Prototype solar cell uses nanotubes to reduce size, boost efficiency

John Toon
Research News

Unique three-dimensional solar cells that capture nearly all of the light that strikes them could boost the efficiency of photovoltaic (PV) systems while reducing their size, weight and mechanical complexity.

The new 3D solar cells capture photons from sunlight using an array of miniature “tower” structures that resemble high-rise buildings in a city street grid. The cells could find near-term applications for powering spacecraft, that would mean less weight and less space taken up by solar cells, that would mean less weight and less space taken up by solar cells, that would mean less weight and less space taken up by solar cells, that would mean less weight and less space taken up by solar cells, that would mean less weight and less space taken up by solar cells.

“Our goal is to harvest every last photon that is available to our cells,” said Jud Ready, a senior research engineer at the Georgia Tech Research Institute, focusing his research and teaching on economics and overall security of Atlanta and the state as a whole. “Ray” S. Farmer Jr., Distinguished Professor and chair of ECE. “They are also of critical importance to the economic and overall security of Atlanta and the state as a whole.”

Judy Ready, senior research engineer at the Georgia Tech Research Institute, observes a process that applies an iron catalyst as part of the fabrication of 3-D solar cells.

The GTRI photovoltaic cells trap light between their tower structures, which are about 100 microns tall, 40 microns by 40 microns square, 10 microns apart — and built from arrays containing millions of vertically aligned carbon nanotubes.

Conventional flat solar cells reflect a significant portion of the light that strikes them, reducing the amount of energy they absorb.

Because the tower structures can trap and absorb light received from many different angles, the new cells remain efficient even when the sun is not directly overhead.

“The efficiency of our cells increases as the sunlight goes away from perpendicular, so we may not need mechanical arrays to rotate our cells,” Ready noted.

The ability of the 3D cells to absorb virtually all of the light that strikes them could also enable improvements in the efficiency with which the cells convert the photons they absorb into electrical current.

Fabrication of the cells begins with a silicon wafer, which can also serve as the solar cell’s bottom junction. The researchers first coat the wafer with a thin layer of iron using a photolithography process that can create a wide variety of patterns. The patterned wafer is then placed into a furnace heated to 780 degrees Celsius. Hydrocarbon gases are then flowed over the wafer, resulting in the formation of vertically aligned carbon nanotubes.

“By capturing more of the light in our 3D structures, we can use much smaller photovoltaic arrays. On a satellite or other spacecraft, that would mean less weight and less space taken up by the PV system,” Ready noted.

“Conventional flat solar cells reflect a significant portion of the light that strikes them, reducing the amount of energy they absorb,” Ready said.”

The design was described in the March 2007 issue of the journal JOM, published by The Minerals, Metals and Materials Society. A global patent application has been filed for the technology.

Solar cell continued. page 3
Tech Fulbrighter wins Gates Cambridge Scholarship

Nabil Wilf is a true Renaissance man. He’s a molecular biologist who studies language, religion and women’s rights. A Fulbright Fellow to Kuwait, he speaks Arabic and has traveled to Egypt, Lebanon, Syria and various other countries in the region. It’s safe to say that if Georgia Tech held a contest naming the most well-rounded student, it’s likely Wilf would get it. Instead, he’ll have to settle for winning another of academe’s most prestigious student honors, the Gates-Cambridge Scholarship.

Wilf received bachelor’s degrees in both biology and international affairs from Tech in the spring of 2006. Last August, he traveled to Syria on a Fulbright language grant to study Arabic. He’s now in Kuwait working with a local scholar to study whether views on women’s rights among the youth indicate that positive changes are likely in the future for women in the country.

“I want to know how women in Kuwait are shaping the national discourse, introducing their agenda for reform and to study how these reforms are received by the youth,” he said.

Wilf became interested in the issue while studying abroad for a year in Egypt on a National Security Education Program Scholarship. “In my classes, I saw how Islamic law is used to limit the rights of women in the Middle East,” he said.

This fall he’ll pursue a doctorate in biochemistry at the University of Cambridge in England.

“Cambridge is a pioneer in genetic and biochemical studies; it’s where James Watson and Francis Crick pro- posed the double-helical structure of DNA,” said Wilf.

While there, Wilf will study the complex regulatory mechanisms involved in bacterial communication and gene expression in virulence in pathogens.

“The overly simplified view of bac- teria is changing,” he said. “A better understanding of bacterial communi- cation and gene expression will lead to the development of new antibiotics and a better understanding of how infections develop."

