome in live, infected cells. This technique allowed them to reconstruct the viral RNA aggregates in three dimensions.

“Most pathologists look at thick sections of RSV in formaldehyde, but our 3D structures are more fluid and amorphous than the solid structures pathologists have observed,” Santangelo says. “The more we know about how RSV really looks, the more we’ll understand about its pathogenesis.”

RSV is the most important cause of respiratory infection in young children worldwide, infecting virtually every child in the first few years of life. Immunity is fleeting, and repeated infections are the rule. One in every 100 or 200 infected infants requires hospitalization, usually for bronchiolitis. There is not yet an effective vaccine for RSV, and current anti-viral drugs are in their infancy in terms of efficacy, Santangelo notes.

Ultimately, researchers want to conduct in vivo testing, but must first adapt their molecular beacon technology for that purpose, Santangelo says. “In the nearer term, we hope to use molecular beacons to detect RSV in clinical samples like with those taken with a nasal swab. We might be able to detect RSV in its first day of incubation and make an early diagnosis,” he adds.

The researchers also hope their research will lead to development of a suite of anti-viral drugs for treating RSV and other viruses, including human influenza.

Read online at: gtresearchnews.gatech.edu/newsrelease/rsv.htm
Skin Deep

Imaging technologies may detect pressure ulcers and deep-tissue injuries that healthcare workers may miss, especially in dark-skinned people.

By Jane M. Sanders

For people with impaired mobility and reduced ability to sense injury, the risk is high for pressure ulcers that can develop when they sit or recline in one position too long or wear a poorly-fit prostheses for an extended period.

Healthcare professionals routinely check patients for early signs of erythema, or skin redness. But visual inspections sometimes fail to detect reddening of the skin and other indicators of tissue damage, especially in people with darkly pigmented skin. If undetected, these at-risk sites can develop pressure ulcers.

Beyond ulcers looms a more serious risk for these patients — that of pressure-induced, deep-tissue injury, which occurs below the skin and is often not diagnosed visually until it has reached a dangerous, advanced stage.

Healthcare practitioners may be able to reduce their patients’ risk of these complications by supplementing their visual inspections with a low-cost, handheld imaging device that could detect both early-stage pressure ulcers and the more serious deep-tissue injuries. Such a device is the ultimate goal of a Georgia Institute of Technology study now in field trials. The work is being funded by a grant from the National Institutes of Health (NIH) in collaboration with the National Institutes of Justice. A significant focus of the study is on detection of bruises and erythema in people with darkly pigmented skin.

“There’s a huge opportunity to intervene if we can see pressure ulcers at a very early stage,” says lead researcher Stephen Sprigle, director of the Georgia Tech College of Architecture’s Center for Assistive Technology and Environmental Access (CATEA). “Detecting them then drives the treatment. If you take the visual indicator away, it adversely impacts care, and for folks with darkly pigmented skin, that’s a problem.”

In addition to the human costs of pressure ulcers, there are monetary burdens, as well. The cost to heal a pressure ulcer is estimated to reach $40,000 for certain ulcers, Sprigle notes. In the United States alone, the costs associated with healing ulcers and worker productivity losses exceed $2 billion a year.
ABOVE: Arthur Williams, who sustained a spinal cord injury in 2003, tosses a football with his son. For people like Williams who use wheelchairs on a permanent basis for mobility, pressure ulcers are often difficult to detect in early stages, especially in people with dark skin.

Promising Technologies

Researchers believe a handheld detection device that combines multi-spectral and acoustic-imaging technologies could lower these costs. Preliminary studies funded internally by the Georgia Tech Research Institute (GTRI) and CATEA showed promise.

So GTRI and Georgia Tech engineers designed an enhanced multi-spectral imaging system for detecting bruising and erythema. The system consists of a laptop computer that imports images from a camera with a multi-spectral filter wheel. The camera’s filters measure narrow bands of visible light—about 10 nanometers in length. “The filters are highly sensitive to particular biological phenomena — such as hemoglobin,” explains Jayme Caspall, a GTRI research engineer.

Researchers shine a broad spectrum of light onto the skin and measure the light that reflects. They focus on the narrow bands because certain chemicals — like proteins in the blood near the skin surface — have peaks in absorption or reflectivity in certain wavelengths. For example, light is absorbed by hemoglobin, so if the scanner display goes dark, a lot of hemoglobin is present under the skin, indicating tissue injury.

Caspall, GTRI research engineer Michael Gray and their colleagues in the Georgia Tech School of Mechanical Engineering are also using acoustic techniques for detecting deep-tissue injury. Researchers use a commercially available dermal scanner — a 20 MHz ultrasound pulse echo device that works like the ultrasonic scanners used to visualize babies in the womb, except this scanner operates at a higher frequency to get more detailed images of the skin.

“Ultrasound is based on the concept of acoustic reflections, which are like shouting in a mountain range and hearing an echo in response,” explains Linghua Kong, a research engineer in CATEA. “Depending on the time it takes for an echo to come back, we can determine the distance of the obstacle.”

In their initial field test using high-frequency ultrasound, researchers noted that the thickness of the skin oscillates slightly. More controlled tests confirmed this finding, and analysis is under way to describe the new phenomena. “This is an exciting result because the frequency and the amplitude information can potentially be used to determine how old the bruise is,” Kong says.

Forensic Evidence

Determining when and how a bruise occurred is important to the National Institutes of Justice for forensic purposes. NJI funded the NIH grant because of its interest in the development of a low-cost imaging device to help officials identify elder neglect and abuse.

“One of the markers of neglect in the elderly is pressure ulcers, and bruises are a marker of abuse,” Sprigle explains. “So detecting these problems in the elderly shares some of the same problems we have in detecting erythema in people with dark skin.”

Currently, doctors examine bruises, and based on their experience and previous research, they guess the age of the bruises depending on their color.

“There’s a lot of error in this process, and it’s not admissible as evidence in court,” Caspall notes. “So we’re trying to come up with some guidelines to quantify bruises so doctors can backwards extrapolate to the onset of the bruise.”

Researchers are monitoring bruising over time and looking for consistent trends in spectral and acoustic components. If they can model bruise behaviors, such as oscillatory function, they can use them as parameters for aging bruises.

Acoustic imaging data also may provide clues as to whether a patient’s injury resulted from a fall or other type...
of impact, Sprigle says. “By combining multi-spectral imaging of bruises, which have a visual indication, with acoustic imaging, which tells us the extent of injury under the skin, it’s possible we can start to form profiles of the types of mechanism of injury — blunt or sharp or a fall versus an impact,” Sprigle says.

Testing the Technologies

Clinical field studies began in January 2006 and will continue through the summer at an A.G. Rhodes nursing home in Atlanta and at the Shepherd Center. Because of immobility, patients at Shepherd and residents in the nursing home are at risk for pressure ulcers. Researchers hope to get data over weeks or months as healing occurs on about 25 to 30 patients, particularly those with dark skin.

Clinical data collection helps drive the researchers’ modeling and algorithm development. Though these studies don’t reveal the etiology and the time base on bruises, they will provide enough background information to do controlled animal studies later, Sprigle says.

The current phase of the project is funded through August 2006, and Sprigle plans to apply to NIH and NIJ for continuation funding. Ultimately, the researchers plan to develop a prototype software program and/or hardware device. The researchers estimate the ultimate product - a handheld imaging device - will cost no more than $5,000 a unit. They want to license the technology to an optics and/or acoustics firm.

“There’s a need for this technology in every nursing unit in every hospital, group home, nursing home and rehabilitation facility,” Sprigle says. “Also, if we can detect bruising caused by abuse, it will be useful to social service agencies.”

Pressure ulcers are a common ailment among patients with impaired mobility, including those with spinal cord injury, multiple sclerosis, stroke, amputation and dementia.

