Gary Goettling
Alumni Association

Pete Ludovice, an associate professor of chemical and biomolecular engineering at Georgia Tech who also performs as a stand-up comic, is the originator of a radio program that strives to “demystify science and technology.” Ludovice, noting the continued acceptance by some people of astrology and fortune telling, said, “Rather than relying on the “great minds” to begin the dialogue, Ludovice continued, “I think we need schlep like myself who know something about science who can maybe put it in a somewhat more useful and maybe even humorous perspective.”

A light approach to science comes naturally to Ludovice and Hunt, both of whom perform comedy routines in their spare time. Ludovice has honed his “nerd comedy” persona at clubs like myself who know some-
Georgia Tech researchers have found a way to shrink all the sensing power of sophisticated biosensors — such as sensors that can detect trace amounts of a chemical in a water supply or a substance in your blood — onto a single microchip.

In compact communication, signal processing and sensing optics technologies, multiple wavelengths of light are combined as a space-saving measure as they carry information. The wavelengths must then be separated again when they reach their destinations. Wavelengths used for these sophisticated applications have very high spectral resolution, meaning the distance between wavelengths is very small. The device that sorts out these crowded wavelengths is called a wavelength-demultiplexer (WD).

Compact optical WDs are key in spectral analysis for biosensors small enough to fit on a chip and for integrated circuits for optical information processing.

Georgia Tech researchers have designed a WD able to function at very high resolution in much tighter confines (as small as 64 microns by 100 microns, or less than a millimeter) by developing a new design for photonic crystals, which are highly periodic structures typically etched in very thin silicon that are designed to control light and have the potential to revolutionize everything from computing to communications. The research had been published in Laser Focus World and Optics Express and was recently presented at the Conference on Lasers and Electro-Optics (CLEO 2006).

"We believe we have developed the most compact WD that has been reported to date," said Ali Adibi, a professor in the School of Electrical and Computer Engineering and the project's lead researcher. "If you want to have many optical functions on a single micro- or nano-sized chip, you have to be able to practically integrate all those functions in the smallest amount of space possible. Our WD solves many problems associated with combining delicate optical functions in such a small space."

The Georgia Tech team was able to shrink its WD by combining three unique properties of photonic crystals — the superprism effect (separating wavelengths much more finely than a regular prism), negative diffraction or focusing (reversing the expansion of the light beam and focusing it back to its original size after interacting with the material being analyzed) and negative refraction (filtering wanted and unwanted wavelengths) — into a single crystal.

By combining these effects, Georgia Tech's WD takes an expanded beam of light and focuses the wavelength into different locations.

"I think the chances are very high that LCP will be practical for a variety of NASA applications," Ponchak said.

Light weight is the material's biggest potential benefit to NASA, he said. Flexible LCP antennas would be lighter than today's structured antennas, and LCP-based circuits molded to available spacecraft areas could eliminate heavy metal boxes that currently house rigid circuit boards.

"Less weight lets us move to a smaller launch system, which in turn saves a lot of money," Ponchak said. John Papapolymerou, a professor in the School of Electrical and Computer Engineering, explains that LCP's unique structure allows it to be heat resistant, flexible and strong, while also possessing excellent electrical performance.

"Moreover, the material can serve as a highly efficient substrate — material on which semiconductor chips are attached — as well as the backbone that connects those chips together," said Papapolymerou, who with Prof. Manos Tentzeris leads a team researching LCP. Even micro-electromechanical system (MEMS) devices could be embedded on LCP, along with integrated circuits.

"It's like having a PC board type of technology that has many other advantages," Papapolymerou said. "We are already developing LCP-based technology for NASA applications, and I think eventually you will see LCP in next-generation consumer systems."

Papapolymerou and Tentzeris are currently developing a precipitation-radar application that NASA could use to monitor global water cycling. But Georgia Tech engineers are also investigating the robust polymer's capacity to embed analog and digital chips, RF MEMS devices and RF circuits together in one flexible, weather-resistant package.
Researchers find controls to gold nanocatalysis

David Terraso
Institute Communications and Public Affairs

Researchers at Georgia Tech have made a discovery that could allow scientists to exercise more control over the catalytic activity of gold nanoclusters. The finding—that the dimensionality and structure, and thus the catalytic activity, of gold nanoclusters changes as the thickness of their supporting metal-oxide films is varied—is an important one in the rapidly developing field of nanotechnology. This and further advances in nanocatalysis may lead to lowering the cost of manufacturing materials from plastics to fertilizers.

“We’ve been searching for methods for controlling and tuning the nanocatalytic activity of gold nanoclusters,” said Uzi Landman, director of the Center for Computational Materials Science and Regents’ professor in the School of Physics. “I believe the effect we discovered, whereby the structure and dimensionality of supported gold nanoclusters can be influenced and varied by the thickness of the underlying magnesium-oxide film, may open new avenues for controlled nanocatalytic activity.”

Landman’s research group has been exploring the catalytic properties of gold, which is inert in its bulk form, for about seven years. Recently, Landman’s group found that by using a thin catalytic bed with a thickness of up to one nanometer (nm) of magnesium oxide, one may activate the gold nanoclusters which may act then as catalysts even if the bed is defect-free. A model reaction tested in these studies is one where carbon monoxide and molecular oxygen combine to form carbon dioxide, even at low temperatures. In this study, Landman and company simulated the behavior of gold nanoclusters containing eight, 16 and 20 atoms when placed on catalytic beds of magnesium oxide with a molybdenum substrate supporting the magnesium oxide film. Calculations showed that when the magnesium oxide film was greater than one nanometer in thickness, the gold cluster held its three-dimensional structure. However, when the film was less than one nanometer, the cluster flattened, the magnesia bed wetting and adhering to it. The gold flattens because the electronic charge from the molybdenum penetrates the thin layer of magnesium oxide and accumulates at the region where the gold cluster is anchored to the magnesium oxide. With a negative charge underneath the gold nanocluster, its attraction to the molybdenum substrate causes the cluster to collapse.

“It’s the charge that controls the adhesive strength of gold to the magnesia film, and at the same time it makes gold catalytically active,” said Landman. “When you have a sufficiently thin layer of magnesium oxide, the change from the underlying metal penetrates through. In the previous experimental studies, defects in the magnesium oxide were required to bring about catalysis of adsorbed clusters.

“Until now, the metal substrate was regarded only as an experimental necessity for growing the magnesium oxide films on top of it. Now we found that it can be used as a design feature of the catalytic system. This field holds many surprises.”

Commuters benefit with new flexible parking plan

The Department of Parking and Transportation has recently initiated a new program to accommodate members of the campus community who use Georgia Tech parking lots on an irregular basis.

Employees wanting to participate in SmartPark must first buy a $25 special permit from the Parking office. Participants’ BuzzCards are automatically programmed for use in the designated areas. Each time SmartPark is accessed, $5 is debited from the BuzzCard account. Users may add additional BuzzCard funds at their convenience.

SmartPark is based on space availability, and does not permit any overnight parking. For more information, visit the “Parking on Campus” section at www.parking.gatech.edu.