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News Release

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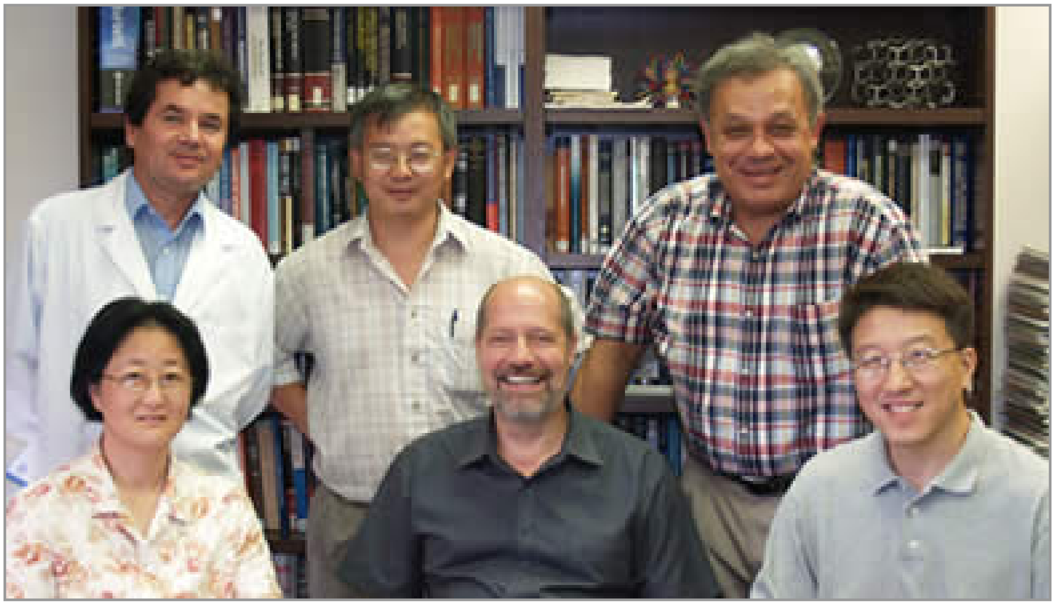
U. T. Dallas-Led Research Team Produces Strong, Transparent Carbon Nanotube Sheets

Numerous Electronic, Optical and Structural Uses Demonstrated; Advance Reported in Aug. 19 Issue of Prestigious Journal Science

RICHARDSON, Texas (Aug. 18, 2005) – University of Texas at Dallas (UTD) nanotechnologists and an Australian colleague have produced transparent carbon nanotube sheets that are stronger than the same-weight steel sheets and have demonstrated applicability for organic light-emitting displays, low-noise electronic sensors, artificial muscles, conducting appliqués and broad-band polarized light sources that can be switched in one ten-thousandths of a second.

Carbon nanotubes are like minute bits of string, and untold trillions of these invisible strings must be assembled to make useful macroscopic articles that can exploit the phenomenal mechanical and electronic properties of the individual nanotubes. In the Aug. 19 issue of the prestigious journal *Science*, scientists from the NanoTech Institute at UTD and a collaborator, Dr. Ken Atkinson from Commonwealth Scientific and Industrial Research Organization (CSIRO), a national laboratory in Australia, report such assembly of nanotubes into sheets at commercially useable rates.



From left: Nanotechnologists Mei Zhang, Ray Baughman and Shaoli Fang rest while Ali Aliev, Sergey Lee and Anvar Zakhidov remain standing. The team sees potential commercial uses for their discovery.

Starting from chemically grown, self-assembled structures in which nanotubes are aligned like trees in a forest, the sheets are produced at up to seven meters per minute by the coordinated rotation of a trillion nanotubes per minute for every centimeter of sheet width. By comparison, the production rate for commercial wool spinning is 20 meters per minute. Unlike previous sheet fabrication methods using dispersions of nanotubes in liquids, which are quite slow, the dry-state process developed by the UTD-CSIRO team can use the ultra-long nanotubes needed for optimization of properties.

Strength normalized to weight is important for many applications, especially in space and aerospace, and this property of the nanotube sheets already exceeds that of the strongest steel sheets and the Mylar and Kapton sheets used for ultralight air vehicles and proposed for solar sails for space applications, according to the researchers. The nanotube sheets can be made so thin that a square kilometer of solar sail would weigh only 30 kilograms. While sheets normally have much lower strength than fibers or yarns, the strength of the nanotube sheets in the nanotube alignment direction already approaches the highest reported values for polymer-free nanotube yarns.