“Given that in the United States we spend billions per year to treat pressure ulcers, prevention is always a better option...” Sprigle says. “This project aims to do that by getting clinicians and practitioners an inexpensive and accessible imaging device they can use at bedside, in the emergency room or at home. Both of these technologies we’re studying meet those requirements.”

Read more at: gbresearchnews.gatech.edu/resor/rh-ss06/bruses.html
Data Sharing

Georgia Tech assists U.S. government agencies with National Information Exchange Model.

BY JOHN TOON

Imagine a situation in which emergency medical, fire, law enforcement, and hazardous materials personnel respond to an emergency — only to find that they all speak different languages and cannot communicate with one another. That scenario unfortunately describes the challenge government agencies often face today when they want to share information among incompatible database systems.

To address this long-standing concern, the U.S. Department of Homeland Security and U.S. Department of Justice are collaborating with related federal agencies on a technology that will facilitate sharing of vital public safety and criminal justice information. Known as the National Information Exchange Model (NIEM), the new interagency effort will provide a foundation for sharing information using extensible markup language (XML), an open standard that allows exchange of information regardless of computer system or platform.

“The National Information Exchange Model (NIEM) was created to assist in developing a unified strategy, partnerships and technical implementations for national information sharing across all levels of government in support of justice, public safety, judicial, intelligence and homeland security interests,” says Jim Feagans, NIEM project manager at the U.S. Department of Justice. “Improving our nation’s ability to exchange mission-critical information cannot be solved by any one entity alone. It will require a partnership among organizations, governments at all levels and industry.”

With technical support from the Georgia Tech Research Institute (GTRI), the NIEM builds on the successful Global Justice XML Data Model developed earlier for the criminal justice community nationwide. The NIEM has released early drafts of the system components and programming tools, with the goal of a completed system ready for use by November 2006.

“By establishing a single standard for XML applications, the NIEM will build a foundation for exchanging information between the U.S. Department of Homeland Security, U.S. Department of Justice and supporting organizations responsible for emergency management, intelligence and other areas,” explains John Wandelt, principal research scientist at the Georgia Tech Research Institute’s (GTRI) Information Technology and Telecommunications Laboratory.

“Building on the success of the Global Justice XML Data Model, NIEM will extend the benefits of a common data model to other agencies at the federal, state and local levels.”

To accomplish that, NIEM is developing broad-based support among potential user groups by involving them in the development process. “NIEM recognizes that the development of successful solutions to improve critical information exchange requires a focus on user needs and requirements,” Feagans notes. “This means ensuring the appropriate input of both practitioners and policy-maker representatives across disciplines, jurisdictions and levels of government. Hence, NIEM supports a local government and practitioner-driven approach to improving information exchange, and will work cooperatively with the nation’s local and state governmental national associations.”

GTRI assisted with the Global Justice initiative and now serves as the technical lead for the NIEM Project Management Office - which was established as a collaborative effort between the Department of Homeland Security and the Department of Justice.

Working with GTRI, the group is identifying the core data components, reusable XML exchange packages and business-process models for information sharing that should be included in the NIEM. The Global Justice XML Data Model serves as a foundation for the expanded system.

“This project focuses on applying reusable components as the foundation and building blocks for our XML exchange packages,” explains Michael Daconta, metadata program manager for the Department of Homeland Security. “This standardization of exchange packages is critical to allowing the kind of information data sharing and interoperability needed among agencies with similar missions.”

Read more at: gtresearchnews.gatech.edu/newsrelease/niem.htm
Faculty Research in the News

Georgia Tech researchers’ work is covered in the media.

Chemical & Engineering News, New Scientist, The Economist and Computerworld reported on research done by Professor Walt de Heer, Associate Professor Phil First, research scientist Claire Berger and others in School of Physics on a new class of circuitry made from ultra-thin layers of graphite known as graphene. More than 60 news outlets have now covered the work. They also include the Atlanta Journal Constitution, Arkansas Democrat-Gazette, Birmingham News, EE Times, Machine Design, Red Herring, R&D Magazine and ElectronicsWeekly.com, a British Web site. (Read the article on this work on page 41 in this issue.)

CNET News, a technology news Web site, published an article on bioremediation research that could help control contamination from the radioactive element uranium. The research is led by Associate Professor of Biology Patricia Sobey and Assistant Professor Martial Taillefert in the School of Earth and Atmospheric Sciences. The Boston Globe Web site Boston.com also published the CNET NewsArticle. (Read the article on this work on page 20 in this issue.)

The Washington Times published a United Press International story about the hybrid wired-wireless network being developed by Gee-Kung Chang a Georgia Research Alliance Eminent Scholar who has appointments in the School of Electrical and Computer Engineering and the Georgia Centers for Advanced Telecommunications Technology. Other reports on this work appeared on California Computer News.com, TechNews.com and ZDNet. (Read the article on this work on page 39 in this issue.)

EE Times, New Scientist, Technology Review, CNET News and Mechanical Engineering magazine published articles on Georgia Tech’s development of a new technique for powering nanometer-scale devices without the need for bulky energy sources such as batteries. The research was led by Regents Professor Z.L. Wang in the School of Materials Science and Engineering. (Read the article on this work on page 38 in this issue.)

AATCC Review, Environmental Design & Construction, Buildings, Interiors & Sources and All Headline News, a supplier of content to Web sites, published an article about the Georgia Tech Research Institute’s new environmental test chamber. Researchers led by Principal Research Scientist Charlene Bayer used the facility to study indoor air pollutants released from furnishings, paints and building materials. (Read the article at gtresearchnews.gatech.edu/newsrelease/envir-chamber.htm)

Advanced Materials & Processes and Material Handling Management covered the 2005 Georgia Manufacturing Survey. The survey, led by Professor Phil Shapiro in the School of Public Policy and Principal Research Associate Jan Youtie in the Enterprise Innovation Institute, underscored the importance of innovation to the competitiveness of manufacturing companies. (Read the article on this work at gtresearchnews.gatech.edu/newsrelease/gms.htm)

Antenna Systems, RF Design and Network World covered GTRI research on an ultra-wideband phased-array antenna that could replace as many as five conventional antennas. Both military and commercial applications are envisioned for the “fragmented aperture” device developed by Senior Research Engineer Paul Friederich, Principal Research Engineer Jim Maloney and others in the Georgia Tech Research Institute’s Signature Technology Lab. (Read the article at gtresearchnews.gatech.edu/newsrelease/wideband.htm)
Awards & Honors

Georgia Tech faculty and staff receive recognition.

The Association for Asian American Studies awarded Professor of History, Technology and Society Ronald Bayer its 2006 Lifetime Achievement Award.

Bruce Ellingwood
Professor of Civil and Environmental Engineering Bruce Ellingwood was presented with the 2006 Lifetime Achievement Award from the American Institute of Steel Construction.

Joseph L.A. Hughes, a professor and associate chair in the School of Electrical and Computer Engineering, was named a Fellow of the American Society for Engineering Education (ASEE).

John Krige, Harranburg Professor in the School of History, Technology and Society, received the Dickinson Memorial Medal at the 26th Annual Dickinson Lecture of the Newcomen Society.

Gregory Nobles
Greg Nobles, a professor in the School of History, Technology and Society, was recently named to the Distinguished Lectureship Program of the Organization of American Historians, and in 2005, he was elected to the Advisory Council of the Society for Historians of the Early American Republic.

For innovative contributions to the understanding and application of the nonlinear optical properties of organic materials, Professor of Chemistry and Biochemistry Joseph Perry has been elevated to the rank of fellow of the Optical Society of America.

A team of engineers in the Aerospace Systems Design Laboratory in the School of Aerospace Engineering received the Society of Automotive Engineers International’s Arch

T. C. Helmer Merit Award
Christopher Raczyński, a graduate research assistant, Michelle Kirby, a research engineer, and Professor Dimitri Movass, received the award.