Wilf, who worked in the molecular biology lab of Professor Roger Wartell, credits the undergraduate research program at Georgia Tech for giving him the opportunity to gain valuable research experience. “The growing biosciences sector is a real plus for Tech,” he said.

In the future, Wilf intends to help promote and build the biotech sector in the Middle East, combining his scientific and social science interests.

“I don’t want to be one of those people who goes to a country, learns the language and then comes back and forgets about it,” he said. “Having this scholarship may make this a pos- sibility.”

Women in Engineering Program honors outstanding students and faculty

Elizabeth Campbell
Institute Communications
and Public Affairs

At the E-Liberia: Vision 2010 conference last week in Monrovia, Liberian President Ellen Johnson Sirleaf, the first woman ever elected head of an African state, unveiled the new National Information and Communication Technologies (ICT) Policy for Liberia to leaders from industry, non-profits and academia. The government sponsored the five-day conference that explored how best to improve Liberia’s ICT capacity and to use the technology as tools for reducing poverty.

“Springing from President Sirleaf’s visit to Georgia Tech last year, we have had a very rich set of research experiences working within Liberia’s ICT sector,” said Michael Best, assis- tant professor in the School of International Affairs and the College of Computing. “We have sent a series of Tech graduate students to Liberia to study, along with local experts, the ICT landscape and scope for development and growth.”

In a country still recovering from recent civil unrest, Best leads an active research project, supported by the Open Society Institute for West Africa, involving five Georgia Tech graduate students who have studied ICT conditions and challenges in Liberia and are providing technical assistance. During E-Liberia Vision 2010, Best’s team presented the findings of their detailed national audit of ICTs and policy recommen- dations.

“Our research in Liberia has been truly life-changing for the many Georgia Tech students who have worked there on our projects,” remarked Best. “And we hope that the work continues to assist the peo- ple of Liberia in developing their ICT infrastructure and rising from the tor- rors of civil conflict.”

These programs include a comput- er center at Monrovia’s Center for Empowerment of Women and Children focused on livelihood develop- ment and training among women displaced by the civil war. In addi- tion, a computer faculty and training center will be implemented at the JFK Hospital, Liberia’s largest health center.

David Terrase
Institute Communications
and Public Affairs

Tech students work to bring technology to post-conflict Liberia

Sandra Song
College of Engineering

During last month’s Women in Engineering Excellence (WIE) Awards Banquet, students, faculty, Institute leaders and corpo- rate representatives filled the Georgia Tech Hotel Grand Ballroom to honor undergraduate female engineering students who had earned an overall GPA of 3.4 or higher. The annual event is the capstone of the WIE Program.

Fully one-third of the College’s female student body of 1,550 met this lofty goal, leading WIE Director Mini Philbosos to underscore this achievement during her remarks.

“Regarding diversity and women,” she said, “when I hear someone say, ‘I just want to hire the best,’ I point to our female students and say, ‘here you are, these are the best!’"

Students also nominated faculty members for their excellence in teaching and mentoring, honoring Associate Professor Jeffrey Steator and Professor Christopher Lynch from Mechanical Engineering, and Industrial and Systems Engineering Assistant Professor Joel Sokol.

The keynote speaker was alumna Lara O’Connor Hodgson, who intro- duced a first-time scholarship for graduating seniors, named “Pay it Forward,” this scholarship is given with the understanding of the recipi- ent returning within five years to give this scholarship in her name enabling the scholarship to continue in perpetuity. O’Connor Hodgson gave two scholarships in her name, and the Philbosos-Armanios family gave two scholarships.
Computing faculty receive Regents’ designation

Two College of Computing faculty members have received Regents’ promotions from the Institute. The promotions, to Richard Fujimoto and Nancy Nersessian, were recently confirmed by President Wayne Clough.

Georgia Tech awards the Regents designation to only two individuals per year. A committee made up of Regents’ Professors and other chaired professors representing the six Georgia Tech colleges considers the nominations and makes a recommendation to the provost based on excellence in research and teaching and contributions to their profession and to Georgia Tech. Any full professor can be nominated.

“For their exceptional contributions, Richard and Nancy are both deserving of this prestigious Georgia Tech honor. That we are congratulating two of our faculty in one year is testament to a growing body of dedicated world leaders in research and education here,” said Richard DeMillo, dean of Computing.

Fujimoto is a professor and chair of the Computational Science and Engineering Division of the College of Computing. He received doctoral and master’s degrees from the University of California at Berkeley and bachelor degrees from the University of Illinois at Urbana-Champaign in computer science and computer engineering.