The nanotube sheets combine high transparency with high electronic conductivity, are highly flexible and provide giant gravimetric surface areas, which has enabled the team to demonstrate their use as electrodes for bright organic light emitting diodes for displays and as solar cells for light harvesting. Electrodes that can be reversibly deformed over 100 percent without losing electrical conductivity are needed for high stroke artificial muscles, and the *Science* article describes a simple method that makes this possible for the nanotube sheets.

The use of the nanotube sheets as planar incandescent sources of highly polarized infrared and visible radiation is also reported in the *Science* article. Since the nanotube sheets strongly absorb microwave radiation, which causes localized heating, the scientists were able to utilize a kitchen microwave oven to weld together plexiglas plates to make a window. Neither the electrical conductivity of the nanotube sheets nor their transparency was affected by the welding process -- which suggests a novel way to imbed these sheets as transparent heating elements and antennas for car windows. The nanotube sheets generate surprisingly low electronic noise and have an exceptionally low dependence of electronic conductivity on temperature. That suggests their possible application as high-quality sensors – which is a very active area of nanotube research.

“Rarely is a processing advance so elegantly simple that rapid commercialization seems possible, and rarely does such an advance so quickly enable diverse application demonstrations,” said the article’s corresponding author, Dr. Ray H. Baughman, Robert A. Welch Professor of Chemistry and director of the UTD NanoTech Institute. “Synergistic aspects of our nanotube sheet and twisted yarn fabrication technologies likely will help accelerate the commercialization of both technologies, and UTD and CSIRO are working together with companies and government laboratories to bring both technologies to the marketplace."

The breakthroughs resulted from the diverse expertise of the article's co-authors. Dr. Mei Zhang and Dr. Shaoli Fang, NanoTech Institute research scientists, first demonstrated the nanotube sheet fabrication process, and this result was translated into diverse applications by the entire team. The other team members include Dr. Anvar Zakhidov, associate director of the NanoTech Institute; Christopher Williams, Zakhidov's graduate student from the UTD Physics Department; Dr. Sergey Lee and Dr. Ali Aliev, research scientists at NanoTech Institute, in addition to Atkinson and Baughman.

The applications possibilities seem even much broader than the present demonstrations, Baughman said. For example, researchers from the Regenerative Neurobiology Division at Texas Scottish Rite Hospital for Children, Dr. Mario Romero, Director, and Dr. Pedro Galvan-Garcia, Senior Researcher Associate, and Dr. Larry Cauller, associate professor in UTD's neuroscience program, have initial evidence suggesting that healthy cells grow on these sheets – so they might eventually be applied as scaffolds for tissue growth.

Baughman said that numerous other applications possibilities exist and are being explored at UTD, including structural composites that are strong and tough; supercapacitors, batteries, fuel cells and thermal-energy-harvesting cells exploiting giant-surface-area nanotube sheet electrodes; light sources, displays, and X-ray sources that use the nanotube sheets as high-intensity sources of field-emitted electrons; and heat pipes for electronic equipment that exploit the high thermal conductivity of nanotubes. Multifunctional applications like nanotube sheets that simultaneously store energy and provide structural reinforcement for a side panel of an electrically powered vehicle also are promising, he said.

UTD researchers began collaborating with their counterparts at CSIRO last year. In November 2004, the organizations achieved a breakthrough by downsizing to the nanoscale methods used to spin wool and other fibers to produce futuristic yarns made from carbon nanotubes.

The latest research was funded by the Defense Advanced Research Projects Agency, an agency of the United States Department of Defense, the U.S. Air Force Office of Scientific Research, the Texas Advanced Technology Program, the Robert A. Welch Foundation and the Strategic Partnership for Research in Nanotechnology.

To obtain a copy of the *Science* article, please contact the journal at (202) 326-6440 or scipak@aaas.org. A supplemental information file and figures describing applications evaluations that go beyond the scope of the *Science* article can also be found at scipak@aaas.org.

About UTD

The University of Texas at Dallas, located at the convergence of Richardson, Plano and Dallas in the heart of the complex of major multinational technology corporations known as the Telecom Corridor®, enrolls more than 14,000 students. The school's freshman class traditionally stands at the forefront of Texas state universities in terms of average SAT scores. The university offers a broad assortment of bachelor's, master's and doctoral degree programs. For additional information about UTD, please visit the university's website at www.utdallas.edu.

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