Bill Sayle, professor and associate chair emeritus of the School of Electrical and Computer Engineering, received the American Society for Engineering Education Distinguished Educator Award.

Andrea Strauss
Assistant Professor Andrea Strauss in the College of Architecture received the National Band Association Citation of Excellence at the 2006 Georgia Music Educators’ Association In-service Conference.

The Georgia Tech Research News and Publications Office, managed by John Toon and the Georgia Tech Research Institute Communications Office, directed by Kirk Englehardt, received a bronze medal in the Circle of Excellence Awards Program sponsored by the Council for the Advancement and Support of Education.

Jim Wiltsie, a researcher in the Georgia Tech Research Institute’s Sensors and Electromagnetic Applications Laboratory, was elected a fellow in The International Society for Optical Engineering (SPIE).
Faculty Column

Addressing Transportation Fuel Challenges

By Art Raguaskas and Colleagues
Associate Professor, Georgia Tech School of Chemistry and Biochemistry

Years before today’s energy challenges, before Hurricane Katrina, before $70 per barrel oil, several researchers and students at the Georgia Institute of Technology, Imperial College London and the Oak Ridge National Laboratory had already begun to develop research and educational programs that envisaged the energy, environmental and sustainability issues we are now encountering.

With world oil demand growing, supplies dwindling and tension brewing in several oil-rich regions, it is apparent that other types of fuels and technologies are needed to help pick up the slack. It is these challenges that encouraged our multi-institutional consortium — called the the Atlantic Alliance for BioPower, BioFuels and Biomaterials — to meet and develop a common roadmap from which collaborative research plans and educational opportunities could be developed.

Now, Alliance experts in science, engineering and public policy agree that the cornerstone to addressing our energy challenges is the integrated biorefinery.

The Technology

In general, the biorefinery integrates biomass conversion processes and equipment to produce fuels, power and chemicals from biomass. The biorefinery works much like a petroleum refinery, which produces multiple fuels and products from petroleum. Its goal is to use all components of biomass to make a range of foods, fuels, chemicals, feeds, materials, heat and power in proportions that maximize economic return.

Our vision is that the biorefinery will complement well-established petroleum refinery processes with some materials and fuels being easier to make from biomass, others from petroleum. But as petroleum resources become more limited, more of these chemicals will be derived from biomass.

A key component of addressing today’s energy challenges in a sustainable manner is the systems integration of:

- genomics and biotechnology
- advanced separation science and engineering
- catalysis, nanotechnology and polymer science
- lignin, polysaccharide and green chemistry
- process chemistry and engineering
- power generation
- life-cycle analysis

The Recommendations

Researchers finalized this roadmap last year, and it contained a series of comprehensive research and policy plans...
to increase the practicality of using biofuels and biomaterials as a supplement to petroleum. A condensed version was summarized as a review article, called “The Path Forward for Biofuels and Biomaterials,” which appeared in the Jan. 27, 2006 issue of Science. (See www.chemistry.gatech.edu/faculty/Ragauskas/)

We can readily address, with research, a third of current transportation fuel needs. But reaching that goal will require five to 10 years and significant policy and technical effort.

While many think of ethanol made from corn when they think of biofuels, our research group recommends a much broader spectrum of possible materials, including agricultural wastes, such as corn stovers and wheat stalks; fast-growing trees, such as poplar and willow; and several perennial energy crops, such as switchgrass.

In addition, the group also recommends some changes to the plants themselves using techniques such as accelerated domestication to make them more efficient energy crops. But doubling the productivity of energy crops will mean identifying constraints and engineering-enhanced pathways with genomic tools.

To make biofuels a truly practical alternative to petroleum, we believe there will need to be significant improvements in how biofuel is processed. Thus, we recommend the biofinery.

Associate Professor Sam Shelton, director of Georgia Tech’s Strategic Energy Institute, says, “The integrated biofinery offers great long-term potential utilization of biomass and dovetails nicely with Georgia Tech’s near-term development of southern pine-to-ethanol technology using the existing southeastern pine pulpwood resource, infrastructure and technology.”

The Research

Our group based its recommendations on research studies of: the development of rapid-growth, high-energy-content trees and perennials; novel environmentally friendly biomass extraction technologies; innovative catalysts for the conversion of agricultural and wood residues to bioethanol/diesel and hydrogen; and biofuel cells and next-generation green plastics and materials derived from functionalized feedstocks prepared from sustainable sources such as plants, sunlight and wastes.

The response to our review article in Science has been fantastic. The authors have been interviewed by numerous news agencies, including Fox, National Public Radio and the BBC. At last count, more than 450 newspapers, Web sites and other news outlets had referenced this article. It has provided a touchstone from which students are being engaged in science and engineering, faculty are pursuing energy-related research programs, and inventors and industrialists are pursuing new technologies to help develop integrated biorefineries.

Researchers from Georgia Tech, Imperial College and ORNL have initiated new biofuel, biopower and biomaterial projects to help solve some of the major research issues surrounding the biofinery. These include unique, green solvent-extraction systems to recover value-added chemicals from biomass, and the development of catalytic systems to reform biomass carbohydrates to biogasoline and biodiesel precursors.

But just as energy is a pesasive societal issue, the solutions will undoubtedly come from many sources. The Alliance encourages a strong dialogue and interactions with its partner institutions’ alumni and the communities the institutions serve. By working together and leveraging our skills, knowledge and synergies, we will provide a sustainable path to renewable biofuels, biopower and biomaterials to address today’s and tomorrow’s energy challenges.

The team leaders of this project are Charlotte Williams and Richard Murphy from Imperial College London; Brian Davidson from Oak Ridge National Laboratory and Art Ragauskas from Georgia Tech. Other key collaborators are: John Cairney, Carol Carmichael, Chuck Eckert, Janne Fredericks, Charles Latta, Jason Hallett, John Muzzy and Robert Snyder from Georgia Tech; Richard Templer, Darol Lusk, George Britocek, Tom Welton, Sergei Kazarian, Sandra Macchietto; Assilio Bauen, Jeremy Woods, Alex Taylor, Tariq Ali and Michiko Shima from Imperial College London; and Timothy Tschapinski, Jonathan Miderz and Lev Raidainger at Oak Ridge National Laboratory. The authors acknowledge the National Science Foundation, U.S. Department of Agriculture and U.S. Department of Energy for their support of the research presented in the Science paper.

Read more at: gtresearchnews.gatech.edu/reshor/rh-ss06/ragauskas.html
Smart Munitions

Researchers use synthetic jet actuators to steer 40mm projectiles in flight.

By Rick Robinson

Large-scale smart weapons such as laser-guided bombs have helped reshape modern warfare. Now, scientists at the Georgia Tech Research Institute (GTRI) are taking an analogous approach with smaller-scale munitions by working on the development of self-guided projectiles.

The concept involves the use of tiny devices called synthetic jet actuators, which squirt out minute puffs of air when these devices are embedded into the surface of a grenade-type projectile, they alter the air flow around it.

“What we’re demonstrating here is that a technology called ‘microadaptive flow control’ can produce forces that can move a projectile enough to be used as a steering system,” says project leader Jim McMichael, director of GTRI’s Aerospace, Transportation and Advanced Systems Laboratory (ATAS).

Called SCORPION — for Self Correcting Projectile for Infantry Operation — this program, supported by the Defense Advanced Research Projects Agency (DARPA), has now moved well beyond the workbench phase. Working jointly with Peter Plostine and his team at the U.S. Army Research Laboratory at Aberdeen, Md., GTRI recently demonstrated the feasibility of this projectile-steering approach on a spinning 40-millimeter projectile fired from an M-203 grenade launcher.