Fujimoto’s research is concerned with the execution of discrete-event simulation programs on parallel and distributed computing platforms. This research has included work on platforms ranging from mobile distributed computing systems to cluster computers to supercomputers. This work has involved several application areas including transportation systems, telecommunication networks, multiprocessor systems and defense systems.

Nersessian is a professor of cognitive science.

For their respective, distinguished careers in academia, Professors Richard Fujimoto and Nancy Nersessian have been added to the state’s list of Regents’ professors.

appointed jointly in the College of Computing and the School of Public Policy. A fellow of the American Association for the Advancement of Science, she earned her undergraduate degree in physics and philosophy from Boston University and advanced degrees in philosophy from Case Western Reserve University. Her research focuses on human creativity in science.

Nersessian’s research includes investigating reasoning and representational procedures in interdisciplinary research laboratories. This research examines the nature and role of physical and computational models researchers construct to simulate biological phenomena in problem solving and in learning.

Regents’ professorships at Georgia Tech are granted for an initial period of three years, with the option to renew for a second three-year period, based upon recommendations. Awardedees receive a permanent increase in salary, as well as a yearly stipend in support of their scholarship.

For more information, contact Electro-Optical Systems Laboratory (EOSL) at eosl.gtri.gatech.edu.

Solar cell, cont’d from page 1

into the furnace, where the carbon and hydrogen separate. In a process known as chemical vapor deposition, the carbon grows arrays of multi-walled carbon nanotubes atop the iron patterns. Once the carbon nanotube towers have been grown, the researchers coat them with photovoltaic materials. In the finished cells, the carbon nanotube arrays serve both as support for the 3-D arrays and as a conductor connecting the photovoltaic materials to the silicon wafer.

The new cells face several hurdles before they can be commercially produced. Testing must verify their ability to survive launch and operation in space, for instance. And production techniques will have to be scaled up from the current two-inch laboratory prototypes.

“We have demonstrated that we can extract electrons using this approach,” Reddy said. “Now we need to get a good baseline to see where we compare to existing materials, how to optimize this and what’s needed to advance this technology.”

For more information, contact Electro-Optical Systems Laboratory (EOSL) at eosl.gtri.gatech.edu.

Wolf, cont’d from page 1

of the Association of Computing Machinery. Through the Embedded Systems Computing, Wolf and his research group developed new distributed smart-camera systems. These cameras cooperate in real time to analyze activities in a scene, such as movements of people, vehicles and other objects. Distributed smart-camera systems can be used in many applications ranging from security and medicine to smart rooms, which automatically track and adjust to the preferences of people in them.

In 2005, Verificon Corporation spun out of Princeton to commercialize this technology. The company is already searching for part-time programmers in Atlanta and plans to hire full-time employees in the area over the next year.

“I’m excited about my move to Georgia Tech,” said Wolf. “It’s a world-class institution with lots of exciting people and projects and a great attraction to me. As for commercial opportunities, I expect this to be a great place to hire talented engineers and programmers to help us build our systems at Verificon. And, because Atlanta is home to so many companies, we hope to find some important clients there as well.”

IN BRIEF:

Techn, cont’d from page 1

open for student input

The course instructor opinion survey is now available for students online at www.coursesurvey.gatech.edu. Surveys will be available through finals, ending on May 6.

The first 10 multiple choice questions are reported to the instructor’s school chair and college dean. All other responses only go to the professor.

For more information and to subscribe, go to www.gatech.edu/news-room and select “Email News Subscriptions” or “RSS Feeds” from the menu at left. More information about news feed aggregators can be found at www.gatech.edu/news-room/rss.

Discussion moderators sought for summer reading program, now expanded to all undergrads

A group of students has planned a book reading program for both students and faculty. Last year’s summer reading program has been renamed “Tech’s Open Book” and has been expanded to include all Georgia Tech students.

The program will expand on the structure established last year: the title will be available to upperclassmen at the bookstore and freshmen at FASET Orientation. Additionally, there will be a presentation by the authors in the fall semester, as well as faculty-led discussion sessions in the library and other venues.

A cross-disciplinary group of faculty, staff and students selected “Freakonomics” by Steven D. Levitt and Stephen J. Dubner as the book for the coming year, and the student committee is asking for support recruiting faculty and staff members who may be interested in leading discussion sessions. To become a moderator, e-mail katie.fluke@gatech.edu for additional information. A large number of moderators are needed, and participation does not require experience leading this type of discussion.