Synthetic jet actuators are derived from the work of Ari Glezer, a professor in the Georgia Institute of Technology’s School of Mechanical Engineering. Some years ago, Glezer developed jets consisting of a minute vibrating diaphragm driven electrically by a piezo-ceramic element. These synthetic jets emit tiny vortices of air as their diaphragms vibrate. By essentially sucking in air and blowing it out thousand of times a second, they form a jet locally without the complex support apparatus conventional jets need.

By switching on an embedded synthetic jet for a few milliseconds, researchers can create an asymmetry in the air flow around the projectile. As the jet flow wraps around the projectile’s tail, its effect is multiplied by a phenomenon called the Coanda effect. That in turn produces an air-flow change strong enough to alter the trajectory.

“The strength of this jet is not that high - it comes out at a velocity that’s about half the speed that the projectile is moving forward,” McMichael explains. “So it’s not like a thruster; it’s not like a rocket engine. It’s a very small effect that is amplified by the Coanda effect.”
Small-scale, self-guided munitions could be useful to the infantry soldier in several ways. Like large-scale munitions, their increased accuracy would allow soldiers to increase both the effectiveness and the efficiency of a combat mission.

Kevin Massey, an engineer involved in SCORPION, observes that for foot soldiers already carrying more than 60 pounds of gear, being able to shoulder fewer rounds of ammunition would be a boon.

“If a round is ... three times more accurate, he can either carry around one-third as much ammunition, or he can engage three times as many targets,” he says.

Massey also envisions a soldier being able to aim and detonate a grenade-type round in mid-air within inches of a pre-determined spot. That could give infantry a powerful weapon against an enemy firing from around a corner or behind a doorway.

Such a super-accurate, steerable round could also improve battlefield security for infantry units, allowing them to be effective at greater distances from an enemy.

“It keeps the soldier farther from harm’s way, increases the stand-off distance and makes his life safer,” Massey says.

To control SCORPION’s synthetic jets, GTRI scientists supplied a 40-mm test projectile with a set of electronics that they hardened to withstand the heavy forces generated during the launch tests. The onboard electronics created a complete system that researchers could pre-program to change trajectory during flight.

The current SCORPION projectile, which is basically a proof-of-concept device, lacks a full guidance system. If the military decides to pursue SCORPION, future program phases would likely add a guidance system that would allow operators to make corrections during flight and dictate the projectile’s exact detonation point.

GTRI is working on a revised prototype that could lead to development of a practical SCORPION round, McMichael says. For one thing, engineers are changing the amount of space that the flow-control system uses inside the projectile.

“If you wanted to have a tactical system,” he says, “you’ll have to give some real estate back to other components that go on real grenades — like explosives.”

A second SCORPION phase, now under way, is investigating the use of gas-generator actuators in the place of synthetic jets. Gas-generator actuators, which use minuscule explosive charges to create stronger forces than synthetic jets can, are being developed to steer higher-speed projectiles.

But the basic idea is the same, McMichael says. Though the gas-generator jets will be higher in strength, they still will steer the projectile by interacting with the air flow around the projectile rather than by using sheer jet thrust.

Read more at: gtresearchnews.gatech.edu/reshor/rh-ss06/scorpion.html

Below: Tiny devices called synthetic jet actuators, which squirt out minute puffs of air, can be embedded into the surface of a grenade-type projectile and alter the air flow around it. Georgia Tech Research Institute engineers recently demonstrated the feasibility of this projectile-steering approach on a spinning 40-millimeter projectile fired from an M-203 grenade launcher.
Protecting Sensitive Data

Researchers develop fail-safe techniques for erasing magnetic storage media.

By John Toon

After a U.S. intelligence-gathering aircraft was involved in a mid-air collision off the coast of China four years ago, the crew was unable to erase sensitive information from magnetic data storage systems before making an emergency landing in Chinese territory.

That event underscored the need for simple techniques to provide fail-safe destruction of sensitive data aboard such aircraft. Working with defense contractor L-3 Communications Corp., scientists at the Georgia Tech Research Institute (GTRI) have developed a series of prototype systems that use special, high-strength permanent magnets to quickly erase a wide variety of storage media.

Developed so far for VHS tapes, floppy drives, data cassettes, and small computer hard drives, the techniques could also have commercial applications for banking, human resource, and other industries that must also protect sensitive information.

“This is a very challenging problem,” says Michael Knotts, a research scientist in the GTRI’s Signature Technology Laboratory. “We had to verify that the data would be beyond all possible recovery even with unlimited budget and unlimited time. Commercial devices on the market for data erasure just couldn’t fill the bill, because they were magnetically too weak, they were physically too large and heavy, or they didn’t meet stringent air safety standards.”

During the project, the researchers developed testing procedures that use a magnetic force microscope (MFM) — a variation on the atomic-force microscope (AFM) more commonly used to provide detailed images of surfaces at the nanometer scale. The MFM mapped the very small magnetic perturbations created by data stored on the media, helping determine how well data patterns had been destroyed.

“If you erase the data by whatever means, you should see a surface devoid of any specific pattern or periodicity,” Knotts explains. “Our goal was to see a random distribution of magnetization that would indicate a clean disk.”

During the three-year project, Knotts and collaborators Don Creys, Dave Maybury, Candy Ekangaki, and Tedd Toler explored a broad range of possible destruction techniques, including burning diskettes with heat-generating thermite materials, crushing drives in presses and chemically destroying the media.

The researchers had to select techniques and equipment that would:

- Be light enough for aircraft use and operate independently of aircraft electrical systems;
- Be mechanically simple to ensure reliable operation;
- Produce no harmful gases or flame;
- Provide mechanisms to prevent inadvertent erasure.

During their first year of work, the researchers learned that data could remain on diskettes that had been subjected to high heat, and had to abandon thermal destruction techniques because of the fire and harmful gases they generated. That left only magnetic techniques.

In developing techniques for complete erasure, the researchers first had to learn how different data storage drives operate, then assess the magnetic field levels necessary for complete erasure. To do that, they obtained a number of commercially available micro-drives, cut the media into sections, subjected them to varying magnetic fields, and then tested the sections with the MFM.
"We had to understand how the data is laid out on the disk so we could know where to look for the patterns, and we had to do a lot of measurements to determine exactly what kind of magnetic field is needed to destroy all data," says Knots. "We had to do a lot of destructive testing to determine that, and our lab is littered with the carcasses of dead hard drives to prove it."

Producing a magnetic field sufficient to destroy data patterns required the use of neodymium iron-boron magnets custom-designed for the project and special pole pieces made of esoteric cobalt alloys. The magnets, which weigh as much as 125 pounds, had to produce fields sufficient to penetrate metallic housings that surround some drives.

"We developed models for magnetic circuits that we could run through optimization codes to design the best shape to get the field that we needed," Knots says. "It takes quite a magnetic field to get through the steel enclosures on some of the drives. We are producing magnetic fields comparable to those used in magnetic resonance imaging equipment, so these are not your ordinary refrigerator magnets."

Mechanically, the researchers faced challenges in reliably moving data storage devices through the magnetic fields. In some cases, aircraft crews would simply insert removable media into a motorized mechanism that pushes them past the magnets, while for other media, crews would have to twist a knob and pull drives out of their enclosures and through a magnetic field. To prevent accidental erasure, each technique requires several deliberate steps.

With success in erasing removable media and small hard drives, the researchers are moving onto a final phase of the project, which will involve large computer hard drives partially encased in thick steel caddies.

Beyond Department of Defense applications, the magnetic erasure techniques could have applications to the commercial world, where banks, human resource agencies and other organizations must ensure complete destruction of data in computer equipment being discarded.

Knots admits he’ll be a bit sad to see the project end. "This was certainly an unusual project," he says. "It’s not often that we get paid to crush equipment in presses, blow things up and set off fires in microwave ovens."

Photo by Gary Meek.

Contact

Michael Knots at 404-385-4534 or michael.knots@gtrri.gatech.edu

Left: Research engineer David Maybury models a magnetic data destruction circuit using 3D finite element analysis.

Read online at: gtresearchnews.gatech.edu/resrch/rh-ss06/guard-dog.htm
Nanogenerators
Researchers convert mechanical energy for self-powered nanoscale devices.

Researchers have developed a new technique for powering nanometer-scale devices without the need for bulky energy sources such as batteries.

By converting mechanical energy from body movement, muscle stretching or water flow into electricity, these “nanogenerators” could make possible a new class of self-powered implantable medical devices, sensors and portable electronics.

Described in the April 14 issue of the journal Science, the nanogenerators produce current by bending and then releasing zinc oxide nanowires — which are both piezoelectric and semiconducting. The research was sponsored by the National Science Foundation (NSF), the NASA Vehicle Systems Program and the Defense Advanced Research Projects Agency (DARPA).

“There is a lot of mechanical energy available in our environment,” says Zhong Lin Wang, a Regents Professor in the School of Materials Science and Engineering at the Georgia Institute of Technology. “Our nanogenerators can convert this mechanical energy to electrical energy. This could potentially open up a lot of possibilities for the future of nanotechnology.”

Nanotechnology researchers have proposed and developed a broad range of nanoscale devices, but their use has been limited by the sources of energy available to power them.

Conventional batteries make the nanoscale systems too large, and the toxic contents of batteries limit their use in the body. Other potential power sources also suffer from significant drawbacks.

“We can build nanodevices that are very small, but if the complete integrated system must include a large power source, that defeats the purpose,” adds Wang, who also holds affiliated faculty positions at Peking University and the National Center for Nanoscience and Technology of China.

The nanogenerators developed by Wang and graduate student Jinhui Song use the very small piezoelectric discharges created when zinc-oxide nanowires are bent and then released. By building interconnected arrays containing millions of such wires, Wang believes he can produce enough current to power nanoscale devices.

To study the effect, the researchers grew arrays of zinc-oxide nanowires, then used an atomic-force microscope tip to deflect individual wires. As a wire was contacted and deflected by the tip, stretching on one side of the
structure and compression on the other side created a charge separation — positive on the stretched side and negative on the compressed side — because of the piezoelectric effect.

The charges were preserved in the nanowire because a Schottky barrier was formed between the AFM tip and the nanowire. The coupling between semiconducting and piezoelectric properties resulted in the charging and discharging process when the tip scanned across the nanowire, Wang explains.

When the tip lost contact with the wire, the strain was released — and the researchers measured an electrical current. After the strain release, the nanowire vibrated through many cycles, but the electrical discharge was measured only at the instant when the strain was released.

To rule out other potential sources of the current, the researchers conducted similar tests using structures that were not piezoelectric or semiconducting. “After a variety of tests, we are confident that what we are seeing is a piezoelectric-induced discharge process,” Wang says.

— John Toon

Contact: Zhong Lin Wang at 404-894-8008 or zhong.wang@mse.gatech.edu. Read more at: gtresearchnews.gatech.edu/newsrelease/nanogenerator.htm

Optical-Wireless Convergence

Telecommunications researchers have demonstrated a novel communications network design that would provide both ultra-high-speed wireless and wired access services from the same signals carried on a single optical fiber.

The new hybrid system could allow dual wired/wireless transmission of the same content such as high-definition television, data and voice up to 100 times faster than current networks. The new architecture would reduce the cost of providing a dramatically improved service to conference centers, airports, hotels, shopping malls — and ultimately to homes and small offices.

“The same services would be provided to customers who would either plug into the wired connection in the wall or access the same information through a wireless system,” explains Gee-Kung Chang, a professor in the School of Electrical and Computer Engineering at the Georgia Institute of Technology. “In an airport, for instance, a traveler could watch a movie, talk to a friend and work interactively through a wireless system or by plugging into the wall.”

Chang described the network architecture and experimental demonstrations of it at the OFC/NFOEC optical conference in March. Chang, who holds the Byers Endowed Chair in Optical Networks at Georgia Tech, is a Georgia Research Alliance Eminent Scholar and a researcher at the Georgia Tech Broadband Institute in the Georgia Centers for Advanced Telecommunications Technology (GCATT).

Today, telecommunications providers generally supply services that are either all-wireless, through cellular telephones or similar devices, or all-wired — through DSL, cable or optical access network. As wireless providers seek to provide new bandwidth-intensive services such as video, music and high-speed Internet access, however, the bandwidth needs of wired and wireless services are converging.

The optical-wireless access network envisioned by Chang and his colleagues would connect existing optical fiber networks that already serve much of the nation. But before entering a building, signals on the optical fiber would be optically up-converted in the central office from their normal infra red wavelengths to the millimeter-wave spectrum. Using a technique developed at Georgia Tech, wireless and baseband signals carried by multiple wavelengths would be converted onto the millimeter-wave carrier simultaneously.

“You could have one network shared by many providers because bandwidth is not a limitation once you combine the advantages of optical and wireless access systems,” Chang says. “If you look into the future, the broadest bandwidth possible would come through combining and integrating optical and wireless services in a single network.”

— John Toon

Contact: G.K. Chang at 404-385-2712 or geekung.chang@ece.gatech.edu. Read more at: gtresearchnews.gatech.edu/newsrelease/hybrid-network.htm

ABOVE: Graduate students Yong-Kee Yeo and Zhenhong Jia operate optical equipment in a hybrid wired/wireless network.

“...the same services would be provided to customers who would either plug into the wired connection in the wall or access the same information through a wireless system.”

G.K. Chang, professor in the School of Electrical and Computer Engineering
Green Chemistry

Using the unique properties of new nanometer-scale magnetic particles, researchers have for the first time separated for reuse two different catalysts from a multi-step chemical reaction done in a single vessel.

By combining the new magnetic separation process with traditional gravity-driven separation, the technique could lead to more efficient production of specialty chemicals — and a reduction in waste normally produced by separation processes. The research was reported March 27 in the journal Angewandte Chemie International Edition.

“We have developed a way to do multiple reactions in a single vessel while being able to recover the catalysts in pure form for reuse,” explains Christopher W. Jones, an associate professor in the School of Chemical & Biomolecular Engineering at the Georgia Institute of Technology. “By doing the reactions in a single vessel, we can cut out two or three separation steps to provide both an economic advantage and an environmentally benign process.”

Separations using magnetic catalysts have been limited by a tendency of the nanoparticles to clump together because of their magnetic attraction for one another. The clumping dramatically reduces their catalytic activity.

To overcome this problem, the Georgia Tech researchers used nanometer-scale magnetic particles that are so small (5 to 20 nanometers in diameter) that they no longer exhibit a net magnetic attraction. But these superparamagnetic nanoparticles, developed by the research group of Z. John Zhang in Georgia Tech’s School of Chemistry and Biochemistry are attracted to an external magnetic source, providing a mechanism for separating them in pure form from the reaction vessel.

“These magnetic nanoparticles work well as catalyst supports because they are very small and so have a high surface area that allows creation of many catalytic sites for high activity levels,” Jones says. “Because they are superparamagnetic, they remain suspended in the reaction vessel and do not clump together until a magnetic source is brought near them.”

The new technique would allow more than one catalyst to be recovered and reused at the end of the one-pot reactions. Jones envisions the new process being used in the specialty chemical and pharmaceutical industries that produce relatively small volumes of high-value chemicals.

— John Toon

ABOVE: Post-doctoral researcher Nam Phan, left, and graduate student Christopher Gill study the separation of magnetic nanoparticle catalysts from polymeric resin catalysts. The magnetic nanoparticles are easily manipulated with magnets as small as simple kitchen magnets.

First Responders

Officials from the Georgia Institute of Technology and Carbon Motors Corporation — a new U.S. automaker that has announced plans to locate in Georgia — have taken the first step toward a collaboration that would develop the world’s first vehicle built expressly for law enforcement agencies.

The company, which will market its innovative “purpose-built” vehicle directly to customers, also plans to revolutionize U.S. automobile manufacturing as a lean and integrated organization. In March, the firm announced plans to locate its headquarters, research and development center, direct sales center, customer service, and mid-volume production and logistics operations in the metropolitan Atlanta area.

On April 19, officials from Georgia Tech and Carbon Motors signed a memorandum of understanding setting out their intent to establish research, education and financial arrangements.

“In this era of enhanced homeland security concerns, law enforcement first responders require the most appropriate specialized equipment delivered to them in the most efficient way possible so our women and men in uniform can patrol our communities in a more effective and safe manner,” says William...
Santana Li, chairman and CEO of Carbon Motors. “With more than 200 law enforcement agencies nationwide, we have developed a list of 74 critical criteria that law enforcement vehicles need to meet. This vehicle will be different in almost every way to truly meet the needs and desires of law enforcement.”

To make that vision a reality, Carbon Motors plans to take advantage of Georgia Tech’s expertise in a broad range of areas. Initially, the company’s designers and engineers plan to tap Georgia Tech’s expertise in the ergonomic design of aircraft cockpits and the integration of highly complex electronic and electrical systems.

“Police vehicles today have a complex set of systems that need to be ergonomically configured to ensure proper flow of information to officers, especially when they are in pursuit or in stressful situations,” Li says. “What we essentially need is comparable to the cockpit of a helicopter — which Georgia Tech has experience in designing. That expertise not normally found in the automotive industry.”

Beyond the human factors interface expertise, the company also intends to take advantage of Georgia Tech experience with integrating complex electronic systems — expertise also developed in decades of work done for military agencies.

The Georgia Tech Research Institute (GTRI), which recently developed a new concept vehicle for the U.S. military, plans to work with Carbon Motors on key tasks.

— John Toon

@ Contact: Carl Rust at 404-385-7405 or carl.rust@innovate.gatech.edu. Read more at gtresearchnews.gatech.edu/newsrelease/carbon.htm

## Manufacturing Road Map

Using a combination of experimental data and simulations, researchers have identified key parameters that predict the outcome of nanoimprint lithography, a fabrication technique that offers an alternative to traditional lithography in patterning integrated circuits and other small-scale structures into polymers.

Results of the three-year study, conducted by researchers at the Georgia Institute of Technology and Sandia National Laboratories, provide a “road map” to guide development of next-generation micron- and nanometer-scale, high-resolution imprint manufacturing. By reducing cost and time, the design rules could help make high-volume production of nanotechnology-based products more economically feasible.

“This work provides a rational link between what engineers want to make using nanoimprint lithography and the path for creating them,” says William King, an assistant professor in Georgia Tech’s School of Mechanical Engineering. “We have developed manufacturing design rules that will give future users of this technology a predictive tool kit so they’ll know what to expect over a broad range of parameters.”

The research results have been published in the *Journal of Vacuum Science Technology* B and the *Journal of Micromechanics and Microengineering*. The research was supported by awards to King through the National Science Foundation’s CAREER program and the PECASE award program of the U.S. Department of Energy.

Nanoimprint lithography is the ultra-miniaturized version of the decades-old embossing process in which a master tool — or a mold — is pressed into a soft material to create detailed patterns. Using a broad range of polymer materials, nanoimprint lithography produces structures on the micron- or nanometer-size scales, offering the potential for lowering production costs.

But quality issues caused by unpredictable polymer flow into the non-uniform features of embossing tools pose a major stumbling block. Earlier research into this complex manufacturing process has produced conflicting recommendations, forcing manufacturers to pursue costly trial and error.

Using the results of experimental work and a simulation program adapted in collaboration with researchers at Sandia, King’s research team examined every variable involved in the nanoimprinting process, recording the outcome of each incremental change through the design space. They studied such variables as shear deformation of the polymer, elastic stress release, capillary flow and viscous flow during the filling of imprinting tool cavities that had varying sizes and shapes.

“This helped us to resolve the phenomenological events that occur during the manufacturing process and to link them to the observed experimental outcomes,” King explains. “Because we have blanketet the entire design space, we have a firm understanding of the linkage between process parameters and outcomes.”

— John Toon

@ Contact: Bill King at 404-385-4224 or bill.king@mgtatech.edu. Read more at gtresearchnews.gatech.edu/newsrelease/nanoimprint.htm
Extraterrestrial Life
Research to improve instruments for analysis of samples from outer space.

Researchers have identified a new test case that could be used for evaluating extraterrestrial samples for evidence of life. The new test could ultimately allow the use of simpler analytical instrumentation on future space missions.

In the search for life on other planets, astrobiologists regard liquid water and chiral biomolecules to be critical components. "Yet because chiral molecules can be made synthetically as well as biologically, it's not enough to just find them on other planets. We need to show a change of chirality over time," says Tracey Thaler, a graduate student at Georgia Tech's School of Chemistry and Biochemistry. She works with Professor Andreas Bommarius in the School of Chemical and Biomolecular Engineering.

Thaler has investigated racemization — the conversion of an optically active compound to a racemic form, which has no optical rotation — as a new approach for analyzing samples in outer space. "Because this type of reaction is found only in biological systems, it could serve as a marker for extant extraterrestrial life," Thaler explains. She presented results from the study in March at the 231st American Chemical Society National Meeting.

The study is part of a collaborative effort with Professor Rick Tembo's research group in Georgia Tech's School of Physics. The two research groups are trying to improve analytical instruments used on space missions, research that is sponsored by NASA.

Chromatography, the current method used to evaluate extraterrestrial samples on space missions, is a tedious process, Bommarius explains. Another drawback, researchers must know in advance the specific compounds they're looking for, which isn't always possible. In contrast, polarimetry, a method for measuring optical activity, does not require knowledge of the structure being analyzed. But because existing polarimeters have performance limitations, Georgia Tech researchers are developing a more sensitive polarimeter that can detect smaller concentrations of optically active compounds. Thaler's work serves as a test bed for such an instrument.

"Tracey's study is significant because it marks the first time that racemization has been looked at as a sign of life on other planets," Bommarius says. "What's more, she has identified two new media in which the enzyme mandelate racemase is active."

Mandelate racemase (MR) is an enzyme that catalyzes the racemization reaction for the substrate mandelic acid. Mandelate is one of the simplest chiral molecules and has a large specific optical rotation, making it well-suited for polarization analysis, Thaler explains.

An important part of the study was to determine if MR reactivity could occur at subzero temperatures found on planets like Mars or moons like Titan, Europa or Enceladus, where recent data shows water is likely to exist.

After a number of unsuccessful attempts with organic cryosolvents — the most common medium to probe enzyme activity at low temperatures — Thaler achieved MR reactivity in two unconventional media. They were concentrated ammonium salt solutions and water-in-oil microemulsions (anionic surfactant Aerosol OT and non-ionic surfactant Triton X-100). Racemization occurred in temperatures as low as -30 degrees Celsius. This was promising because both the microemulsions and the concentrated salt solutions are expected to form on other planets and moons.

Another auspicious finding: Measurements for the activation parameters (thermodynamics) in the ammonium salt solutions and water-in-oil microemulsions were very similar. "This tells us that racemization is not only possible in other media, but some dynamic parameters found in these media are similar to those found in media that's normally used," Thaler says.

— T.J. Becker

© Contact: Tracey Thaler at 404-385-3089 or 404-388-5974 or tracey.thaler@cbbe.gatech.edu; or Andreas Bommarius at 404-385-1334 or andreas.bommarius@cbbe.gatech.edu. Read more at: generosity.gatech.edu/newsrelease/extraterrestrial.htm
Explaining Nanotech

Who will operate the nanotechnology factories of the future? Will the public be able to make informed decisions about new nanometer-scale products and services? Will tomorrow's nanotechnology industry face the same kind of backlash as today's genetically modified food industry?

These are some of the questions that concern Nancy Healy. As education coordinator for the National Nanotechnology Infrastructure Network (NNIN), she's helping develop educational outreach programs designed to ensure that tomorrow's workers have the right skills for nanotechnology industries — and that the public will be able to separate nanotechnology fact from fiction.

Her biggest challenge: helping people relate to structures whose size is measured in billionths of meters. And that's without explaining the quantum mechanical effects that make nanotechnology processes, such as friction, dramatically different at the nanoscale.

"There's a misperception that nanotechnology is really just science fiction," says Healy, who described NNIN education efforts at the 2006 meeting of the American Association for the Advancement of Science. "People generally don't know what nanotechnology really is. There's a risk that their perceptions will be based on popular culture portrayals of it rather than fact."

The U.S. government is investing a billion dollars a year in the technology of the very small. The National Science Foundation (NSF) estimates that by 2015, nanotechnology will directly employ more than two million workers worldwide. Yet 80 percent of the people currently surveyed by the Project on Emerging Nanotechnologies acknowledged knowing little or nothing about it.

"We still have a long road ahead in educating people," says Healy, whose efforts are headquartered at the Georgia Institute of Technology. "But we don't have much time because the technology is moving forward quickly. Nanotechnology is already here, though some of the most important aspects of it are still 10 or 15 years away."

Today, nanotechnology is mostly seen as the province of Ph.D. scientists and engineers. But as the industry grows, it will need people at all education and skill levels to meet needs that range from cutting-edge research to maintenance of manufacturing equipment.

"The field is wide open," Healy adds. "There are many opportunities, not just for technical people, but also for specialists such as patent attorneys, pharmacists, entrepreneurs and marketers. The most important skill will be the ability to work with people in other disciplines — to be an interdisciplinary person."

— John Toon

@ Contact: Nancy Healy at 404-385-4307 or nancy.healy@micr.gatech.edu. Read more at: gtresearchnews.gatech.edu/newsrelease/nnin-education.htm

Military IT Capability

Georgia Tech Research Institute engineers are leading the system integration and production design effort that will create a broad-based information technology capability for the command and control needs of future U.S. task forces. Their work is part of an approach that includes not only full information technology (IT) capabilities (networks, voice, video, telephone, etc), but also shelters environmental control units and power for a stand-alone, fully deployable system.

The Deployable Joint Command and Control (DJC2) program is envisioned as a "system of systems." It will integrate new and existing applications into a shared-information environment that connects a joint task force (JTF) with the national military command structure, combat support, regional combatant commands, intelligence, and service and multinational components.

The DJC2 program is headed by the DJC2 Joint Program Office and is run through the Naval Surface Warfare Center in Panama City, Fla. Georgia Tech Research Institute (GTRI) support is funded under the C4I Munitions Test and Improvement Contract (CIMTIC II) contact, for which GTRI is a prime contractor.

"DJC2 is the hardware and software solution to bring everything together that needs to be packaged and sent out for joint task force deployments," says Carlee Bishop, a GTRI researcher and DJC2 project director. "With this equipment, they can set up a command center in the middle of nowhere and run a full JTF."

GTRI engineers are designing the information technology portion of DJC2, with the aim of integrating custom military technology and off-the-shelf civilian technology into a seamless unit. This effort includes network, software, communications and telephony/video subsystems. GTRI is also researching state-of-the-art concepts to enhance the
DJC2 capabilities, plus designing and integrating the engineering solution.

The prototype DJC2 system was tested during the Hurricane Katrina relief effort last year. While the task force was being formed to support the victims of the hurricane, the DJC2 system was being packed up and shipped to Louisiana to support command and control of these efforts. Although still under development, the system provided essential communications capabilities needed to conduct the complex task of coordinating civilian, state, federal and military personnel.

— Rick Robinson

Contact: Carlee Bishop at 404-407-6335 or carlee.bishop@gtri.gatech.edu.
Read more at: gtresearchnews.gatech.edu/reshor/hh-ss06/DJC2.html

Georgia Tech in Ireland

The Georgia Tech Research Institute (GTRI), the applied research arm of the Georgia Institute of Technology, is establishing a research enterprise in Athlone, Ireland, to focus on industry research and development needs. GTRI Ireland will be GTRI’s first applied research facility outside the United States.

Over the next five years, the Irish operation plans to build up a portfolio of research programs and collaborations with industry valued in excess of $24 million, and at full operation, it will employ 50 highly qualified researchers.

GTRI, which conducts nearly $140 million in research and development each year for industry, government and academic institutions across the globe, will receive support from IDA Ireland, the agency responsible for industrial development and overseas investment in Ireland. The new institute will focus on four technology areas that mirror Ireland’s research strengths — digital media, radio frequency identification (RFID), biotechnology and energy.

“Ireland is increasingly known as a world leader in innovation and for embracing technology. As Georgia Tech expands its global horizons, we seek partners who share our values and goals,” says Georgia Tech President Wayne Coughlin. “Thus, we are especially pleased to celebrate the formation of this forward-looking collaboration with Ireland and our Georgia Tech Research Institute. We are grateful to the government and civic leaders of Ireland who worked on this exciting initiative with us.”

The institute will work closely with Irish corporations and universities, the Georgia Tech research community and U.S. companies to provide companies on both sides of the Atlantic with industry-focused research and development that bridge the gap between academic discovery and commercial success.

— Megan McRainey

Contact: Kirk Englehardt at 404-407-7280 or kirk. englehardt@gtri.gatech.edu.
Read more at: www.gatech.edu/newsroom/release.php?id=897

Maintainer’s Support

Aircraft technicians these days are likely to use a laptop as a printed manual and logbook, and to turn to the Internet for the latest job-status reports and technical information.

Engineers from the Georgia Tech Research Institute (GTRI) are assisting them, using current computer and database technology to help military aircraft maintainers get their work done more efficiently. A team from GTRI’s Electro-Optical Systems Laboratory (EOSL) has been developing and improving maintenance software for the U.S. Navy since 2000.

Called the Maintainer’s Electronic Performance Support System (MEPSS™), this software was initially developed for the Navy’s P-3C Orion patrol aircraft. A more recent version is now helping maintain the RQ-2 Pioneer Unmanned Aerial Vehicle, and portions of the GTRI software are being used in other aircraft maintenance programs.
"The idea is to give maintainers all the information tools and decision-making capabilities that they need," says Gisele Bennett, director of EOSL and principal investigator for the project. "From a simplified standpoint, you can almost look at it as an information portal, where you're collecting and disseminating information to the maintainers."

MEPSS is typically installed on a laptop computer. Technicians can check parts lists, consult manuals and add information about their work as they go. The system can be updated in a variety of ways — through a squadron LAN, a standalone server, CD-ROMs, USB devices, or the World Wide Web. A Web-enabled system gives maintainers access to up-to-the-minute technical and parts information, and helps them both access and share work-related information.

Whatever the connectivity approaches used, the software performs a needed centralizing function, Bennett says. For example, by reviewing software reports maintainers can detect trends involving, say, troublesome parts that need multiple replacements. Or they can pinpoint repair techniques that need improvement.

And maintainers can conveniently brief themselves on an aircraft's maintenance history right down to work done recently by a previous shift that is not on site to answer questions.

MEPSS uses MS Internet Explorer as the delivery mechanism for the information that is extracted from a database. The system also has the ability to post announcements, allowing effective dissemination of critical issues and information among an entire maintenance community.

— Rick Robinson

Contact: Gisele Bennett at 404-894-0155 or gisele.bennett@gtri.gatech.edu.

Read more at: gtresearchnews.gatech.edu/newsrelease/maintainer.htm

Enterprise Innovation Institute

The Georgia Institute of Technology has launched a sweeping restructuring of its business and community assistance programs as part of a new initiative known as the Enterprise Innovation Institute.

The restructuring brings new and established Georgia Tech programs together into a broadly integrated initiative designed to help industry, entrepreneurs, economic developers and communities become more competitive through the application of science, technology and innovation.

Creation of the Enterprise Innovation Institute represents the first major reorganization of Georgia Tech's economic development and business assistance programs since the Economic Development Institute (EDI) was formed in 1993. The changes affect all activities of Georgia Tech's former Office of Economic Development and Technology Ventures, including the Advanced Technology Development Center (ATDC) business incubator, VentureLab research commercialization effort, Commercialization Services initiative and former Economic Development Institute.

Supporting Georgia Tech's goal of defining the technological university of the 21st century, the new organization is expanding efforts to identify and transfer key innovations likely to have significant impacts on local, state and national economies. Plans for restructuring grew out of consultations with key Georgia Tech stakeholders, findings of the 2005 Georgia Manufacturing Survey and recommendations from the National Innovation Initiative co-chairs by Georgia Tech President Wayne Clough.

"The future viability of local, state and national economies will depend largely on their ability to successful apply science, technology and innovation," says Georgia Tech Provost Jean-Lou Chameau. "Through the Enterprise Innovation Institute, Georgia Tech will bring its considerable resources to bear on helping enterprises of all types become more competitive in today's global marketplace."

A leader in science and engineering education and with a research program totaling more than $400 million a year, Georgia Tech is a major developer of science and technology innovations. Building on these new technologies and collaborating with like-minded organizations, the Enterprise Innovation Institute will work with the private sector to apply innovations to real marketplace needs, Chameau adds.

"Business is now global, and companies must compete on the basis of innovation."

Wayne Hodges, Georgia Tech Vice Provost
“The rapid and dramatic changes taking place throughout the world mean U.S. companies can no longer compete just by reducing costs and boosting efficiency,” says Georgia Tech Vice Provost Wayne Hodges, who heads the new organization. “Business is now global, and companies must compete on the basis of innovation. To succeed in the future, companies must be able to develop and commercialize innovative products, processes and services ahead of their competition.”

— John Toon

@ Contact: John Toon at 404-894-6866 or john.toon@innovate.gatech.edu. Read more at: www.innovate.gatech.edu

Preventing Pollution

Although stormwater runoff may not seem particularly threatening, it ranks among the most common sources of water pollution in the United States. Especially at industrial sites, rain and melting snow can pick up a variety of pollutants — ranging from processing chemicals to cleaning solvents — and sweep them into nearby creeks, lakes and rivers.

Federal regulation calls for companies engaged in certain industrial activities to obtain a stormwater permit and implement a pollution prevention program. Although an important endeavor, this can also be an onerous task, especially for small and mid-sized companies with fewer resources.

To ease compliance headaches, the Georgia Institute of Technology’s Energy and Environmental Management Center (EEMC) has developed stormwater pollution prevention plan (SWPPP) software that streamlines the planning process — reducing time and effort by as much as 80 percent.

Funded by the U.S. Environmental Protection Agency’s Office of Water, this Web-based tool helps companies determine whether they even need a stormwater permit. “If you don’t have any pollutants exposed to storm water, you are exempt, but most manufacturers fall into one of the 11 categories that require a permit,” says Ginny Key, an instructional designer at EEMC.

Available at either www.gatechstormwater.com or www.gatechenvironment.com, the SWPPP software walks companies through a series of questions about their facilities, such as whether they have outdoor fueling stations or loading docks. Then the tool guides companies through:

• assembling a pollution prevention team;
• identifying potential pollutants;
• selecting appropriate best management practices to control pollutants;
• record keeping and reporting;
• employee training; and
• implementing and updating the plan.

Some pollution-prevention remedies may require structural modifications, such as installing mechanisms to equipment to prevent fuel spills. Yet many best practices are a simple matter of good housekeeping, say Ed Hardison and Jim Walsh, EEMC project engineers who helped develop the SWPPP tool.

When the SWPPP tool presents a best practice, it includes various business factors, such as implementation and maintenance costs, level of difficulty and expertise required.

At the end of the program, the SWPPP tool produces a customized plan in a rich-text-format document that can be easily converted to any word-processing system.

— T.J. Becker

@ Contact: Ginny Key at 404-894-6107 or ginny.key@innovate.gatech.edu; Jim Walsh at 404-402-3263 or jim.walsh@innovate.gatech.edu; Ed Hardison at 229-430-4210 or ed.hardison@innovate.gatech.edu; Greg Rupert at 770-345-9256 or greg.rupert@innovate.gatech.edu. Read more at: gtresearchnews.gatech.edu/resen rms/ss06/stormwater.html
No Pictures Please

Researchers develop system to thwart video and still photography.

By Rick Robinson

Researchers at the Georgia Institute of Technology have completed a prototype device that can block digital-camera function in a given area. Commercial versions of the technology could be used to stymie unwanted use of video or still cameras.

The prototype device, produced by a team in the Interactive and Intelligent Computing division of the Georgia Tech College of Computing, uses off-the-shelf equipment — camera-mounted sensors, lighting equipment, a projector and a computer — to scan for, find and neutralize digital cameras. The system works by looking for the reflectivity and shape of the image-producing sensors used in digital cameras.

Gregory Abowd, an associate professor leading the project, says the new camera-neutralizing technology shows commercial promise in two principal fields — protecting limited areas against clandestine photography or stopping video copying in larger areas such as theaters.

“The prototype we have developed could lead to products for markets that have a small, critical area to protect,” Abowd says. “Then we’re also looking to do additional research that could increase the protected area for one of our more interesting clients, the motion picture industry.”

The small-area product could prevent espionage photography in government buildings, industrial settings or trade shows, Abowd notes. It also could be used in business settings — for instance, to stop amateur photography where shopping-mall Santa pictures are being taken.

Meanwhile, preventing movie copying could be a major application for camera-blocking technology, says James Clason, a research technician on Abowd’s prototype team.

“Movie piracy is a $3 billion-a-year problem,” Clason adds. It’s a problem that is reportedly acute in Asia. “If someone videotapes a movie in a theater and then puts it up on the Web that night or burns half a million copies to sell on the street, then the movie industry has lost a lot of in-theater revenue.”

Moreover, movie theaters are likely to be a good setting for camera-blocking technology, says Jay Summet, a research assistant who is also working on the prototype. A camera’s image sensor — called a CCD — is “retroreflective,” which means it sends light back directly to its origin rather than scattering it. Retroreflectors probably would make it relatively easy to detect and identify video cameras in a darkened theater.

The current prototype uses visible light and two cameras to find CCDs, but a future commercial system might use invisible infrared lasers and photo-detecting transistors to scan for contraband cameras. Once such a system finds a suspicious spot, it would feed information on the reflection’s properties to a computer for a determination.

Once a scanning laser and photodetector located a video camera, the system would flash a thin beam of visible white light directly at the CCD. This beam — possibly a laser in a commercial version — would overwhelm the target camera with light, rendering recorded video unusable. Energy levels used to neutralize cameras would be low enough to preclude any health risks, researchers note.

Still-camera neutralization in small areas also shows near-term commercial promise, Abowd says. Despite ambient light levels far higher than in a theater, still cameras at a trade show or a mall should be fairly easy to detect, he adds. That’s because image sensors in most cell phones and digital cameras are placed close to the lens, making them easier to spot than the deeper-set sensors of video cameras.

The potential of camera neutralization has helped bring it under the wing of VentureLab, a Georgia Tech group that assists fledgling companies through the critical feasibility and first-funding phases.

Read more at: gtresearchnews.gatech.edu/reshor/rh-ss06/camera.html